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Jens Forssbäck

# Essays on market discipline in commercial and central banking

Essays on market discipline in  
commercial and central banking

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# Essays on market discipline in commercial and central banking

Jens Forssbäck

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## **Abstract**

The thesis studies how financial markets discipline commercial and central banks' behavior in various ways. In the first part, two papers test different aspects of market discipline of commercial banks' risk taking, using a dataset of several hundred banks worldwide. In the first paper, it is shown that the risk-shifting opportunity of shareholders introduced by deposit insurance depends on ownership structure and the extent of market discipline by uninsured creditors. I find that the effect of shareholder control on risk is convex, and that creditor discipline tempers this effect but has little individual influence on risk. The second paper tests the monitoring dimension of market discipline and formulates a two-step procedure which makes it possible to sidestep the common methodological problem that banks' 'true' risk is unobserved. Results suggest that if the quality of institutions is sufficiently high, some market-based indicators may be more accurate measures of banks' true risk than a set of commonly used accounting-based benchmark indicators – a possibility effectively precluded by much of previous research.

In the second part of the thesis, three papers study constraints on central bank behavior introduced by financial markets, using data from a set of small, open European economies during the 1980s and 1990s. The first of these papers tests how capital account liberalization and exchange-rate regime constrain monetary policy autonomy. Contrary to traditional theory, the paper finds no autonomy effect of exchange rate flexibility, whereas capital controls provided some (albeit limited) independence from innovations in foreign money market interest rates. The remaining two papers address how deregulation, innovation, and growth in domestic money markets interplay with central banks' choices of monetary policy operating procedures. The analysis of the European countries suggests that while deregulation and the emergence of short-term financial markets constrained central bank discretion and compelled increased reliance on open market operations, the paths of money market development in different countries were also partially determined by the respective central banks' decisions. In the final paper, the same framework of analysis is applied to China, which has announced its intention to rely increasingly on market operations in monetary policy. The results suggest that the disciplining effect of domestic financial markets on central bank behavior in China is so far very small, largely due to remaining de facto financial repression.



# **Essays on market discipline in commercial and central banking**

## **Introduction**

The main theme for this thesis is how financial markets discipline, or restrict, the behavior and actions of commercial and central banks in various ways. The thesis is divided into two parts. The first part deals with commercial banking, and consists of two papers – both essentially concerned with the extent to which financial markets discipline banks' risk taking. The second part of the thesis deals with central banking, and consists of three papers. The first of these papers studies how capital account openness and varying degrees of exchange rate rigidity restrict central banks' autonomy in setting monetary policy. The remaining two papers address how financial market development affects the arsenal of instruments used by central banks to implement monetary policy.

In commercial banking, the full effect of market discipline is dulled because banks' financing comes in large part in the form of relatively small deposits which benefit from explicit or implicit deposit insurance. Having their funds thus insured, depositors have little incentive to monitor their bank's risk behavior. Of course, market discipline may still be exerted by uninsured investors. The extent to which this occurs has been primarily an empirical issue in the literature.

The incentive for banks to increase asset risk when market discipline is muffled by the existence of a safety net – i.e., the moral hazard effect of deposit insurance – can be traced back to the option value of equity: the value of an equity stake in a firm is increasing in the volatility of the value of the firm's assets. It is therefore the bank's shareholders that have the incentive to increase risk. But the extent to which this incentive is acted upon depends on how well the shareholders can convince the bank's managers to act in their interest. The overall risk effect of deposit insurance thus depends both on the extent of market discipline by

creditors not benefitting from deposit insurance, and on shareholder control. Essay 1 studies the interplay between these factors both analytically and empirically. The formal analysis is done within the context of a Jensen-Meckling-type model, amended to account for partial deposit insurance. It is demonstrated why shareholder control may have a non-monotonic influence on risk (a common empirical result in the literature), it shows how the risk effects of the two main governance variables of interest – market discipline and shareholder control – are interrelated, and how leverage partially determines the impact of the governance variables on risk. The main predictions of the model are then tested on a panel of several hundred banks worldwide over the years 1994-2005. The empirical results essentially bear out the predictions of the model, but indicate a weak and primarily indirect effect of creditor discipline on bank risk.

If Essay 1 was partially motivated by a shortage of formal analyses of the market discipline mechanism in banking, Essay 2 focuses on a particular methodological problem in a large part of the empirical market discipline literature. A central question in this literature is how well financial markets carry out the monitoring aspect of market discipline – i.e., how well the market tracks bank-specific risk. This has often been tested by regressing market-based risk indicators on various benchmark risk measures (such as accounting ratios and credit ratings). The problem on which the paper focuses is that the benchmark measures typically used are also imperfect proxies of ‘true’ default risk (which is necessarily unknown), and regressing one imperfect proxy on another when the ‘true’ value is unknown does not necessarily say much about the adequacy of either proxy – particularly if no significant association between the proxies can be established.

However, the expected accuracy of market-based risk indicators depends positively on the institutional conditions for market discipline to function (such as financial market openness and the absence of bailout expectations). Assuming that the benchmark measures

typically used are comparatively insensitive to such conditions, the paper develops a measure of ‘divergence’ between market-based and non-market risk indicators. Divergence between a market-based indicator and a benchmark indicator may arise either because the market-based indicator is less informative about ‘true’ risk *or* because it is more informative than the benchmark indicator, suggesting that divergence is a non-linear function of the conditions for market discipline (‘institutional quality’).

Using essentially the same dataset as in Essay 1, the paper then applies the methodology to three different market-based risk indicators commonly used in the banking literature, using various accounting ratios as benchmark risk measures. The results suggest, among other things, that yield spreads on uninsured bank debt may be more informative than either equity-based or accounting-based risk measures when the conditions for market discipline are well satisfied. This result calls into question some recent results within the market discipline literature, where failure to establish significant relationships between spreads on uninsured bank debt and various benchmark risk indicators has been interpreted as absence of market discipline.

Moving on to part 2 of the thesis, the perspective on market discipline is more macro-oriented. The included papers study how central banks are constrained both in setting monetary policy and in the use of various policy instruments as a consequence of the increased cross-border mobility of capital and the emergence of increasingly sophisticated alternatives to central-bank money that result from financial deregulation and innovation. Thus, Essay 3 investigates international monetary-policy transmission under different exchange-rate and capital-account regimes in a number of small and open European economies during the 1980s and 1990s. The period was one of broad-based financial deregulation in the included countries, and one of general reorientation of the goals as well as the instruments of monetary policy (including formal exchange-rate arrangements).

Interpreting transmission of foreign innovations in money-market interest rates as absence of monetary-policy autonomy, the paper – in contrast with the traditional Mundell-Fleming trilemma – finds no systematic link between observed (ex post) autonomy and exchange-rate regimes. Capital controls appear to have provided a degree of temporary insulation from foreign monetary policy shocks, though not strict autonomy. Overall, the results are consistent both with short term autonomy for small countries even under fixed exchange rates and an open capital account, *and* with long term dependence under flexible exchange rates and an independent stability target.

Still focusing on the same set of European countries and the same time period, Essay 4 studies the interplay between financial deregulation, the development of an efficient short-term segment in domestic financial markets, and changes in monetary policy operating procedures. The paper recounts and empirically examines the extent of reorientation of monetary policy instruments away from quantitative direct control instruments toward indirect market-based instruments, and relates this process to that of financial deregulation and money market development. While the process of financial deregulation was relatively uniform across the different countries studied, the path of money market development varied substantially. Central bank responses in terms of adopting new instruments and operating procedures show both similarities and differences.

Overall, the analysis indicates that while central banks' decisions to increase the use of open market operations were clearly prompted in large part by financial deregulation and innovation, developments in domestic money markets were in themselves influenced by the central banks' choices and decisions. Central banks – once traditional direct-control instruments had become ineffective or unavailable – typically had an incentive to stimulate some market segments, because more efficient money markets would result in increased transmission and precision of open market operations.

Essay 5, finally, addresses China's present level of money market development and prospects for a transition to a market-based operating framework for Chinese monetary policy. Making use of the results in Essay 4, a comparative analysis of the Chinese situation up to about 2005 and developments in the European countries between the late 1970s and the late 1990s is performed. China is currently experiencing problems with monetary policy similar to those experienced by several of the European countries in the 1970s and 1980s, including inability to counteract the liquidity effects of a non-credible exchange rate goal, poor monetary transmission due to excess liquidity in the banking system, and conflicts of interest due to unclear priority among multiple policy goals.

Although the process of opening up financial markets and reforming monetary-policy operating procedures has been initiated, the evidence shows that it has not come far: the financial system remains repressed, the significance of open-market operations for the conduct of monetary policy seems negligible, and the money market (beyond a primary market for central bank paper) is essentially non-existent. Despite commitments to the contrary, the Chinese central bank seems to habitually resort to methods such as de facto credit controls and moral suasion in order to influence the banking system. Of course, under these circumstances the banks have no incentive to act as though the credit system were deregulated. In some sense, the central bank's own manoeuvres to sidestep the market discipline of cross-border capital movements largely nullifies efforts to develop a domestic money market that can serve as arena for an effective market-based monetary policy.



2008-10-02

## **Ownership structure, market discipline, and banks' risk taking incentives under deposit insurance**

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### **Abstract**

The paper studies the effect of two governance factors, ownership structure and market discipline by creditors, on banks' risk-taking incentives in the presence of deposit insurance and related bank safety net components. A simple Jensen-Meckling-type model is developed, where optimal capitalization and the deposit-insurance-induced risk incentive are determined by equity and debt agency costs. Explicit and implicit deposit insurance coverage determines the level of creditor discipline. It is demonstrated why shareholder control may have a non-linear effect on risk-taking, how the risk effects of ownership structure and market discipline are interdependent, and what role is played by the bank's level of capitalization. The implications of the model are tested on a panel of several hundred banks worldwide over the years 1995-2005. The empirical results suggest that creditor discipline has an insignificant effect on risk as a stand-alone variable, but reduces risk for poorly capitalized banks. Shareholder control has a convex individual effect on risk, but whether the negative or positive effect dominates depends on the measure of risk used. Finally, the empirical results by and large support the theoretical model's prediction that creditor discipline and shareholder control have a mutually counteracting effect on bank risk.

**Key words:** bank risk; ownership structure; market discipline; deposit insurance; corporate governance; capital structure

**JEL:** G21; G28; G32

## **Ownership structure, market discipline, and banks' risk taking incentives under deposit insurance**

### **1. Introduction**

Banks' risk taking incentives is an issue of considerable importance for overall financial system stability – the more so the greater the importance of bank finance within a particular (national) financial system – and is therefore an issue of much interest for financial supervisory authorities, central banks, and equivalent government agencies entrusted with the task of overseeing financial and payment system stability in countries around the world. The importance of banks' risk taking has resulted in the imposition in most countries of various safety net arrangements targeting banks and intended, *inter alia*, to stave off excessive risk taking in banks and to protect bank customers from the possible consequences of such excessive risk taking should it occur. The importance of the issue has also sparked a considerable interest among researchers for the drivers of risky behavior within banking institutions in general and, in particular, the effects of the safety net arrangements on different bank stakeholder groups' taste for risk – i.e., the risk taking incentive effects of safety net arrangements on bank shareholders, managers, depositors, and other creditors. As a consequence of such research, the extent and design of safety net arrangements have progressively come to be widely recognized as an important determinant of the risk taking incentives of banks, particularly bank



shareholders. Because different stakeholder groups are differently affected by safety net arrangements, not only the safety net arrangements as such, but also corporate governance factors (such as ownership structure and the control powers associated with various forms of stakes in the bank) matter for banks' risk taking behavior.

The purpose of this paper is to study the effect of bank governance factors on the relationship between safety net characteristics and bank risk taking. Two specific governance factors are at the focus of interest: equity ownership structure and market discipline by the bank's creditors.

The discussion of the association between bank ownership structure and risk taking trails back to the issue of the 'moral hazard risk' introduced by deposit insurance (Merton, 1977, and many subsequent papers). Roughly, the basic argument here is that deposit insurance introduces an incentive for owners of a bank to increase the bank's risk in search for higher profits, because the insurance will cover a large part of the bank's debts in case of default. In other words, deposit insurance limits the bank's downside risk. The research on ownership structure and risk (e.g., Gorton and Rosen, 1995) suggests that the extent of the moral hazard problem introduced by deposit insurance depends on the extent of shareholder control over the bank. This is because the risk-increasing incentive introduced by deposit insurance lies with the shareholders, whereas the ones who make the lending decisions (and therefore have the most direct influence on the risk profile of the bank's asset portfolio) are the bank's managers, and they may have other interests. Hence, this literature brings the issue of deposit-insurance-related moral hazard into the context of a traditional owner-manager agency conflict.

The extent to which deposit insurance induces banks to take on excessive risk is not only determined by the level of shareholder control, but also directly on the scope of the deposit insurance as such (deposit insurance coverage), or – conversely – the level of market discipline exerted by those creditors who are *not* covered by the insurance. This line of research, however, has been less pursued, and consideration of the effect of *variations* in deposit insurance coverage, related bank safety net characteristics, and other institutional factors, has so far been limited (partly as a consequence of the dominance of empirical results on US data alone). The empirical literature on ownership structure and risk studies shareholder control as an individual risk determinant, rather than as a factor conditioning the risk effects of deposit insurance. A certain ‘consensus’ view seems to be emerging within this research area, and many recent empirical studies find a convex effect of shareholder control on bank risk (although the underlying theory remains somewhat unclear).

Now, the argument that shareholder control conditions the effect of deposit insurance on risk suggests interdependence between deposit insurance coverage and shareholder control. But because the effect of shareholder control on risk is empirically ambiguous, the argument that increased shareholder control strengthens the risk-increasing effect of deposit insurance may be too simplified.

There are thus outstanding issues to be addressed both when it comes to the effect of ownership structure and the effect of deposit insurance coverage/creditor discipline on banks’ risk taking. The motive for studying both factors together is that the suggestion of previous literature that they are interdependent has not really been tested. They are also theoretically strongly related through the two fundamental agency conflicts in a firm. The

effect of ownership structure depends on the owner-manager conflict. The effect of deposit insurance coverage/creditor discipline, in turn, depends on the owner-creditor conflict. An explanation of this latter point might take its point of departure in the observation that it is not deposit insurance as such that is the source of the moral hazard problem, it is limited liability: the conflict of interest between owners and creditors and the incentive of owners for risk shifting at the expense of creditors exist even in the absence of deposit insurance. This is what the owner-creditor conflict is all about. What deposit insurance does is to take away the market's spontaneous correction of it, by de-incentivizing depositors (and possibly other creditors) to charge a risk premium (debt agency costs) as compensation for this moral hazard problem. Creditors' response to deposit insurance will essentially be determined by the scope and the credibility of the insurance: the broader and more credible the insurance, the more creditors will expect to be bailed out in case of insolvency, and the less market discipline they will exert.

In summation, this paper studies primarily two governance factors – ownership structure and market discipline by holders of debt claims on the bank – as determinants of bank risk taking. The empirical part makes use of a panel data set covering several hundred banks worldwide, with observations between the years 1995 and 2005. This affords the opportunity to fully exploit variations in the institutional setting, both in terms of safety net characteristics and in terms of governance.

The paper is structured in the following way: Section 2 makes a review of the literature on deposit insurance, bank risk, and (debt) market discipline on the one hand, and ownership structure and banks' risk taking on the other. Section 3 develops a simple model along the lines of Jensen and Meckling's (1976) model of the determination of

capital structure in the presence of equity and debt agency costs, sorts out the inter-relationships among the main variables of interest in the context of this model, and derives a number of testable hypotheses. In Section 4, the data and empirical method is presented, whereas Section 5 contains the results. Section 6, finally, concludes.

## **2. Related literature**

The present section of the paper recaps previous literature on the relationship between deposit insurance, market discipline and banks' risk-taking, and bank ownership structure and risk, respectively.

### 2.1. Background

It is worth noting, first, that the source of the moral hazard risk associated with deposit insurance lies in the conflict of interest between owners and creditors induced by limited liability (Barth et al, 2006): limited liability, not deposit insurance *per se*, gives shareholders the incentive to transfer wealth at the expense of creditors by increasing asset risk and leverage, and creates the option value of equity. Absent third party guarantees of the debt the spontaneous market solution is for creditors to charge a risk premium on the extended debt commensurate with their own costs of monitoring the borrower (and other agency-related costs; Jensen and Meckling, 1976).

Deposit insurance removes depositors' (and possibly other bank creditors') incentives to discipline the bank's risk-taking and so gives free(r)<sup>1</sup> play to the risk-shifting incentives of the shareholders. The value to shareholders of deposit insurance, as described by Merton (1977), Marcus and Shaked (1984), and several subsequent

contributions, is thus in a sense equivalent to the value of having creditor discipline lifted. The ‘victim’ of this moral hazard risk is now no longer the (insured) creditor, but the insurer (i.e., the deposit insurance fund). This is true as long as the insurance is not, or is only partially, funded by the insured banks themselves or – in the case where the banks collectively fund the deposit insurance scheme – as long as insurance premiums do not fully reflect the asset risk of each bank.

The usual motivation for the imposition of deposit insurance is to protect the public from the effects of systemic banking crises; in particular, by removing the threat of contagious bank runs, it is perceived that deposit insurance reduces overall banking system fragility (see, e.g., Diamond and Dybvig, 1983). However, since deposit insurance unleashes the risk-increasing incentives of bank shareholders, it is clear that, unless these incentives can be otherwise sufficiently contained, the net effect on banking system stability is at best uncertain.<sup>2</sup>

## 2.2. Market discipline

In addition to minimum capital ratio requirements, a (partial) solution to the stability-reducing potential of deposit insurance which has become part of ‘best practice’ is to limit the coverage of deposit insurance, and thereby ‘reinstating’ a degree of market discipline by creditors (see, for instance, Bhattacharya et al, 1998; for evidence on the determinants of deposit insurance system design, see Laeven, 2004).

The (yet rather few) extant studies that empirically exploit cross-country variations in deposit insurance coverage indicate that restricting deposit insurance coverage does indeed reduce its destabilizing potential (Angkinand and Wihlborg, 2005; Demirgüç-

Kunt and Detragiache, 2002; Demirgüç-Kunt and Huizinga, 2004; Hovakimian et al., 2003).

There is a related market discipline literature, concerned primarily with studying the extent to which bank risk is reflected in the yields on large certificates of deposit, subordinated notes and debentures, and other types of bank debt not formally covered by deposit insurance. Risk-pricing of uninsured bank debt is taken as evidence of market monitoring of banks' risk behavior (if not necessarily *disciplining*). A key insight in this literature is that the extent to which non-insured bank creditors charge risk premiums corresponding to the bank's asset risk critically depends on their beliefs regarding the prospects of being bailed out despite being formally uninsured (Angkinand and Wihlborg, 2005, 2006, call this the 'credibility of non-insurance'). In other words, market discipline is exerted by creditors who do not perceive themselves to be covered by explicitly *or* implicitly issued guarantees. In other words, the extent of *de facto* market discipline by creditors is the 'flip side' of the *expected* (rather than the formal) coverage of such guarantees.

Thus, Flannery and Sorescu (1996) find limited evidence of bank-specific risk measures reflected in the secondary market spreads of US banks' subordinated notes and debentures (SNDs) over the eight-year period preceding the reform of the US federal deposit insurance system in 1991, which committed more credibly to a no-bailout policy as regards US banks' subordinated debt.<sup>3</sup> They conclude that "bank investors clearly impounded the value of conjectural government guarantees into debentures prices" (p. 1373). Conversely, several later papers (Morgan and Stiroh, 2000; Jagtiani et al, 2002),

studying the post-reform period, do find evidence that the pricing of US banks' sub-debt significantly depends on underlying credit risk, as traditionally measured.

The pattern is far from consistent, however, with regard to the US experience of the effect of implicit creditor insurance. Hall et al. (2002) explicitly test the effect of the US deposit insurance reform on the risk sensitivity of average interest paid on uninsured deposits in a cross section of US banks, and find that the risk sensitivity did not significantly increase after 1991. Similar results are obtained by Covitz et al. (2004). On the other hand, some older papers do find cross-sectional links between spreads paid on large CDs and balance sheet risk in the *pre*-reform period (Baer and Brewer, 1986; Hannan and Hanweck, 1988; James, 1988, 1990; Keeley, 1990; and Ellis and Flannery, 1992).

Gropp and Vesala (2004) also make a point of distinguishing between explicit and implicit deposit insurance. They show theoretically that the adoption of an explicit deposit insurance scheme under reasonable assumptions can reduce moral hazard and risk taking in banks if the scheme effectively limits the scope of the safety net, thus providing space for 'residual' market discipline and reducing bailout expectations of formally uninsured creditors. They apply their model to a sample of European banks over the 1990s, and obtain results largely consistent with their predictions (except for large, 'too-big-to-fail' banks).<sup>4</sup>

Angkinand and Wihlborg (2006), finally, test for market discipline using proxies for deposit insurance coverage in a large sample of banks in both developed and emerging-market countries. They posit, and find evidence of, a U-shaped relationship between bank risk-taking and deposit insurance coverage. The intuition is that zero or

very low formal coverage is not credible, and will tend to push up risk due to expectations of *ad hoc* bailouts in the event of failure; intermediate levels of coverage will effectively increase the scope for market discipline by reducing bailout expectations (as in Gropp and Vesala, 2004); higher levels of coverage, finally, will again drive up risk incentives, in line with the standard moral hazard view of deposit insurance (and consistent with the empirical results of, e.g., Demirgüç-Kunt and Detragiache, 2002).

### 2.3. Ownership structure

The central message of the literature on bank ownership structure and risk is that the extent to which shareholders can exploit the ‘option value of deposit insurance’ depends on their ability to make the bank’s managers act in their interest. Therefore, the effects of deposit insurance on bank risk-taking depend not only on the extent of creditor discipline implied by effective limits on deposit insurance coverage, but also on the traditional owner-manager agency conflict. However, available empirical results extend only to the stand-alone effect of owner control on risk (rather than the interactive effect suggested by the above argument).

Among the earliest widely quoted results on the relationship between banks’ ownership structure and their risk taking are those of Saunders et al (1990), who test different stock market measures of risk as a (linear) function of the fraction of managerial ownership, the capital-asset ratio, and a number of control variables. They hypothesize a positive relationship between managerial ownership and risk taking, which is motivated by the following: bank managers with zero or small ownership stakes in the bank are more risk averse than outside owners of the bank for the traditional reasons (they are



more concerned with enjoying the perks of office than with exploiting the option value of equity by increasing asset volatility, they have invested non-diversifiable human capital in the bank, etc.); Low managerial ownership should therefore imply lower risk taking. As managers' ownership share in the bank increases, their interests (including their expected benefits of increased risk) become more aligned with those of outside equity holders, and so the bank's asset risk should increase. Moreover, Saunders et al (1990) assume that changes in the regulatory environment toward more lax regulation strengthen the positive association between stockholder control of the bank and risk taking.<sup>5</sup> Their empirical results for US banks over the 1978-1985 period are mixed but are somewhat supportive of a positive relationship between managerial ownership and risk taking in periods of lax regulation.

Similar results are reached by Knopf and Teall (1996), who explicitly test the impact of the 1989 US bank reform on the relationship between risk and ownership structure. They find a positive association between several different measures of risk on the one hand and insider ownership on the other before the regime shift, but a negative one following it. They also find a strong negative relationship between risk and *outside* ownership throughout the sample period, possibly indicating that dispersed ownership makes it difficult for shareholders to enforce their interests of higher risk taking.

Gorton and Rosen (1995) provided the first more elaborate analytic treatment of the issue – also fundamentally based on the insight that managers, not shareholders, control banks' loan portfolios, and therefore their risk. They propose a game-theoretic model of the conflict of interest between shareholders and managers, of which the main prediction is an inverse U-shaped relationship between managerial ownership and risk. However,

they also open up for the possibility of a U-shaped relationship; first, because the model's prediction of functional form is indeterminate short of an explicit assumption about the relative size of an exogenous 'state of the industry' parameter;<sup>6</sup> second, based on the argument that under normal circumstances, outsiders' chances of controlling managers may be best either at low levels or at high levels of managerial ownership.

The empirical results of Gorton and Rosen (1995) for US bank holding companies do not unequivocally support either form, but the latter argument, in particular, has subsequently been used to motivate the hypothesis of a non-linear relationship between ownership and risk (Brewer and Saidenberg, 1996; Cebenoyan et al., 1999; Knopf and Dolde, 2006). The idea is that at intermediate levels of ownership, managers become 'entrenched', and – while hard for outside owners to get rid of – are then best able to maximize their benefits of control by acting in a more risk-averse manner than the outsiders would like them to.<sup>7</sup>

Brewer and Saidenberg (1996) find evidence of a weakly convex relationship between risk (measured as the standard deviation of stock returns) and insider ownership for a sample of US savings and loan institutions over the latter half of the 1980s. Extending the sample period to cover 1986-1995 and using other risk measures, Cebenoyan et al (1999) obtain similar results (except for an intermediate period of regulatory stringency in the late 1980s and early 1990s; cf. Knopf and Teall, 1996).

Knopf and Dolde (2006) similarly hypothesize that increased insider (managerial) ownership will either linearly increase or have a U-shaped influence on bank risk taking. They use both market-based and accounting-based risk measures. The empirical results generated from their dataset on US thrift institutions from 1990 to 2003 are, again,

somewhat mixed, but do tend to lend some support to the idea of a U-shaped link from insider ownership to risk, whereas the effect of outsider ownership is indeterminate.

The gist of these empirical results seems to be that the risk effects of increased shareholder control can be both positive and negative. In light of this, the argument that shareholder control strengthens the positive risk effects of more extensive deposit insurance may be too simplified.

### **3. Analytics and hypotheses**

In this section, I first develop a simple model of bank capital, which links deposit insurance with risk taking through, on the one hand, equity ownership structure and, on the other hand, the effect of the insurance on creditor discipline. In the second subsection, I analyze the implications of the model, briefly consider minimum capital adequacy requirements, and derive testable hypotheses.

#### 3.1. A simple model

##### *Introduction to the model*

The risk incentives of banks in the presence of deposit insurance was, as previously indicated, first theoretically analyzed within an options-pricing framework by Merton (1977). Subsequent theoretical contributions primarily study factors which condition the risk effects of deposit insurance – in particular factors related to market structure and competition (e.g., Keeley, 1990; Boyd and Nicoló, 2005), or different regulatory measures (e.g., Calomiris and Kahn, 1991; Boot and Thakor, 1993; Besanko and Kanatas, 1996) – often using a game-theoretic/optimal-contracting approach. The conditioning

effect of ownership structure and market discipline on the risk incentives created by deposit insurance may be viewed as two additional such factors. Existing theoretical contributions on the role of these factors follow the contingency-claims-pricing (Levonian, 2001; Nivorozhkin, 2005) or game-theoretic (Gorton and Rosen, 1995) approaches.

The various components featuring in the basic problem I have set out to analyze – ownership structure, the option value of equity, the owner-manager conflict, a reduction in the debt premium, etc. – suggested to me that the problem could be approached using a more corporate governance-oriented framework. As such, the primary inspiration of the model that follows comes not from within the banking literature, but in particular from Jensen and Meckling (1976), who, among other things, present an agency-cost-based framework for capital structure choice, especially for entrepreneurial firms. The following model is largely a formalization of their conceptual framework, applied to banks.

In the model, I have used insights from the banking literature (empirical and theoretical), as reviewed in Section 2. The most important of these are as follows. First, the model incorporates the insight that the source of deposit-insurance-related moral hazard is identical to the source of the agency costs of debt in a traditional corporate governance sense, *viz.* the conflict of interest between owners and creditors (Barth et al., 2006). From this also follows the interpretation of creditor discipline as the reverse of *de facto* deposit insurance coverage: market discipline is exerted by those creditors whose claims are not covered by guarantees. Second, the model ‘operationalizes’ the insight that the effect of deposit insurance on bank risk taking is conditioned by ownership structure.

This has, to my knowledge, been *theoretically* analyzed previously only by Gorton and Rosen (1995), but their model is very different from mine. The contribution of the model I present is, again, to demonstrate how the insight can be analyzed within a traditional corporate governance/agency cost framework.

### *Safety net characteristics and capital structure choice*

Let  $E_O$  denote outside equity and let  $D$  denote debt. Moreover, let lower-case letters indicate scaling by the total amount of external capital, so that  $d = D/(D+E_O)$ . Suppose, along the lines of Jensen and Meckling (1976)<sup>8</sup>, that for a firm the agency cost of equity is described by a function  $A_E$  on  $d$  such that  $A_E(1) = 0$ ,

$A_E'(d) < 0$ , and  $A_E''(d) > 0, \forall d \in [0,1]$ . Similarly, let the agency costs of debt be represented by a function  $A_{D_0}$  on  $d$  such that  $A_{D_0}(0) = 0$ ,

$A_{D_0}'(d) > 0$ , and  $A_{D_0}''(d) > 0, \forall d \in [0,1]$ . Optimal capital structure,  $d_0^*$ , is determined by minimizing total agency costs,  $A_{T_0} = A_E + A_{D_0}$ .

I use the concept of agency costs as basically meaning a spread, or a premium, over the risk-free rate of return, charged by the providers of external finance as compensation for monitoring activities and agency-related risks (I will henceforth use ‘agency cost’ and ‘risk premium’ synonymously). They are the market’s solution to the agency problem because outside investors will adjust the premium charged in accordance with their perception of monitoring needs and of the risks they incur by extending capital to the firm. The premium enters into the firm’s optimization problem, and the firm is thereby disciplined not to behave in a manner unwanted by outside investors. The concept of agency costs as just described corresponds exactly to that of market discipline

according to the generally accepted ‘monitoring-and-influence’ definition of this concept (see, e.g., Flannery, 2001; Bliss and Flannery, 2002). Thus,  $A_{D_0}$  can be interpreted as a manifestation of creditor discipline and  $A_E$  as market discipline by outside shareholders.

The basic structure of the model is depicted in Figure 1. Leverage,  $d$ , runs along the horizontal axis, and can vary between 0 and 1. The vertical axis shows the premium charged by investors. The agency cost structure given by  $A_{D_0}$ ,  $A_E$ , and  $A_{T_0}$ , with the resulting optimal capital structure indicated by  $d_0^*$ , refers to any unregulated firm – it is the equilibrium solution for the general case. For simplicity, we might think of it as a bank *before* the introduction of deposit insurance.

[Figure 1]

Now assume deposit insurance is introduced. (I effectively assume underpriced deposit insurance, possibly with a premium which is fixed-rate, or at least adjusts imperfectly to risk, and which can also be thought of as a limit on deposit insurance coverage, see below).<sup>9</sup> Deposit insurance enters the model in the following way. The holders of credibly insured debt will no longer charge a premium as compensation for monitoring activities and other agency-related risks since they are now essentially holding a risk-free asset. The agency costs attached to insured debt thus drop to zero. It will prove convenient to name this function as well, even though it is always zero. Thus, the agency premium charged on debt covered by deposit insurance is  $A_{D_1}(d) = 0$ . It is not indicated in Figure 1, but would appear as a straight line along the horizontal axis.

The insurance can effectively be seen as an exogenously financed ‘risk subsidy’ on some bank debt.<sup>10</sup> In the typical case of a bank benefitting from limited deposit insurance, there are thus two types of debt – uninsured debt, which carries the ‘normal’ debt agency premium  $A_{D_0}(d)$ , and insured debt, which carries zero premium over the risk-free rate. Insured debt would typically be small deposits, uninsured debt would be large CDs, unsecured notes and bonds, etc.

To make the model more realistic, and to make it applicable to countries without any formal deposit insurance system, I have chosen also to include uncertainty about actual deposit insurance coverage. There might be both expected losses for formally insured debt, and expected bailouts for formally uninsured debt. To model these different possibilities, three parameters need to be introduced.

Let  $\phi, \gamma, \kappa$  be fractions.  $\phi$  denotes the share of debt claims formally covered by deposit insurance,  $\gamma$  denotes public confidence in the deposit insurance system (the extent to which insured depositors trust that they will be bailed out), and  $\kappa$  indicates the credibility of *non*-insurance (the reverse probability of *ad hoc* bailouts of formally uninsured creditors). For simplicity,  $\phi$  enters here as an exogenous parameter, but may be viewed partly as a choice variable. It is trivially zero for countries with no explicit deposit insurance. For countries *with* explicit deposit insurance, it will typically be less than unity for several reasons, among which are regulatory limits on deposit insurance coverage, bank or bank-customer co-financing of the deposit insurance scheme, etc. All these reasons imply that the benefit of insurance comes to creditors at a cost so that the net of this benefit does not fully compensate for the premium  $A_{D_0}(d)$  that they would have charged if there were no deposit insurance. Such costly insurance is equivalent to

$\phi < 1$ .<sup>11</sup> It also seems reasonable to assume that public confidence in the deposit insurance system is never so complete so as to make an unconditional cover-all deposit insurance fully credible at all times (for a motivation, see, e.g., Cook and Spellman, 1994). Less than full credibility indicates  $\gamma < 1$ . Finally, the no-bailout credibility  $\kappa$  is a probability and so by definition lies between 0 and 1 (as previously mentioned, expectations of *ad hoc* bailouts for formally uninsured debt have been documented by, e.g., Gropp and Vesala, 2004; Angkinand and Wihlborg, 2006).

This gives rise to four distinct theoretical agency cost structures. Formally and credibly insured debt carries the cost  $\phi\gamma A_{D_1}(d) = 0$ ; formally but *non*-credibly insured debt follows  $\phi(1-\gamma)A_{D_0}(d) \geq 0$ ; formally and credibly *uninsured* debt costs  $(1-\phi)\kappa A_{D_0}(d) \geq 0$ ; and, finally, formally but *non*-credibly uninsured debt (i.e., implicitly insured debt) carries the premium  $(1-\phi)(1-\kappa)A_{D_1}(d) = 0$ . The agency costs of debt actually faced by the bank are the sum of the two non-zero cost structures above:

$A_{\bar{D}}(d) = \phi(1-\gamma)A_{D_0}(d) + (1-\phi)\kappa A_{D_0}(d) = [\phi(1-\gamma) + (1-\phi)\kappa]A_{D_0}(d)$ .  $A_{\bar{D}}$  can be seen as a weighted average of the zero-agency-cost function  $A_{D_1}$  and the non-zero function  $A_{D_0}$ , with the weight on  $A_{D_0}$  given by the term

$$\Lambda = [\phi(1-\gamma) + (1-\phi)\kappa]. \quad (1)$$

This term is a summary measure of the amount of market discipline exerted by creditors. In terms of the three component parameters, we can see that market discipline is exerted by holders of debt claims that are (a) formally but non-credibly insured, and (b) formally and credibly uninsured. It is easily ascertained that  $\Lambda \in [0,1]$ , and that a higher  $\Lambda$  indicates more market discipline.



Total agency costs are now  $A_{T_1}(d) = A_E(d) + \Lambda A_{D_0}(d)$ , and the optimal capital structure is therefore:

$$d_1^* = \arg \min_{d \in [0,1]} \{A_E(d) + \Lambda A_{D_0}(d)\} \quad (2)$$

In Figure 1, the new situation brought about by deposit insurance is indicated by a flatter debt agency cost curve ( $A_{\bar{D}}$ ), lower total agency costs ( $A_{T_0}$ ) for all levels of leverage ( $d$ ), and a higher optimal leverage ( $d_1^*$ ) as compared to the pre-deposit-insurance situation.

The bearing idea here is thus that deposit insurance diminishes market discipline by the bank's creditors. The effect is a reduction in the bank's overall risk premium (total agency costs) and an accompanying change in capital structure. For the purposes of the empirical part of the paper, I shall assume that this subsidy on the bank's total risk premium is a determinant of its risk taking as measured by some proxy for asset or default risk. The next step is therefore to find an analytic expression for this subsidy. The cost reduction on debt financing generated by deposit insurance (or the would-be 'risk neutral' deposit insurance premium) is simply the drop in debt agency costs at optimal leverage, that is  $(1 - \Lambda)A_{D_0}(d_1^*)$ . But the reduction in the bank's *overall* risk premium (total agency costs) is

$$S_T = A_E(d_0^*) + A_{D_0}(d_0^*) - [A_E(d_1^*) + \Lambda A_{D_0}(d_1^*)]. \quad (3)$$

It is the difference between total agency costs at optimal leverage in the absence of deposit insurance, and total agency costs at optimal leverage in the presence of deposit insurance. Because total agency costs are always higher in the absence of deposit insurance, this subsidy is always positive. As suggested by equation (3), it depends both on debt and equity agency costs, leverage, and market discipline by creditors. In figure 1,

it appears as the vertical distance between the pre- and the post-deposit-insurance optima ( $d_0^*$  and  $d_1^*$ ).

#### *Cross-sectional variation and the determinants of agency costs*

Expression (3) describes the link between bank risk taking and governance factors. The governance factors, which are my primary interest, enter the equation through the agency cost functions and through the market discipline parameters (which in turn are determined by explicit and implicit deposit insurance coverage). Very generally, the sharper the average slope of the cost function over the leverage interval  $d \in [0,1]$ , the greater the agency problem, assuming owners and creditors price the problem adequately. But what determines the cross-sectional variation in these functions?

The original Jensen and Meckling (1976) article assumes that the slopes of the agency cost functions  $A_E$  and  $A_{D_0}$  are mainly determined by the relationship between inside and outside financing of each individual firm ('ownership structure'), and I shall do likewise. Note that I have kept assumptions regarding the functional form of the agency cost functions at a minimum: the only requirement I have imposed beyond those of Jensen and Meckling (where the requirement is implicit) is that they be convex, so that it is actually possible to minimize the sum of the two functions. Without loss of generality the agency cost functions can be written as  $A_{D_0}(d) = gd^h$  and  $A_E(d) = k(1 - d^m)$ , where  $g > 0$ ,  $h > 1$ ,  $k > 0$ , and  $0 < m < 1$ , in keeping with previous assumptions regarding first and second derivatives.

By assumption, the main determinant of the slope coefficients  $g$  and  $k$  is the bank's ownership structure (whereas  $h$  and  $m$  are best interpreted as risk aversion

parameters which should be constant across firms). If  $\omega$  denotes the share of inside to outside financing the agency cost functions can be written as:

$$A_{D_0}(d) = g(\omega)d^h, \text{ and} \quad (4)$$

$$A_E(d) = k(\omega)(1 - d^m) \quad (5)$$

Now plug in (4) and (5) into (3) to get the full picture of the effect of the governance factors on the deposit-insurance-induced risk subsidy:

$$\begin{aligned} S_T &= k(\omega)(1 - d_0^{*m}) + g(\omega)d_0^{*h} - [k(\omega)(1 - d_1^{*m}) + \Lambda g(\omega)d_1^{*h}] \\ &= k(\omega)(d_1^{*m} - d_0^{*m}) + g(\omega)(d_0^{*h} - \Lambda d_1^{*h}), \end{aligned} \quad (6)$$

or, with the components of the creditor discipline parameter given in full:

$$S_T = k(\omega)(d_1^{*m} - d_0^{*m}) + g(\omega)(d_0^{*h} - [\phi(1 - \gamma) + (1 - \phi)\kappa]d_1^{*h}) \quad (7)$$

Equations (6) and (7) indicate that the size of the deposit-insurance-induced risk subsidy depends on equity ownership structure (in terms of the ratio of inside to outside capital), a leverage effect, and the extent of market discipline by creditors.

### 3.2. Implications and hypotheses

Evaluation of the individual effects of the governance factors on the risk subsidy is done by taking partial derivatives on equation (6) or (7). The effect of ownership structure is complex, and is given by:

$$\frac{\partial S_T}{\partial \omega} = k'(\omega)(d_1^{*m} - d_0^{*m}) + g'(\omega)(d_0^{*h} - \Lambda d_1^{*h}) \quad (8)$$

It is now necessary to make some assumption regarding the relationship between the ratio of inside to outside financing on the one hand, and the steepness of the agency cost

curves on the other. Jensen and Meckling (1976) suggest both curves become less steep with increased insider ownership, i.e.,  $k'(\omega) < 0$  and  $g'(\omega) < 0$ . In the case of equity agency costs, this is probably fairly unproblematic. The slope of the  $A_E$  function reflects the conflict of interest between outside shareholders and insiders/managers. It seems natural to assume that the conflict – and therefore the slope – increases as the share of insider financing drops, and vice versa, because as this share decreases (increases), the interests of insiders/managers and outside shareholders become less (more) aligned. For all cases except the trivial case of perfect creditor discipline (nothing happens), first-order conditions of the bank's optimization problem (2) ensure that  $(d_1^{*m} - d_0^{*m}) > 0$ . With  $k'(\omega) < 0$  this makes the first term on the right hand side in (8) negative.

In the case of the debt agency cost curve, it is not equally clear that it should steepen with increased outside financing. The average slope of this curve reflects the conflict of interest between owners and creditors: owners benefit from higher leverage and higher asset risk, whereas the opposite is true for creditors. But financing and investment policy is determined by managers; thus, the shareholder-debtholder conflict is affected by the extent of shareholder control (in other words, debt agency costs are affected by equity agency costs, as emphasized by, e.g., Brander and Poitevin, 1992). The manager of a leveraged firm *always* has an opportunity to shift risk for the benefit of the shareholders. If the manager has no ownership stake he has no incentive to do so (particularly, but not only, if he is more risk averse than shareholders), which would indicate a flatter debt agency cost curve for low levels of insider ownership/shareholder control.<sup>12</sup> As the ownership stake of the manager/insider increases, his incentives become more aligned with outside shareholders, effectively increasing shareholder control. This

should exacerbate the shareholder-creditor conflict. Since the ratio of inside to outside financing is a monotonic positive function of the share of insider equity ownership, this line of reasoning would suggest that the slope of  $A_{D_0}$  increases with the share of *inside* rather than outside financing. Therefore, my first guess is that  $g'(\omega) > 0$ .<sup>13</sup> In that case, the sign of the second right hand side term of equation (8) depends on  $(d_0^{*h} - \Lambda d_1^{*h})$ , which is more likely to be positive if creditor discipline is lax ( $\Lambda$  is small).

It is evident from (8) that a necessary condition for insider control to have a non-linear effect on the risk subsidy (as suggested by the literature on ownership structure and risk, reviewed in subsection 2.3) is that the effect of insider ownership on the slope of the debt agency cost curve is non-constant (i.e.,  $g''(\omega) \neq 0$ ), and/or that the marginal effect of insider ownership on the slope of the equity agency cost curve is increasing ( $k''(\omega) > 0$ ). In the absence of  $g''$  and  $k''$  effects, insider ownership will affect risk positively only if the sensitivity of the slope of  $A_{D_0}$  to changes in ownership structure is higher than that of the slope of  $A_E$  (that is, if  $g'(\omega) > |k'(\omega)|$ ) and if creditor discipline is relatively low; short of these conditions, increased insider capital will affect risk negatively.

In summation, this yields the following main predictions for the effect of ownership structure on risk:

$$\begin{aligned} \frac{\partial S_T}{\partial \omega} < 0 & \quad \text{if the marginal sensitivity of equity agency costs to changes in} \\ & \quad \text{ownership structure is relatively high, the leverage effect is} \\ & \quad \text{large, and/or creditor discipline is strong;} \\ \frac{\partial S_T}{\partial \omega} > 0 & \quad \text{if the marginal sensitivity of debt agency costs to changes in} \\ & \quad \text{ownership structure is relatively high, the leverage effect is} \\ & \quad \text{small, and/or creditor discipline is weak;} \end{aligned} \tag{9}$$

$\frac{\partial^2 S_T}{\partial \omega^2} \neq 0$  if the marginal effect of changes in ownership structure on either agency cost curve (or both) is non-constant;

and, finally,  $\frac{\partial^2 S_T}{\partial \omega \partial \Lambda} < 0$ .

An intuitive explanation to the result that increased shareholder control may reduce risk is that shareholders will trade off the benefits of increasing asset risk and those of increased leverage. They may choose to decrease risk and instead increase leverage unless the marginal effect on debt agency costs curve is sufficiently great to make that relatively less beneficial.<sup>14</sup> The final term in (9) suggests that the product of the partial derivatives of shareholder control and creditor discipline, respectively, is negative. The most straightforward interpretation of this result is that creditor discipline reduces the risk effect of owner control (whether this effect is primarily positive or negative).

The effects on the subsidy of the creditor discipline/deposit-insurance-related parameters are less ambiguous. The composite measure of market discipline by creditors has a negative effect on risk:

$$\frac{\partial S_T}{\partial \Lambda} = -g(\omega)d_1^{*h} < 0 \quad (10)$$

Expression (10) also shows that the negative effect of creditor discipline is greater for higher levels of leverage (i.e., when capitalization is poorer). Increasing the share of formally insured debt will (generally)<sup>15</sup> increase risk by decreasing creditor discipline:

$$\frac{\partial S_T}{\partial \phi} = (\gamma + \kappa - 1)g(\omega)d_1^{*h} > 0 \quad (11)$$

Similarly, confidence in the deposit insurance system increases risk by reducing uncertainty among insured depositors about the prospects of being bailed out:

$$\frac{\partial S_T}{\partial \gamma} = \phi g(\omega) d_1^{*h} > 0 \quad (12)$$

The credibility of the no-bailout commitment for formally uninsured debtholders, finally, decreases risk taking by reducing implicit insurance:

$$\frac{\partial S_T}{\partial \kappa} = (\phi - 1) g(\omega) d_1^{*h} < 0 \quad (13)$$

All the effects of the creditor discipline parameters are strengthened with increased leverage (as measured by the debt share of outside capital).

Now briefly consider the effect of capital requirements. Let  $\varsigma$  be the minimum ratio of equity capital, as defined on the book value of total assets ( $V_B$ ). So long as the equity share of capital exceeds the required ratio, minimum capital requirements will have no effect on the bank's capital structure choice or risk taking. In terms of the debt share of outside capital (which is how capitalization/leverage is defined in the model), the minimum capital regulation kicks in when  $(\varsigma - E_I / V_B) V_B / (V_B - E_I) > 1 - d_1^*$ , where  $E_I$  is equity held by insiders. In that case, the optimization problem in equation (2) will be overridden by regulation, and  $d_1^*$  will be replaced by

$1 - (\varsigma - E_I / V_B) V_B / (V_B - E_I) = V_B (\varsigma - 1) / (E_I - V_B)$  in expression (3). Then, first-order conditions from the bank's optimization problem can no longer be relied upon to sign partial derivatives, and the predictions of the model may not hold. In principle, this requires an assumption of effective and more or less immediate enforcement of capital requirements (no regulatory forbearance), which may or may not be a realistic assumption. However, this brief analysis of the effect of capital requirements does indicate that undercapitalization should be accounted for in the empirical testing of the model's predictions.

### 3.3. Discussion

In the model I have assumed that market discipline is exerted by the imposition of a premium on capital extended to the bank, which is set by claimants in accordance with their perception of the risk they incur by extending the capital. This premium was interpreted and analyzed along the lines of a standard agency cost model. Deposit insurance lowers the risk incurred by (some) creditors, and therefore lowers the debt service costs of the bank. The extent to which this occurs depends on the explicit and implicit coverage of the deposit insurance. Conversely, the extent of market discipline by creditors was defined in terms of the share of debt credibly exempt from insurance. The decrease in debt service costs will lower the *overall* risk premium faced by the bank (total agency costs) by some amount, i.e., risk becomes cheaper. This is why deposit insurance may increase banks' risk taking. However, the reduction in total agency costs – which I have called the (total) 'risk subsidy',  $S_T$  – is not just determined by the coverage of explicit and implicit deposit insurance, but also by equity ownership structure and by leverage.

The main contribution of the model – whose basic structure is simple enough, but whose predictions are in part rather complex – is twofold. First, it incorporates a number of insights from the banking literature in a standard corporate governance framework, as explained in the introduction to the model. Second, it highlights a few points that have not been systematically clarified in previous literature: (i) Leverage is a *central* conditioning variable for the effect of governance variables on risk taking. It both affects market discipline, and can be used to explain a non-monotonic effect of shareholder



control on risk (without having to invoke concepts like entrenchment). (ii) Previous literature basically suggests that the risk effect of deposit insurance – and therefore of creditor discipline – depends on shareholder control (more shareholder control leads to a greater risk effect and vice versa). But because the risk effect of shareholder control is *a priori* indeterminate, so is the overall effect of this interdependence between the governance variables. This finding is more easily interpreted in terms of market discipline as a conditioning variable to the risk effect of shareholder control (rather than the other way around). Therefore, the interpretation that I will use henceforth is the following: the reduced market discipline that follows from deposit insurance is what triggers the effect of shareholder control on risk (this effect can then be positive or negative). (iii) Predictions about the effect of ownership structure on risk presume an assumption about its effect on the agency costs of debt – an issue which is surprisingly little researched.

For the purposes of the empirical section of the paper, I will assume that the determinants of the risk subsidy are also correlated with the overall risk of the bank (as measured by some suitable proxy for default risk). It may be worth pointing out that this does not follow directly from the model – it is a hypothesis. I here rely on the intuitive appeal of the suggestion that a reduction in the punitive costs of risk will generate higher risk taking. In that case, overall risk taking – when controlled for other determinants – should also be correlated with the determinants of the reduction in the risk premium. This is what I am effectively testing in the empirical section of the paper.

Moreover, insofar as a reduction in the overall risk premium induces more risk taking, it is not clear what the function projecting a reduction in the premium onto overall

risk should look like. The hypothesis suggests not that we move along a (presumably) positive curve between risk and risk premium, but – on the contrary – that the curve shifts to allow higher risk at an equal (or lower) cost.

## **4. Data and empirics**

### 4.1. Estimation

#### *Baseline regression*

The model presented in Section 3 suggests that banks' risk taking (or, to be specific, the 'risk subsidy' following from deposit insurance) is determined by the scale of inside to outside financing, by formal and informal deposit insurance coverage (which taken together determine the level of market discipline imposed by creditors), and the debt share of outside capital. The effect of ownership structure may be non-linear, and is partially determined by the level of creditor discipline; the effect of overall creditor discipline is negative, and this effect is strengthened by increased leverage.

Allowing for other factors to influence banks' overall risk, a number of control variables are included in the empirical specifications. The choice of control variables at the bank level is largely made on the basis of previous literature. I thus follow Marcus (1984) and Keeley (1990), and include Tobin's  $q$  as a measure of charter value, which should negatively affect risk. Like Gorton and Rosen (1995), Brewer and Saldenber (1996), and Cebenoyan et al. (1999), for instance, I also add bank size and a measure of institutional or outside ownership (in this case, institutions' share of outside equity). In parallel with Angkinand and Wihlborg (2006), I also include liquid assets over total assets.

The predictions of the model hinge on the bank's basic optimization problem (2), which determines its optimal capitalization. However, capital requirements set an exogenous bound on leverage, which implies that at a certain leverage ratio, the predictions do not necessarily hold (as noted at the end of subsection 3.2). To account for the fact that predictions are unclear for undercapitalized banks, I include a dummy for banks whose share of equity capital is too low according to the applicable regulation. In addition, I include dummies for foreign ownership and government ownership, since these types of ownership arrangement may be well as important for bank governance as the relation between inside and outside ownership seen in a global perspective (see La Porta et al., 2002, and Caprio et al., 2004).

Another effect of studying banks across a wide range of different countries is the necessity to consider country-level control variables. Most existing empirical results, including the ones just cited as sources for the choice of bank-level control variables, study US banks alone. An exception is Angkinand and Wihlborg (2006), and I follow them in controlling for income level (measured as the log of GDP/capita), real GDP growth, the real interest rate, and the inflation rate. An additional country-level control is a measure of overall regulatory stringency (see section 4.2 for details). Finally, a potentially complicating factor is the inclusion in the sample of observations for banks/countries severely hit by the Asian financial crisis in 1997-98. The sample also contains several other episodes of systemic financial turbulence (for instance, a number of Argentinean banks hit by crisis in 2001). If these observations are affected by factors outside the model, such as contagion, etc., it is conceivable that the inclusion of them will

affect estimation results in an unforeseen way. I therefore include a ‘crisis dummy’ to control for this possible effect.<sup>16</sup>

Based on the model’s main implications and the above considerations regarding control variables the basic empirical specification is formulated as follows (where subscripts  $i$ ,  $j$  and  $t$  denote bank, country and year):

$$\begin{aligned} \text{Risk}_{it} = & \beta_0 + \beta_1(\text{Inside to outside capital})_{it} + \beta_2(\text{Inside to outside capital})_{it}^2 \\ & + \beta_3(\text{Inside to outside capital})_{it} \times (\text{Market discipline})_{it} + \beta_4(\text{Market discipline})_{it} \\ & + \beta_5(\text{Market discipline})_{it} \times (\text{Leverage})_{it} + \beta_6(\text{Leverage})_{it} \\ & + \sum_{m=1}^6 \beta_{7+m}(\text{Bank-level control})_{im} + \sum_{n=1}^6 \beta_{14+n}(\text{Country-level control})_{jn} + \varepsilon_{it} \end{aligned} \quad (14)$$

Two of the right hand side variables in the above model are potentially endogenous: leverage and charter value. As for the leverage variable, it is obvious that it is partially determined within the model described in Section 3; as for charter value, the reasoning is that since risk shifting increases the option value of equity, riskier banks should be more highly valued – hence a higher Tobin’s  $q$  (see, e.g., Keeley, 1990). I use different measures of risk and of creditor discipline, and start by running a Hausman test to check for endogeneity of the charter-value and leverage variables for each combination of risk and market discipline measures. I then run model (14) for all banks in the dataset by either panel OLS or 2SLS, depending on the results of the Hausman tests.

#### *The effects of the individual components of the market discipline parameter*

Equation (14) is estimated with a composite measure of market discipline by creditors constructed in accordance with the model from proxies of the individual components (the share of formally insured debt, public confidence in the deposit insurance scheme, and the credibility of the deposit insurer’s no-bailout commitment for uninsured debt). The

variable ‘market discipline’ in the estimation equation (14) is thus a direct empirical counterpart to the theoretical model’s summary measure of market discipline,  $\Lambda$ , as defined by equation (1).

Although the overall effect of creditor discipline is at the center of interest together with ownership structure, it may be of interest also to consider the effect of each individual component of the market discipline parameter. As is clear from partial derivatives (11) – (13) the direction of the effects of these components should be fairly unambiguous, but the size of the effect depends on interaction between the three components, interaction with ownership structure, and interaction with leverage. In order to keep the specification tractable in terms of interpretation, I estimate a simplified version of the implied estimation equation, where I drop the interaction between the creditor discipline components. This results in an equation which differs from (14) in that the individual components have been substituted for overall creditor discipline, the interaction variable between inside to outside capital and market discipline is replaced by three interaction variables (one for each creditor discipline component), and similarly for interaction with leverage.

#### *Alternative specifications*

In order further to test the general predictions of the model, I test a number of alternative specifications. First, there may be concern that the effect of the institutional setting (beyond characteristics of the deposit insurance system and banking regulation stringency) and other effects specific to each country are not sufficiently taken into account. This may be particularly important if the risk measure used is based on

accounting variables, in which case different accounting practices, definitions of particular financial statement items related to risk, etc., may impact on the variation in the dependent variable. For this reason, I test a model replacing the country-specific control variables with country fixed effects, which should soak up any systematic effects of the type just mentioned.

Second, market discipline may be measured by a composite of institutional variables, and – as explained above – I first construct the market discipline parameter from such variables directly in line with the model. However, market discipline may possibly also be inferred from some other characteristic of a bank if that characteristic is correlated with market discipline. It has been suggested in the literature (see, for instance, Calomiris, 1999; Evanoff and Wall, 2000; Sironi, 2001; Benink and Wihlborg, 2002) that requiring banks to carry a minimum portion of subordinated debt on their books (a ‘mandatory subordinated debt policy’) could enhance market discipline (by creditors). In the spirit of this argument (and following Gropp and Vesala, 2004), I reestimate the basic specification (14) with the composite measure of market discipline replaced by the ratio of subordinated debt to total assets, as an alternative proxy for creditor discipline.

#### 4.2. Data

The paper uses two main types of data: firm-level data on publicly traded banks all over the world, and country-level data related to bank safety net characteristics, institutions more generally, and macroeconomic conditions. The resulting dataset is an unbalanced panel covering a maximum of 331 banks in 47 countries over the period 1995-2005. The total number of banks in the dataset is larger than 331, but as data availability varies

considerably for different variables, the exact number of banks covered depends on the combination of variables used in a particular regression specification. As for the distribution over time, coverage is fragmentary for the first three years, but relatively even between 1998 and 2005. The appendix provides more detailed information about the sample and its distribution across countries and over time.

Definitions of all variables used in the analysis are presented in Table 1, which also specifies the sources, and summary statistics appear in Table 2. Below follows a description of all variables, where some are explained more in detail. The description largely follows Table 1's categorical division of the variables.

[Table 1]

[Table 2]

### *Risk proxies*

The paper uses two measures of bank risk – one accounting-based and one market-based measure. The accounting-based measure used is the ratio of non-performing loans to equity capital as reported in BankScope's balance sheet data. The market-based measure is a market version of the so-called Z-score, which is defined by

$$Z_{it} = \frac{\mu_{it} - k_{it}}{\sigma_{it}}, \quad (15)$$

where  $\mu_{it}$  and  $\sigma_{it}$  are the mean and standard deviation, respectively, of bank  $i$ 's return on assets, and  $k_{it}$  is the average share of capital to total assets over the period  $t$ . The Z-score

is negatively related to the probability of default (and I therefore use it in the negative as a dependent variable for simplicity of comparison). The ‘market version’ Z-score is calculated using the return on equity and the standard deviation of stock returns.<sup>17</sup> Stock market data for the included banks were collected from Datastream.

#### *Ownership variables*

Ownership data were collected from Reuters. The Reuters database distinguishes between ownership by three owner categories: insiders/stakeholders, institutions, and mutual funds. It contains percentages of ownership by the different categories and by individual shareholders. The Reuters figures were combined with BankScope balance-sheet data on equity capital and total assets to calculate the share of inside to outside capital (since the model focuses on inside to outside capital rather than shares of equity ownership), based on the total ownership share of all insiders.

All ownership data are originally time-invariant, but since I use balance sheet data to transform equity ownership shares to proxies for inside to outside capital, the resulting variables are time-variant. Reuters data was also used to obtain the measure of institutions’ share of outside equity, and the dummy variables for foreign and government ownership. The latter take on unit value if the largest insider/stakeholder is foreign or is the government, respectively, and zero otherwise.

#### *Market discipline/deposit insurance*



Variables related to market discipline and bank safety-net characteristics were constructed using a combination of balance-sheet data and country-level institutional data collected from World Bank databases.

As a proxy for the share of formally insured debt (at the bank level), I use country-level data on the fraction of deposit value covered by explicit deposit insurance, net of the coinsurance ratio (available from Demirgüç-Kunt et al., 2005), and multiply it by the ratio of deposits to total debt for each bank and year.<sup>18</sup> For countries where a specific coverage percentage is not available in the World Bank database, I use

$$\min\left(1, \frac{\text{coverage limit}}{\text{deposits/capita}}\right) - \text{coinsurance ratio}$$

as a proxy (also from Demirgüç-Kunt et al.,

2005), and multiply by the ratio of deposits to total debt for each bank and year, as previously.<sup>19</sup> The share of formally insured debt is always zero for countries/years with no explicit deposit insurance scheme (see Table A1 in the appendix for details on which countries and years did and did not have formal deposit insurance systems in place).

The proxy for public confidence in the deposit insurance system is the average 1996-2005 scores on the ‘Government effectiveness’ index in Kaufmann et al. (2006). Confidence in the deposit insurance system obviously requires that such a system be in place; therefore, the confidence proxy is only assigned a positive value for the countries/years for which such is the case.

The preferred measure of non-insurance credibility for formally uninsured debt is the Fitch Support Rating, which is an index variable showing the probability that a bank will be bailed out in case of default. However, because of limitations in the number of banks in the dataset covered by these ratings, full reliance on this indicator alone would

result in the loss of a large number of observations (and possible bias toward larger, developed-country banks, which are more likely to be rated).

My alternate proxy is based on a combination of the Fitch rating and the bank's share of all deposits in its home country – a measure intended to capture the role of a bank's systemic importance for the credibility of non-insurance and the possibility to exert market discipline (in line with the results of, e.g., Gropp and Vesala, 2004, who document muted market discipline for 'too-big-to-fail' banks). The combination variable equals the Fitch rating for banks where such a rating is available; for all other banks, I take one less the bank's share of total deposits in its country of origin. Balance-sheet data on deposits for each bank are from BankScope, as before, and data on total deposits in each country (or M2, depending on data availability) are from IMF's *International Financial Statistics*.

The three proxies of the share of formally insured debt, public confidence in deposit insurance, and no-bailout credibility, are combined to form the proxy for overall market discipline used in the baseline regressions (the regression equation [14]). The empirical market-discipline proxy is constructed in direct correspondence with the definition of its theoretical counterpart (the variable called  $\Lambda$  in the model). Thus, the definition of the empirical proxy variables for market discipline in Table 1 corresponds exactly to the theoretical definition of  $\Lambda$  given by equation (1). This also means that the components of the summary market-discipline measure must conform to a common, theoretically accurate scale and assume values only between zero and unity. Transformations are made wherever necessary. If each component is in the interval [0,1], so, by definition, is overall market discipline (see Table 2). Again, one may think of this

variable as a weight determining what fraction of a bank's outstanding debt is priced according to the 'normal' (pre-deposit-insurance) debt agency cost function.

### *Capital structure*

Leverage is BankScope's indications of debt to total assets transformed to correspond to the model's focus on the debt share of outside (rather than total) capital. For banks, this share is typically very large (close to unity), so to be able to interact it with other variables it is standardized around the mean.

A dummy was constructed to identify undercapitalized banks. Capital adequacy requirements for each country in the sample were taken from Barth et al. (2001, 2006). A bank was considered undercapitalized if its ratio of tier-one capital (all equity) to total assets was less than 0.5 of the minimum regulatory requirement on *total* capital in the bank's country of origin. I thus assume that 50 percent of the capital adequacy requirement must be covered by tier-one capital, otherwise the bank is technically undercapitalized.

A final variable related to capital structure is the ratio of subordinated debt to total assets. It is used in some specifications as an alternative measure of overall market discipline (cf., e.g., Gropp and Vesala, 2004), and is taken directly from the banks' balance-sheet statements as reported by BankScope.

### *Bank- and country-level control variables*

Bank-level control variables include the market to book value of assets (Tobin's  $Q$ ), which measures charter value (see Marcus, 1984; Keeley, 1990). I use the same definition

as Keeley (1990) and many others:  $Q$  equals the sum of the market value of equity and the book value of liabilities, divided by the book value of total assets. I also use the size of the bank, defined as the natural logarithm of total assets (in thousands of USD), and liquid assets over total assets. The balance-sheet data and the stock-price data used for calculating these control variables are from BankScope and Datastream, respectively, as before.

Country-level control variables are real GDP growth, real interest rate, inflation rate, and the natural logarithm of GDP per capita (in thousands of USD) – all from the World Bank’s *World Development Indicators*. I also use a summary measure of regulatory stringency, based on the sum of the index variables ‘Capital regulation’, ‘Official supervisory power’, and ‘Prompt corrective power’ from Barth et al. (2001, 2006). These indices are based on comprehensive surveys of banking regulation and supervision in countries around the world, and the summary measure takes on higher values for higher total levels of regulation, supervision and enforcement.

A dummy was also constructed to flag countries undergoing a systemic banking crisis. The identification of country-year observations with crises is based on Honohan and Laeven (2005). The source covers the period up to and including the year 2002. At that time, a number of countries were still affected by crises, according to the source (i.e., no ‘end date’ is available). For banks from these countries, I flag observations from the subsequent years as well, effectively assuming that the crisis was still ongoing between 2003 and 2005.

## **5. Results**

Results from baseline regressions, with risk measured as either non-performing loans over equity capital or the negative market Z-score, and two different market discipline composite measures based on the two different proxies for no-bailout credibility, are presented in Table 3. All models use period fixed effects. Hausman tests showed that leverage was endogenous when the Z-score was used as dependent variable.

Consequently, these models are estimated by 2SLS, adding country dummy variables to the list of instruments. Coefficient standard errors for all models are White-type errors robust to time-varying residual variance and correlation over time within cross-sections. A priori, it is not evident which problem is worse – heteroscedasticity in the cross-section dimension, or in the period dimension with serial correlation within cross-sections – but the White period standard errors reported are ‘stricter’ (they are usually more than 60 percent greater than normal standard errors), so I use them.

#### *Baseline regression results*

With the interpretation of market discipline used in this paper, weaker market discipline basically corresponds to more generous *de facto* deposit insurance (and vice versa). Since more generous deposit insurance should exacerbate the moral-hazard problems stemming from such insurance, it should also increase the bank’s risk. Conversely, stronger market discipline should be associated with lower risk. The empirical results of the baseline regression, as reported in Table 3, do not seem to support this hypothesis. Market discipline is not significant as a stand-alone variable in any of the specifications, i.e., regardless of which risk proxy is used as dependent variable, and regardless of which market-discipline measure is used. However, the theoretical analysis in this paper

suggests that a potentially important conditioning variable for the effect of market discipline is the bank's leverage (cf. equation [10]): the higher the leverage, the stronger the negative effect of market discipline on risk. This implication of the model receives some, albeit limited, support in the empirical tests. Interacted with leverage, the coefficient for market discipline is, indeed, negative when risk is measured by the Z-score, but it is (marginally) significant only in one of the specifications.

[Table 3]

As for the second main governance variable of interest, the argument ran as follows. Deposit insurance increases the incentive for *shareholders* to increase the bank's risk, but because managers, not shareholders, determine the bank's risk exposure, the extent to which this incentive materializes in higher risk depends on the level of shareholder control over the bank. However, as indicated both by the theoretical model in this paper and previous research, the risk effect of increased shareholder control *for a given level of deposit insurance coverage* (and therefore a given level of market discipline by creditors), is not unambiguous: it can be either positive or negative. In the model it depends – in simplified terms – primarily on how sensitive the pricing of equity and debt capital are to changes in ownership structure. The effect may also be non-linear.

The effect of shareholder control (for constant market discipline) turns up in Table 3 as the coefficients for the terms inside to outside capital, and inside to outside capital squared. The results seem to strongly suggest a convex relationship between shareholder control and risk, but whether the negative or the positive effect dominates

depends on which risk measure is used. When the (negative) Z-score is used, the negative effect is the dominant one for the vast majority of observations (the break-point comes only at around 40 percent of inside to outside capital). The ratio of non-performing loans to equity, on the other hand, typically drops slightly until about 3 percent of insider capital, then increases. The mean for the insider capital ratio is 3.6 percent, but the distribution is quite skewed, which suggests that a good portion of the observations are on the negatively sloping part of the estimated non-performing-loans functions as well.

Because of the quadratic effects, the coefficients are not entirely straightforward to interpret. To simplify interpretation, Figure 2 depicts the estimated effects of ownership structure on risk graphically. Panels A, B, C, and D in the figure correspond to specifications 1 through 4 in Table 3. The horizontal axes represent the ratio of inside to outside capital. I have cut the axes at the 95<sup>th</sup> percentile (which corresponds to 12 percent insider capital) to suppress the effect of outliers from the graphs. The vertical axes represent the relevant risk measure used. The scale for the vertical axes is zero plus/minus two standard deviations. The graphs clearly show the largely positive effect of shareholder control on the share of non-performing loans, and its predominantly negative effect on risk as measured by the negative Z-score. Panel C also highlights the comparatively weak effect of shareholder control on non-performing loans when the second composite measure of market discipline is used. Using this measure gives about 50 percent more observations – an increase entirely consisting of observations on banks that do not have Fitch support ratings (cf. the description of these variables in subsection 4.2). Smaller and/or emerging-market banks are overrepresented among the non-rated

banks, so the result seems to indicate that increased shareholder control is less likely to affect the share of non-performing loans in this type of bank.

[Figure 2]

A primary reason for studying the effect of ownership structure on risk is that it conditions the risk effect of market discipline/deposit insurance coverage. The documented non-monotonic effect of shareholder control could therefore explain the insignificant stand-alone effect of market discipline on risk. Conversely, if the effect on risk of increased shareholder control is primarily caused by the presence of deposit insurance, then less extensive deposit insurance – i.e., more market discipline – should diminish the effect. This, too, follows both from the basic argument for including ownership structure in the analysis (as laid out, e.g., in Gorton and Rosen, 1995), and from the theoretical part of this paper (see the last term in expression [9]). In the regression analyses it is accounted for by the interaction term between inside to outside capital and market discipline. As seen in Table 3, the coefficients of this interaction term are negative when the positive effect of insider ownership dominates, and positive when the negative effect of insider ownership dominates, in accordance with predictions. They are also relatively large and highly significant in three of four specifications. The sizes of the coefficients indicate that moving from zero to full market discipline (a unit increase in market discipline) diminishes the dominant effect of shareholder control on risk by between 40 and 100 percent. These results would tend to suggest that the relaxation of



creditor discipline caused by deposit insurance is a major factor behind the effect of ownership structure on bank risk taking, but it is not clear if it is the only factor.

The individual effect of leverage is positive and highly significant when the Z-score is the dependent variable, but small and insignificant for estimations on non-performing loans. (This result for non-performing loans is perhaps a bit surprising, since lower capitalization would tend to increase the share of bad loans, *ceteris paribus*.) It is notable that coefficients for the interaction term between market discipline and leverage are significant only when the individual effect of leverage is large.

As for the control variables, most of those at the bank level are small and insignificant. One exception is that undercapitalized banks have a systematically higher share of non-performing loans to equity (which is true almost by definition and may in part explain the insensitivity of the NPL/equity ratio to leverage). At the country level, banks from faster-growing countries have a significantly lower portion of bad loans, and banks from higher-income countries are less risky, regardless of risk measure used. Banks from countries undergoing a systemic financial crisis, finally, are also significantly riskier.

#### *Regressions on the individual components of market discipline*

Table 4 shows the results of regressions in which the components of the creditor discipline measure have been entered separately (rather than as a composite measure of market discipline).

[Table 4]

Expectations on the individual market-discipline components are as follows: the share of formally insured debt and confidence in the deposit insurance system should increase risk (by discouraging market discipline), whereas higher credibility of the no-bailout commitment for non-insured debt should decrease risk (by encouraging market discipline). The share of formally insured debt significantly increases risk in three out of four specifications, and seems particularly to affect the share of non-performing loans. The effect also seems economically important: for example, a 10 percentage point increase in the reliance on insured deposits for funding would increase the ratio of non-performing loans to equity by about 6 percentage points. The other two components (confidence in the deposit insurance system and no-bailout credibility) are either statistically insignificant or point in different directions depending on the specification. The effects are not clarified by conditioning them on leverage.

To some extent, the mixed findings on the individual components of overall market discipline are of course consistent with the previous finding that the stand-alone impact of creditor discipline on risk is weak or absent. However, given the findings regarding the share of formally insured debt, it raises the question whether the previous weak results for overall market discipline was driven primarily by the poor empirical performance of the proxies for deposit-insurance confidence and no-bailout credibility. These components were designed to capture the effect of *implicit* (as opposed to formal, or *de-jure*) guarantees. Such effects are of course difficult to operationalize for empirical purposes. I see basically two possible interpretations of their inability to explain risk empirically: either, implicit effects (essentially the misalignment between the formal

design of the deposit insurance system and people's expectations about how it will be applied) are relatively unimportant in practice, *or* the proxies I have used are too crude.

Turning now to the effect of shareholder control, the altered specification with respect to the market discipline variables does not challenge the overall impression of the effect of insider capital share on risk given in Table 3. Coefficient signs and sizes are similar, indicating that the overall impression of the results remain robust to the difference in specification: increased shareholder control affects risk in a convex way, but the positive effect predominates when risk is measured as non-performing loans over equity, whereas the negative effect is dominant when risk is measured by the market Z-score.

Interacting the market discipline components with insiders' share of capital, the basic expectation is that the share of formally insured debt and confidence in the deposit insurance system should reinforce the effect of increased shareholder control (since they imply more extensive guarantees), and vice versa for the credibility of non-insurance. I find only limited support for these expectations. Increased formal deposit insurance coverage seems, if anything, rather to counterbalance the dominant effect of insider capital on risk (coefficients for the interaction variables are negative for NPL/equity ratio and positive for Z-score models). Statistically speaking, however, the effect is weak (specifications 3 and 4) or completely insignificant. Nor can any statistically significant effects be found for the interaction variables between inside to outside capital and confidence in the deposit insurance system. Unlike the two first components, the no-bailout credibility variable, finally, interacts with the insider capital share in accordance with expectations: higher credibility (implying more effective limits to deposit insurance

coverage) reduces the dominating effect of increased shareholder control on risk. The effect is statistically significant in all four specifications in Table 4, and are on a scale comparable to (but a bit smaller than) the corresponding effect of overall market discipline (as reported in Table 3).

The estimated effects of the control variables do not differ dramatically from those reported in Table 3. The one notable exception is that both the real interest rate and inflation now turn out to significantly influence the market Z-score.

#### *Alternative specifications*

Tables 5 and 6 report the results of alternative specifications with respect to country effects and market-discipline proxy employed, respectively. Two differences between the baseline specifications and the country fixed effects specifications of Table 5 (estimated only on NPL/equity) stand out.

First, the convexity of the insider capital effect is reinforced. Whereas Table 3 suggested that non-performing loans are only marginally negatively affected by an initial increase in the share of insider capital, and the effect turns positive at about 3 percent, the Table 5 specifications suggest a stronger initial negative effect, which turns positive only at around 15 percent. In this respect, the latter make the results on non-performing loans more aligned with those for the Z-score.

Second, the market discipline variable no longer significantly affects the insider capital effect. In fact, market discipline is insignificant both individually and in interactivity with ownership structure and leverage.

[Table 5]

In light of the latter result, it may be of interest to see if the estimated effects of market discipline from the baseline regressions stand up to the use of a different proxy for creditor discipline. These results are reported in Table 6, where market discipline is proxied by the share of subordinated debt (sub-debt) to total assets, but the specifications in all other respects are as in Table 3.

The share of sub-debt works in a similar way as the composite measure of creditor discipline, when risk is proxied by the market Z-score: it is individually not significant, but significantly reduces risk when conditioned by leverage; it also reduces the (mainly negative) effect of insider ownership on risk. The coefficients for the interaction variables are large due to the typically very small shares of sub-debt on banks' balance sheets, and suggest a potentially strong disciplining effect of relatively small changes in those shares. When risk is proxied by the bad-loans ratio, however, there is no discernible disciplinary effect of sub-debt.

The individual effect of inside to outside capital on the Z-score remains similar to previous specifications. The estimated effect of the insider capital share on the non-performing loans ratio, on the other hand, is in Table 6 much more similar to the results previously obtained for the Z-score. The negative effect now predominates and bottoms out only at about 42 percent of inside over outside capital.

[Table 6]

## *Discussion*

Three main expectations on the empirical results sprang from previous research and the theoretical section of the paper: market discipline by creditors (which I have defined as the ‘reverse’ of *de facto* deposit insurance coverage) reduces bank risk; shareholder control has an *a priori* indeterminate, but quite likely non-linear effect on bank risk; finally, creditor discipline is a major determining factor for whether shareholder control affects risk at all. I found mixed empirical evidence of the first hypothesis, although there is some indication that market discipline reduces risk (as measured by the Z-score) if leverage is high (i.e., for poorly capitalized banks). I also found evidence that one of the components of the composite market-discipline measure used in the baseline regressions – the share of formally insured debt – has a significantly positive stand-alone impact on risk.

Second, the U-shaped influence of insider control on bank risk found in previous research is confirmed, although the relative strengths of the negative and positive effects vary – not only depending on the risk measure used, as observed already in Table 3, but, when risk is proxied by the ratio of non-performing loans to equity, also on exactly how the regression equation is specified.

Third, the baseline regression results are strongly confirmative of the hypothesis that the weakening market discipline that follows from deposit insurance is an important reason for the occurrence of a shareholder-control effect on bank risk (or, alternatively, that the risk effect of deposit insurance/market discipline is conditional on shareholder control). For alternative specifications, results on this point are more mixed. In particular, the only individual market-discipline component that significantly reduces the risk effects

of increased shareholder control is ‘no-bailout credibility’, the variable proxying effective limits to deposit insurance coverage.

A possible explanation for the differences in test results across different risk measures (with similar specifications on the right-hand side) may be that the non-performing loans ratio and the Z-score measure somewhat different aspects of risk. This explanation seems all the more plausible because the effects of control variables are generally consistent across specifications so long as the same risk measure is used, but not always otherwise. For example, undercapitalized banks always have a significantly higher ratio of non-performing loans to equity (as should be expected, since undercapitalized banks are low on equity), but undercapitalization never significantly impacts the Z-score. Moreover, GDP growth is also consistently negatively associated with non-performing loans, but has the opposite effect on risk measured as the Z-score.

## **6. Conclusion**

The bearing idea in this paper was that governance variables, in the guise of ownership structure and market discipline by creditors, are major determinants of banks’ risk taking incentives in the presence of (partial) deposit insurance. The existence of deposit insurance reduces market discipline by the bank’s creditors, and introduces a subsidy on increased risk, but the size of this subsidy depends on the agency cost structure of the bank, and therefore on its ownership structure. The structure of equity ownership – insofar as it is related to the extent to which (outside) shareholders can enforce their interests – affect both equity and debt agency costs. The extent of market discipline by creditors depends not only on the formal coverage of deposit insurance, but also on the

credibility of the guarantees, and formally non-insured creditors' expectations of *ad hoc* bailouts of in the event of default.

The interrelationships between the variables of interest were analyzed in a standard agency cost model, augmented in a simple way to account for partial deposit insurance. The model implies that market discipline by creditors should decrease risk, it demonstrates why insider ownership may have a non-monotonic influence on risk (a common empirical result in the literature), it shows how the risk effects of the two main governance variables of interest – market discipline and shareholder control – are interrelated, and how leverage partially determines the impact of the governance variables on risk. The effects of minimum capital requirements and regulatory forbearance on undercapitalized banks were also briefly considered in the model.

By exploiting a dataset with bank-level data for several hundred banks worldwide and the World Bank's datasets on bank safety net characteristics at the country level, I was able to test the general predictions of the analysis. The results strongly suggest a convex effect of insider ownership on risk, but whether the negative or positive effect dominates depends on the measure of risk used. Creditor discipline has an insignificant effect on risk as a stand-alone variable, but interacted with ownership structure and/or leverage affects risk in the predicted way in several specifications. Of the individual components which together form the creditor discipline measure, the proxy for formal deposit insurance coverage is a significant determinant of bank risk, whereas proxies for implicit guarantees are not.

Although the results on market discipline are somewhat mixed, the empirical results overall are essentially consistent with the implications of the theoretical model.



The results on the effect of ownership structure on risk are relatively strong and consistent. On the other hand, the risk-decreasing effects of limiting deposit insurance (thereby strengthening market discipline) seem limited in general. The often-stated argument that the risk-increasing effects of discouraging creditor discipline (by introducing deposit insurance) is conditional on shareholder control – if by that one means that increased shareholder control strengthens the risk-increasing effect of deposit insurance – seems too simplistic. Shareholder control and creditor discipline are interdependent, but because the individual risk effect of increased shareholder control is ambiguous, so is the effect of interaction between these two variables. Therefore, it is possible that the relatively weak individual risk effect of creditor discipline is due to the fact that this effect is conditional on ownership structure, whose effect is – in turn – non-monotonic. A ‘cleaner’ interpretation is to turn the argument around, and say that the risk effect of ownership structure is conditional on creditor discipline: the less market discipline by creditors, the stronger the effect of shareholder control on risk.

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Table 1. Variable definitions

Variable	Description	Source
<u>1. Risk proxies</u>		
a. Non-performing loans / equity	Non-performing loans divided by equity capital	BankScope
b. Z-score	(Average return on equity – equity capital over total assets) divided by standard deviation of equity returns	Datastream, BankScope
<u>2. Ownership variables</u>		
a. Inside to outside capital	Equity held by all insiders/stakeholders divided by the sum of equity <i>not</i> held by insiders/stakeholders and total liabilities	Reuters, BankScope
b. Institutions' share of outside equity	Equity held by institutional investors divided by all equity not held by insider/stakeholders	Reuters
c. Government ownership	Dummy variable indicating largest insider/stakeholder is the government	Reuters
d. Foreign ownership	Dummy variable indicating largest insider/stakeholder is foreign	Reuters
<u>3. Market discipline / deposit insurance</u>		
a. Share of formally (explicitly) insured debt <sup>a</sup>	% country-wide deposit insurance coverage multiplied by each bank's ratio of deposits to total debt	BankScope, Demirgüç-Kunt et al. (2005)
b. Public confidence in the deposit insurance system <sup>a</sup>	Index value of 'government effectiveness'	Kaufmann et al. (2006)
c. No-bailout credibility 1	The Fitch support index of probability of bailout	Fitch/BankScope
d. No-bailout credibility 2	The Fitch support index (c) wherever available, otherwise one minus the bank's share of total deposits (alt. M2) in its country of residence	BankScope + IMF International Financial Statistics
e. Market discipline 1	$a \times (1-b) + (1-a) \times c$	As above
f. Market discipline 2	$a \times (1-b) + (1-a) \times d$	As above
<u>4. Capital structure</u>		
a. Leverage of outside capital	Total liabilities divided by total non-insider capital, standardized around the mean	BankScope, Reuters
b. Undercapitalization indicator	Dummy variable indicating if equity divided by total assets < 50% of the total applicable capital requirements	BankScope, Barth et al. (2001, 2006)
c. Subdebt	Subordinated debt divided by total assets	BankScope
<u>5. Bank-level control variables</u>		
a. Charter value (Tobin's <i>Q</i> )	The sum of market value of equity and book value of liabilities divided by the book value of total assets	BankScope, Datastream
b. Bank size	The natural logarithm of total assets in thousands of USD	BankScope
c. Liquid assets	Liquid assets divided by total assets	BankScope

6. Country-level control variables

a. Country income level	The natural logarithm of real GDP per capita in thousands of USD (constant 2000 prices)	World Development Indicators
b. Real interest rate	Real interest rate	World Development Indicators
c. Inflation	Inflation rate	World Development Indicators
d. Growth	The growth rate of real USD GDP (constant 2000 prices)	World Development Indicators
e. Systemic financial crisis	Dummy variable equal to one if the country was undergoing a systemic financial crisis, zero otherwise	Honohan and Laeven (2005)

7. Institutional variables

a. Summary regulation	Sum of Capital Regulation, Supervisory Power, and Prompt Corrective Power indices	Barth et al. (2001, 2006)
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Note: a) For countries/years with explicit deposit insurance system in place. All other countries: entries equal zero.

Table 2. Descriptive statistics (all banks/countries)

Variable	Mean	Std.dev.	Min	Max	Obs
<u>Risk measures</u>					
Non-performing loans / equity	0.67	0.73	0.00	4.89	2534
Z-score	5.35	5.28	0.35	40.3	2688
<u>Governance variables</u>					
Inside to outside capital	0.036	0.056	0.00	0.75	2745
Institutions' share of outside equity	0.15	0.19	0.00	0.99	2755
Leverage (debt share of outside capital, standardized)	0.00	1.00	-9.80	1.19	2720
Share of formally insured debt	0.53	0.35	0.00	0.99	2881
Public confidence in the deposit insurance system	0.55	0.30	0.00	0.96	47 countries
No-bailout credibility 1	0.48	0.26	0.10	0.90	3444
No-bailout credibility 2	0.61	0.29	0.10	0.90	5066
Composite market discipline 1	0.43	0.18	0.076	0.90	1509
Composite market discipline 2	0.53	0.22	0.04	0.90	2896
<u>Bank-level control variables</u>					
Charter value	1.01	0.13	0.41	2.89	2669
Bank size	15.1	2.10	6.94	21.2	3389
Liquid assets / total assets	0.25	0.19	0.00	0.97	3388
Subordinated debt / total assets	$2.7 \times 10^{-4}$	0.0016	0.00	0.055	2100
<u>Country-level control variables</u>					
Country income level	8.82	1.56	5.87	10.6	47 countries
Growth	0.033	0.031	-0.13	0.18	47 countries
Inflation	0.067	0.14	-0.039	1.55	47 countries
Real interest rate	0.060	0.091	-0.91	0.78	47 countries
Summary regulation	20.4	4.41	11.0	28.0	47 countries

Table 3. Results from estimation of the baseline regressions (equation [14])

Dependent variable	1. Non-performing loans / equity	2. Negative market Z-score	3. Non-performing loans / equity	4. Negative market Z-score
Estimation method <sup>a</sup>	OLS	2SLS	OLS	2SLS
Market discipline 1	.54 (1.17)	.36 (.27)		
Market discipline 2			.12 (.37)	2.19 (1.18)
(Market discipline 1) × Leverage	.21 (.44)	-4.06 (-1.89)*		
(Market discipline 2) × Leverage			.43 (1.35)	-2.22 (-.54)
Inside to outside capital	-2.06 (-.65)	-90.9 (-6.87)***	-.47 (-.30)	-57.2 (-3.49)***
(Inside to outside capital) <sup>2</sup>	39.5 (2.81)***	105.5 (1.65)*	7.14 (2.10)**	68.77 (3.31)***
(Inside to outside capital) × (Market discipline 1)	-16.6 (-2.89)***	71.6 (2.28)**		
(Inside to outside capital) × (Market discipline 2)			-7.42 (-2.16)**	23.1 (.84)
Leverage	.21 (.44)	4.91 (4.48)***	-.027 (-.15)	5.13 (2.03)**
Charter value (Q)	-.26 (-1.39)	-.41 (-.49)	-.085 (-.59)	.047 (.030)
Bank size	-.0033 (-.10)	.0051 (.041)	-.012 (-.54)	.56 (3.21)
Liquid assets / total assets	-.20 (-.53)	.71 (.83)	-.39 (-1.38)	-1.19 (-.95)
Institutions' share of outside equity	-.34 (-1.64)	-.069 (-.076)	-.41 (-2.44)**	1.02 (.82)
Foreign-owned	.067 (.67)	.33 (.97)	.16 (1.97)**	.040 (.056)
Government-owned	.21 (1.57)	.96 (2.97)***	.18 (1.61)	-.48 (-.76)
Undercapitalized	.44 (3.78)***	-.084 (-.32)	.76 (6.93)***	.086 (.20)
Growth	-3.24 (-3.22)***	4.91 (1.64)	-3.66 (-3.19)***	7.73 (2.24)**
Inflation	-.44 (-.89)	4.77 (3.44)	-.68 (-1.57)	2.76 (1.30)
Real interest rate	-.30 (-.84)	.82 (.75)	-.065 (-.20)	-1.04 (-.68)
Income level	-.15 (-2.25)**	-.21 (-1.80)*	-.13 (-2.96)***	-1.07 (6.21)***
Summary regulation	-.018 (-1.31)	.016 (.51)	-.015 (-1.35)	-.034 (-.79)
Systemic financial crisis	.40 (4.08)***	1.30 (4.67)***	.44 (5.59)***	2.01 (4.64)***
Period fixed effects (F-statistic)	5.09***		5.25***	
Regression F	22.3***	40.4***	38.9***	53.7***
Adj. R <sup>2</sup>	.36	.56	.40	.46
No of obs.	1001	1131	1556	1873
No of banks	185	206	282	330

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. \*/\*\*/\*\* denotes significance at 10/5/1 percent confidence level.

Note: a) Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Table 4. Results from estimation on individual market discipline components

Dependent variable	1. Non-performing loans / equity	2. Negative market Z-score	3. Non-performing loans / equity	4. Negative market Z-score
Estimation method <sup>a</sup>	OLS	2SLS	OLS	2SLS
Share of formally insured debt	.55 (2.58)**	-.061 (-.13)	.61 (3.47)***	1.16 (1.68)*
Confidence in deposit insurance	-.33 (-1.24)	1.43 (2.13)**	-.27 (-1.25)	-1.95 (-1.96)**
No-bailout credibility 1	.033 (.13)	-.32 (-.41)		
No-bailout credibility 2			.46 (2.54)**	-2.60 (-3.00)***
(Share of formally insured debt) × Leverage	-.17 (-.46)	.95 (.65)	-.21 (-1.32)	-6.35 (-5.24)***
(Confidence in deposit insurance) × Leverage	.22 (.38)	1.63 (.79)	.12 (.53)	13.1 (5.93)***
(No-bailout credibility 1) × Leverage	-.12 (-.35)	-1.10 (-.72)		
(No-bailout credibility 2) × Leverage			.18 (.65)	-1.46 (-.86)
Inside to outside capital	-2.33 (-.57)	-86.6 (-4.52)***	2.77 (1.02)	-97.0 (-7.18)***
(Inside to outside capital) <sup>2</sup>	38.2 (2.74)***	122.9 (2.23)**	7.23 (1.72)*	135.1 (3.15)***
(Inside to outside capital) × (Share of formally insured debt)	-4.68 (-1.47)	12.54 (1.48)	-5.27 (-1.83)*	21.1 (1.76)*
(Inside to outside capital) × (Confidence in deposit insurance)	-4.22 (-.75)	-13.0 (-.45)	.65 (.17)	-28.3 (-1.30)
(Inside to outside capital) × (No-bailout credibility 1)	-5.80 (-1.80)*	51.7 (4.44)***		
(Inside to outside capital) × (No-bailout credibility 2)			-6.59 (-2.77)***	53.2 (4.22)***
Leverage	.37 (.89)	2.49 (1.63)	.090 (.36)	1.29 (.90)
Charter value (Q)	-.27 (-1.25)	-.51 (-.74)	-.079 (-.55)	.67 (.67)
Bank size	-.023 (-.59)	-.052 (-.38)	.016 (.64)	-.58 (-2.34)**
Liquid assets / total assets	-.40 (-.96)	.17 (.19)	-.46 (-1.57)	-.015 (-.014)
Institutions' share of outside equity	-.26 (-1.16)	-.55 (-.61)	-.31 (-1.72)*	1.83 (1.31)
Foreign-owned	-.010 (-.092)	.51 (1.31)	.096 (1.32)	-1.01 (-2.03)**
Government-owned	.17 (1.10)	.93 (2.76)***	.17 (1.49)	.20 (.37)
Undercapitalized	.46 (4.20)***	-.27 (-.86)	.72 (6.89)***	.12 (.35)
Growth	-2.65 (-2.61)***	4.99 (1.72)*	-3.33 (-2.80)***	5.30 (1.60)
Inflation	-.11 (-.20)	4.78 (3.56)***	-.58 (-1.27)	4.50 (2.71)***
Real interest rate	-.24 (-.64)	3.05 (2.74)***	-.24 (-.75)	3.77 (2.12)**
Income level	-.15 (-2.42)**	-.30 (-2.51)**	-.11 (-2.59)***	-.45 (-2.97)***
Summary regulation	-.017 (-1.23)	.0093 (.33)	-.016 (-1.51)	.0077 (.21)
Systemic financial crisis	.21 (3.08)***	.89 (3.75)***	.20 (3.22)***	1.17 (3.08)***
Period fixed effects (F-statistic)	4.73***		5.96***	
Regression F	18.9***	39.7***	34.8***	61.3***
Adj. R <sup>2</sup>	.37	.59	.42	.51
No of obs.	993	1122	1535	1852
No of banks	185	206	282	330

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance

and correlation over time within cross-sections. \*/\*\*/\*\* denotes significance at 10/5/1 percent confidence level.

Note: a) Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Table 5. Results from estimation of country fixed effects models<sup>a</sup>

Dependent variable	1. Non-performing loans / equity	2. Non-performing loans / equity
Estimation method	OLS	OLS
Market discipline 1	-.017 (-.045)	
Market discipline 2		.052 (.19)
(Market discipline 1) × Leverage	-.42 (-.98)	
(Market discipline 2) × Leverage		.027 (.079)
Inside to outside capital	-17.3 (-4.19)***	-4.41 (-1.84)*
(Inside to outside capital) <sup>2</sup>	62.4 (4.12)***	11.4 (2.14)**
(Inside to outside capital) × (Market discipline 1)	2.47 (.45)	
(Inside to outside capital) × (Market discipline 2)		-1.83 (-.40)
Leverage	.79 (3.26)***	.31 (1.58)
Charter value (Q)	-.047 (-.32)	-.051 (-.39)
Bank size	-.027 (.71)	-.019 (-.71)
Liquid assets / total assets	-.80 (-1.64)	-.070 (-.23)
Institutions' share of outside equity	-.19 (-.75)	-.26 (-1.32)
Foreign-owned	-.13 (-1.29)	.15 (2.31)**
Undercapitalized	.37 (3.59)***	.78 (7.28)***
Systemic financial crisis	.27 (2.18)**	.19 (2.06)**
Country fixed effects (F-statistic)	39.9***	65.6***
Period fixed effects (F-statistic)	9.65***	8.30***
Regression F	24.9***	31.0***
Adj. R <sup>2</sup>	.58	.52
No of obs.	1034	1609
No of banks	192	292

The table reports coefficient estimates from panel OLS estimation with country and period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. \*/\*\*/\*\*\*/ denotes significance at 10/5/1 percent confidence level.

Note: a) The government ownership dummy variable had to be dropped from these specifications to accommodate fixed effects for all countries.



Table 6. Results from estimation of the baseline regression with market discipline measured as subordinated debt/total assets<sup>a</sup>

Dependent variable Estimation method <sup>b</sup>	1. Non-performing loans / equity OLS	2. Negative market Z-score 2SLS
Subordinated debt/total assets	2.07 (.83)	-43.5 (-1.39)
(Subordinated debt/total assets) × Leverage	.62 (.70)	-60.0 (-2.09)**
Inside to outside capital (Inside to outside capital) <sup>2</sup>	-3.52 (-2.59)***	-57.3 (-4.23)***
(Inside to outside capital) × (Subordinated debt/total assets)	4.22 (1.35)	79.1 (1.96)*
(Inside to outside capital) × (Subordinated debt/total assets)	-28.9 (-.71)	879.5 (1.72)*
Leverage	.19 (2.22)**	5.76 (4.95)***
Charter value (Q)	-.15 (-.91)	-2.66 (-1.12)
Bank size	-.023 (-1.05)	.50 (2.12)**
Liquid assets / total assets	-.36 (-1.11)	.25 (.14)
Institutions' share of outside equity	-.35 (-1.79)*	-.16 (-.095)
Foreign-owned	.24 (2.40)**	.53 (.54)
Government-owned	.24 (1.73)*	-.46 (-1.00)
Undercapitalized	.67 (5.80)***	.33 (.62)
Growth	-4.89 (-3.24)***	.88 (.20)
Inflation	-2.42 (-3.14)***	2.96 (.75)
Real interest rate	-.052 (-.15)	-1.13 (-.71)
Income level	-.16 (-3.50)***	-.98 (-5.35)***
Summary regulation	-.022 (-1.84)*	-.015 (-.26)
Systemic financial crisis	.53 (4.95)***	1.62 (4.08)***
Period fixed effects (F-statistic)	2.28**	
Regression F	30.8***	64.4***
Adj. R <sup>2</sup>	.42	.33
No of obs.	1120	1391
No of banks	241	282

The table reports coefficient estimates from panel OLS/2SLS estimation with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. \*/\*\*/\*\* denotes significance at 10/5/1 percent confidence level.

Notes:

- Coefficients reported are for subordinated debt/total assets measured in percent (rather than as fractions as in Table 2).
- Estimation method was determined by Hausman tests of possible endogeneity of leverage and charter value. 2SLS uses country dummies as additional instruments.

Figure 1. Agency costs, creditor discipline, and the risk subsidy from deposit insurance

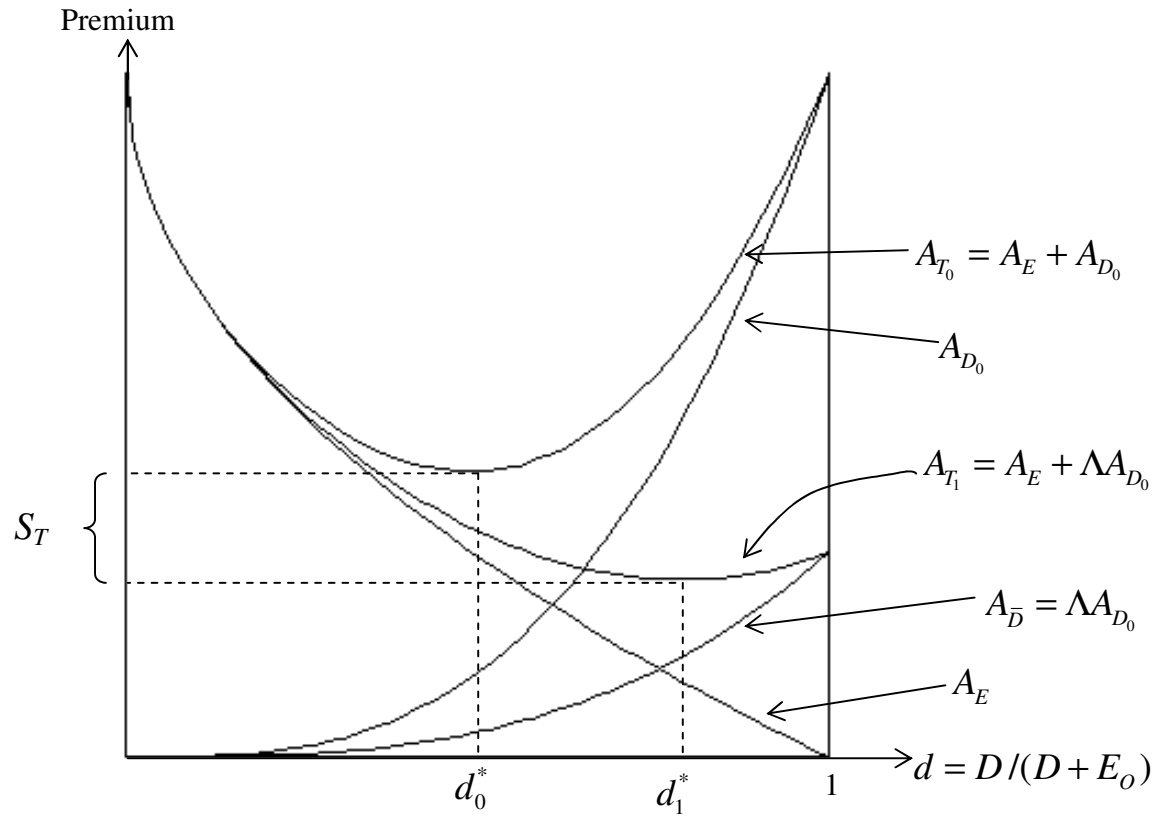
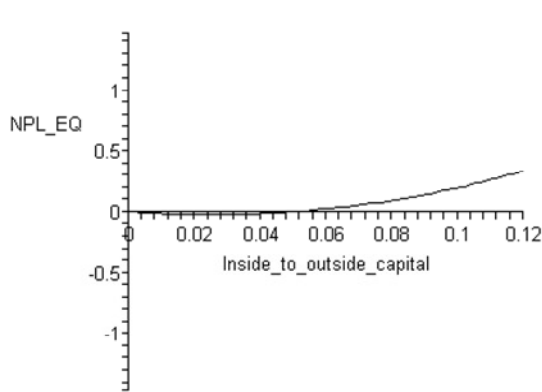
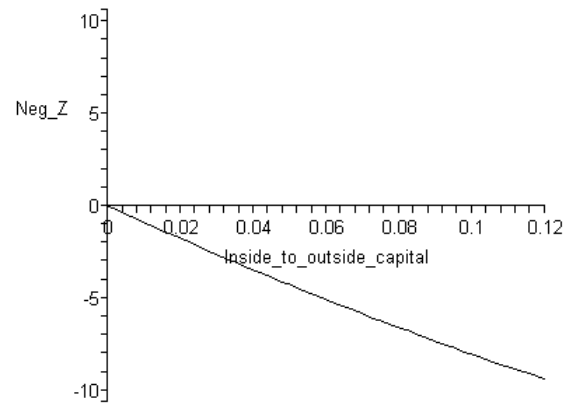


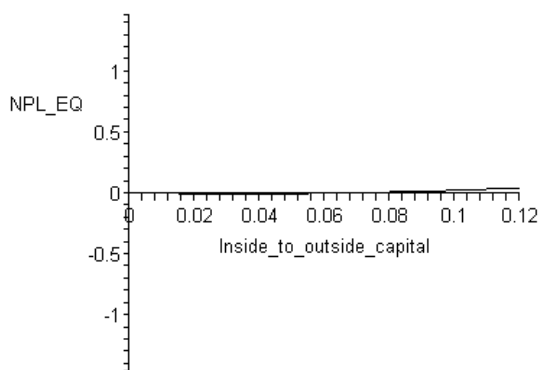
Figure 2. Estimated functions of the effect of ownership structure on risk



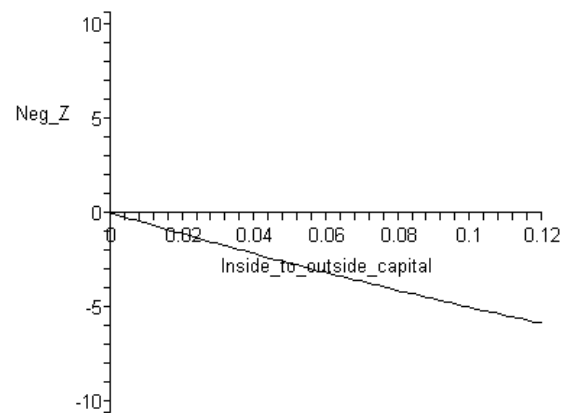
A. Risk is measured as non-performing loans over equity; market discipline measure 1 is used; 1001 observations (corresponds to specification 1 in Table 13)



B. Risk is measured as the negative market Z-score; market discipline measure 1 is used; 1131 observations (corresponds to specification 2 in Table 13)



C. Risk is measured as non-performing loans over equity; market discipline measure 2 is used; 1556 observations (corresponds to specification 3 in Table 13)



D. Risk is measured as the negative market Z-score; market discipline measure 2 is used; 1873 observations (corresponds to specification 4 in Table 13)

## Appendix. Sample distribution across countries and over time

Table A1. Distribution of banks and key institutional features by country

Country	Number of banks	Average size <sup>a</sup> of included banks in 2005	Formal deposit insurance in place	Financial crisis during sample period
Argentina	4	4,853	Yes	1995, 2001-2005
Australia	9	55,698	No	No
Austria	4	18,625	Yes	No
Brazil	14	13,558	Yes	1995-1999
Canada	9	90,587	Yes	No
Chile	5	14,229	Yes	No
Colombia	11	2,244	Yes	No
Czech Republic	1	20,942	Yes	No
Denmark	40	847	Yes	No
Egypt	20	978	No	No
Finland	2	8,201	Yes	No
France	11	22,495	Yes	No
Germany	16	11,632	Yes	No
Greece	10	13,638	Yes	No
Hong Kong	7	15,165	No	No
Hungary	2	5,265	Yes	1995
India	37	13,051	Yes	No
Indonesia	22	4,154	Yes (from 1998)	1997-2002
Ireland	5	127,953	Yes	No
Israel	8	16,406	No	No
Italy	19	28,383	Yes	No
Japan	86	19,092	Yes	1995-2005
Kenya	7	575	Yes	1995
South Korea	8	33,349	Yes (from 1996)	1997-2002
Lithuania	4	955	Yes (from 1996)	1995-1996
Malaysia	3	28,277	Yes (from 1998)	1997-2001
Malta	4	1,425	No	No
Morocco	5	6,241	No	No
Netherlands	1	1,039,000	Yes	No
Pakistan	20	1,345	No	No
Peru	9	948	Yes	No
Philippines	15	1,626	Yes	1998-2005
Poland	12	6,548	Yes	1995
Portugal	3	73,289	Yes	No
Romania	3	1,472	Yes (from 1996)	1995-1996
Singapore	2	71,652	No	No
South Africa	2	5,477 <sup>b</sup>	No	No
Spain	14	25,982	Yes	No
Sri Lanka	7	658	Yes	No
Sweden	2	217,181	Yes	No
Switzerland	6	6,780	Yes	No
Taiwan	15	11,636	Yes	1997-1998
Thailand	13	7,679	Yes (from 1997)	1997-2002
Turkey	12	8,183	Yes	2000-2005
United Kingdom	3	18,409	Yes	No
United States	15	3,511	Yes	No
Venezuela	14	1,027	Yes	1995

Notes: a) Total assets in millions of USD. b) Refers to average size in 2004 (no observations for 2005).

Table A2. Distribution of observations on the dependent variables over time

Year	Dependent variable, number of obs's	
	Non-performing loans over equity	Market Z-score
1995	0	1
1996	2	1
1997	19	23
1998	207	227
1999	271	273
2000	306	301
2001	325	321
2002	340	341
2003	345	357
2004	380	433
2005	339	410

## Notes

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<sup>1</sup> Some aspects of bank or banking system characteristics may counterbalance this effect – e.g., entry barriers caused by restrictive regulation or market concentration (Marcus, 1984; Keeley, 1990), creating rents from valuable bank charters for ‘incumbent’ banks.

<sup>2</sup> At country-level, recent studies indicate that the existence of an explicit deposit insurance system increases the probability of systemic banking crises, and that such systems have a more detrimental effect on banking system stability in weak institutional environments, where effective prudential supervision and overall transparency and reliability of the legal system, etc., cannot easily counterbalance the moral hazard risk introduced by deposit insurance (Demirgüç-Kunt and Detragiache, 2002). These results parallel historical studies of bank failures in the US before and after the introduction of federal deposit insurance, which have found bank risk-taking and failure rates to correlate with the presence of deposit insurance. For instance, Calomiris (1990) and Alston et al (1994) found that US banks in the 1920s were on average riskier and more susceptible to failure in states where a deposit insurance system was present than in states without such a system. Grossman (1992) found that the introduction of federal deposit insurance in the 1930s initially lowered banks’ risk taking, but that once insured, banks increased risk beyond pre-deposit-insurance levels. The effect was particularly pronounced in states with comparatively lax supervision.

<sup>3</sup> Benston and Kaufman (1997) report that formally uninsured deposit holders incurred losses in only 17 percent of bank failures in 1991, and that the deposit insurance reform pushed that figure up to 54 percent in the following year.

<sup>4</sup> One weakness with their results, however, may be that they are not necessarily particularly representative out of sample. Clearly, their results imply comprehensive implicit guarantees in European countries before the introduction of formal deposit insurance systems. However, several European countries introduced such systems, if not as a direct consequence of, then very shortly after having experienced major banking crises, involving massive bailouts. Crises were particularly prevalent in smaller, highly concentrated banking markets centered around a small number of systemic banks (Finland, Norway, Sweden) – a factor which contributed to the extensive bailouts. It is not clear that post-crisis, pre-deposit-insurance risk behavior in these countries’ banks reflects average *ex ante* bailout expectations for countries without explicit deposit insurance in general. If the authors’ observations on ‘no deposit insurance’ are unbalanced toward such

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countries and such circumstances, they will overestimate the risk-reducing potential of explicit deposit insurance.

<sup>5</sup> This is consistent with the predictions of, e.g., Marcus (1984) and Keeley (1990) that deregulation will tend to erode the value of incumbent banks' charters that otherwise serves to counterbalance the risk-increasing incentives of deposit insurance.

<sup>6</sup> The 'state of the industry' parameter takes on a role similar to that of charter value in other studies: an exogenous conditioning variable representing investment opportunities, the regulatory climate, the level of competition, etc.

<sup>7</sup> To my knowledge, the entrenchment hypothesis has never been operationalized and directly tested, but is only used to explain certain empirical results.

<sup>8</sup> Jensen and Meckling (1976) make agency costs a function of capitalization rather than, as here, of leverage,  $d$ , which makes my model a 'mirror image' of theirs. It has no bearing on the model's implications. The explicit assumptions about the functional form of agency costs that I make here are largely implicit in Jensen and Meckling (1976).

<sup>9</sup> Whether the assumption of underpriced deposit insurance is a realistic one is open to debate. Laeven (2002) finds that the difference between average 'fair' (option-value) premia and average official premia over the 1990s in a number of countries with explicit deposit insurance was not significantly different from zero (although official premia were substantially lower for some countries). However, this non-significance is hardly surprising: given the large variance in option-implied premia over the cross-section of banks a null hypothesis of equality would be difficult to reject. Demirgüç-Kunt and Huizinga (2004), on the other hand, find that explicit deposit insurance does indeed provide a subsidy, in terms of a reduction in average debt-service rates net of deposit insurance premia, for a larger sample of countries over the same time period as that studied by Laeven. The assumption of imperfect risk adjustment of insurance premia is probably less controversial than that of underpricing, given that during the period covered here, the vast majority of countries did not risk-adjust premia at all. Exceptions were Finland, Peru, Sweden, and the US (again, see Demirgüç-Kunt and Huizinga, 2004).

<sup>10</sup> Note that a necessary condition for deposit insurance to shift the agency cost curve is that disciplining by the 'exogenous' insurer – i.e., in practice government supervision – is less effective than disciplining by

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holders of risky debt. This is a less dramatic assumption than it might seem at first, since the supervisory authorities' main disciplinary tool is a more or less discrete capital adequacy requirement (the effect of which is considered in the model). Moreover, I don't make any *a priori* assumption about the effectiveness of market discipline by creditors, and the effect of bank co-financing of the deposit insurance scheme, finally, has already been mentioned.

<sup>11</sup> I also assume that outside financing purely by (insured) deposits is not possible because of a number of 'institutional' constraints related to equity: for instance (though, perhaps, rather trivially), the included banks are all listed on a stock exchange, and maintaining that listing presumes that a certain share of the equity capital be tradable (which would imply that at least some *outside* equity capital is maintained). However, the assumptions on the deposit-insurance-related parameters are what most generally prevent optimal capital structure from simply turning to  $d = \phi = 1$  within the model.

<sup>12</sup> This does not mean that the shareholders' moral hazard incentive is not there, only that it is not exploited, and that the creditors know about the shareholders' weak position and price the debt accordingly.

<sup>13</sup> Previous research provides surprisingly few clues as to the effect of equity ownership structure on debt agency costs, as noted by Anderson et al. (2003): "little, if any, work examines the relation between ownership structure and the shareholder-bondholder conflict" (p. 264). The work that does exist is somewhat contradictory. Kim and Sorensen (1986) find that firms with more insider ownership have higher debt ratios, but cannot distinguish between the effect of equity and debt agency costs. Bagnani et al. (1994) argue for a non-monotonic relationship between managerial ownership and bondholder returns, but only find evidence of a positive association at intermediate levels of managerial ownership. Anderson et al. (2003) also find evidence that equity ownership structure affects debt costs, but they focus on a particular aspect of ownership structure – ownership by founding families – which makes the results difficult to generalize. Cremers et al. (2006) conclude that the net impact of shareholder control on bondholders is theoretically unclear, and produce results where the effect of shareholder control on credit risk premia depends on takeover vulnerability.

<sup>14</sup> In option-pricing-based analyses of the value to shareholders of deposit insurance, value can be created both by increasing asset risk and by increasing leverage (defined as the ratio of insured debt to total assets)



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– see, e.g., Merton (1977). The ‘tradeoff’ between asset risk and leverage is unclear. In this paper, it is determined by ownership structure.

<sup>15</sup> The condition is that the sum of  $\gamma$  and  $\kappa$ , confidence in the deposit insurance scheme and the received probability that uninsured creditors will not be bailed out, exceeds unity.

<sup>16</sup> See, e.g., Martinez Peria and Schmukler, 2001, for evidence on bank risk and depositor discipline during banking crises.

<sup>17</sup> The Z-score is widely used as a risk measure in the banking literature, see, e.g., Hannan and Hanweck (1988), Boyd et al. (1993), Beck and Laeven (2006); the market-based version is used by, e.g., Crouzille et al. (2004).

<sup>18</sup> A potential weakness with this proxy of deposit insurance coverage is that it assumes that banks within a country generally have similar portions of insured and uninsured deposits; that is, that no individual bank, for instance, has an unusually large share of very large (and hence uninsured) deposits.

<sup>19</sup> This proxy is equivalent to the share of deposit value covered under the assumption of one deposit per capita, and may overstate coverage, particularly in rich countries where the deposit count can reasonably be expected to well exceed the population count; it may be less of an overestimation for developing countries where the average number of bank accounts per capita is lower.



## **Divergence of bank risk indicators and the conditions for market discipline in banking**

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### **Abstract**

Using market forces to discipline banks' risk taking is high on the agenda for regulators, as manifested, e.g., by the inclusion of a pillar for 'market discipline' in the Basle II framework. Market monitoring of bank risk has typically been tested by regressing market-based risk indicators on various benchmark indicators (such as accounting ratios and credit ratings) to detect whether the market tracks bank risk. This approach overlooks the methodological 'unobservability' problem that testing one against another (group of) imperfect proxy indicator(s) of an unknown true value must yield limited conclusions as to the appropriateness of either measure – particularly in the event of failure to establish a significant association. This paper uses an unobserved-variables approach to associate the divergence between different risk indicators on the one hand, with proxies of the conditions for market discipline to function on the other, and identifies implied functional relationships of differences in relative information content in the included risk measures. Empirical results for a large panel of banks worldwide suggest that market-based measures are less accurate than accounting indicators for most levels of institutional quality, but that spreads on subordinated debt may be more informative than either equity-based or accounting-based measures if the conditions for market discipline are well satisfied. A combination measure incorporating both accounting and market data, finally, has superior accuracy regardless of the level of institutional quality, indicating that market data may contain complementary information on risk. This result confirms previous results on the relative information content of different risk indicators.

**Key words:** bank risk; risk indicators; subordinated debt; market discipline; panel data

**JEL:** G10; G21; G28

## **Divergence of bank risk indicators and the conditions for market discipline in banking**

### **1. Introduction**

Banks' risk behavior is a matter of considerable interest because of the potential systemic consequences of excessive risk taking in banks, and because of the particular incentive structure facing banks (especially bank shareholders) as a consequence of their typical financing pattern, which is in large part insured debt. In the debate and research on bank regulation and supervision, there has been an increased interest of late, among academics and representatives of regulatory bodies alike, in the idea of creating supervisory structures which offer the possibility to employ, to a greater extent, market forces in the service of banking sector supervision. The goal is to make supervision more market driven and 'incentive-compatible' (Calomiris, 1999). Market discipline as a complementary mechanism (beside the traditional tools used by supervisory authorities) to 'regulate' banks' risk behavior has long been an issue of study for academics, but has recently gained increasing attention with regulators, as manifest, for instance, by the inclusion of the third pillar in the Basle II Accord.

Market discipline (in banking) is commonly defined as a combination of *monitoring* and *influence* (see, e.g., Flannery, 2001; Bliss and Flannery, 2002), where 'monitoring' refers to the process whereby market participants (holders of various classes of bank capital) collect information on the bank's financial condition and market prices on bank claims reflect this information, and 'influence' refers to the market's capacity to actually get the bank to adjust its risk behavior in accordance with the signals generated by fluctuations in market prices.

Most of the literature in this area has focused on the prospects for market discipline being exerted by holders of equity and, in particular, by holders of uninsured (subordinated)

debt. Specifically, the empirical literature has focused on the monitoring aspect (the extent to which equity prices or rates of interest paid on subordinated bonds adequately reflect variation in bank risk). The vast majority of papers testing the risk sensitivity of market prices perform (linear) regressions of some market-based measure of bank risk (e.g. the spreads on the bank's subordinated debt) on a set of other risk measures – typically accounting information and/or ratings. The establishment of a significant relationship between the market-based measure and the benchmark measure(s) is interpreted as a sign that the market adequately prices risk, and thus that market discipline would be a useful mechanism to restrain excessive risk taking by banks. Equally importantly, failure to establish a significant relationship is interpreted as absence of market discipline.

There are several methodological problems with this general approach (including, for instance, various specification problems related to functional form, omitted variables, etc. – see, e.g., Gorton and Santomero, 1990, and Pennachi, 2001). In this paper, I focus on the fact that this general approach (and thus much of the empirical literature in this field) overlooks an *unobservability problem*, which limits the scope for interpreting the results in terms of the prospects for market discipline in general. The problem essentially lies in benchmarking one imperfect proxy (based on market prices) on other imperfect proxies (based on accounting information, ratings, etc.) of an unknown fundamental variable, *viz.* ‘true’ risk. It is not possible to know a priori which proxy contains the more accurate information on risk, and therefore – in the event of failure to establish a statistically significant association between the left-hand side variable and the right-hand side variable(s) – it is not possible to infer which side of the equation that is ‘wrong’. Using accounting information, ratings, and other commonly used risk proxies as benchmarks effectively entails restricting the definition of ‘success’ to correspondence with another, already available and imperfect measure. The implication is that (i) market prices can never contain more (useful) information than the benchmark measures (and

whenever market prices do not correspond with the benchmark measures they are irrelevant), and (ii) therefore, indirect market discipline as a supervisory tool is superfluous, because all the information we need or could possibly hope to extract is already incorporated in already available measures. In a manner of speaking, market information is then not ‘allowed’ to contain any more information than we already have.

The purpose of this paper is to devise and implement a simple methodology which addresses this unobservability problem, and by which it is possible to identify if, which, and under what circumstances, market-based measures may contain more information than certain common benchmark measures. This is an important question for assessing the potential merits of market discipline, because although it may be relatively uncontroversial to suggest that market-based risk indicators contain *complementary* information, one of the points with market discipline is that the indicators are observed continuously (whereas, e.g., financial statement data are only observed at an annual or quarterly basis). It is therefore of interest to assess the informativeness of market-based indicators *individually*.

The paper uses an unobserved-variables approach to associate the divergence between different risk indicators on the one hand, with proxies of the conditions for market discipline to function on the other, and identifies implied functional relationships of differences in relative information content in the included risk measures. The approach is essentially a systematization of the simple idea that if the disconnection between a market-based risk indicator and some benchmark indicator is greater when the conditions for market discipline are well satisfied, then it may be the benchmark indicator, rather than the market-based indicator, that is relatively less informative.

The methodology is implemented empirically on a panel of several hundred banks worldwide between the years 1994 and 2005. The results suggest that market-based risk measures are less informative than accounting indicators of risk for most levels of institutional

quality, but that some market-based indicators are more informative if the conditions for market discipline are well satisfied. Specifically, stock return volatility proves to be less informative than the accounting indicators for all observed levels of institutional quality, whereas spreads on subordinated debt are more informative for the highest level of institutional quality. A combination measure incorporating both accounting and market data, finally, has superior accuracy regardless of the level of institutional quality, indicating that market data always contains complementary information on risk.

The paper is structured in the following way. Section 2 contains a selective review of literature addressing the conditions for market discipline and a brief run-down of empirical literature testing market monitoring in banking. Section 3 describes the methodology and develops the hypotheses, whereas Section 4 presents the estimation methods and the data. In Section 5, the empirical results are reported, and Section 6, finally, concludes.

## **2. Market discipline and bank risk – concepts, results, and methodological problems**

### **A. Market discipline**

In principle, any holder of a risky claim on the bank which is tradable on a market could instill market discipline on banks. Holders and prospective buyers of the claim would have an incentive to monitor the bank's risk taking, and would therefore discipline banks' risk-taking – directly, by (incrementally) influencing the bank's cost of capital, and indirectly, by providing a signal (in the form of the market price of the claim) to the bank itself, to the supervisory authority, and to other stakeholders, of the market's assessment of the bank's risk behavior. Indirect market discipline could be imposed, e.g., by using such price signals as triggers for prompt corrective action (PCA) or for on-site examinations by the supervisory authority, or as basis for setting risk-adjusted deposit insurance premia.

The indirect and direct dimensions of market discipline are captured by the widely used definition of market discipline as a combination of *monitoring* and *influence* (see, e.g., Flannery, 2001; Bliss and Flannery, 2002). Monitoring captures the information aspect of market discipline: current and prospective claimants on the bank inform themselves of the bank's condition and set prices on their claims accordingly. Influence refers to the mechanism by which banks, in order to avoid the adverse consequences of stronger discipline (such as higher financing costs, closer monitoring by market participants as well as regulators, and, ultimately, liquidity problems as a consequence of some sources of financing being cut off) decrease their risk exposure (or, indeed, avoid increasing it in the first place).

The literature on market discipline in banking is mostly empirical (see next subsection), but more or less implicit in the empirical applications are assumptions on a couple of underlying questions, which have received some – but rather limited – treatment elsewhere. The first relates to the *conditions under which market discipline can be expected to 'work'* – i.e., a systematization of the basic requirements on the institutional setting that need to be satisfied for the market to (be able to) fulfill its task as disciplinarian. The second is related to the first: are the market prices of some classes of bank capital better able to produce useful signals of bank risk – or, differently put, *can market discipline be better imposed by shareholders or by debtholders?* This second question is related to the first one insofar as its answer may depend on differences in the extent to which the conditions for market discipline are satisfied for different classes of claims on the bank.

As a general treatment of the first question, Lane (1993) sets up four conditions for market discipline to work:<sup>1</sup> (i) open capital markets; (ii) good information about a borrower's existing liabilities<sup>2</sup>; (iii) no prospect of a bailout (the supplier of financing must not benefit from third-party guarantees issued on the claim); and (iv) responsiveness of the borrower to

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<sup>1</sup> Lane presumes a debt claim, but these conditions for market discipline should hold more generally for any type of risky claim.

<sup>2</sup> Presumably, one would add to this information about the borrower's assets and/or income streams.



market signals. Of these four conditions for market discipline in general, the first three concern primarily the monitoring aspect, whereas the fourth directly reflects the influence aspect. The monitoring aspect of market discipline is equivalent to the requirement that market signals accurately reflect risk; if they do, then the conditions for market monitoring of risk are satisfied. Therefore, market monitoring (the extent to which risk information is impounded in market prices) is conditioned on the openness of capital markets, the quality of the available information about the issuer of the security, and the *de facto* riskiness of the claim. However, if monitoring is costly, it is unlikely that market participants will expend costs for monitoring banks that are unresponsive to market signals (Llewellyn, 2005); thus, the monitoring aspect of market discipline is somewhat conditional on the influence aspect, so that the expectation of finding risk-relevant information in market prices becomes conditional on all four conditions. I will rely on this general grouping of market-discipline conditions in the empirical part of the paper.

The answer to the question whether shareholders or debtholders are more apt to exert market discipline is more ambiguous. One class of debtholders usually precluded from the discussion altogether, however, are (small) deposit holders. They are generally considered more or less immune to bank risk, since under deposit insurance, they have little incentive to monitor bank risk and instill market discipline. On the other hand, it is often considered that holders of *risky* debt (such as unsecured, or subordinated, bonds and notes) would act as better monitors of bank risk than equity holders (see, for instance, Calomiris, 1999; Evanoff and Wall, 2000; Sironi, 2001; Benink and Wihlborg, 2002). The argument largely rests on the notion that the risk-shifting incentives of shareholders resulting from the option value of equity in the presence of deposit insurance (Merton, 1977) make shareholders too inclined toward risk to serve as effective disciplinarians. Conversely, the focus of bondholders on downside risk mean that their incentives are more or less in line with those of the supervi-

sor/deposit insurer, and consequently that prices of uninsured debt would better reflect default risk (or at least be a more relevant risk meter for supervisors) than equity prices.

It is not clear if this argument stands up to closer inspection. The relatively scant theoretical research that exists (Levonian, 2001; Nivorozhkin, 2005) suggests that spreads on subordinated debt would more accurately reflect default risk than equity prices only under certain conditions (associated with, *inter alia*, the relative shares of insured and uninsured debt, and the magnitude of bankruptcy costs). Some criticism voiced against the idea of relying on debt market discipline rests on the more mundane and practical point that stock markets are typically much more liquid than debt markets, and that bond spreads would be noisy signals of risk because the risk information is obfuscated by large liquidity premia (see, e.g., Saunders, 2001). The question whether stock prices or bond spreads better reflect bank risk is therefore to some extent an empirical one.

I next turn to a brief run-down of some main empirical results, and then turn to the particular methodological problem that is the focus of interest in this paper.

## B. Evidence on market monitoring of bank risk

Tests of monitoring by holders of risky bank claims have typically been conducted by one of two main approaches. The first general method – which I will henceforth refer to as the ‘risk-sensitivity’ approach – consists in regressing some market-based risk indicator on a set of benchmark risk measures (typically credit ratings and/or various accounting ratios) and control variables. If the benchmark risk measures are found to be significant determinants of the market signal, the result is taken as evidence of market self-regulation of bank risk; conversely, absence of significant associations between the market and the benchmark indicator(s) is interpreted as a rejection of market monitoring.

In the other main approach – which may be termed the ‘early-warning’ approach – market-based risk measures are tested as *predictors*, or leading indicators of actual bank failure, of insolvency, or of general deterioration of financial status (defined in different ways). Both these general approaches have been applied to both equity- and debt-based risk indicators with varying results. In what follows, I will focus on the risk-sensitivity approach (for a more comprehensive overview of results, and a methodological criticism against the early-warning approach, see Appendix B).

A number of early studies test the sensitivity of the interest cost of large (and hence uninsured) certificates of deposit (CDs) or of the spreads on subordinated notes and debentures (SNDs) issued by US banks during the 1980s to various accounting measures of risk, using straightforward linear regression specifications. The results of these studies are, taken together, fairly inconclusive: whereas, for instance, Avery et al. (1988) and James (1990) find little evidence of accounting risk reflected in debt prices, other studies find that CD rates or SND spreads are significantly determined by at least some balance sheet items (Hannan and Hanweck, 1988; James, 1988; Keeley, 1990). Pointing out that theory predicts a non-linear relation between risk premia on debt and balance-sheet measures of risk, Gorton and Santomero (1990) derive implied asset volatilities from sub-debt spreads, and regress them on accounting indicators (using the same dataset as Avery et al., 1988), but do not find evidence in support of the market-monitoring hypothesis. Brewer and Mondschean (1994), on the other hand, find evidence that the quality of banks’ assets is reflected in both CD rates and in stock return volatilities.

Several later studies report relatively consistent evidence in support of market monitoring by sub-debt holders, using credit ratings, or ratings changes, as benchmark risk measures (Jagtiani et al., 2002; Sironi, 2002, 2003; Pop, 2006). Hall et al. (2001) and Krishnan et al. (2006), on the other hand, are unable to produce evidence of ratings being reflected in

various equity-based risk measures or in bond spreads, respectively. Event studies on announcement effects of ratings changes further complicate the picture: Berger and Davies (1998) find no announcement effects on abnormal stock returns, whereas Gropp and Richards (2001) find significant effects on stock returns but not on bond returns.

Considerations regarding the underlying conditions for market discipline often explicitly or implicitly factor into the research design of a large part of this literature (as previously noted). The ‘no-bailout’ condition, for example, is addressed by a number of papers. Thus, the conjectural government guarantees possibly associated with banks being ‘too big to fail’ are considered by Ellis and Flannery (1992) and Morgan and Stiroh (2001). Both papers find evidence of a ‘too-big-to-fail’ effect. Accounting for possible differences in the extent of implicitly issued guarantees under different regulatory regimes, Flannery and Sorescu (1996) and Hall et al. (2002) reach different results: whereas Flannery and Sorescu find that a more credible commitment to a no-bailout policy on the part of the deposit insurer leads to higher sensitivity of sub-debt yield spreads to underlying credit risk, Hall et al. find no such effect. The condition that markets must have good information about the borrower is also addressed by Morgan and Stiroh (2001). Their findings indicate that the market is tougher on more opaque banks, in terms of the sensitivity of sub-debt spreads to variations in asset quality.

A number of studies address various methodological problems associated with the standard risk-sensitivity approach to testing market monitoring.<sup>3</sup> At the focus of interest for the remainder of this paper is the *unobservability problem* described in the introduction.<sup>4</sup> The

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<sup>3</sup> The issue of non-linearity between bond spreads and standard accounting-based risk indicators, as addressed by Gorton and Santomero (1990), has already been mentioned. This and other potential specification errors inherent in the standard risk-sensitivity approach, including possible omitted-variables problems, are addressed by Flannery and Sorescu (1996) and Pennachi (2001). Other contributions, for instance Covitz et al. (2004) and Goyal (2005), argue that the association between spreads on risky debt and standard benchmark risk measures may be underestimated unless it is taken into account that riskier banks may avoid issuing sub-debt in the first place (in order to avoid being disciplined), or that they may be forced to accept a higher number of restrictive covenants being included in the debt contracts. Covitz et al. (2004) find limited evidence in support of the former hypothesis, whereas Goyal (2005) finds that risk significantly determines covenants included in sub-debt issues.

<sup>4</sup> I have not seen this problem explicitly addressed in any of the empirical literature, although the problem is implicit in, e.g., Evanoff and Wall (2001) and Gropp and Richards (2001); already Gorton and Santomero (1990)

problem is this: If the existing benchmark risk indicators against which the market-based measure is tested are *a priori* ‘better’ measures, what is the point of having supervisors paying more attention to the market and imposing indirect market discipline by using market indicators as triggers for prompt corrective action, etc.? On the other hand, if the benchmark indicators are unsatisfactory gauges of risk, what can possibly be learnt from a test where ‘success’ is defined in terms of a close association between the tested market indicator and the unsatisfactory benchmark measures? Presumably, if markets can track risk as well as accounting ratios or rating agencies do, they can also do it better. If so, failure to uncover any significant relation between the market-based and the benchmark measures is consistent both with the hypothesis that market prices incorporate more information *and* with the hypothesis that they incorporate less information than the benchmark indicators. Event-study-type tests suffer from a similar type of problem, as illustrated by the results of Gropp and Richards (2001), for example.

As should be evident from the brief literature review above, improvements of risk-sensitivity tests have often consisted in controlling for factors thought to influence the extent to which markets can be expected to monitor risk. This reflects a *de facto* recognition that market discipline is conditioned on a number of parameters, such as the institutional setting. However, simply controlling for these factors does not remedy the unobservability problem. In the following section, I outline a method which makes use of the fact that the informativeness of market-based risk indicators is dependent on the *conditions for market discipline*, as laid out in Section 2A, whereas typical benchmark measures are not (or at least less so). Although the informativeness of different measures cannot be directly observed, observations on the institutional setting can provide a point of reference for inferring the relative informativeness of different risk indicators.

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recognize that the validity of this type of tests is conditional on the auxiliary hypothesis that the independent variables are accurate proxies of true risk; a similar criticism against the approach is raised in Saunders (2001).

### 3. Method and hypotheses

#### 3.1. Basic concepts and conjectures

Suppose a bank's 'true' risk equals the probability of default  $P$  (with mean  $\bar{P}$  and constant variance). True risk is unknown and can only be observed by proxy. There are two approximate indicators of  $P$ : a market-based indicator,  $M$ , and a benchmark indicator,  $B$ . From the hypothetical regressions

$$P = \alpha_M + \beta_M M + u \quad (1)$$

and

$$P = \alpha_B + \beta_B B + v, \quad (2)$$

define the *informativeness* of  $M$  and  $B$ , respectively, as  $R_M^2 = 1 - \frac{\text{var}(u)}{\text{var}(P)}$ , and  $R_B^2 = 1 - \frac{\text{var}(v)}{\text{var}(P)}$ .

Because  $P$  is unknown,  $R_M^2$  and  $R_B^2$  are also unknown, and therefore it is not possible to observe directly whether  $M$  or  $B$  is the more informative indicator of  $P$  (i.e., if  $R_M^2 < R_B^2$  or  $R_M^2 > R_B^2$ ).

Following the above notation, a standard 'risk-sensitivity' regression on the market-based risk indicator takes the (simplified) form

$$M = \gamma_0 + \gamma_1 B + w, \quad (3)$$

which by (1) and (2) can be rewritten as

$$\frac{P - \alpha_M - u}{\beta_M} = \gamma_0 + \gamma_1 \left( \frac{P - \alpha_B - v}{\beta_B} \right) + w. \quad (4)$$

Rearranging and simplifying yields

$$w = \delta_1 P + \delta_2 u + \delta_3 v, \quad (5)$$

where the lower-case  $p$  denotes deviations from the mean,  $\delta_1 = \frac{1}{\beta_M} - \frac{\gamma_1}{\beta_B}$ ,  $\delta_2 = -\frac{1}{\beta_M}$ , and

$\delta_3 = \frac{\gamma_1}{\beta_B}$ . Squaring both sides of (5) and taking expectations generates

$$\begin{aligned} E(w^2) &= \delta_1^2 E(p^2) + \delta_2^2 E(u^2) + \delta_3^2 E(v^2) + 2\delta_1\delta_2 E(pu) + 2\delta_1\delta_3 E(pv) + 2\delta_2\delta_3 E(uv) \\ &= \delta_1^2 \text{var}(P) + \delta_2^2 \text{var}(u) + \delta_3^2 \text{var}(v) + 2\delta_1\delta_2 \text{cov}(pu) + 2\delta_1\delta_3 \text{cov}(pv) + 2\delta_2\delta_3 \text{cov}(uv). \end{aligned} \quad (6)$$

One way to describe the unobservability problem is in terms of the relative contributions of  $\text{var}(u)$  and  $\text{var}(v)$  to  $E(w^2)$  (or, equivalently, to  $\text{var}(w)$ ). We can run the risk-sensitivity regression and observe  $E(w^2)$  (or, strictly speaking, we observe  $\hat{w}^2$ ), but it is not possible to determine the relative contributions of its components. If we observe a ‘large’  $\hat{w}^2$ , it could be due to a large contribution of  $\text{var}(u)$  relative to  $\text{var}(v)$ , or vice versa. Rejecting the market discipline hypothesis on the basis that  $M$  explains  $B$  poorly effectively entails *presuming* that  $\text{var}(u)$  is larger than  $\text{var}(v)$ .

But  $E(w^2)$  indicates how well  $M$  measures  $B$ . A small  $E(w^2)$  would suggest that  $M$  is a good proxy of  $B$ ; conversely, a large  $E(w^2)$  would suggest the opposite. In the latter case,  $M$  could be a poor proxy of  $B$  *either* because it is a less informative proxy of  $P$ , *or* because it is *more* informative.

Now assume that the informativeness of the market-based indicator depends positively on the extent to which the conditions for market discipline are satisfied, as measured by some variable  $C_{MD}$ , whereas the benchmark indicator is invariant to these conditions.<sup>5</sup> In other words, more liquid financial markets, better information, lower bailout probability, etc., will result in a higher  $R_M^2$ , but will not affect  $R_B^2$ .

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<sup>5</sup> I will henceforth refer to these conditions as ‘conditions for market discipline’, ‘MD conditions’, or sometimes more loosely as ‘institutional quality’. The assumption that market-based risk indicators are sensitive to these conditions, whereas common benchmark indicators are not, is qualified and discussed more in detail in subsection 3.3.

Suppose further that from a regression of the type represented by equation (3) over a large sample for which there is ‘sufficient’ variation in  $C_{MD}$ , we retrieve the individual  $\hat{w}_i^2$ ’s. I will call this a measure of the *divergence* between  $M$  and  $B$ . In line with the above argument,  $\hat{w}_i^2$  could be large either because  $M_i$  is less informative of  $P_i$  than  $B_i$  is, or because it is more informative. But we know that the informativeness of  $M$  is increasing in  $C_{MD}$  (whereas  $B$  is invariant to  $C_{MD}$ ). Now matching each  $\hat{w}_i^2$  against the corresponding observation on MD conditions,  $C_{MDi}$ , it would make intuitive sense to suggest, for example, that if large  $\hat{w}_i^2$ ’s were observed when conditions for market discipline are poorly satisfied ( $C_{MDi}$  is ‘small’), it is more likely to be because  $M_i$  is less informative of  $P_i$  than  $B_i$ . In fact, it is possible to infer more than that. Suppose that over the entire sample we observe that the  $\hat{w}_i^2$ ’s consistently decrease as the  $C_{MDi}$ ’s increase. Such an observation is only consistent with  $M$  being an ‘initially’ less informative indicator of  $P$ ; as  $C_{MD}$  increases, so does  $R_M^2$ , thereby successively closing the gap to  $R_B^2$ , and by so doing also decreasing the ‘divergence’ between  $M$  and  $B$ . Conversely, if  $\hat{w}^2$  consistently *increases* in  $C_{MD}$ , then that would suggest that  $M$  becomes a poorer and poorer indicator of  $B$  – not because it becomes less informative about  $P$  (since we know that  $R_M^2$  increases in  $C_{MD}$ ), but because it becomes increasingly *more* informative than  $B$  about  $P$  (the gap between  $R_M^2$  and  $R_B^2$  opens up more and more. The main possible outcomes of a test of the *divergence* between  $M$  and  $B$  against the conditions for market discipline are as follows.

If  $M$  is on average *more* informative than  $B$  (over the entire sample), then the divergence between  $M$  and  $B$  (defined as  $\hat{w}^2$ ) will be increasing in the conditions for market discipline; if  $M$  is on average *less* informative than  $B$ , then the divergence between  $M$  and  $B$  will be decreasing in the conditions for market discipline; if no significant correlation can be estab-



lished, then the difference in informativeness between  $M$  and  $B$  is random, implying that the market-based measure and the benchmark measure are about equally informative on average (regardless of the quality of institutional features fostering market discipline). These three main possibilities are summarized in Table 1.

[Table 1]

### 3.2. Implementation and hypotheses

The discussion in the previous subsection suggests a two-step methodology, where the overall objective is to infer the difference in informativeness between some market-based and some benchmark indicators of bank risk. The steps are:

- 1) Run a standard risk-sensitivity regression of a market-based risk indicator  $M$  on one or several benchmark indicators  $B$ . Retrieve the residuals  $\hat{w}$ , and use them (squared) as a measure of the ‘divergence’ between  $M$  and  $B$ .
- 2) Run a regression of  $\hat{w}^2$  against some proxy of  $C_{MD}$ , and infer the relative informativeness of  $M$  and  $B$  from the sign of the slope coefficients.

The overall approach can be described in terms of an unobserved variables methodology.

Switching to lower-case, let  $m$  be a market-based measure of firm (bank) risk,  $\mathbf{b}$  a vector of benchmark risk measures, and  $\mathbf{z}$  a vector of control variables accounting for known (and observed) differences in variation between  $m$  and  $\mathbf{b}$  that are unrelated to the conditions for market discipline. Market and non-market measures do not contain exactly the same amount of information, so that  $E[m | \mathbf{b}, \mathbf{z}] = \alpha + \mathbf{b}\boldsymbol{\beta} + \mathbf{z}\boldsymbol{\gamma} + q$ , where  $q$  captures the difference in informativeness between  $m$  and  $\mathbf{b}$ . Because this difference is unknown,  $q$  is unobserved. In this framework, a ‘risk-sensitivity’ regression can be formulated as:

$$m = \alpha + \mathbf{b}\boldsymbol{\beta} + \mathbf{z}\boldsymbol{\gamma} + w, \quad w \equiv q + \varepsilon \quad (7)$$

where  $\varepsilon$  is the random error term. If  $q$  is strictly additive and uncorrelated with  $\mathbf{b}$ ,  $\mathbf{z}$ , a regular OLS regression on the above equation will produce consistent estimates of  $\beta$  and  $\gamma$ . By the inclusion of the intercept term, nothing of the information contained in  $q$  is lost, but it does normalize  $q$  so that  $E[q] = E[\varepsilon] = E[w] = 0$ .

With  $q$  still unobserved, it can be proxied by  $\hat{w}$ , since the only other component of  $\hat{w}$  is a random error, but because  $\hat{w}$  varies around zero, the actual values – positive or negative – do not reveal which measure is more informative,  $m$  or  $\mathbf{b}$ . However, as argued in subsection 3.1, the size of the ‘divergence’ between  $m$  and  $\mathbf{b}$ , measured as  $\hat{w}^2$ <sup>6</sup>, may vary systematically with the extent to which the conditions for market discipline are satisfied. Thus, the second step is to regress  $\hat{w}^2$  on some proxy for  $C_{MD}$ :

$$\hat{w}^2 = \tau_0 + \tau_1 C_{MD} + v \quad (8)$$

Again, in accordance with the arguments advanced in subsection 3.1 (as summarized in Table 1), the following hypotheses can be formulated on the slope coefficient  $\tau_1$  in this regression:

- H1. If the market-based indicator  $m$  is on average less informative about the true probability of default than the benchmark indicators  $\mathbf{b}$ , the divergence between  $m$  and  $\mathbf{b}$  will be a negative function of MD conditions ( $\tau_1$  will be negative); this will be more likely in an institutional setting where the conditions for market discipline are poorly satisfied.
- H2. If the market-based indicator  $m$  is on average equally informative as the benchmark indicators  $\mathbf{b}$ , the divergence between  $m$  and  $\mathbf{b}$  will be a zero-slope function of the conditions for market discipline ( $\tau_1$  will be small and insignificant); this will (possibly) be more likely in an average-quality institutional setting.

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<sup>6</sup> In order to make the divergence measure comparable for different market-based measures (i.e., comparable for different regressions of the type represented by equation 7, above), the squared standardized residuals will be used as divergence measure in this paper.

H3. If  $m$  is on average more informative than  $\mathbf{b}$  about the true probability of default, the divergence between  $m$  and  $\mathbf{b}$  will be a positive function of MD conditions ( $\tau_1$  will be positive). This will be more likely for an institutional setting where the conditions for market discipline are well satisfied.

In practice, it is likely that for a large enough sample (sufficient variation in institutional conditions), the relationship between  $\hat{w}^2$  and  $C_{MD}$  may not be monotonic. In particular, if institutional conditions are bad enough, market prices will not reflect risk as well as other, less ‘institution-sensitive’ measures do, implying a relatively large divergence; as institutional conditions improve, the gap in informativeness successively closes; ultimately, when institutional conditions are good enough, market prices may increasingly incorporate more information than the benchmark measures, implying that divergence again starts to increase. Therefore, if the benchmark measures are more informative for adverse institutional conditions, but market-based measures are more informative for benevolent institutional conditions, then a non-linear (U-shaped) function should be expected

To round off this subsection, it is useful to consider more explicitly what testing these hypotheses might actually tell us? First, testing these hypotheses for a sample with a wide enough distribution in MD conditions, the test may inform as to whether market-based risk measures are more informative for some (high) ranges of institutional quality, or, conversely, whether non-market risk measures are more informative for some (low) ranges of institutional quality. By so doing, the test provides a point of reference for assessing the outcome of risk-sensitivity tests of market-based risk indicators in light of the unobservability problem. Second, insofar as the test is devised in a way which allows repeating it for different market-based risk measures and comparing the results, it may inform on the relative informativeness of equity-based risk measures and risk measures based on uninsured debt. Third, the test in-

forms on the relative sensitivity of different market-based measures to MD conditions. These two last issues can contribute to a better understanding of the relative merits of shareholder vs. creditor discipline (for a given institutional setting). All these three aspects contribute to understanding the viability of market discipline in general, and may help to answer questions such as, for example: Is a sub-debt policy a viable alternative to shareholder discipline? Could market discipline (whether by shareholders or creditors) be relied on as a complementary supervisory mechanism even in environments where institutional conditions are relatively poor? Etc.

### 3.3. Discussion

At this point, a few comments on the main assumptions of the methodology described in this section may be warranted. In what follows, I address three key assumptions, point out potential weaknesses, and provide further motivation.

The first discussion relates to the assumption that the benchmark risk measures are invariant to the conditions for market discipline. In theory, these conditions can easily be ‘isolated’ and defined as distinct vis-à-vis any factors conditioning the informativeness of the benchmark risk measures; in practice, however, the assumption is unlikely to fully hold. To illustrate with an obvious example, the availability of ‘good information’ should affect the informativeness of market-based risk measures, but is conceivably also strongly correlated with disclosure quality, and therefore with the informativeness of accounting-based benchmark measures. A similar argument could possibly be advanced for other dimensions of MD conditions: factors related to overall financial-system transparency and institutional integrity are likely to positively influence the informativeness of both market-based and benchmark measures of risk.

However, a sufficient condition for the methodology to still be valid is that the market-based measures are *more* responsive to overall MD conditions than the benchmark measures. This is the softer version of the assumption that I effectively rely on in the empirical implementation of the methodology, and it can be motivated by again considering each of the four conditions for market discipline, and their likely impact on the informativeness of market prices on the one hand, and accounting variables on the other.<sup>7</sup>

- (i) *Open capital markets*: This condition relates to general financial-market efficiency, liquidity, absence of price-distorting restrictions, etc. Almost by definition, it should influence the accuracy of market prices more than the informativeness of accounting variables. It could have an effect on accounting variables as well if financial market development increases the demand for information, and this demand positively affects the quality of financial statements, but if so, the effect is indirect.
- (ii) Markets' access to *good information* could, in principle, refer to information from any source, but provided financial statements are an important source of information for financial markets,<sup>8</sup> it is clear that – as indicated above – this particular condition for market discipline also measures the informativeness of accounting variables.
- (iii) *No prospects of bailout*: this condition directly measures the propensity of an investor to incorporate risk in the price of a financial claim, but it is difficult to see how it should be in any way correlated with disclosure quality.
- (iv) *Responsiveness to market signals*: this condition directly measures the 'influence' aspect of market discipline, and could therefore be a determinant of the amount of monitoring effort investors are prepared to expend. Again, it is difficult to see how it should

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<sup>7</sup> I focus on accounting variables as benchmark indicators here, since that is what I will use in the empirical part of the paper. It is not certain that all arguments are equally applicable to all conceivable kinds of benchmark indicators (e.g. credit ratings).

<sup>8</sup> Yu (2005) finds that accounting transparency significantly affects spreads on corporate bonds – i.e., that bond holders charge an 'opacity premium'; this result would imply that financial statements are an important source of information for investors, and – more indirectly – that the informativeness of (debt) market-based risk indicators and that of accounting-based benchmark indicators are correlated. See also Morgan and Stiroh (2001) for results on the effect of opacity on the risk sensitivity of banks' sub-debt spreads.

be associated with the informativeness of accounting variables (other than, possibly, via an indirect mechanism related to the information condition [ii]: investors' ability to enforce their interests depends to some extent on the quality of corporate governance, which is in turn associated with the availability of good information).

These considerations seem to suggest that the validity of the assumption that market-based risk indicators are more sensitive to the conditions for market discipline hinges on finding a proxy for these conditions that does not primarily measure condition (ii), but which factors in all four dimensions (or, indeed, focuses on one or all three of the other conditions).

The second assumption up for discussion relates to the possible specification errors in linear risk-sensitivity tests of market-based risk indicators (as mentioned briefly earlier on in the paper). The assumption is that these errors are small and unimportant. Flannery and Sorescu (1996) provide a good overview of possible specification problems for linear bond-spread regressions, but also conclude that the problem of non-linearity is probably small in practice. I effectively rely on this conclusion when specifying the first-stage regressions linearly. The risk I run is that the residuals from these regressions capture a non-linear relationship rather than (or in addition to) differences in informativeness. It is not likely, however, that this would systematically affect the results in the stage-2 regressions. If it does not bias the stage-2 results in any particular direction (which appears difficult to argue), it would simply appear as additional noise which renders estimates somewhat less precise.

A third assumption lies in that the hypotheses developed, and interpretation of the second-stage regression results along the lines I have suggested, presume that the market-based indicator and the benchmark indicators are *ex ante* expected to measure more or less the same thing. It is of course possible that as the conditions for market-based indicators to be informative improve, the disconnection between those indicators and the benchmarks could increase because they reflect *different* information better (rather than *more* or *less* information about

the same underlying ‘true’ variable). On the margin, this will probably be the case, to some extent, but I will assume that the effect is not powerful enough to ‘crowd out’ the effect of differences in informativeness of true risk.<sup>9</sup>

## 4. Estimation and data

### 4.1. Estimation

#### *4.1.1. First-stage regressions*

I extract divergence measures between three different market-based risk indicators (sub-debt spreads, stock return volatility, and a market version of the so-called Z-score), and accounting-based risk measures, for a large panel of banks with annual observations over 12 years (see subsection 4.2 for details). As regards the first-step regressions (as specified in equation 7), the (unbalanced) panel structure of the data introduces some minor issues that need to be addressed. In order not to lose information, the unobserved variable  $q$  should be allowed to vary both over time and across firms, but should not be correlated with  $\mathbf{b}$ ,  $\mathbf{z}$ . Period effects need to be added to account for changes over time that affect all firms equally, but they must be fixed in the cross-section dimension. Adding firm-specific effects, on the other hand, might pick up a significant amount of the information I hope to extract from  $\hat{w}$  (insofar as variation in MD conditions is observed at firm-level), so cross-section effects should not be used. Correcting only for a (fixed) time effect will result in serial correlation in  $\hat{w}$ , which is ‘desirable’ to the extent that  $q$  is expected to be serially correlated and contain firm-specific information which is more or less time-invariant. Since inference on  $\beta$  and  $\gamma$  is not the primary objective, inference-related issues could, in principle, be left aside so long as they are of no direct consequence for producing consistent estimates of  $\beta$  and  $\gamma$  and thus a  $\hat{w}$  which is as informative and as good a proxy of  $q$  as possible. Nonetheless, since inference at least on  $\beta$  may be of

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<sup>9</sup> Assuming anything else would, in fact, imply that most of the empirical literature on market discipline is misspecified from beginning to end.

(secondary)<sup>10</sup> interest in itself, standard errors should be corrected for within-cross-section serial correlation.

Including the period fixed effects in the specification, the risk-sensitivity regression can be reformulated as:

$$m_{it} = \alpha_0 + \alpha_1 D2_t + \dots + \alpha_{T-1} DT_t + \mathbf{b}_{it}\boldsymbol{\beta} + \mathbf{z}_{it}\boldsymbol{\gamma} + w_{it}. \quad (9)$$

The  $\alpha_k$ 's represent separate intercepts for each time period between period 1 and period  $T$ .

This model is estimated by panel least squares on the different market-based risk indicators, and the squared standardized residuals from these regressions are used as divergence measures. There is thus one divergence measure corresponding to each market-based risk measure tested.

#### 4.1.2. Second-stage regressions

The second step consists in running regression of the divergence measures obtained in step 1 on a proxy for MD conditions. As the primary proxy I use the first principal component of a large number of institutional features (again, see subsection 4.2 for details), denoted  $PCI$ . In practice, it is not possible to know *a priori* whether the relationship between the divergence measure and the proxy for MD conditions is monotonic or not. Conceivably, for a dataset where the dispersion of observations on the independent variable is sufficiently wide, it would not be – unless, of course, market-based risk measures are not more informative than the benchmark measures for *any* levels of institutional quality actually observed (or, conversely – but perhaps less likely – if market-based risk measures are *always* more informative). Given that a major objective of the paper is to explore this very question – whether market-based risk measures are sometimes ‘better’ – and given the heterogeneity of the dataset at hand, it is

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<sup>10</sup> The conclusions one can draw from inference on these regressions are limited, since factors known to influence the relationship between the market-based measure and the benchmark measures – in particular, any number of proxies for the extent to which the conditions for market discipline are satisfied – are *deliberately* left out, in order to lose as little information as possible in the ‘divergence’ measure.



clearly warranted to at least open up for the possibility of a non-monotonic relationship. In order to cover for all eventualities, I will test three different specifications. The first is a simple bivariate linear regression (cf. equation 8):

$$\hat{w}_{it}^2 = \tau_0 + \tau_1 PC1_{it} + v_{it}, \quad (10)$$

where  $\hat{w}_{it}^2$  is the squared standardized residual for the  $i$ 'th bank at time  $t$ , obtained from a regression of equation (9) on one of the considered market-based risk measures,  $PC1_{it}$  is the corresponding observation on the first principal component of MD conditions, and  $v_{it}$  is a random error. The second specification is a non-linear version of equation (10):

$$\hat{w}_{it}^2 = \tau_0 + \tau_1 PC1_{it} + \tau_2 PC1_{it}^2 + v_{it} \quad (11)$$

with notation and variable definitions as above. In some regressions, I will add control variables to the two basic specifications above. Finally, I will run piecewise linear regressions according to the following specification:

$$\hat{w}_{it}^2 = \tau_0 + \tau_1 D_{1it} PC1_{it} + \tau_2 D_{2it} PC1_{it} + \tau_3 D_{3it} PC1_{it} + \tau_4 D_{4it} PC1_{it} + v_{it}, \quad (12)$$

where the  $D_j$ 's are dummy variables taking on unit value for the first, second, third and fourth quarters, respectively, of the observations on  $PC1$ , and zero for all other ranges of  $PC1$ .

The expectations on the coefficient signs, in line with the hypotheses advanced in subsection 3.2, are as follows. For equation (10),  $\tau_1$  will be positive if, on average over the entire sample, the market-based risk measure corresponding to the divergence measure used as dependent variable in the regression is more informative than the benchmark measures (the  $\mathbf{b}$ 's) from equation (9). Conversely,  $\tau_1$  will be negative if the benchmark risk measures are more informative on average for the present sample. The final possibility is that  $\tau_1$  is insignificantly different from zero, which could have two reasons: first, market and non-market measures may be about equally informative regardless of MD conditions; second, the linear specifica-

tion is inadequate because the slope coefficient depends on the value of *PCI* (and positive and negative slopes are more or less symmetrically distributed over *PCI*).

For equation (11), the basic expectation is a convex relationship, implying that  $\tau_2$  should be positive, regardless of whether the slope is positive or negative on average. If the relationship is U-shaped, or if a negative effect of mostly inferior market-based measures dominates, then  $\tau_1$  should be negative. The perhaps more far-fetched possibility that market-based risk measures are always superior – and increasingly so over the entire range of observations on MD conditions – would imply a positive  $\tau_1$ .

Finally, the  $\tau_j$ 's from equation (12) can be interpreted in analogy with the  $\tau_1$  in equation (10), except now the interpretation is valid only for the sub-sample of *PCI* corresponding to the  $\tau_j$  in question. A negative coefficient value would be most expected for  $\tau_1$ , and a positive value most expected for  $\tau_4$ .

Equations (10)-(12) are estimated as before by panel OLS. While for the estimations producing the divergence measures, the necessary panel adjustments were more or less given by the underlying assumptions and the objectives of the regressions, for these second-stage regressions, they are more of an open issue. Because (fixed) time effects were accounted for in the first-stage regressions, I expect they are of little importance in the residuals obtained from these regressions. Cross-section effects, on the other hand, were considered inappropriate given the small number of observations over time relative to the number of cross-section units (I actually have a single observation for several banks, especially for the divergence measure of sub-debt spreads, for which I have the smallest number of observations). While using cross-section effects would push up the overall explanatory value of the second-stage regressions, interpretation of the coefficients on the principal component(s) of MD conditions would be made difficult with a large portion of the cross-sectional variation being picked up

by the cross-section effects. I thus estimate the equations without either period or cross-section effects, but correct standard errors for contemporaneous correlation and cross-section heteroscedasticity.

A final econometric note pertains to the use of residuals measured with error as variables in the second-stage regressions, and its possible implications for errors-in-variables (EIV) problems. EIV correction is necessary when using a variable known to contain measurement errors (for example because it is obtained from a prior regression) as independent variable in a regression. Here, however, I use the (transformed) residuals from a first regression as *dependent* variable in a second regression. In order for this not to necessitate correction in the second stage, it is required that the measurement errors are assumed to be random. They can then be considered as part of the random error term  $\varepsilon$  in equation (7). Their effect on the informational content of  $w$  will thereby also be random, and they will be picked up in the second-stage residuals, implying that they will have no effect on second-stage parameter estimates.<sup>11</sup>

## 4.2. Data

The empirical methodology described in the previous section is applied to a panel dataset comprising several hundred banks worldwide. The banks are publicly traded banks with annual financial statement data available in the BankScope database between 1994 and 2005. As data availability varies considerably for different bank-level variables, the exact number of banks covered depends on the combination of variables used in a particular regression specification, but coverage is typically around 300 banks. The bank-specific data is supplemented by country-specific data characterizing various aspects of the institutional setting in the banks' countries of origin (47 countries in all). Appendix A (Tables A1 – A3) provides more detailed

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<sup>11</sup> For general treatments of EIV in panel data, see for instance Biørn (1992), and Griliches and Hausman (1986).

information about the sample (in terms of banks, countries, and years covered), and lists all variables used at different stages in the analysis, with brief definitions and sources. In what follows, I describe these variables, explain some of them in more detail, and provide summary statistics.

#### *4.2.1. Market-based risk measures*

I use three market-based risk measures, which were chosen on the basis that they were the most frequently used in the literature and/or represented different categories of risk measures (a comprehensive overview of different bank risk measures used in previous literature – whether market-based, accounting-based, or ratings-based – is given in Table B1 in Appendix B).

The first market-based risk measure is the spread over the risk-free interest rate on subordinated notes or bonds. Spreads on sub-debt, or other types of formally uninsured bank debt, have been widely subjected to risk-sensitivity tests of the type represented by equation (9), especially for US data (see the literature review). The spreads used here were observed at year-end and were collected directly from Datastream and Reuters, with comparable risk-free rates subtracted from the sub-debt yields at source. They are mostly secondary-market spreads, but in some cases primary-market spreads were used, depending on availability. A large portion of the banks included did not have any subordinated debt outstanding during the sample period; consequently, subordinated-debt spreads were completely unavailable for these banks. Spreads were also unavailable for a portion of the banks that did have subordinated debt outstanding (according to the balance sheet). As shown in Table 2, the total number of observations on subordinated debt spreads was 637 – considerably less than for the other risk measures. In addition, because accounting data (and consequently benchmark risk measures) are often missing for the early part of the sample period (1994-97) and missing

values for sub-debt spreads and accounting variables only partially overlap, about 300 of these observations are lost for the risk-sensitivity regressions.

The second measure is the volatility of total equity returns, which is one of the most widely used equity-based risk measure in the literature.<sup>12</sup> The return volatility is the standard deviation of daily equity returns, calculated separately for each year. Daily stock market prices for the included banks were collected from Datastream.

The third market-based measure is a market version of the so-called Z-score, which is one of the simpler examples of what I have called ‘combination measures’ in Table B1. The Z-score is originally defined on accounting variables as

$$Z_{it} = \frac{\mu_{it} - k_{it}}{\sigma_{it}}, \quad (13)$$

where  $\mu_{it}$  and  $\sigma_{it}$  are the mean and standard deviation, respectively, of bank  $i$ ’s return on assets, and  $k_{it}$  is the average share of capital to total assets over the period  $t$ . The ‘market version’ Z-score is calculated using the return on equity and the standard deviation of equity returns. It can be regarded as a combination measure (rather than as a ‘pure’ market-based measure), since it incorporates both accounting data and stock market data. The Z-score is negatively related to the probability of default (and I therefore use it in the negative as dependent variable for simplicity of comparison).<sup>13</sup>

Summary statistics for the three market-based risk measures appear in Table 2 (panel A). The two equity-based risk measures were divided between bank/year observations where the bank had sub-debt outstanding<sup>14</sup> and observations where it did not, and tested non-

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<sup>12</sup> A theoretically ‘better’ alternative would possibly have been to use the volatility of *abnormal* equity returns, based on some version of the market model or CAPM. I ran several versions of one- and two-factor market models (using Datastream’s global general and bank stock price indices), and found that the volatilities of the resulting abnormal returns are correlated with total stock return volatility by a coefficient typically larger than 0.90. I conclude that using one or the other matters little.

<sup>13</sup> The Z-score is widely used as a risk measure in the banking literature, see, e.g., Hannan and Hanweck (1988), Boyd et al. (1993), Beck and Laeven (2006); the market-based version is used by, e.g., Crouzille et al. (2004).

<sup>14</sup> Either because the balance sheet reported a non-zero amount of outstanding subordinated debt, or because sub-debt spreads were available for that bank/year observation.

parametrically for significant differences in distribution. The purpose of these tests was to provide an initial indication of whether riskier banks are less likely to rely on uninsured debt for financing (as suggested by Covitz et al., 2004), resulting in possible selection bias in risk-sensitivity tests on sub-debt spreads. The results of the tests indicate that there are indeed significant differences in risk between the two groups, although the differences are small. Moreover, the direction of the difference depends on the risk measure used: the stock return volatility measure indicates that banks with sub-debt outstanding are less risky, whereas the Z-score suggests the opposite. These results remain when instead applying a  $t$ -test to the sub-sample means (not reported). A possible explanation is of course that other factors need to be controlled for; for example, if larger banks are both more likely to issue subordinated debt and more likely to enjoy conjectural government guarantees, then the ‘true’ relationship between risk and sub-debt issuance likelihood may be obscured in a simple sub-sample comparison.

[Table 2]

#### *4.2.2. Benchmark risk indicators and control variables*

The benchmark risk measures used in this paper – as in most of the related literature – are various standard accounting ratios believed to be correlated with the bank’s overall risk. A wide range of accounting-based measures have been used, as indicated by Table B1. The categorization of these various measures and the exact choice of variables to be included in the regressions are to some extent a matter of discretion. The vast majority of studies use some measure of leverage, or capital adequacy. Similarly, different measures of asset structure and/or asset quality are typically included – particularly proxies related to the quality of extended loans and to the ease with which the bank can absorb temporary losses (such as different liquidity measures). Finally, it is common to control for profitability. Based on these

conventions, I include *leverage* (defined as one minus the ratio of equity to total assets), *loan quality*, (the ratio of non-performing loans to equity), *liquidity* (liquid assets over total assets), and *the return on assets* (ROA – defined as net earnings divided by total assets).<sup>15</sup>

All these accounting-based benchmark measures are calculated from annual balance sheet and income statement data as reported in BankScope. Descriptive statistics are reported in panel B of Table 2. Again, the sample is divided into sub-samples based on whether the bank had subordinated debt outstanding or not. The table reinforces the impression given by the Z-score in the previous table that banks without any outstanding sub-debt are, in fact, *less* risky than other banks. Banks without outstanding sub-debt have significantly lower leverage, lower share of non-performing loans, higher share of liquid assets, and are significantly more profitable than other banks. Again, the conclusion would be that in a heterogeneous sample such as this one, any tendency for riskier banks to be discouraged to issue uninsured debt (if it exists) is obscured by other factors which are more important determinants of sub-debt issuance. Such factors could be related to the size and main line of business of the bank, financial development and other local market conditions, etc.<sup>16</sup> For example, sub-debt issuance is more likely by larger banks, which may benefit from conjectural ‘too-big-to-fail’ guarantees, and are therefore more risk prone. Another possibility is that subordinated debt is more likely to be issued by banks originating in financial systems that are more developed, less regulated, and more competitive, which could in turn indicate a weaker risk-reducing effect of charter values and lower profitability for these banks (see, e.g., Keeley, 1990; see Boyd and Nicoló, 2005, for an alternative view).

The choice of which control variables to include in the first-stage regressions is a delicate balance, since I want to lose as little information as possible related to the conditions for

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<sup>15</sup> Cf., e.g., Sironi’s (2003) division into a leverage, a profitability, an asset quality, and a liquidity component of bank risk.

<sup>16</sup> Of course, it could also be that riskier banks are just inherently more likely to issue subordinated debt, although it is difficult to envision an economically sensible rationale for that possibility.

market discipline, while at the same time controlling for factors unrelated to these conditions. Many of the strongest candidate control variables – such as bank size, ownership structure, home country income level, deposit insurance coverage, etc. (not to mention country dummy variables) – are conceivably strongly correlated with MD conditions. After much deliberation, and loosely following the few previous cross-country studies that exist (see for instance Angkinand and Wihlborg, 2006), I include three bank-level and four country-level control variables. At the bank level, I include the deposit share of total assets, net interest margin, and the cost/income ratio.<sup>17</sup> These variables are reasonable proxies for general bank characteristics without being too strongly correlated with the extent to which market discipline can be imposed. Moreover, they are fairly orthogonal in variation (a pairwise correlation matrix for the first-stage bank-level variables is shown in Appendix A, Table A4). The source for these, as for previous financial-statement variables, is BankScope. Sub-debt spreads are also controlled for time to maturity (in years) and the size of the issue (the natural logarithm of the issue amount in million USD), in accordance with most previous studies on subordinated debt spreads. This information was collected together with the spreads from the same sources (i.e., Reuters and Datastream).

[Table 3]

At the country level, control variables for general macroeconomic conditions are included in the form of the real interest rate, the inflation rate, and real GDP growth – all from the World

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<sup>17</sup> The one control variable that is included in almost all previous studies on bank risk is the size of the bank (typically measured as the log of total assets). Most of my deliberations revolved around whether to include this variable or not in the first-stage regressions. Absolute bank size would be correlated with the extent to which market discipline can be imposed insofar as it proxies for the existence of conjectural 'too-big-to-fail' guarantees, and for general liquidity of the bank's stock and bonds. These aspects of MD conditions should obviously be (and are) accounted for in the second-stage regressions. Therefore, because of the substantial risk that 'bank size' – in the absence of more direct proxies – would pick up a lot of these dimensions of MD conditions (with the effect that much information is lost for the second stage of the analysis), I decided in the end *not* to include bank size as a control variable.



Bank's *World Development Indicators*. To control for the possibility that a systemic financial crisis (such as the Asian financial crisis in 1997-98 or the Argentinean bank crisis in 2001) has an independent effect on the extent to which different risk measures diverge, I include a crisis dummy. The source for identifying countries/years where there was a systemic crisis was Honohan and Laeven (2005). The source covers the period up to and including the year 2002. At that time, a number of countries were still affected by crises, according to the source (that is, no 'end date' is available). For these countries, I flag observations from subsequent years as well, effectively assuming that the crises were still ongoing between 2003 and 2005.

#### *4.2.3. Proxies of the conditions for market discipline*

As the primary measure of MD conditions I use the first principal component of a set of bank- and country-level variables – each of which proxy for one dimension or other of the extent to which the conditions for market discipline are satisfied. A relatively large number of bank-level and firm-level variables were used to construct the composite measure. Variable definitions are summarized in Table A3 (Panel B), with indicative categorizations according to which one of Lane's (1993) four conditions for market discipline that they primarily capture, as well as brief descriptions where definitions are not obvious. Summary statistics are reported in Table 4. The exact choice of variables contains an obvious discretionary element, but because the data are reduced, the choice is a matter of trading off tractability and comprehensiveness, rather than a matter of accuracy in capturing any one specific condition for market discipline.

The data reduction itself has advantages and drawbacks. The motive for using principal components analysis (and for focusing on the first principal component) in this paper is essentially three-fold. First, for ease of interpretation, it is preferable to focus on *one* proxy of  $C_{MD}$ , which however by definition is a multi-dimensional concept. Reducing the data makes it

possible to capture several facets of the concept in a single measure. Second, the technique implies ‘efficient’ use of the variation in individual proxies of MD conditions, and avoidance of multicollinearity issues due to high correlation between (some of) these individual proxies. Third, the variation in the individual variables used to proxy  $C_{MD}$  occurs at the bank-level for some variables, at the country level for others; combining them eliminates the need to deal with potential interpretation and error-correction problems associated with this partial ‘clustering’ of the data. A potential drawback with the method is that one potentially loses sight of the contribution of specific dimensions of MD conditions, or specific market-discipline conditions.<sup>18</sup> A related problem is caused by the fact that the principal components are orthogonal to one another. This makes it increasingly difficult to interpret the (successively less important) lower-order components in terms of what they have to say about the overall conditions for market discipline.

Below follow a description by category of the variables that went into the principal components analysis.

(i) *Open capital markets:* This condition for market discipline is primarily captured by a proxy of the liquidity of the bank’s securities (the average daily turnover rate of the bank’s stock), and various standard measures of financial development at country level. I used four measures suggested by Rajan and Zingales (2003) – total bank deposits (or M2, as available) over GDP, stock market capitalization over GDP, net equity issues over gross fixed capital formation, and the number of firms with stock traded on public exchanges per million of population; in addition, I used private sector credit over GDP (as suggested by La Porta et al., 1997), and private-sector bond-market capitalization as a share of GDP. Sources for these variables were IMF *International Financial Statistics* or the World Bank’s *World Develop-*

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<sup>18</sup> Suppose, for instance, we are particularly interested in analyzing the extent to which deposit insurance coverage contributes to making spreads on subordinated bonds a more or less informative measure of bank risk. Insofar as the proxy for deposit insurance coverage is decomposed according to its (partial) covariation with other measures of MD conditions, and the principal components are aggregations of different measures, this contribution may be difficult to assess.

*ment Indicators* (GDP, investment, bank deposits, and credit); Eurostat (stock market capitalization for most European countries) or Datastream (all other stock market data); and the Bank for International Settlements (bond market capitalization). Net equity issues were proxied as the year-on-year change in stock market capitalization, corrected for the change in stock prices as measured by Datastream's overall market price index for each country. Net issues were calculated for each of the years 1994-2005, and then averaged. To capture the international dimension of capital market openness, finally, I used an index of foreign-investment openness, based on the presence of restrictions on capital-account transactions as reported in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, and taken from Brune et al. (2001).

(ii) *Quality of information*: The availability of bank-specific information is proxied by a single country-level index variable. The variable equals CIFAR's index of overall financial-reporting transparency (see Bushman et al., 2004) for all countries where this index is available, and Barth et al.'s (2001, 2006) private monitoring index (recalculated to the CIFAR scale) for all other countries.<sup>19</sup>

(iii) *No prospects of being bailed out*: The probability that claimants on the bank will be bailed out depends primarily on explicit and implicit deposit insurance coverage. As a proxy for the share of formally insured debt (at the bank level), I use country-level data on the fraction of deposit value covered by explicit deposit insurance (net of the coinsurance ratio; available from Demirgüç-Kunt et al., 2005), and multiply it by the ratio of deposits to total debt for each bank and year. For countries where a specific coverage percentage is not avail-

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<sup>19</sup> It is clear that the focus on accounting transparency in this condition for market discipline makes it questionable whether market-based risk measures are more responsive to the condition than the accounting-based benchmark measures. However, as argued in Section 3, a sufficient condition for the paper's main hypotheses to hold is that market-based measures are *more* responsive to the *overall* conditions for market discipline than the benchmarks; if the market-based measure and the accounting-based measure are about equally responsive to financial-statement transparency (as seems plausible), the inclusion of this variable neither adds nor subtracts anything from the end results. Conceivable alternative measures of quality of information typically make use of the market variables themselves (as in Morck et al., 2000, and Durnev et al., 2003, for instance).

able, I use  $\min\left(1, \frac{\text{coverage limit}}{\text{deposits/capita}}\right)$  – coinsurance ratio as a proxy (also from Demirgüç-Kunt et al., 2005), and multiply by the ratio of deposits to total debt for each bank and year, as previously. The share of formally insured debt is always zero for countries/years with no explicit deposit insurance scheme.

Implicit guarantees are proxied by a variable called ‘no-bailout credibility’ in Table A3. It equals the Fitch Support Rating (which is an index variable showing the probability that a bank will be bailed out in case of default) for banks where such a rating is available; for all other banks, I take one less the bank’s share of total deposits in its country of origin and transform the result to the Fitch scale. Balance-sheet data on deposits for each bank and data on total deposits (or M2) in each country are from BankScope and IMF’s *International Financial Statistics*, respectively, as before. Finally, I use the Reuters ownership data (see under condition [iv], below) to construct a government-ownership dummy, to account for the possibility that government-owned banks may be more likely to be bailed out in the event of failure.

(iv) *Responsiveness to market signals*: The last condition for market discipline is summarized at the bank level by a number of corporate governance variables (in the absence of more direct proxies for responsiveness). Ownership data were collected from Reuters. The Reuters database distinguishes between ownership by three types of owner: insiders/stakeholders, institutions, and mutual funds. It contains percentages of ownership by the different categories and by individual shareholders within the three groups. Both insider ownership and outsider ownership (as proxied by the ownership share of institutional investors) were used. In addition, responsiveness to market signals may depend on how well capitalized the bank is. To measure this in a simple way, the minimum Tier-1 capital requirement (assumed to be 50% of the home country’s total capital requirement, as reported by Barth et al., 2001, 2006) is subtracted from each bank’s equity-to-assets ratio; the result gives the proxy

for ‘excess capital’. At the country level, bank claimants’ possibilities to exert influence are proxied by the widely used creditor and shareholder rights indices (originally from La Porta et al., 1997, 1998; with additional country scores from Allen et al., 2006; Djankov et al., 2005, 2006; and Pistor et al., 2000), and the *International Country Risk Guide*’s index of legal system integrity.

[Table 4]

Table 5 reports a summary of the outcome of the principal components analysis on all the variables described above. The (linear) decomposition can be summarized as:

$$PCn_{it} = \sum_{k=0}^{K-1} a_{n1+k} X_{kit} + \sum_{s=0}^{S-1} b_{n1+s} Y_{sjt}, \quad (14)$$

where  $PCn$  is the  $n^{\text{th}}$  principal component, the  $X$ ’s are  $K$  different bank-level proxies of MD conditions, the  $Y$ ’s are  $S$  different country-level proxies of MD conditions, and the subscripts  $i, j$  and  $t$  denote bank, country and year. The decomposition is based on the correlation matrix of the included variables.

I have only included the first six principal components in Table 5 (as well as in the stage-two regressions), as lower-order components account for less than five percent each of the variation in the proxies for MD conditions. The proportion of the total variance accounted for by each of components 1-6 is shown in Panel A in the table. The first component – that on which I mainly rely – explains about 28 percent of the variation. This indicates that using it as a single explanatory variable, almost three quarters of the potential explanatory power of the proxies for MD conditions will be lost in the second-stage regressions. On the other hand, it also illustrates one of the advantages with using principal components analysis: the first principal component incorporates *in a single variable* much more of the *overall* variation in the

proxies than any one individual proxy. The first six components together account for about 70 percent of the variation in the variables described previously in this sub-section.

Panel B of Table 5 reports the coefficients on the individual market discipline conditions for principal components 1-6 (i.e., the  $a$ 's and the  $b$ 's in expression [14]). It shows that PC1 puts most weight on the indicators of financial system development, but is also strongly positively correlated with the quality of information (the transparency index), and general legal-system integrity (as proxied by the rule-of-law index). The one dimension of MD conditions that is not well reflected in PC1 is the no-bailout condition. This dimension is instead an important element in PC2 – as indicated by the positive coefficient on ‘no-bailout credibility’ and the negative (though relatively small) weights on the share of formally insured debt and government ownership. PC2 seems however to be negatively related to the responsiveness dimension of MD conditions (as indicated by the positive coefficient on ‘excess capital’ and the negative one on the shareholder rights index). This illustrates the point made earlier that lower-order principal components become increasingly more difficult to interpret in terms of their *overall* impact on the conditions for market discipline. This point is further reinforced by looking at coefficients for PC3-PC6. It is not always clear whether the ‘net’ impact of these components on general MD conditions is positive or negative. Due to this difficulty of interpretation, PC2-PC6 will only be used as control variables in the regressions on the divergence measures to check the stability of the estimates on the first principal component (rather than as explanatory variables in their own right).

[Table 5]

## 5. Results

### 5.1. First-stage regressions

Table 6 reports the results of the first-stage regressions on all three market-based indicators. Coefficient columns 1 and 2 report the results for two specifications of the regressions on sub-debt spreads, where the only difference is that model (2) includes a correction term for possible selection bias (which was constructed because the summary statistics suggested a significant difference in risk distribution for the sub-sample of banks that had issued sub-debt vis-à-vis those banks that had not). I followed Covitz et al. (2004), Birchler and Hancock (2004), and Evanoff and Jagtiani (2004), and adopted the Heckman (1979) two-step approach to selection-bias correction, where the correction term is the inverse Mills ratio from a probit regression on a dummy variable indicating whether or not a bank had issued sub-debt for each period. To preserve space, and because they are of secondary interest for the main analysis, the specification and results of this regression are reported in Appendix A (Table A6). As evident from Table 6, selection bias seems to be a minor issue here, and the inclusion of the correction term does not affect the overall results. (I therefore use the squared standardized residuals from model [1] as the sub-debt spread divergence measure in the second-stage regressions.)

All benchmark risk measures except leverage significantly influence sub-debt spreads, whereas the common control variables have little effect. In terms of coefficient signs, the (negative) market Z-score responds in a similar way as the sub-debt spread, whereas return volatility coefficients on both leverage and ROA are negative (but indistinguishable from zero). Both equity-based measures are much more sensitive to variation in the macroeconomy (except to real interest rates).

In line with the implications of the unobservability problem and the fact that the regressions deliberately leave out variables believed to influence the estimated relationships, I do not want to draw too far-reaching conclusions from these first-stage results. I just observe that they seem, overall, fully reconcilable with results reached in previous studies using simi-

lar approaches and specifications (e.g., Sironi, 2003, for a cross-country sample of sub-debt spreads, and Hall et al., 2002, for various stock-market measures of risk, using US data).

[Table 6]

## 5.2. Second-stage regressions

### *5.2.1. Sub-debt spread divergence*

Table 7 reports the stage-two results for sub-debt spread divergence (i.e., the squared standardized residuals from the stage-one regressions on sub-debt spreads). Five different specifications are estimated, all using different combinations of the first six principal components of MD conditions as independent variables. The first coefficient column shows sub-debt spread divergence regressed on an intercept and the first principal component of MD conditions only. It indicates a positive average relationship, but the right-hand-side variables are jointly insignificant, as indicated by the regression F-statistic. Controlling for principal components 2 through 6, the slope coefficient on the first component proves to be negative on average for the whole sample (specification [2]).

Models (3) and (4) are specified to reflect the hypothesis of a possible non-monotonic relationship between divergence and MD conditions. They allow for a second-degree polynomial relationship between the divergence measure and the first principal component of MD conditions – with or without controlling (linearly) for components 2-6. These specifications – especially model (4) – seem to strongly suggest a U-shaped relationship between divergence in information content and institutional quality, very much in accordance with the advanced hypotheses. In other words, as the institutional conditions for market discipline move from poor to average, the disconnection between sub-debt spreads and the accounting-based risk measures becomes successively smaller (indicating that accounting-based indicators are ini-



tially ‘better’ when conditions are poor); but as conditions continue to improve, divergence starts to increase again (suggesting that the informativeness of sub-debt spreads is higher than that of accounting variables when conditions are good). The piecewise specification, finally, strongly supports the results of the non-linear specifications. The slope on the independent variable is significantly negative for the first two quarters of PC1, zero for the third, and significantly positive for the top quarter.

In line with what has been said earlier about the composition of lower-order principal components, I have made no attempt to interpret the coefficients on PC2-PC6 in specifications (2) and (4). They are entered only as a means to check the stability of the estimates on PC1. Overall, these seem reasonably stable qualitatively, in the sense that they are consistent with a convex relationship between sub-debt spread divergence and PC1, which is negative on average over the full sample distribution of PC1, but turns positive toward the end of this distribution.

[Table 7]

Although the overall explanatory power is fairly low for these regressions (as expected), these results would suggest that the unobservability problem cannot be ignored in risk-sensitivity tests of sub-debt spreads in relatively mature markets with limited implicit guarantees of formally uninsured bank liabilities. This result seems to open up for an alternative interpretation of the ‘non-results’ of, e.g., Hall et al. (2002), Covitz et al. (2004), and Krishnan et al. (2006). They all find, by and large, that standard benchmark measures of banks’ default risk are not significantly reflected in the spreads of risky debt, and interpret the results in terms of a lack of risk-sensitivity on the part of the market-based measure. The point of the unobservability problem is that this interpretation cannot be made, unless we are certain that the benchmark

indicator is *always* more informative (which, in turn, disqualifies much of the idea with market discipline in the first place). The results reported here on the relationship between sub-debt spread divergence and the conditions for market discipline suggest that the lack of risk-sensitivity may be on the part of the benchmark measures, rather than on sub-debt spreads.

### 5.2.2. *Stock return volatility divergence*

Table 8 shows the results of estimation of stock return volatility divergence as a function of the principal components of MD conditions. Here, too, the results support the supposition of an initially negative but convex function. The slope coefficients on the first principal component are consistently negative. Allowing for a non-linear relationship, the coefficient for the quadratic term turns out significantly positive (but small). Controlling for successively less important principal components (again, PC2-PC6 enter only linearly for ease of exposition) does little to boost explanatory power, and does not affect the coefficients of PC1 and PC1<sup>2</sup>.

Finally, the results of the piecewise specification, as reported in coefficient column (5), support the results of the non-linear specifications (3) and (4) for all but the bottom 25 percent of MD conditions. For quarters 2-4, the coefficients on the first principal component are all negative and significant, but decrease in magnitude as conditions for market discipline improve. For the top quarter, the coefficient is close to zero, indicating that the divergence between stock return volatility and the accounting benchmark measures is relatively insensitive to improvements in MD conditions for this sub-sample; however, the coefficient is still significantly negative, so there is no basis for suggesting that stock-return volatility contain more information on bank risk for higher levels of institutional development (as was the case with sub-debt spreads). The coefficient for the bottom fourth of PC1 is insignificantly different from zero. In line with the basic hypotheses and arguments advanced previously, this would suggest that the difference in information quality between the stock-market indicator

and the accounting indicators is random when market-discipline conditions are poorly satisfied. A tentative explanation for this finding is that both types of indicator are ‘just as bad’ when the institutional environment is sufficiently poor. This explanation conflicts somewhat with the assumption that the benchmark measures are invariant to MD conditions, but it would seem to be the most plausible explanation for this result.

Notwithstanding the indeterminate result for the first quarter in specification (5), the overall impression from all regressions reported in Table 8 is that the divergence between stock return volatility and accounting risk is a negative function of the conditions for market discipline, but that the negative slope becomes increasingly flat as conditions improve. The implication is that accounting measures of risk are *a priori* more informative, but the difference in informativeness becomes successively less important.

[Table 8]

### 5.2.3. Z-score divergence

The results from regressions of Z-score divergence on the conditions for market discipline (Table 9) impart the overall impression of a monotonically increasing divergence between the Z-score and the accounting-based benchmarks over the entire distribution of MD conditions. The first principal component of the conditions for market discipline has a consistently positive and highly significant coefficient for specifications (1)-(4). The quadratic PC1 terms in specifications (3) and (4), on the other hand, are small and statistically insignificant. The piecewise specification on the first principal component, finally, seems to suggest that divergence increases the most over low-to-medium ranges of MD conditions, but the parameter estimates for this specification are jointly insignificant (as shown by the regression F).

The overall insignificance of specification (5), along with the very small  $R^2$ 's in specifications (1) and (3), suggests that the first principal component explains considerably less of the Z-score divergence than the divergence of stock return volatility and sub-debt spreads. The lower-order principal components (PC2-PC6), on the other hand, seem to add considerably to the explanatory power of the regressions (without necessarily clarifying the relationship between Z-score divergence and overall MD conditions).

The implication of the results – in accordance with the hypotheses laid out in this paper – would be that the Z-score is always more informative on bank risk than accounting-based risk indicators. However, given the relatively low capacity of the most overall measure of MD conditions (*viz.* the first principal component) to explain this difference in informativeness, the message needs perhaps to be nuanced somewhat.

One explanation could lie in the fact that the Z-score is a combination measure, incorporating both market and accounting data. Keeping this in mind, a possible implication of the result could run along the lines that combination measures capture information not contained in more one-dimensional measures of risk, and the market can always produce valuable complementary information (regardless of the level of institutional quality).

This line of interpretation would suggest that the results here obtained substantiate the results of previous research – by, e.g., Berger et al. (2000), Evanoff and Wall (2001), Gunther et al. (2001), and Gropp et al. (2006) – which has also concluded that information impounded in market measures of risk could provide an important complementary signal of banks' financial health, and thus has pointed to the potential value of indirect market discipline in bank supervision.

[Table 9]

#### 5.2.4. *Regressions on individual conditions for market discipline*

As an additional robustness test of the results, and as a means to clarify the results, I ran regressions of the three divergence measures extracted from the stage-one regressions on an individual proxy of the conditions of market discipline. The proxy used as regressor in these additional stage-two regressions is the ‘no-bailout credibility’ variable. It was chosen on the grounds that it is a bank-level variable, has a low weight in the first principal component of MD conditions (and thus so far ‘untested’), and has a relatively ‘clean’ interpretation in terms of its impact on the viability of market-based measures of risk. I ran one linear and one quadratic specification for each divergence measure (corresponding to equations [10] and [11], and equivalent to specifications [1] and [3] in Tables 7-9). The results are reported in Table 10.

[Table 10]

Sub-debt spread divergence displays a negative average relationship with no-bailout credibility, but when the quadratic term is introduced again proves to be a convex function, in accordance both with the advanced hypotheses and with the results obtained earlier when the first principal component was used as regressor. The estimated relationship suggests that sub-debt spread divergence drops for the initial two thirds of the distribution of no-bailout credibility, but then bottoms out and turns positive for the top third of the distribution. The function hits its minimum at around 3.5, which is close to the mean value for no-bailout credibility.

Stock return volatility divergence instead shows a positive overall relationship with no-bailout credibility, but as indicated by the very low adjusted  $R^2$ 's and the insignificance of all regressors in the quadratic specification, the association is relatively weak. The conclusion would be that this particular dimension of the conditions for market discipline is less important than those dimensions captured in the first principal components.

Z-score divergence, finally, appears to be positively related to no-bailout credibility on average, but allowing for non-linearity, the posited convex relationship emerges. The estimated coefficients in specification (2) for Z-score divergence are similar to those estimated for sub-debt spread divergence, although the function reaches its minimum somewhat earlier (which explains why the estimated relationship is positive on average). Comparing these results with those obtained with the first principal component of MD conditions as the primary explanatory variable, it is clear that the no-bailout condition has a higher power to explain the difference in informativeness between the Z-score and accounting variables than those proxies of MD conditions that have a high weight in PC1.

Again, a possible explanation of the finding that the Z-score more often has a higher informativeness than the benchmark indicators is that it incorporates information contained in both market prices and accounting data. These two types of information could be complementary even when the institutional environment is not good enough to make market-based measures *individually* ‘better’ than accounting-based indicators of bank risk.

## **6. Conclusions**

The potential merits of market discipline in banking have often been assessed empirically by focusing on the monitoring aspect of market discipline – that is, the extent to which prices on banks’ securities reflect the risk of the issuing banking organization. Two main approaches have been adopted: the ‘risk sensitivity’ approach (where various indicators of risk derived from market prices are regressed on benchmark risk measures, such as different accounting ratios, or credit ratings), and the ‘early warning’ approach (where market-based risk measures are tested as predictors, or leading indicators, of bank distress, defined in some way). The overall results are relatively inconclusive, and each approach has its methodological problems. I have focused on the former approach in this paper. In this approach, one previously

largely overlooked problem is that both market-based risk measures and the benchmark indicators commonly used are imperfect proxies of ‘true’ risk. Therefore, absence of a significant association between a market signal and benchmark risk indicators could result either because market prices do not adequately reflect risk, or because market prices in fact incorporate the available information on banks’ risk *better* than other available measures.

The problem is thus that it is not possible to observe which of the indicators that is more informative about the bank’s ‘true’ risk. What *is* possible to observe, though, is how well the institutional setting in a particular market is geared toward inducing market discipline. In the paper, I suggested a simple measure of informativeness *divergence* between a market signal and benchmark risk measures, and showed that – although it cannot be observed directly – it is possible to infer from the function projecting this measure onto a proxy of the extent to which the conditions for market discipline are satisfied which one of the measures that is more informative.

Applying the methodology to a panel of several hundred banks worldwide, with the divergence measure calculated on the basis of three common market-based risk indicators, I find that market-based measures as stand-alone variables are less informative than accounting indicators for most levels of institutional quality. Stock return volatility is never more informative than accounting measures, but spreads on subordinated debt may be more informative if the conditions for market discipline are well satisfied (for the top 25-30 percent of the observed distribution). This finding raises the question if the failure to find significant associations between subordinated-debt spreads and accounting data in some studies using US data is driven by lower information content in accounting data than in spreads (rather than the other way around, which is the common interpretation). A combination measure incorporating both stock market data and accounting data, finally, is more informative than accounting variables alone for most levels of institutional quality (although the most overall measure of institu-

tional quality used seems to be a relatively weak determinant of the difference in informativeness between the combination risk indicator and the benchmarks). This result is consistent with the results of some previous studies comparing the relative informativeness of different risk indicators, which have seem to imply that stock-market data contains information that is complementary to accounting data and other commonly used benchmark risk measures. It also makes intuitive sense that a measure incorporating information from different sources should be more informative overall than single-source indicators.



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**Table 1. Possible outcomes for the function relating divergence between market and non-market risk indicators to the conditions for market discipline**

<i>Functional outcome</i>	<i>Interpretation</i>	<i>Implication</i>
Divergence is increasing in the conditions for market discipline	As conditions for market prices to reflect risk improve, the difference in informativeness between the market-based measure and the benchmark measure increases; since the benchmark measure is invariant to the conditions for market discipline, it implies that the increasing 'divergence' reflects that $M$ becomes increasingly <i>more</i> informative.	The market-based measure is on average more informative
Divergence is decreasing in the conditions for market discipline	As conditions for market prices to reflect risk improve, the divergence between the market-based risk measure and the benchmark measure decreases; alternatively, as conditions for market prices to reflect risk deteriorate, the divergence between $M$ and $B$ increases; this means that the gap in informativeness successively closes (opens) as the conditions for market discipline improve (deteriorate).	The benchmark measure is on average the more informative risk measure
No functional relationship can be established	The divergence between the market-based and the benchmark measures shows no systematic relationship with the conditions for market discipline, indicating that on average, these variables carry about the same risk information content.	Neither measure is <i>a priori</i> more informative than the other

**Table 2. Descriptive statistics, market-based and accounting-based risk measures**

The table reports summary statistics for the included market-based (Panel A) and benchmark/accounting-based (Panel B) risk measures. Summary statistics for the included measures (except sub-debt spreads) are reported separately for bank/year observations with subordinated debt outstanding (sub outst.) and those without (no sub outst.), as well as for the full sample of observations (all). The ‘Test’ column reports the Wilcoxon/Mann-Whitney rank-based test statistic for the null hypothesis that the ‘sub outst.’ and the ‘no sub outst.’ groups have equal distributions around the median.

**Panel A: Market-based risk measures**

	<i>Group</i>	<i>Mean</i>	<i>Std dev</i>	<i>Median</i>	<i>Test</i>	<i>Min</i>	<i>Max</i>	<i>Obs</i>
Sub-debt spread (bp's)	All	115	208	81.0		-370	988	637
Stock return volatility	All	0.0228	0.0171	0.0191		0.000	0.202	4964
	Sub outst.			0.0184				1556
	No sub outst.			0.0196	3.42***			3408
Market Z-score	All	5.35	5.28	3.55		0.350	40.3	2688
	Sub outst.			3.20				1318
	No sub outst.			3.94	8.40***			1370

**Panel B. Accounting-based risk measures**

	<i>Group</i>	<i>Mean</i>	<i>Std dev</i>	<i>Median</i>	<i>Test</i>	<i>Min</i>	<i>Max</i>	<i>Obs</i>
Leverage	All	0.914	0.055	0.931		0.462	0.990	3322
	Sub outst.			0.942				1510
	No sub outst.			0.914	20.0***			1812
Non-performing loans / equity	All	0.666	0.726	0.458		0.000	4.89	2534
	Sub outst.			0.505				1241
	No sub outst.			0.404	4.74***			1293
Liquid assets / total assets	All	0.253	0.189	0.214		0.000	0.974	3388
	Sub outst.			0.181				1523
	No sub outst.			0.257	8.31***			1865
ROA	All	0.0081	0.0159	0.0077		0.0944	0.0708	3315
	Sub outst.			0.0064				1501
	No sub outst.			0.0090	7.32***			1814

\*\*\* Indicates rejection of the null hypothesis of equal medians at the 0.01 level.

**Table 3. Descriptive statistics, control variables included in first-stage regressions**

The table reports summary statistics for the included bank-level and country-level control variables included in the regressions of market-based risk measures on benchmark risk measures.

	<i>Mean</i>	<i>Std dev</i>	<i>Min</i>	<i>Max</i>	<i>Obs</i>
<u>Bank-level control variables</u>					
Deposits	0.82	0.12	0.16	0.95	2878
Net interest margin	0.040	0.051	-0.63	0.48	3363
Cost/income ratio	0.65	0.34	0.077	8.59	3318
<u>Country-level control variables</u> (annual obs's for 47 countries)					
Real interest rate	0.060	0.091	-0.91	0.78	
Inflation	0.067	0.14	-0.039	1.55	
Growth	0.033	0.031	-0.13	0.18	

**Table 4. Descriptive statistics, conditions for market discipline**

The table reports summary statistics for variables included in the composite measures of the extent to which the conditions for market discipline are satisfied (open capital markets, good information, no prospects of bailout, and responsiveness to market signals).

	<i>Mean</i>	<i>Std dev</i>	<i>Min</i>	<i>Max</i>	<i>Obs</i>
<u>Bank-level variables</u>					
Turnover rate	0.79	2.27	0.00	53.3	4564
Share of formally insured debt	0.53	0.35	0.00	0.99	2881
No-bailout credibility	3.56	1.45	1.00	5.00	5066
Institutional ownership	0.10	0.16	0.00	0.98	5377
Insider ownership	0.39	0.31	0.00	0.99	5377
Excess capital	0.044	0.055	-0.030	0.49	3322
<u>Country-level variables</u> (annual obs's for 47 countries)					
Bank deposits/GDP	0.67	0.36	0.10	2.55	
Private-sector credit/GDP	0.84	0.63	0.072	2.60	
Equity issues/Gross Fixed Capital Formation	0.18	0.13	0.021	0.63	
Equity market capitalization/GDP	0.45	0.40	0.00	2.75	
Number of publicly traded firms/mn. population	23.3	28.5	1.13	194	
Corporate bond market capitalization/GDP	0.31	0.40	0.00	2.12	
Foreign-investment openness	3.51	2.71	0.00	9.00	
Corporate transparency/private monitoring index	67.2	8.74	32.7	85.0	
Shareholder rights index	3.16	1.25	1.00	5.00	
Creditor rights index	2.39	1.24	0.00	4.00	
Index of rule of law	4.15	1.38	1.00	6.00	

**Table 5. Principal components analysis of conditions for market discipline, summary**

Panel A reports eigenvalues and variance proportions of the first six principal components (of a total of 18 components) from a principal components analysis on the conditions for market discipline, based on the correlation matrix of the included variables. PC1 refers to the first principal component, PC2 to the second, etc. The bottom row in Panel A shows cumulative variance proportions. Panel B shows coefficients on the individual proxies of the conditions for market discipline (the parameter vectors  $a$  and  $b$  in equation [14]). The total number of included observations was 1862.

<b>Panel A. Eigenvalues and variance proportions</b>						
	PC1	PC2	PC3	PC4	PC5	PC6
Eigenvalue	4.96	2.37	1.70	1.38	1.23	0.99
Variance proportion	0.275	0.131	0.095	0.077	0.068	0.055
Cumulative variance proportion	0.275	0.407	0.502	0.578	0.647	0.702
<b>Panel B. Coefficients on individual proxies of MD conditions</b>						
	PC1	PC2	PC3	PC4	PC5	PC6
<u>Open capital markets</u>						
Turnover rate	-0.08	0.04	-0.21	0.07	-0.49	0.42
Bank deposits/GDP	0.29	-0.31	0.17	-0.04	0.04	0.35
Private-sector credit/GDP	0.33	0.02	0.36	0.01	0.01	0.16
Equity issues/Gross Fixed Capital Formation	0.24	-0.24	-0.27	-0.39	0.00	0.17
Equity market capitalization/GDP	0.38	-0.06	-0.03	-0.25	0.04	0.13
Number of publicly traded firms/mn. population	0.31	-0.15	-0.35	0.06	0.13	0.07
Corporate bond market capitalization/GDP	0.24	0.45	0.13	0.11	0.05	0.03
Foreign-investment openness	0.32	0.29	-0.05	-0.08	0.08	0.08
<u>Good information</u>						
Corporate transparency/private monitoring index	0.33	0.08	-0.03	0.16	0.12	-0.11
<u>No prospects of bailout</u>						
Share of formally insured debt	-0.02	-0.07	0.64	-0.03	-0.28	0.23
No-bailout credibility	-0.04	0.38	-0.11	-0.03	0.27	0.00
Government ownership	-0.12	-0.19	-0.07	0.26	0.40	0.43
<u>Responsiveness to market signals</u>						
Insider ownership	-0.23	-0.07	0.01	-0.42	0.28	0.18
Institutional ownership	0.14	-0.13	-0.27	0.22	-0.51	-0.08
Excess capital	-0.03	0.35	-0.26	-0.22	-0.18	0.23
Shareholder rights index	0.10	-0.42	-0.04	0.21	0.11	-0.30
Creditor rights index	-0.14	0.07	-0.10	0.54	0.15	0.42
Index of rule of law	0.34	0.13	0.08	0.22	0.02	-0.08

**Table 6. Results of regressions of market-based risk measures on accounting-based risk measures**

The table reports coefficient estimates from panel OLS regressions with period fixed effects. T-statistics in parentheses are based on White type standard errors robust to time-varying residual variance and correlation over time within cross-sections. In the regressions on sub-debt spreads, accounting variables and macroeconomic variables are measured in percent (rather than fractions). Market Z-score is entered negatively in the regression (it decreases in risk) for ease of comparability. Squared standardized residuals from regressions 1, 3, and 4 are used as ‘divergence’ measures (for sub-debt, stock return volatility, and Z-score, respectively) in the subsequent analysis.

	<i>Dependent variable</i>			
	1. Sub-debt spread	2. Sub-debt spread	3. Stock return volatility	4. Negative market Z-score
Leverage	12.2 (1.08)	10.9 (0.96)	-0.019 (-1.40)	48.9 (6.72)***
Non-performing loans	1.20 (2.03)**	1.21 (2.02)**	0.004 (5.27)***	0.76 (3.64)***
Liquid assets	3.00 (1.91)*	3.01 (1.91)*	0.024 (5.97)***	3.98 (4.66)***
Return on assets (ROA)	60.9 (2.19)**	63.8 (2.27)**	-0.028 (-0.55)	4.08 (0.33)
Time to maturity	-3.78 (-2.58)**	-3.82 (-2.61)***		
Amount of issue	-15.3 (-0.73)	-16.8 (-0.78)		
Heckman ‘lambda’ <sup>a</sup>		-22.1 (-0.68)		
Deposits	0.072 (0.054)	0.29 (0.22)	-0.003 (-0.50)	-0.91 (-0.73)
Net interest margin	-3.54 (-0.32)	-3.89 (-0.34)	-0.051 (-3.22)***	-21.5 (-2.69)***
Cost/income ratio	-0.15 (-0.098)	-0.27 (-0.18)	0.001 (0.28)	-0.86 (-1.50)
Real interest rate	2.14 (1.04)	2.15 (1.06)	0.013 (1.62)	5.75 (3.79)***
Inflation	15.7 (1.34)	15.3 (1.30)	0.047 (6.72)***	12.4 (5.03)***
Growth	21.4 (1.87)*	19.14 (1.67)*	0.035 (2.71)***	21.3 (5.08)***
Systemic financial crisis	38.5 (0.87)	35.8 (0.79)	0.004 (3.12)***	1.56 (4.73)***
Period fixed effects (F-statistic)	5.18***	5.28***	9.32***	4.80***
Adj. R <sup>2</sup>	0.33	0.33	0.26	0.33
Regression F	7.55***	7.26***	35.5***	47.7***
No. of observations	267	264	1831	1781
No. of banks	97	96	349	347

\*/\*\*/\*\*\*/\*\*\* denotes significance at 10/5/1 percent confidence level.

Note: a) Correction for possible selection bias, based on the Heckman (1979) two-step procedure; the variable is the inverse Mills ratio calculated from a probit selection regression, as specified in Table A6.

**Table 7. Results of regressions of sub-debt spread divergence on conditions for market discipline**

The table reports coefficient estimates from panel OLS regressions of the squared standardized residual from model 1 in Table 6 on various combinations of the first six principal components of the conditions for market discipline (PC1-PC6). Model 5 reports coefficient estimates from a piecewise linear regression on the first principal component, where the distribution of the independent variable is split into four even quarters. T-statistics in parentheses are based on White standard errors robust to contemporaneous correlation and cross-section heteroscedasticity.

	1	2	3	4	5
Intercept	0.88 (4.90)***	0.74 (4.51)***	0.36 (2.29)**	0.31 (2.11)**	0.37 (2.02)**
PC1	0.11 (4.60)***	-0.11 (-4.00)***	-0.005 (-0.17)	-0.13 (-5.71)***	
PC1 <sup>2</sup>			0.11 (24.5)***	0.10 (10.9)***	
PC2		-0.17 (-2.31)**		-0.11 (-1.57)	
PC3		-0.24 (-7.73)***		0.043 (1.13)	
PC4		0.080 (1.45)		0.13 (2.31)**	
PC5		-0.42 (-3.35)***		-0.41 (-3.36)***	
PC6		-0.17 (-1.98)**		-0.21 (-2.03)**	
PC1 – Q1					-0.25 (-3.55)***
PC1 – Q2					-0.38 (-3.83)***
PC1 – Q3					0.03 (0.31)
PC1 – Q4					0.43 (12.14)***
Adj. R <sup>2</sup>	0.01	0.06	0.06	0.09	0.06
Regression F	2.40	3.71***	8.87***	4.36***	4.66***
No. of observations	239	239	239	239	239
No. of banks	91	91	91	91	91

\*/\*\*/\*\*\* denotes significance at 10/5/1 percent confidence level.

**Table 8. Results of regressions of stock return volatility divergence on conditions for market discipline**

The table reports coefficient estimates from panel OLS regressions of the squared standardized residual from model 3 in Table 6 on various combinations of the first six principal components of the conditions for market discipline (PC1-PC6). Model 5 reports coefficient estimates from a piecewise linear regression on the first principal component, where the distribution of the independent variable is split into four even quarters. T-statistics in parentheses are based on White standard errors robust to contemporaneous correlation and cross-section heteroscedasticity.

	1	2	3	4	5
Intercept	0.60 (7.80)***	0.62 (7.23)***	0.52 (7.20)***	0.51 (6.29)***	0.49 (5.09)***
PC1	-0.14 (-4.07)***	-0.13 (-4.04)***	-0.14 (-4.27)***	-0.13 (-4.34)***	
PC1 <sup>2</sup>			0.017 (4.42)***	0.022 (2.42)**	
PC2		0.060 (2.56)**		0.074 (2.55)**	
PC3		-0.015 (-0.83)		0.035 (0.95)	
PC4		0.080 (1.45)		-0.039 (-2.12)**	
PC5		-0.053 (-2.34)**		0.050 (4.56)***	
PC6		0.10 (3.09)***		0.084 (2.41)**	
PC1 – Q1					-0.071 (-1.27)
PC1 – Q2					-0.24 (-3.01)***
PC1 – Q3					-0.13 (-2.47)**
PC1 – Q4					-0.043 (-2.71)***
Adj. R <sup>2</sup>	0.03	0.03	0.03	0.04	0.04
Regression F	47.0***	9.49***	25.7***	8.88***	15.0***
No. of observations	1489	1489	1489	1489	1489
No. of banks	282	282	282	282	282

\*\*\* denotes significance at 10/5/1 percent confidence level.



**Table 9. Results of regressions of market Z-score divergence on conditions for market discipline**

The table reports coefficient estimates from panel OLS regressions of the squared standardized residual from model 4 in Table 6 on various combinations of the first six principal components of the conditions for market discipline (PC1-PC6). Model 5 reports coefficient estimates from a piecewise linear regression on the first principal component, where the distribution of the independent variable is split into four even quarters. T-statistics in parentheses are based on White standard errors robust to contemporaneous correlation and cross-section heteroscedasticity.

	1	2	3	4	5
Intercept	0.78 (7.25)***	0.96 (6.01)***	0.85 (4.17)***	0.95 (4.69)***	0.82 (4.30)***
PC1	0.086 (2.90)***	0.15 (3.21)***	0.082 (2.25)**	0.15 (2.88)***	
PC1 <sup>2</sup>			-0.014 (-0.58)	0.001 (0.042)	
PC2		0.63 (3.58)***		0.63 (3.59)***	
PC3		-0.047 (-1.01)		-0.045 (-0.94)	
PC4		-0.041 (-0.39)		-0.040 (-0.41)	
PC5		0.13 (2.41)**		0.13 (2.15)**	
PC6		0.26 (6.48)***		0.26 (7.66)***	
PC1 – Q1					0.10 (2.11)**
PC1 – Q2					0.13 (2.16)**
PC1 – Q3					0.13 (0.80)
PC1 – Q4					-0.000 (-0.002)
Adj. R <sup>2</sup>	0.003	0.06	0.002	0.06	0.002
Regression F	4.65**	17.7***	2.75*	15.1***	1.62
No. of observations	1483	1483	1483	1483	1483
No. of banks	282	282	282	282	282

\*/\*\*/\*\*\* denotes significance at 10/5/1 percent confidence level.

**Table 10. Regressions on individual conditions for market discipline**

The table reports coefficient estimates from panel OLS regressions of the squared standardized residuals from model 1 (sub-debt spread divergence), model 3 (stock-return volatility divergence), and model 4 (Z-score divergence) in Table 6 on an index of ‘no-bailout credibility’. T-statistics in parentheses are based on White standard errors robust to contemporaneous correlation and cross-section heteroscedasticity.

	Dependent variable					
	Sub-debt spread divergence		Stock-return volatility divergence		Z-score divergence	
	1	2	1	2	1	2
Intercept	1.77 (6.06)***	3.50 (6.06)***	0.04 (0.17)	-0.18 (-0.28)	-0.84 (-3.27)***	1.81 (5.65)***
No-bailout credibility (No-bailout credibility) <sup>2</sup>	-0.29 (-5.56)***	-1.80 (-5.58)***	0.26 (3.30)***	0.42 (0.72)	0.51 (4.58)***	-1.47 (-4.85)***
Adj. R <sup>2</sup>	0.03	0.05	0.004	-0.02 (-0.26)	0.02	0.30 (4.86)***
Regression F	8.18***	7.89***	8.58***	0.004	42.2***	28.6***
No. of obs.	259	259	1823	1823	1773	1773
No. of banks	96	96	348	348	346	346

\*/\*\*/\*\*\* denotes significance at 10/5/1 percent confidence level.

## Appendix A. Additional data tables

**Table A1. Distribution of banks by country**

Country	Number of banks	Average size <sup>a</sup> of included banks in 2005	Number of banks with subordinated debt outstanding in 2005	Average MD conditions of included banks in 2005 <sup>b</sup>
Argentina	4	4,853	2	-3.09
Australia	9	55,698	9	2.84
Austria	4	18,625	4	-0.68
Brazil	14	13,558	6	-3.79
Canada	9	90,587	8	4.41
Chile	5	14,229	3	-1.14
Colombia	11	2,244	1	-3.48
Czech Republic	1	20,942	0	-2.60
Denmark	40	847	25	2.11
Egypt	20	978	1	-2.41
Finland	2	8,201	2	2.06
France	11	22,495	5	1.08
Germany	16	11,632	8	-0.10
Greece	10	13,638	5	-0.63
Hong Kong	7	15,165	3	5.12
Hungary	2	5,265	2	-2.64
India	37	13,051	10	-2.73
Indonesia	22	4,154	9	-3.28
Ireland	5	127,953	5	2.30
Israel	8	16,406	5	0.06
Italy	19	28,383	13	-0.78
Japan	87	19,133	54	0.91
Kenya	7	575	0	-4.79
South Korea	8	33,349	3	-1.31
Lithuania	4	955	3	-1.70
Malaysia	3	28,277	3	0.53
Malta	4	1,425	1	-0.21
Morocco	5	6,241	1	-2.79
Netherlands	1	1,039,000	1	4.59
Pakistan	20	1,345	8	-2.94
Peru	9	948	3	-2.19
Philippines	15	1,626	8	-2.11
Poland	12	6,548	2	-2.96
Portugal	3	73,289	3	0.28
Romania	3	1,472	1	-3.43
Singapore	2	71,652	2	3.33
South Africa	2	5,477 <sup>c</sup>	1	-1.66 <sup>d</sup>
Spain	14	25,982	9	1.78
Sri Lanka	7	658	4	n.a.
Sweden	2	217,181	2	2.92
Switzerland	6	6,780	3	3.90
Taiwan	15	11,636	5	-0.46
Thailand	13	7,679	11	-1.48
Turkey	12	8,183	3	-2.78
United Kingdom	3	18,409	2	4.48
United States	15	3,511	6	3.34
Venezuela	14	1,027	0	-4.78

n.a.: Not available

Notes: a) Total assets in millions of USD. b) Index of the conditions for market discipline given by the first principal component of variables listed in Table A3, Panel B. A higher value indicates better conditions for market discipline. Total sample observations on the index run between -6.69 and 5.78 and have zero mean. c) Refers to average size in 2004 (no observations for 2005). d) Refers to average MD conditions in 2002 (no observations for 2003-2005).

**Table A2. Distribution of observations on market-based risk measures over time**

Year	Risk measure, number of obs's		
	Sub-debt spreads	Stock return volatility	Market Z-score
1994	10	299	0
1995	10	333	1
1996	14	344	1
1997	23	375	23
1998	34	395	227
1999	38	415	273
2000	51	431	301
2001	61	448	321
2002	70	461	341
2003	89	475	357
2004	103	489	433
2005	134	499	410

**Table A3, Panel A. Risk measures (market- and accounting-based) and control variables**

Variable	Description	Source
<u>Market-based risk measures</u>		
Subordinated debt spreads	Spread over equal-maturity riskfree rate of yields on the bank's subordinated bonds or notes, in basis points	Datastream, Reuters
Stock return volatility	Standard deviation of daily equity returns (calculated for each year)	Datastream
Z-score	(Average return on equity – equity capital over total assets) divided by standard deviation of equity returns	Datastream, BankScope
<u>Accounting-based risk measures</u>		
Leverage	One minus the equity share of total assets	BankScope
Non-performing loans	Non-performing loans divided by equity capital	As above
Liquid assets	Liquid assets divided by total assets	As above
Return on assets (ROA)	Net earnings divided by total assets	As above
<u>Bank-level control variables</u>		
Deposits	Deposits divided by total assets	As above
Net interest margin	Interest income over interest expenditure	As above
Cost/income ratio	Total costs divided by total income	As above
<u>Country-level control variables</u>		
Real interest rate	Real interest rate	World Development Indicators
Inflation	Annual change in consumer prices	As above
Growth	Real GDP growth	As above
Systemic financial crisis	Dummy variable equal to one if the country was undergoing a systemic financial crisis, zero otherwise	Honohan and Laeven (2005)

**Table A3, Panel B. Proxies of conditions for market discipline**

	Open capital markets	Bank-level variables	Source	Country-level variables	Source
Monitoring		Turnover rate <sup>a</sup>	Datastream	Bank deposits (or M2)/GDP	IMF's IFS + World Bank's WDI
				Private-sector credit/GDP	As above
				Equity issues/Gross Fixed Capital Formation <sup>g</sup>	Datastream, Eurostat + IFS or WDI
				Equity market capitalization/GDP	As above
Influence				Number of publicly traded firms/mn. population	Datastream + WDI
				Corporate bond market capitalization/GDP	Bank for International Settlements + IMF's IFS
				Foreign-investment openness <sup>h</sup>	Brune et al. (2001)
				Corporate transparency/private monitoring index <sup>i</sup>	Bushman et al. (2004), Barth et al. (2001, 2006)
	Good information				
	No bailout	Share of formally insured debt <sup>b</sup>	BankScope, Demirgüç-Kunt et al. (2005)		
		No-bailout credibility <sup>c</sup>	Fitch/BankScope + IMF's IFS		
		Government ownership dummy <sup>d</sup>	Reuters		
	Responsiveness to market signals	Institutional ownership <sup>e</sup>	Reuters	Shareholder rights index <sup>j</sup>	La Porta et al., 1997, 1998; Pistor et al., 2000; Djankov et al., 2005, 2006; and Allen et al., 2006
		Insider ownership <sup>e</sup>	Reuters	Creditor rights index <sup>j</sup>	As above
		Excess capital <sup>f</sup>	BankScope, Barth et al. (2001, 2006)	Index of rule of law	International Country Risk Guide

Notes:

- Average daily turnover divided by market value of equity
- Country-wide deposit insurance coverage in percent multiplied by each bank's ratio of deposits to total debt (equals zero for banks from countries with no explicit deposit insurance)
- The Fitch support index of probability of bailout, wherever available, otherwise one minus the bank's share of total deposits (alt. M2) in its country of residence
- Dummy variable equal to one if the largest insider/stakeholder is the government
- Equity held by institutional investors and insiders, respectively, divided by all equity
- The equity share of total assets minus the applicable regulatory Tier-1 capital requirement, defined as 50% of the *total* capital requirement
- Net equity issues are approximated as the year-on-year change in a country's stock market capitalization, corrected for the change in stock prices as measured by Datastream's overall market price index for each country; the variable used is an average of observations for 1995-2005

- h) Index of capital-account openness based on nine categories of capital-account transactions as reported in IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*
- i) Equals the score on CIFAR's (Center for Financial Analysis and Research) overall index of financial-reporting transparency, wherever available, otherwise Barth et al.'s (2001, 2006) Private Monitoring index, recalculated to the CIFAR index scale
- j) Antidirector rights and creditor rights index, respectively; originally from La Porta et al. (1997, 1998); additional sources are for countries included in this paper's country sample but not in La Porta et al. (1998) are Allen et al., (2006), Djankov et al. (2005, 2006), and Pistor et al. (2000).

**Table A4. Pairwise correlations, bank-level benchmark risk measures and control variables**

	Leverage	Non-performing loans	Liquidity	ROA	Deposit share	Net interest margin
Non-performing loans	0.375					
Liquidity	-0.116	-0.089				
ROA	-0.423	-0.463	0.185			
Deposit share	0.512	0.216	-0.124	-0.236		
Net interest margin	-0.361	-0.219	0.149	0.385	-0.189	
Cost/income ratio	0.049	0.142	0.035	-0.412	0.004	-0.024



**Table A5. Pairwise correlations, conditions for market discipline****Panel A. Bank-level variables**

	Turnover rate	Share of formally insured debt	No-bailout credibility	Institutional ownership	Inside ownership
Share of formally insured debt	-0.024				
No-bailout credibility	-0.049	-0.171			
Institutional ownership	0.140	-0.045	-0.273		
Inside ownership	-0.060	-0.002	-0.032	-0.344	
Excess capital	0.088	-0.118	0.278	-0.003	0.067

(Panel B shown on next page)

(Table A5, cont'd)

**Panel B. Country-level variables**

	Bank depo- sits/GDP	Private sector credit/GDP	Equity issues/ investment	Equity market cap./GDP	Listed firms/mn. population	Corporate bond market cap./GDP	Foreign- investment openness	Corporate transparency/ private moni- toring	Shareholder rights	Creditor rights
Private sector cre- dit/GDP	0.671									
Equity issu- es/investment	0.434	0.319								
Equity market cap./GDP	0.619	0.647	0.635							
Listed firms/mn. Popu- lation	0.529	0.320	0.521	0.535						
Corporate bond market cap./GDP	0.171	0.521	0.076	0.380	0.190					
Foreign-investment openness	0.349	0.431	0.284	0.510	0.380	0.677				
Corporate transparen- cy/private monitoring	0.428	0.503	0.285	0.524	0.479	0.464	0.452			
Shareholder rights	0.233	0.226	0.219	0.238	0.299	-0.158	-0.272	0.290		
Creditor rights	-0.013	-0.180	-0.400	-0.243	-0.011	-0.088	-0.126	-0.104	-0.001	
Rule of law	0.481	0.515	0.190	0.496	0.479	0.572	0.539	0.568	0.145	0.010

**Table A6. Estimation results of the sub-debt sample selection model**

The table shows coefficient estimates from a pooled probit regression of the selection indicator (a dummy variable indicating if the bank had sub-debt outstanding during the observation year) on bank- and country-level regressors.<sup>a</sup> T-statistics in parentheses are based on regular probit standard errors (and should therefore be interpreted with caution, given the panel structure of the dataset). Observation-specific estimates of the inverse Mills ratio from this model were used as an additional explanatory variable in Table 6's model (2) to account for possible sample-selection bias.

	<i>Dependent variable: Sub-debt dummy</i>
Leverage	6.47 (5.89)***
Non-performing loans	-0.12 (-1.98)**
Liquid assets	-0.43 (-1.73)*
Return on assets (ROA)	0.064 (0.020)
Real interest rate	0.90 (1.82)*
Inflation	-0.49 (-0.81)
Growth	0.22 (0.17)
(Sub-debt dummy) <sub>t-1</sub>	2.76 (32.7)***
Undercapitalization dummy	0.58 (4.15)***
Intercept	-6.93 (-6.79)***
McFadden pseudo-R <sup>2</sup>	0.59
Regression likelihood ratio	2030***
No. of observations (of which dep. var. = 1)	2496 (1228)
No. of banks	437

\*/\*\*/\*\* denotes significance at 10/5/1 percent confidence level.

Note: a) To my knowledge, Covitz et al. (2004) were first to use the Heckman (1979) two-step approach to correct for sample-selection bias in the context of risk-sensitivity tests on sub-debt spreads. They estimate a model where the bank's decision to issue sub-debt is a function of the bank's own risk level, macroeconomic and market conditions, firm-specific advantages, and the regulatory pressure to issue. I based the above model on that general structure, and variables are grouped accordingly in the table. Proxies for bank risk and macroeconomic variables need no explanation or motivation. Firm-specific advantages are summarized by the lagged sub-debt dummy (used also by Covitz et al., 2004) since it can reasonably be assumed that this variable is strongly serially correlated within cross-section units; Covitz et al. (2004) use examination ratings to measure regulatory pressure to issue capital (which could be at least in part sub-debt); such ratings are not available for cross-country samples, and I instead use the undercapitalization dummy to proxy for the pressure to issue.

## **Appendix B. Empirical evidence on market monitoring of bank risk**

The empirical market discipline literature has been primarily concerned with one or both of the following closely related questions: first, whether market prices of bank claims are any good as gauges of the risk levels of banks – ‘do market-based risk indicators adequately reflect the risk levels of banks?’; second, whether putting the market meter on banks actually affects their risk-taking – ‘do banks adjust their risk behavior in accordance with fluctuations in the prices of their outstanding equity and debt?’. The questions posed in the literature thus essentially mirror the distinction between the monitoring and influence dimensions of market discipline. In practice, studies on the former question by far outnumber those on the latter one. Below, empirical results primarily on market monitoring are surveyed by type of claim. Section B.1 focuses on monitoring by holders of risky debt, whereas Section B.2 considers studies of equity-based risk indicators (or of both stock and bond prices). Section B.3, finally, discusses a methodological problem with ‘early-warning’-type tests of monitoring, and its connection with the methodological problems involved in empirically addressing the influence dimension of market discipline. Table B1 at the end of the appendix contains a summary of different market-based and benchmark indicators used in the literature.

### **B.1. Monitoring by holders of subordinated debt**

The evidence piled up over the years from studies using the risk-sensitivity approach paint a mixed picture as to the correlation between sub-debt spreads and other risk measures. Several factors come into play: the exact dataset tested (types of debt instrument, maturities, primary or secondary market spreads), characteristics of the banks included (size and charter value), benchmark risk measures used, and the time period investigated. As for the latter factor, most of the empirical tests are done on US data, and a common conclusion seems to be that correlations became stronger after the FDICIA<sup>20</sup> reform of 1991, which committed more credibly to a no-bailout policy as regards US banks’ uninsured creditors.<sup>21</sup>

Thus, Avery et al. (1988) and Flannery and Sorescu (1996) find mixed evidence of bank-specific risk measures reflected in the secondary market spreads of US banks’ subordinated notes and debentures (SNDs) during the 1980s. The former paper finds that, controlling for various issue-related features of the sub-debt (issue size, maturity, and issue-rating dummies), the benchmark risk proxies used are insignificant determinants of sub-debt spreads almost without exception, both individually and jointly, and the authors conclude that “important differences apparently exist between the market’s assessment of default risk and the balance-sheet measures of risk” (p. 605). Flannery and Sorescu

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<sup>20</sup> Federal Deposit Insurance Corporation Improvement Act.

<sup>21</sup> Benston and Kaufman (1997) report that formally uninsured deposit holders incurred losses in only 17 percent of bank failures in 1991, and that the FDICIA pushed that number up to 54 percent in the following year.

(1996) conclude from their qualitatively similar results that “bank investors clearly impounded the value of conjectural government guarantees into debentures prices” (p. 1373).

Jagtiani et al. (2002), on the other hand, testing a panel of mostly long term subordinated bonds in the *post*-FDICIA period, do find evidence that the secondary market pricing of bank sub-debt significantly depends on underlying credit risk, as traditionally measured, and that this effect is stronger for poorly capitalized banks. Also testing long term bonds (average maturity is 8.6 years) in the post-FDICIA period, Morgan and Stiroh (2001) find a link between *primary* market spreads and the quality of the banks’ asset portfolios. According to expectation, they also find the link to be stronger for more opaque banking institutions, and weaker for larger institutions (i.e., that ‘too-big-to-fail’ considerations cause the market to be softer on bigger banks).

The pattern is far from consistent, however, with regard to the US experience of the effect of implicit insurance of sub-debt. Hall et al. (2002) explicitly test the effect of FDICIA on the risk sensitivity of accounting-based yields (i.e., averages of interest expenditure over outstanding debt) on short-term certificates of deposit (CDs) in a cross section of US banks, and find that the risk sensitivity did not significantly increase after FDICIA. Similar results are obtained by Covitz et al. (2004). Studying secondary-market spreads of sub-debt of various maturities (of which 12 percent is short term) over a sample period covering the second half of the 1990s, Krishnan et al. (2006) find only weak and inconclusive evidence of a link between spreads and other risk variables. On the other hand, some older papers do find cross-sectional links between spreads on large CDs and balance sheet risk in the *pre*-FDICIA period (Hannan and Hanweck, 1988; James, 1988, 1990; Keeley, 1990; and Ellis and Flannery, 1992).

Sironi (2002, 2003) and Pop (2006) are among the few sources so far studying the determinants of the risk premium on non-US banks’ subordinated debt. Sironi (2002, 2003) finds that spreads reasonably well reflect ratings, that the pricing of bonds is similar in the US and Europe, but that the European bonds’ spreads contain a slightly higher liquidity premium. Pop (2006) regresses yield spreads on senior and junior bonds of European banks on credit ratings, controlling for various issue features, including subordination status. Results overall are consistent with the hypotheses that lower-rated bonds trade at higher yields than higher-rated bonds, and that sub-debt trades at higher yields than senior bonds.

As one step toward refining the basic risk-sensitivity approach, Covitz et al. (2004) make the observation that if riskier institutions avoid issuing sub-debt in the first place, in order to avoid being disciplined, then simply examining the relationship between risk profile and yield spreads may *underestimate* correlations because of sample selection bias. They use the standard Heckman (1979) two-step approach to correct for possible sample selection bias, and although some risk measures are (marginally) significant determinants of the issuance decision, the sample-selection correction variable is consistently insignificant in the second-step regressions sub-debt spread. The same approach to sample-selection correction is used by Birchler and Hancock (2004) and Evanoff and Jagtiani (2004), with

qualitatively similar results. These results would suggest that explicit consideration of sample-selection problems contribute little to the understanding of the association between sub-debt spreads and standard benchmark risk measures.

Goyal (2005) focuses on the effect of banks' risk incentives (measured as charter value) on both sub-debt spreads at issuance and the inclusion of restrictive covenants in the sub-debt contracts of 150 of the largest US bank holding companies (BHCs) over the 1974-95 period. The paper corrects for selection bias along similar lines as Covitz et al. (2004), Birchler and Hancock (2004), and Evanoff and Jagtiani (2004), but the yield spread regressions correct for self-selection into the sample group of bonds that include covenants (rather than for self-selection into the sample group of banks that issued any sub-debt at all). The yield spread regressions also correct for other risk proxies in the form of credit ratings and capital ratios. The results indicate that several factors proxying for bank risk are significantly related to both sub-debt spreads and to the inclusion of restrictive covenants in the sub-debt contracts, which is interpreted as evidence of market discipline – both through the pricing of uninsured debt *and* through conditioning the extension of such debt on limitations as to how it may be used.

A smaller number of studies make use of the time-series variation in sub-debt spreads to study the way in which new information is incorporated in different indicators. For instance, DeYoung et al. (2001) extract a proxy of the 'private information' contained in bank supervisors' examination ratings, and find that this information has some (albeit limited) predictive power for subsequent sub-debt spreads (at least if that information is 'bad news'). The result is interpreted along the lines that supervisory agencies are quicker to acquire risk-relevant information about banks than bond markets. Direct application of the early-warning approach is made in Evanoff and Wall (2001, 2002), who test secondary-market sub-debt spreads as leading indicators of bank risk, as measured by subsequent supervisory examination ratings (CAMEL/BOPEC). The predictive power of spreads is compared to that of various capital adequacy measures used by supervisors to trigger prompt corrective action (PCA). Results indicate that sub-debt yield spreads perform as well as, or better than, the capital-adequacy measures in terms of predicting one-quarter-ahead examination ratings (bifurcated into one high-ratings and one low-ratings category), with the possible exception of the Tier-1 capital ratio. However, all the considered measures misclassify a large portion of the included banks. All things considered, the paper provides weak evidence that market-based measures of bank risk may contain information that accounting-based measures do not.

In summation, the evidence on the informativeness of sub-debt yield spreads is mixed. Although risk-sensitivity tests often reveal a statistically significant association between sub-debt spreads and *some* benchmark measures, these results may be difficult to interpret in the absence of associations with other benchmark indicators. Furthermore, many risk-sensitivity studies find only weak, or altogether non-existent, correlations. Using somewhat different approaches, Evanoff and Wall (2001, 2002), for example, find that sub-debt spreads may be more informative than some capital-adequacy

measures, whereas the results of DeYoung et al. (2001), on the other hand, would suggest that bond markets cannot tell bank supervisors anything that they do not already know.

Tests along the lines just mentioned, that attempt more directly to compare the informativeness of different types of indicator, are in relatively short supply – especially for sub-debt spreads (although one might reasonably have expected that they should be at the center of attention, since the *relative* informativeness of market signals is really the be-all and end-all of market discipline). I next turn to the literature testing equity-based measures of bank risk, and to the few existing studies that test both equity-based measures and sub-debt spreads.

## B.2. Market monitoring by shareholders

If the literature on sub-debt spreads is dominated by the ‘risk-sensitivity’ approach, the portion of the literature studying equity-based risk measures is methodologically more varied. Early studies testing stock-market reactions to changes in bank risk include Pettway (1976, 1980), who test if large US bank failures in the 1970s caused any structural shifts in required rates of return on the equity of non-failed banks, and estimate abnormal equity returns as leading indicators of bank failure. The results suggest that the stock market was able early on to predict subsequent failures of a number of large banks, and that returns of non-failed banks were largely insensitive to the failure of other banks. Pettway and Sinkey (1980) build on these results to argue for an early-warning system for bank failure based on equity-price signals.

The early-warning approach is also adopted by several later papers, for instance Gunther et al. (2001), Bongini et al. (2002), Krainer and Lopez (2004), and Gropp et al. (2006). Gunther et al. (2001) estimate the ability of an options-pricing-type measure based on equity prices (expected default frequency, EDF) to predict supervisory examination ratings (levels and downgrades) next to past ratings and various standard accounting-based risk measures for about 900 ratings set on US banks in the period 1996-2000 (cf. Evanoff and Wall, 2001, 2002, testing sub-debt spreads in a similar manner). It is found that EDF makes only a marginal contribution to predicting subsequent examination ratings, whereas the contribution to predicting ratings downgrades is larger (unfortunately, no formal test is performed to ascertain whether this contribution is statistically significant or not). The Krainer and Lopez (2004) study is similar, and tests abnormal returns, EDFs, and a simpler equity-based proxy of asset volatility, along with various accounting measures and supervisory ratings for approximately 1500 ratings of about 390 US BHCs between 1990 and 1999, in the context of an ordered logit model. Results indicate that among the equity-based indicators only stock returns are significant predictors of subsequent BOPEC scores (possibly proxying for the profitability component entering into these ratings), whereas the more explicitly risk-related stock market indicators (EDF and asset volatility) have virtually no predictive power.

Bongini et al. (2002) test different market and non-market indicators (specifically an index of balance-sheet indicators, credit ratings, and implicit deposit insurance premia) as predictors of finan-

cial distress for a sample of 246 banks from four East Asian countries before and during the financial crisis around the years 1997-98. The authors find low power in all indicators to predict distress (i.e., to distinguish subsequently distressed banks from healthy ones); the equity-based measure (the 'fair' deposit insurance premium) did best, but the effect was still small and statistically insignificant.

A slightly different approach to establish lead- and lag-structures among different risk indicators is adopted by Berger et al. (2000). They apply Granger-causality techniques to a sample of 184 US BHCs during 1989-92 (a problem period for banks) to test if market-based and supervisory assessments of bank condition 'cause' one another. Results indicate that credit-rating agencies' ratings and supervisors' examination ratings 'cause' one another, but that there is weak or non-existing causality between supervisory ratings and stock-market measures of risk. The paper also investigates the power of these various indicators to predict future changes in (accounting-based) profitability, loan quality, and capital ratios. Results for these latter tests suggest that supervisory ratings are only useful as predictors of future performance for a very short period of time after the examination, whereas market-based indicators are of some value for predicting future bank performance (except, perhaps, capital ratios).

Hall et al. (2001) use the risk-sensitivity approach and regress several equity-based measures of risk *and* supervisory ratings for 98 US BHCs year by year over the 1988-93 period on the same set of accounting-based risk measures (proxies of loan quality, capital adequacy, liquidity, and credit commitments). Results suggest that equity-based risk measures respond primarily to variation in loan quality (as measured by the share of non-performing loans in total assets), whereas supervisory ratings are sensitive both to loan quality (in about the same extent as equity-based measures) and to capital ratios. No systematic attempt is made to assess the relative information content of the various measures employed.

Berger and Davies (1998) use event-study methodology to estimate 'announcement' effects of supervisory examination ratings on abnormal returns for 390 examinations of US banks during the 1985-89 period. As the authors stress, the results of these examinations are not actually announced to the public, so the test is on the joint hypothesis that the examinations produce information that significantly affects bank value and that some of this information leaks out to the market. Results are somewhat mixed but suggest an asymmetric effect of ratings downgrades (except for banks whose examination ratings were already unsatisfactory), indicating that examinations reveal private information that the stock market does not already have.

A few papers test both equity-based indicators and sub-debt spreads as risk measures. Brewer and Mondschean (1994) adopt the risk-sensitivity approach and estimate both stock return volatility and rates of interest paid on large CDs as functions of leverage, loan structure, and non-loan asset structure (such as junk-bond holdings and direct real-estate investments). Their results for 74 US savings and loans institutions during the latter half of the 1980s suggest a strong positive correlation between stock return volatility and both leverage and junk bond holdings, whereas evidence of equity-



market responsiveness to other components of the asset structure is mixed. The results for CD rates indicate that better-capitalized banks pay lower interest on uninsured deposits; coefficient estimates for other risk measures also have the right sign and are generally significant. No systematic attempt to compare the informativeness of the different market-based measures is made.

A methodological approach similar to that of Berger and Davies (1998) is adopted by Gropp and Richards (2001). They test announcement effects of credit ratings changes on abnormal returns on stocks *and* bonds. The sample covers a maximum of about 190 ratings changes for 32 EU-15 banks over the 1989-2000 period. Their results indicate small or non-existent announcement effects on bond prices. As the authors point out, this could be because (i) ratings changes do not convey any new information, or (ii) bond prices do not respond to the information contained in ratings changes.<sup>22</sup> These two alternative explanations obviously yield opposite conclusions as to the effectiveness of bond yields as risk measures (i.e., the unobservability problem is the same for event-type studies as for risk-sensitivity studies when failing to detect significant effects). The authors make additional tests to distinguish between these possibilities, and on the basis of these tests (although results are weak and relatively inconclusive) lean toward the latter explanation.

Results for stock returns indicate substantial announcement effects of both up- and downgrades. Interestingly, when distinguishing between the effect of ratings changes motivated by changes in the earnings outlook and those motivated by changes in risk, it is found that profitability-related downgrades result in negative abnormal returns, whereas risk-related downgrades trigger positive abnormal stock returns. This finding lends some support to the notion that shareholders may not discipline banks to decrease risk and/or leverage, due to risk-shifting incentives.

Gropp et al. (2006), finally, test the equity-based ‘distance to default’ (DD) *and* sub-debt spreads as predictors of bank distress, as proxied by credit rating downgrades for about 100 European banks over 1991-2001. Controlling for previous ratings or a (small) set of accounting variables, both indicators show signs of predictive power outperforming that of both credit ratings and balance-sheet information. The authors also make one of the very few attempts in the literature to directly compare the equity-based and the bond-based measure, but the results can essentially be interpreted both in terms of complementarity and substitutability of the information contained in the respective measures.

### B.3. Market influence and early-warning tests of monitoring: a methodological note

Early-warning-type tests have to some extent been devised in response to the insight that risk-sensitivity tests are ill-equipped to inform on the relative accuracy of different indicators (see, e.g., the discussion in Evanoff and Wall, 2001). In principle, the early-warning approach can be used both to test the adequacy of market signals as forward-looking indicators of future risk/solvency (rather than

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<sup>22</sup> Non-responsiveness could have several explanations. The authors discuss the possibility that bond markets are simply too illiquid to incorporate new information in any measurable way; an equally plausible explanation, it seems to me, is that bondholders believed they were not at risk due to conjectural government guarantees. This seems particularly plausible for European banks during the 1990s.

just testing their correlation with some existing contemporaneous benchmark measures), *and* to assess whether market prices contain information beyond that contained in other existing indicators: controlling for such indicators, any remaining significant explanatory power of the market measure represents distinct information. This type of test could therefore potentially answer the question if market signals would be useful by furnishing supervisors with information they do not already have.

Unfortunately, early-warning tests – like risk-sensitivity tests – are also problematic due to a type of ‘unobservability’ problem, which in this case stems from the impossibility to empirically isolate the monitoring and influence aspects of market discipline. Conceptually, the distinction between these two aspects of market discipline is quite clear. Empirically, however, it is difficult to separate them in any methodologically consistent and satisfactory way. The problem is that if the *influence* aspect of market discipline works, then banks will react to market signals by lowering their risk, which would, in turn, make the market indicator a *poor* predictor of bank risk – not because market discipline does not work, but precisely because it does work (in both dimensions). Conversely, if some market-based indicator is a good predictor of financial distress, and proves to contain information on future asset quality not contained in other risk measures, then that would suggest that the monitoring aspect of market discipline works, but that the influence dimension does not, i.e., banks do not react to market signals. Thus, adopting the early-warning approach necessarily involves making a composite hypothesis – one about monitoring and one about influence. If assumptions about the second dimension are not made clear, then it is difficult to interpret the results in terms of the first dimension – particularly if those results reveal a low power to predict risk.

The problem with the early-warning tests largely coincides with the difficulties of directly testing the influence aspect of market discipline. These difficulties are, in short, first to find an appropriate dependent variable (i.e., a measure of ‘discipline’, or influence), second, to get around the problem of counterfactuals – the inevitable ‘what if...’ questions that result from arguing that someone did or did not do something because of something: in this case arguing that banks changed their risk behavior in response to market signals, or, more troublesome, that banks kept their risk behavior on a steady level to avoid being disciplined. Evanoff and Wall (2000) make this distinction between *ex post* discipline and *ex ante* discipline, and express the problem in the following way: examining only *ex post* discipline is “analogous to saying that speed limit laws (or laws against robbing banks) are not effective in influencing behavior because speeders (bank robbers) are often repeat offenders [which] entirely ignores the influence these laws have on the behavior of the vast majority of people” (p. 18). This is the main criticism directed at Bliss and Flannery (2002), who use event study methodology to study the effect both of stock and bond prices on managerial decisions in US bank holding companies. The results do not provide support for any systematic effect (in terms of *ex post* discipline) of security prices on risk behavior, but – as follows from the above criticism – cannot be taken too far in terms of their *general* implications for market discipline, given the methodological problems.

Recognizing the difficulties of, particularly, accounting for *ex ante* discipline, Krishnan and al. (2006) attempt to get around them by asking whether banking firms' risk characteristics change after a *first* issue of subordinated debt; in other words, they ask if banks' risk behavior is different depending on whether sub-debt is outstanding or not. They find that it is not. However, given their extremely limited sample, certain timing issues, and – not least – the fact that *one* issue probably does not typically lead to banks having a sufficient amount of sub-debt on their balance sheet for it to engender any effective direct market discipline, their conclusions must be considered very tentative.

The problem of what might be considered a sufficient amount is directly addressed by Jordan (2000), who tests whether a sample of subsequently failed US banks' exposures to financing through large (jumbo) CDs affect the pricing of these CDs (and the pricing of smaller ones). Although this does not test the directly disciplining effect of sub-debt financing, the evidence produced support the hypothesis that the amount of subordinated debt on the balance sheet affects the *potential* for market discipline (both by a 'mechanical' cost of capital effect, and by virtue of the fact that CD pricing becomes more risk sensitive as the amount of CDs outstanding grows).

To sum up, a considerable body of literature is concerned with testing for market discipline in banking in various ways. The majority of contributions are concerned with testing market *monitoring* (i.e., the extent to which market prices of banks' securities reflect the bank's risk exposure). However, both the main testing approaches found in this literature – the 'risk-sensitivity' approach and the 'early-warning' approach – are fraught with methodological shortcomings which potentially make interpretation of the results difficult. For the risk-sensitivity approach, this difficulty essentially lies in knowing which measure of risk is *a priori* more informative. For the early-warning approach, the problem is the composite-hypothesis nature of the test. For both approaches, the problems are such that they preclude any substantive conclusions from the tests in the event of failure to establish significant results, since such results are consistent both with the presence and with the absence of market discipline. For the early-warning approach, also establishing market-based indicators as significant predictors of distress is problematic (in terms of the more general implications for market discipline), since it corroborates the monitoring dimension of market discipline, but contradicts the influence dimension (direct market discipline). As for more direct tests of the *influence* dimension of market discipline, finally, results are few, and this issue has essentially been left open by the literature so far.

**Table B1. Summary of risk indicators used in previous studies on market discipline in banking**

<b>Market-based risk indicators</b>	
<u>Equity-based</u>	
Equity return volatility (various definitions)	Brewer and Mondschean (1994); Hall et al. (2001); James (1988, 1990)
Abnormal equity returns (market model) <sup>a</sup>	Berger and Davies (1998); Berger et al. (2000); Birchler and Hancock (2004); Bliss and Flannery (2002); Gropp and Richards (2001); Krainer and Lopez (2004); Pettway (1976, 1980); Pettway and Sinkey (1980)
Beta (CAPM or market model)	Gunther et al. (2001); Hall et al. (2001)
Other, equity-based	Bliss and Flannery (2002); Ellis and Flannery (1992); Hall et al. (2001); Krainer and Lopez (2004)
<u>Debt-based</u>	
Primary-market spreads on subordinated notes and bonds	Evanoff and Jagtiani (2004); Goyal (2005); Morgan and Stiroh (2001); Sironi (2002, 2003)
Secondary-market spreads on subordinated notes and bonds	Avery et al. (1988); Birchler and Hancock (2004); Covitz et al. (2004); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Evanoff and Wall (2001, 2002); Flannery and Sorescu (1996); Gorton and Santomero (1990); Gropp et al. (2006); Jagtiani et al. (2002); Krishnan et al. (2006); Pop (2006)
Interest rate spreads on large certificates of deposit (CDs)	Brewer and Mondschean (1994); Ellis and Flannery (1992); Hall et al. (2002); Hannan and Hanweck (1988); James (1988, 1990); Jordan (2000); Keeley (1990)
Other, debt-based <sup>b</sup>	Birchler and Hancock (2004); Bliss and Flannery (2002); Gropp and Richards (2001); Martinez Peria and Schmukler (2001); Park (1995); Park and Perestiani (1998); Pop (2006)
<b>Accounting-based risk indicators</b>	
<u>Capital-structure-based</u>	
Leverage, or capital ratio (various definitions, e.g. equity/total assets, liabilities/market or book value of equity, etc.)	Avery et al. (1988); Berger et al. (2000); Birchler and Hancock (2004); Bliss and Flannery (2002); Brewer and Mondschean (1994); Covitz et al. (2004); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Evanoff and Wall (2001, 2002); Flannery and Sorescu (1996); Goyal (2005); Gropp et al. (2006); Gunther et al. (2001); Hall et al. (2001, 2002); Hannan and Hanweck (1988); Jagtiani et al. (2002); James (1988); Keeley (1990); Krainer and Lopez (2004); Krishnan et al. (2006); Martinez Peria and Schmukler (2001); Morgan and Stiroh (2001); Park and Perestiani (1998); Park (1995); Sironi (2003)
Debt or deposit structure <sup>c</sup>	Bliss and Flannery (2002); Evanoff and Jagtiani (2004); Gunther et al. (2001); Hall et al. (2002); Jagtiani et al. (2002); Park (1995)
<u>Loan- or asset-structure-based</u>	
Non-performing loans or similar (non-accruing loans, loans past due, etc)/total assets	Avery et al. (1988); Berger and Davies (1998); Berger et al. (2000); Birchler and Hancock (2004); Bliss and Flannery (2002); Covitz et al. (2004); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Flannery and Sorescu (1996); Gorton and Santomero (1990); Gropp et al. (2006); Gunther et al. (2001); Hall et al. (2001, 2002); Jagtiani et al. (2002); Krainer and Lopez (2004); Krishnan et al. (2006); Martinez Peria and Schmukler (2001); Morgan and Stiroh (2001); Park and Perestiani (1998); Park (1995)

(continued on next page)

(Table B1, continued from previous page)

Loan-loss provisions or loan-loss reserves/total loans or total assets	Avery et al. (1988); Baumann and Nier (2003); Berger and Davies (1998); Bliss and Flannery (2002); Bongini et al. (2002); Gunther et al. (2001); James (1988); Krainer and Lopez (2004); Krishnan et al. (2006); Sironi (2003)
Other, loan structure <sup>d</sup>	Avery et al. (1988); Bliss and Flannery (2002); Brewer and Mondschean (1994); Hall et al. (2002); James (1990); Krishnan et al. (2006); Martin (1977); Martinez Peria and Schmukler (2001); Morgan and Stiroh (2001); Park and Peristiani (1998)
Non-loan asset structure <sup>e</sup>	Avery et al. (1988); Birchler and Hancock (2004); Bliss and Flannery (2002); Bongini et al. (2002); Brewer and Mondschean (1994); Covitz et al. (2004); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Flannery and Sorescu (1996); Gunther et al. (2001); Hall et al. (2001, 2002); Krainer and Lopez (2004); Martin (1977); Martinez Peria and Schmukler (2001); Morgan and Stiroh (2001); Park and Peristiani (1998); Park (1995); Saunders et al. (1990); Sironi (2003)
<u>Profitability-based</u>	
Return on assets <sup>f</sup>	Avery et al. (1988); Berger et al. (2000); Bliss and Flannery (2002); Bongini et al. (2002); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Flannery and Sorescu (1996); Gropp et al. (2006); Gunther et al. (2001); Hall et al. (2001, 2002); Jagtiani et al. (2002); Krainer and Lopez (2004); Krishnan et al. (2006); Martinez Peria and Schmukler (2001); Morgan and Stiroh (2001); Park and Peristiani (1998); Park (1995); Sironi (2003)
Earnings volatility	Avery et al. (1988)
<u>Other, accounting-based</u>	Birchler and Hancock (2004); Bongini et al. (2002); Covitz et al. (2004); DeYoung et al. (2001); Flannery and Sorescu (1996); Gorton and Santomero (1990); Gropp et al. (2006); Hall et al. (2001); James (1988); Morgan and Stiroh (2001)
<b>Combination measures<sup>g</sup></b>	Bongini et al. (2002); Gorton and Santomero (1990); Gropp et al. (2006); Gunther et al. (2001); Hannan and Hanweck (1988); Krainer and Lopez (2004)
<b>Ratings</b>	
Rating agencies' bond issue ratings	Berger et al. (2000); DeYoung et al. (2001); Flannery and Sorescu (1996); Goyal (2005); Gropp and Richards (2001); Jagtiani et al. (2002); Krishnan et al. (2006); Morgan and Stiroh (2001); Sironi (2002, 2003)
Rating agencies' issuer (bank) ratings	Avery et al. (1988); Bongini et al. (2002); Evanoff and Jagtiani (2004); Gropp et al. (2006); Pop (2006); Sironi (2002, 2003)
Examination/supervisory ratings (CAMEL/BOPEC) <sup>h</sup>	Berger and Davies (1998); Berger et al. (2000); DeYoung et al. (2001); Evanoff and Jagtiani (2004); Evanoff and Wall (2001, 2002); Gunther et al. (2001); Hall et al. (2001); Jagtiani et al. (2002); Krainer and Lopez (2004); Krishnan et al. (2006)

Notes:

- Used to detect market reactions to events or information that may signal changes in bank risk, rather than as an explicit risk indicator.
- Regular deposit interest rates, spreads on senior bonds, etc.
- Jumbo or brokered CDs/total assets, insured deposits/total assets, etc.
- Loan assets/total assets, commercial and industrial loans/total assets, residential real estate loans/total assets, renegotiated loans/total assets, etc.
- Liquid assets/total assets, fixed or tangible assets/total assets, trading assets or investment securities/total assets, repossessed assets/total assets, etc.
- Used mainly as a control variable.

- g) These indicators use both market prices and accounting data; the category includes option-pricing-based measures (implied volatility, implicit deposit insurance premium, etc.) and the Z-score used in this paper.
- h) These are composite ratings assigned by the US federal supervisory agencies following on-site examinations of banking firms (CAMEL) or BHCs (BOPEC). They are thus only applicable to US datasets.

# On the Link Between Exchange-rate Regimes, Capital Controls and Monetary Policy Autonomy in Small European Countries, 1979–2000

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## 1. INTRODUCTION

THE changing climate for policy-making pursuant to the globalisation of financial markets during the last few decades has fostered a widespread belief that governments, particularly those of small economies, have essentially lost the power to pursue independent and sovereign economic policies. It is still widely held, however, that loss of the monetary-policy instrument is a major cost for a country assuming a rigid fixed exchange-rate regime – or, in the European context, for countries joining the EMU. This paper addresses the contradictory content of the two arguments, and informs the re-awoken debate about the role of exchange-rate regimes for economic growth and for the possibility to pursue independent stabilisation policies, which has in part been set in motion by the recent enlargement of the EU to include ten new member states.

The traditional Mundell-Fleming paradigm posits that under capital mobility, a country that wants to pursue an autonomous monetary policy, oriented toward the domestic economy, must allow its exchange rate to float. If, on the other hand, the country fixes its exchange rate, it must follow the monetary policy of the

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anchor country. Because monetary policy is determined abroad, the country has in this case effectively lost monetary policy autonomy.

In this paper, we analyse if monetary policy in our focus economies was 'determined' abroad – that is, if it was dominated by the policies of the larger benchmark countries – and whether the degree of dominance differed systematically depending on the exchange-rate regime pursued by the small country.

The motivation is, first, that the exchange-rate regimes as such are by no means clear-cut: the existence of intermediate regimes along a gradual scale between 'fixed' and 'float', and the sometimes sharp discrepancy between official and actual exchange-rate regimes, beg the question whether mainstream thinking in this area attaches too much weight to exchange-rate regimes. It is also possible to argue that short of monetary union, the exchange rate is always adjustable enough to accommodate *some* policy autonomy (see, e.g., Svensson, 1994). Arguments such as these have spurred a wave of recent literature on exchange-rate regime classification (Calvo and Reinhart, 2002; Bubula and Ötoker-Robe, 2002; and Reinhart and Rogoff, 2002), and on the link between '*de facto*' exchange-rate regimes and economic growth (Levy-Yeyati and Sturzenegger, 2001 and 2003; Bailliu et al., 2003; and Eichengreen and Leblanc, 2003), which complements the more traditional literature on the relative merits of different exchange-rate arrangements (for a survey, see Tavlas, 2003).

Second, in the trilemma described by the traditional Mundell-Fleming conditions, monetary autonomy is essentially a residual product of capital mobility and the choice to stabilise or not to stabilise the exchange rate. However, the link between the exchange rate and other nominal variables runs both ways: price stability induces exchange rate stability as much as pegging the exchange rate induces low inflation. Over the medium and long run, then, it could be argued that monetary autonomy is really a residual product of capital mobility and nominal variables in general. Increasing financial integration in combination with converging inflation rates and the pursuit of similar nominal stability targets in most industrialised countries may, to all practical intents and purposes and for any reasonable time horizon, constrain monetary policy as much as an explicit exchange rate peg. Under perfect capital mobility, a flexible exchange rate indeed offers – almost by definition – full theoretical monetary autonomy, but in light of the above arguments, there is reason to question the practical, empirical relevance of such autonomy: the question of autonomy may be reduced to the question of the potential presence of sharp asymmetric shocks to the real economy.

Third, if autonomy is the residual product of a nominal regime and capital mobility, what happens if capital mobility is imperfect? Absence of capital controls does not imply perfect capital mobility *de facto*: if anything, empirical studies indicate poor performance of, e.g., uncovered interest parity (for some recent results and references, see Chinn and Meredith, 2005). To the extent that there is reason to question the monopoly rights of the exchange-rate regime



(among alternative nominal stability targets) on determining monetary policy autonomy, there is equal reason to question the empirical relevance of a strong link between the two (i.e. between exchange-rate regime and autonomy) on the grounds that capital mobility is in reality imperfect.

We thus hypothesise that there is no systematic empirical link between exchange-rate regime and monetary policy autonomy. We test this hypothesis using a general methodology that has previously been used for similar purposes in the literature on monetary transmission and asymmetry within the European Monetary System (EMS).<sup>1</sup> Most of that literature has been concerned specifically with the so-called German-dominance hypothesis (GDH) and essentially attempted to answer the question if the EMS was a 'D-mark area'. The basic underlying reasoning is very simple: in a two-country setting, assume that one country is (very) small, and one country is (very) large; assume, further, that – in the case of fixed exchange rates – it is the small country that pegs the large country's currency, rather than vice versa, so that it is up to the small country to adjust monetary policy to maintain the peg. From these assumptions follow that the relationship between money-market conditions in the two countries is not symmetrical, but the small country is then the potential policy-taker. We therefore hypothesise an asymmetric relationship between the small and the large country: if there is international monetary policy transmission (non-autonomy), then the small country's monetary policy will be influenced by that of the large country but not vice versa.

A number of studies focusing on the behaviour only of interest rates, and covering primarily the 1980s (Karfakis and Moschos, 1990; and Gardner and Perraudin, 1993), find various degrees of support for the hypothesis of asymmetry (German dominance), while others (Katsimbris and Miller, 1993) find that the EMS was essentially a symmetrically-working system. Some studies (Cohen and Wyplosz, 1989; Fratianni and von Hagen, 1990; and Koedijk and Kool, 1992) devise models to assess the degree of autonomy in terms of more than a single variable (adding to interest rates primarily variables such as inflation rates and/or money-supply growth). These studies tend generally to assert a 'special role', though not strict dominance, to Germany. Among the more recent studies, which cover developments in the 1990s, most have focused either solely on monetary aggregates (Holmes, 1995), or on interest rates (Henry and Weidman, 1995; Hassapis et al., 1999; Uctum, 1999; and Bajo-Rubio et al., 2001). The inferences

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<sup>1</sup> Providing a definitive estimation of the degree of monetary policy autonomy based on international transmission of monetary policy indicators would require information not only about the outcome but also about the *ex ante* preferred path of policy. What we measure here is thus the *ex post*, realised autonomy – in line with our intent to investigate the practical empirical relevance of the conventional wisdom – rather than the *potential* for autonomy. Alternative approaches to measuring monetary-policy autonomy are based on parity conditions (Oxelheim, 1990), central-bank reaction functions, see Clarida, Galí and Gertler (1998 and 2000), or on target-zone models, see Bertola and Svensson (1993), Svensson (1994) and Fratzscher (2002).

drawn from the empirical analyses in terms of symmetry/asymmetry within the EMS come out about fifty-fifty. Most of these studies analyse only the larger EMS countries like France, Italy and the UK (beside Germany), sometimes adding Belgium, Ireland and the Netherlands.<sup>2</sup> None of the studies include countries *outside* the EMS on the receiving end of ‘dominance’.

Our case countries are basically just a complete list of the developed European countries that fit the small-size criterion (GDP) and had their own currencies in the 1980s and 1990s – starting with Ireland (the smallest) and ranging up to the Netherlands (the largest). After that, there is a jump up to the medium-sized countries such as Spain. In addition to Ireland and the Netherlands, the focus countries are: Austria, Belgium, Denmark, Finland, Greece, Norway, Portugal, Sweden and Switzerland. Apart from the fact that they are small, which means that they can reasonably be expected to have a role of price-takers, or ‘policy-takers’, in international markets, the choice of case countries is motivated by the fact that these countries have, collectively and at various intervals during the sample period (1979–2000), employed more or less every exchange-rate regime imaginable, from free float to full monetary union, with or without restrictions on capital movements or other foreign-exchange transactions. The countries also represent the full spectrum with regard to the level of ambition of exchange-rate policy, and ‘reputation’ in monetary matters: from hard-currency, low-interest-rate countries like Switzerland, the Netherlands and Austria, to countries which during part of the period investigated here had a near-emerging-market status (Greece and Portugal). The common foreign benchmarks are Germany and the United States.

The paper is organised as follows. Section 2 introduces a classification system of different exchange-rate regimes, based on an adapted version of the IMF’s classification scheme. The system is applied to each of the focus countries in order to split up the whole sample period into sub-periods for each one.<sup>3</sup> Section 3 is devoted to practical considerations, including a discussion of the data used in the empirical tests. If the small countries’ policies really *were* ‘determined’ abroad, then it is conceivable that a *statistical causal relationship* can be established, in the sense that the path of ‘domestic’ monetary-policy variables can be predicted by the ‘foreign’ counterparts. We use two different methods. In Section 4 we calculate the cross-country elasticities of changes in policy interest rates, while in Section 5 we extract the cross-country multipliers from bivariate Granger-causality tests on short-term market interest rates. Section 6 concludes.

<sup>2</sup> The exception to the rule is Bajo-Rubio et al. (2001), which includes also Spain and Portugal.

<sup>3</sup> Exchange-rate flexibility has generally not been taken explicitly into account in the literature cited above. Of course, given that the principal aim of most of the contributions in the area has been to find out how the EMS worked, it is not surprising that the exchange-rate regime has been taken for granted (although the *de facto* regimes pursued by participants in the system and the actual degrees of exchange-rate variability differed widely; see Section 2).

## 2. EXCHANGE-RATE REGIMES: CATEGORISATION, CLASSIFICATION AND DISCUSSION

This section presents the classification system used in the empirical analysis later in the paper to examine the role of exchange-rate regimes in determining monetary policy autonomy. The system captures the main choice between fix and float, but also leaves room for some nuance. Because many of the countries have been involved in the exchange-rate cooperation within the European Monetary System (EMS), this in-between situation should be reflected in the classification. Moreover, to capture the capital mobility dimension (since monetary policy autonomy, according to the general view, is the residual product of exchange-rate regime *and* capital mobility), we let the imposition of capital controls be an aspect of the formal institutional arrangements of exchange-rate management. Based on these considerations, a framework for the classification of exchange-rate regimes is depicted in the matrix in Table 1.

The matrix categorises exchange-rate arrangements according to two dimensions: what is the principal regime pursued for the exchange rate, and are restrictions on capital movements imposed to support the regime? The categorisation matrix is based on the classifications made in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*, and covers the main types of arrangements that have been in place in the survey countries since March 1979, when the European Monetary System was introduced.

At the time, some of the countries' currencies were essentially floating ('flexible/managed float') and, hence, belonging to our first main regime type. The EMS is categorised as a 'cooperative, semi-fixed' regime. Central parity rates of each currency within the system were adopted, but realignments of those parity rates were possible – indeed, realignments were quite frequent in the early years of the EMS. Several of the countries that were not in the EMS had pegged their currencies to some anchor currency or weighted average of currencies. This third category is called a 'unilaterally inflexible' regime.

TABLE 1  
Exchange-rate Regimes

		<i>Exchange Rate</i>			
		<i>Flexible/Managed Float</i>	<i>Cooperative/ Semi-fixed</i>	<i>Unilaterally Inflexible</i>	<i>Superfix (EMU)</i>
Restrictions on	Yes	1a	2a	3a	–
Capital Movements	No	1b	2b	3b	4
		→ Degree of rigidity			

The difference between categories 2 and 3 is the cooperation component of the EMS. Through this component all members of the exchange-rate mechanism (ERM) of the EMS automatically received help from the other members to keep the exchange rate stable should it approach the outer margins of the central parity rate. This was supposed to make the cooperative regime somewhat less of a strain to enforce than a unilateral peg. A particular, and complicating, circumstance of this arrangement that needs to be considered already at this stage is the widening of the fluctuation margins within the EMS/ERM to  $\pm 15$  per cent, which took place in August 1993. After this point, it is highly questionable whether it is useful to talk about the cooperation component as an effective tool for exchange-rate management, as currencies are allowed to fluctuate so much. Countries within the EMS wanting to pursue greater nominal exchange-rate stability must essentially do so by their own measures. Similarly, the difference between post-1993 ERM and a traditional float is marginal at best. The odd conclusion is that although a majority of the countries covered adhered to the ERM formally at some point or another, the system was only effectively exploited (after the fact, leaving aside more or less immeasurable factors such as possible credibility effects) by a few countries during limited periods.

In 1999, finally, stage 3 of the European Economic and Monetary Union went into force, by which the currencies of six of the eleven countries included in the study were irrevocably fixed with respect to one another and with respect to the other currencies that partake in the union. This is the maximum degree of inflexibility imaginable. The degree of rigidity, that is the degree of assumed infraction on national monetary autonomy, of each regime thus increases left to right. Under a floating exchange rate, monetary autonomy is, in principle, total. Under EMU even *formal* monetary autonomy, or monetary sovereignty, has been given up.

The second dimension of our classification scheme concerns the degree of capital mobility. In all the countries of our study – except Switzerland and to some extent Belgium – capital-account liberalisation was initiated during the 1980s. None of the countries included in the study employ since the mid-1990s capital controls in any meaningful sense of the word. Regulations concerning exchange transactions may exist, but are mainly in the form of reporting requirements, prudential foreign-exchange-exposure rules, investment rules for insurance and pension funds, or are related to ownership restrictions within protected sectors.

To summarise, the classification is based on the main consideration required to generate our hypothesis of asymmetric monetary transmission: specifically, whether the small countries' exchange rates are fixed or flexible, the degree to which it is up to the small country itself to enforce the exchange-rate peg (this is implicitly considered by the use of an intermediate regime), and the degree of capital

mobility (are capital controls imposed or not?).<sup>4</sup> Below we will discuss in detail the two dimensions of the classification for each focus country.

*a. Exchange-rate Regimes and Capital-account Liberalisation in the Focus Countries*<sup>5</sup>

The classification of the different exchange-rate regimes involves some discretion while at the same time being critical for the results of the study. Hence, below we will penetrate the classification we use country by country.

In *Austria*, 1979 marked the breakthrough of the hard currency policy, with a redesign of interest-rate policy and the adoption of an adjustable peg *vis-à-vis* the currencies of the EMS cooperation, in March 1979. The ECU peg, however, relatively instantaneously developed into a *de facto* DEM peg. After a number of minor adjustments of the exchange rate in the late 1970s and early 1980s, the ATS/DEM relation stabilised in late 1981 – a situation which remained intact even after Austria entered the ERM in January 1995 (the time of its entry into membership of the European Union). Consequently, although Austria formally switched currency regimes from ‘unilateral peg’ to ‘semi-flexible cooperation’ for the period from 1995 to the introduction of the EMU in January 1999, maintaining the strong D-Mark peg was in fact the overriding objective of Austrian monetary policy during the entirety of the sample period preceding the EMU.

Austria applied a relatively comprehensive set of capital controls around 1980. Liberalisation was initiated in the early-to-mid-1980s, intensified in 1989 and completed in November 1991. Although not formally an EC member country at this time, Austria essentially shadowed the deregulation process in the community as part of its exchange-rate policy.

*Belgium* adhered to the EMS from 1979 until the introduction of the EMU in 1999. Until March 1990, however, Belgium applied a dual-exchange-rate system. Under this system, there were two markets for foreign exchange: the official BEF rate (the EMS rate) was determined in a regulated market, which was associated with current account transactions; in the unregulated market, the franc was floating freely, and this market was associated mainly with capital account transactions. Because capital flows went mainly through the unregulated market, it would be difficult to motivate using the regulated rate in attempting to measure capital mobility. The *de facto* regime for the Belgian franc until early 1990 was thus, for the purposes of this study, a free float. After the abolition of the dual-rate system,

<sup>4</sup> Cf. the categorisations made by Helpman (1981), who also distinguishes between a float, a fix and a cooperative regime, and of Levy-Yeyati and Sturzenegger (2001 and 2003), who similarly distinguish between float, fix and an intermediate regime.

<sup>5</sup> A general reference for this sub-section on the formal (and to some extent the *de facto*) exchange rate arrangements in the focus countries is the IMF’s *Annual Report on Exchange Arrangements and Exchange Restrictions* for the various years that the study covers.

the BEF was (unilaterally) pegged to the DEM with the tight margins of  $\pm 0.5$  per cent. This peg was also maintained throughout the 1990s.

Belgium did not impose capital controls in the ordinary sense of the word to any significant degree during the period under investigation here, but its dual exchange market has certain implications for the assessment. The appropriate analytical approach for empirical investigations involving exchange-rate time series for countries with dual exchange rates depends on the *nature* of the dual-rate system and on *which one* of the exchange rates that is used.<sup>6</sup> Since, in the case of Belgium, a portion of the cross-border capital flows were directed to a regulated market, it seems reasonable to classify the two-tier system as a (moderate) restriction on capital flows: the basic point of the system is to control the official exchange rate and protect the external reserves against capital flows, while still upholding free capital mobility in a sort of formal sense (dual exchange-rate systems also fall into a separate category of exchange-control measures according to the IMF's classifications).

*Denmark* participated in the exchange-rate mechanism of the EMS from March 1979, but in the period from the late 1970s and during the course of the 1980s, devaluations of the krone were made eight times (each by an average of 1.4 per cent *vis-à-vis* the ECU), in connection with general realignments of the EMS parity rates (Holden and Vikøren, 1994 and 1996). The stability of the DKK *vis-à-vis* the other participating currencies of the system increased gradually during the 1980s. After the widening of the EMS intervention margins in 1993, the central rate of the DKK was essentially kept within the previous narrow band by unilateral action of the Nationalbank, and fluctuated only marginally. Denmark negotiated an opt-out from the EMU in the Maastricht Treaty, but the continuation of a strict exchange-rate policy was formalised by the inception of ERM2 in January 1999. The Danish krone has since shadowed the euro within fluctuation margins of  $\pm 2.25$  per cent. Post-EMU, then, the regime for the DKK is once again 'cooperative, semi-fixed'.

The liberalisation of the Danish capital account picked up speed in the early 1980s: the period of systematic abolition of capital controls can be said to have begun in 1983, when the deregulation of outward cross-border direct investment and portfolio flows was initiated. In 1988, the last restrictions were lifted.

*Finland.* Finnish exchange-rate policy during the 1980s and up to the early 1990s was characterised mainly by frequently adjusted pegs. The markka was pegged to a trade-weighted currency basket from 1973 until mid-1991 (the Deutschmark and the Swedish krona were the heaviest components – one-fifth each), and then to the ECU in 1991–92. During the period 1979–92, three devaluations (two in 1982, and one in 1991) and three revaluations (in 1979, 1980 and

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<sup>6</sup> Discussions of the analytical treatment of dual exchange rates more generally are provided in Dornbusch (1986) and Obstfeld (1986).



1989) were carried out. In September 1992 the markka was allowed to float on a more permanent basis. In February 1993, the Finnish central bank announced an inflation target (of two per cent) as a new nominal anchor for monetary policy. The ERM link-up in October 1996 *theoretically* did not change much in Finnish monetary policy; however, notwithstanding the fact that the wide intervention margins did not pose a significant conflict with the inflation target (which was also officially maintained), the Finnish monetary authorities began at this point to manage the exchange rate heavily and by its own accord – a shift to an exchange-rate-oriented monetary policy which no doubt should be viewed in the light of the projected euroisation of the markka a few years on.

Foreign-exchange regulations were in place in Finland during the whole post-war period until the late 1980s. In 1986, however, the external-regulation system began to be gradually dismantled. Most long-term, wholesale capital transactions were free in September 1989, while the last restrictions on short-term capital movements for households were lifted in November 1991.

In *Greece*, the drachma followed a regime of ‘managed float’, which had taken shape during the 1970s, during most of the period here studied. In June 1985, Greece did formally join the EMS, but *not* the exchange-rate mechanism, and the GRD continued to depreciate *vis-à-vis* the ECU. The conclusion of this is that even after its adherence to the EMS, the managed float continued. It did so until February 1995, when the Bank of Greece went from continual discretionary exchange-rate adjustments to announcing a target path for the devaluation of the drachma *vis-à-vis* the other EMS currencies (that is, an announced crawling peg). Since it is, conceptually speaking, equally constraining, in terms of latitude for discretion, to announce a devaluation target path of  $X$  per cent whether  $X$  equals one or two or zero (that is, in the latter case, a fixed exchange rate), we will call this a ‘unilaterally inflexible’ exchange-rate regime, according to the classifications of Table 1 (cf. Portugal 1979–92). In March 1998, the drachma formally entered into the Exchange Rate Mechanism of the EMS, but fluctuated quite heavily (spanning in excess of 20 per cent in 1998 alone) within the wide margins of the post-crisis ERM. Greece stayed in the ERM (formally, it entered, with Denmark, into ERM 2) as stage 3 of the monetary union was launched, then joined the EMU as from January 2001 (outside the sample period covered here).

When Greece joined the European Community in 1981, it imposed strict regulations on all cross-border payments. The liberalisation process began in 1988–89, was intensified in 1990, and by June 1993, all cross-border capital transactions (except transactions with original maturities of less than one year) were free. Remaining controls on short-term capital flows and derivatives were abolished as of May 1994.

*Ireland* joined the EMS in March 1979, and the GBP peg was replaced by a ‘cooperative’ ECU peg as of the following month. Larger devaluations were then made in 1986 and in 1993. In the intervals, exchange-rate developments were

relatively undramatic, but continual realignments of the IEP were made throughout the 1980s and up to the early 1990s. As a result of the exchange-rate crisis in 1992 (resulting in a devaluation of the IEP in early 1993), and the widening of the ERM intervention margins in August 1993, the cooperative component of the EMS effectively ceased to be a major determinant of the IEP exchange rate, and the currency began to fluctuate rather strongly *vis-à-vis* both the ECU central rate and *vis-à-vis* the DEM. From this period, therefore, and up to the eve of the EMU's third stage (although the pound was surely managed to *some* extent during this period), the IEP seems most appropriately labelled 'flexible'.

Ireland applied relatively strict regulations on capital outflows (but not on inflows) *vis-à-vis* most of the world until the mid-1980s. During the course of the 1980s there were both some relaxation and some tightening of the rules. The first more unequivocal step towards liberalisation was taken in 1989, when most restrictions on long- and medium-term portfolio transactions were lifted. The process then went on to be completed by January 1993.

*The Netherlands* followed a consistent exchange-rate-oriented monetary policy during the entire sample period: the value of the NLG was in practice kept constant with respect to the DEM (with a self-imposed fluctuation margin of  $\pm 0.5$  per cent of the mid-1980s), implying a gradual revaluation of the NLG *vis-à-vis* the theoretical ECU through the realignments of EMS currencies. The *de facto* DEM peg remained also through the turbulence of 1992–93, until the introduction of the euro in 1999.

The Netherlands, together with Switzerland, pursued a somewhat more liberal capital-account policy than the other countries considered in this study. Most capital transactions were free already by the late 1970s, but nonetheless, various types of restrictions were imposed on portfolio transactions until the early-to-mid-1980s. The remaining restrictions on capital exports were removed in 1986.

*Norway.* From December 1978 until October 1990, the krone was pegged to a basket of anchor currencies in a regular fixed-exchange-rate regime with an announced fluctuation band. In October 1990, the Norges Bank changed anchors for the NOK and adopted a unilateral ECU peg, which lasted until December 1992, when the krone was floated. During this period, the Norwegian central bank undertook six devaluations, each by an average of 3.4 per cent (Holden and Vikøren, 1994 and 1996). Norwegian monetary policy between the 1992 float and the end of our study period is not entirely straightforward to categorise. Formally, the krone floated: there was no declared exchange-rate target and no fluctuation margins. At the same time, it is clear that Norges Bank used the exchange rate as a nominal anchor (indeed, exchange-rate stability *vis-à-vis* the most important European currencies was the *only* goal acknowledged for monetary policy in the Bank's reports), but it was apparently not prepared to go out of its way to defend the stability of the exchange rate in case of a shock. The arrangement might be characterised as a sort of 'long-term peg', applied with



plenty of short-term pragmatism. For lack of a better alternative, and since the NOK was formally (if this is understood as the absence of a declared parity and fluctuation margins) floating after 1992, we shall call it 'flexible'.

In Norway the aim of external regulations during the 1960s–80s was to isolate the Norwegian interest level and allow autonomy in monetary policy. A number of deregulatory measures in the early 1980s were followed by a temporary tightening of capital controls in 1984–85. In 1987, however, a second wave of deregulations was initiated, resulting in a total abolition of the remaining capital controls by the spring of 1990.

*Portugal.* From the mid-1970s onward, the Portuguese escudo essentially followed a crawling peg *vis-à-vis* a basket of currencies, which was revised and reweighed at a number of occasions during the 1980s. The Banco de Portugal announced a target depreciation rate for the escudo every six months, which was gradually reduced (as the EMS was launched in March 1979, the target rate was 1.25 per cent/month). The PTE was also subject to a number of larger, discrete devaluations, and one revaluation, in the early 1980s. In September 1989, the escudo was included in the ECU basket, and Portugal formally joined the EMS (but not the ERM) in October 1990. Until April 1992, the policy for the PTE was to shadow a trade-weighted index of the leading EMS currencies. In April 1992, the PTE entered the cooperative regime of the ERM, and remained within the mechanism until it joined the EMU. The European currency crises in the early 1990s triggered three devaluations between November 1992 and August 1993. Between the last of these devaluations and the launch of the EMU the Banco de Portugal was essentially left to its own devices when it came to keeping the escudo stable (considering the widened intervention margins), but did so (save a minor devaluation in spring 1995). This unilaterally inflexible regime was terminated when the PTE became part of the euro from 1999.

By the 1970s, the policies surrounding international economic transactions into and out of Portugal had developed into a very complex system of exchange controls, encompassing more or less all transaction types – capital as well as current account. The purpose of capital controls, in the form applied in the late 1970s and up to about 1986, was to maintain foreign-exchange reserves at an adequate level and to hinder capital flight. Toward the end of the 1980s, however, the situation was reversed as Portugal began to experience the effects of massive inward investment (partly as a consequence of the EC membership in 1986), and the focus had to be shifted toward the management of capital *inflows*. Throughout the 1980s, capital controls were considered a vital instrument of exchange-rate and monetary policy (see Larre and Torres, 1991; and Pinto, 1996). The process of liberalisation of the control system began after Portugal's EC accession; after 1988 the process was managed according to the conditions stipulated in the EC's capital-liberalisation Directive (and the transitory exemptions granted to Portugal therein). In 1989, restrictions on portfolio flows began to be gradually lifted, and

the capital-account liberalisation process was completed between August and December 1992.

In *Sweden*, the krona was pegged to a trade-weighted currency basket (in which the weight for the US dollar was doubled and accounted for about 20 per cent) from August 1977 until 1991. Two major devaluations of the krona were made in this period: in 1981 (ten per cent) and in 1982 (16 per cent). In May 1991, the krona was unilaterally pegged to the ECU (cf. Finland and Norway), but was floated in November the following year. The floating-rate regime has remained since 1992, and the Riksbank applies an explicit inflation target of two per cent since 1995.

In Sweden, regulations on capital movements were gradually, and slowly, abolished from the mid-1970s onward. Interest-rate deregulation and the emergence of an efficient domestic money market in the early 1980s are likely to have substantially undermined the effectiveness of the foreign-exchange regulations. A (reluctant) commitment to capital-control liberalisation emerged toward the mid-to-late 1980s. The bulk of liberalisation measures were taken between 1987 and July 1989, when capital controls were completely abolished.

*Switzerland* has not pursued an explicit exchange-rate policy during any part of the period here studied. Instead, other nominal targets have been applied. The Swiss National Bank readopted targeting the monetary base in the course of 1979, after a series of more or less explicit targets during the years preceding. This policy was then pursued consistently – at least in theory – until 1999, although in practice the central bank has sometimes been forced to counteract excessive movements in the exchange rate, and thus accept undesired fluctuations in the monetary base in the face of large capital inflows.

Switzerland has to a lesser degree than the other case countries employed controls on cross-border capital transactions in the period since 1979. Various restrictions *have* indeed been in force at intervals – notably on short-term capital. These, however, have been almost exclusively ‘contingency’ measures to temporarily stifle massive capital inflows, and have been less comprehensive than in other countries.<sup>7</sup> As a result, it is not possible to describe the capital-account liberalisation process in Switzerland in the terms used for the other countries, or to specify a date for the abolition of capital controls.

Since 1999, the *euro-area countries* pursue a common monetary policy within a unified policy framework. Monetary policy is entirely focused on maintaining price stability, and thus no active exchange-rate policy is pursued. In terms of our categorisation of exchange-rate regimes, the euro-area countries thus pursue a

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<sup>7</sup> The restrictions imposed by the Swiss authorities over the years fall mostly into group (d) according to the IMF’s categorisation of exchange-control types: a ‘residual’ group of restrictions encompassing, for instance, limitations on interest payments on deposit accounts from non-residents, reserve requirements which discriminate between foreign and domestic banks, etc.

completely fixed regime ('super-fix') with respect to each other, and a flexible regime *vis-à-vis* the rest of the world. Additionally, the European System of Central Banks (ESCB) has the obligation of cooperating with potential candidate countries which are in ERM 2.

*b. A Summary Classification of External Policy Regimes*

In the first part of this section, the matrix in Table 1 provided a summary classification of the external policy regimes pursued in the survey countries between March 1979 and November 2000, based on the exchange-rate arrangements and on whether or not capital controls were in place. On the basis of the account in the rest of the section, we were then in a position to categorise the actual regimes pursued in the survey countries according to the categories specified by this classification model, and to divide the total period under investigation into sub-periods for each country. As explained earlier, this will enable us to systematically relate the degree of capital mobility and different levels of constraint on domestic monetary policy to the exchange-rate policy pursued during a certain sub-period. Applying this categorisation scheme to our case countries, we end up with sub-periods for each country as listed in Table 2. The classifications deviate in certain instances from the official descriptions, based on the 'soft' *de facto* policy analysis in Section 2a, above.

An important conclusion of this section is that it is difficult to make a completely accurate and consistent classification of the exchange-rate regimes actually pursued in different countries over an extended period of time. The 'same' regime may also mean different things in terms of nominal exchange-rate variability – not only in different countries but even in the same country over different time spaces. Such differences are the effect of credibility and other historical and symbolic factors, which cannot easily be incorporated in a simple and tractable classification model. Where it is appropriate, we have clearly accounted for the various parameters and the various 'discretionary' considerations that have been allowed to influence the classification of regimes in the countries studied over different periods of time. The important thing to keep in mind for the remainder of this article is that any classification of an exchange-rate regime is approximate.

### 3. MONETARY POLICY INDICATORS AND DATA CONSIDERATIONS<sup>8</sup>

If we want to assess the behaviour of monetary policy, the dependent variable should be one that reflects policy, with due consideration taken to the issue of

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<sup>8</sup> The exact data series used in Section 5, along with sources, are listed in the Appendix.

TABLE 2  
Summary of External-policy Arrangements

Category							
	1a: Flexible Exchange Rate W/Capital Ctrls	1b: Flexible Exchange Rate, No Capital Ctrls	2a: Cooperative Regime W/Capital Ctrls	2b: Co-operative Regime No Capital Ctrls	3a: Unilateral Fix W/Capital Ctrls	3b: Unilateral Fix, No Capital Ctrls	4: Monetary Union, No Capital Ctrls
Austria	<b>P1:</b> 1979:03–1990:02				<b>P1:</b> 1979:03–1991:10	<b>P2:</b> 1991:11–1998:12	<b>P3:</b> 1999:01–2000:11
Belgium						<b>P2:</b> 1990:03–1998:12	<b>P3:</b> 1999:01–2000:11
Denmark				<b>P2:</b> 1988:10–1993:07 <b>P4:</b> 1999:01–2000:11		<b>P3:</b> 1993:08–1998:12	
Finland		<b>P3:</b> 1992:09–1996:09	<b>P1:</b> 1979:03–1988:09		<b>P1:</b> 1979:03–1990:12	<b>P2:</b> 1991:01–1992:08 <b>P4:</b> 1996:10–1998:12 <b>P3:</b> 1995:02–1998:02	<b>P5:</b> 1999:01–2000:11
Greece <sup>a</sup>	<b>P1:</b> 1979:03–1994:04	<b>P2:</b> 1994:05–1995:01 <b>P4:</b> 1998:03–2000:12 <b>P3:</b> 1993:08–1998:12					
Ireland		<b>P3:</b> 1992:12–2000:11	<b>P1:</b> 1979:03–1992:12	<b>P2:</b> 1993:01–1993:07	<b>P1:</b> 1979:03–1985:12 <b>P1:</b> 1979:03–1990:05 <b>P1:</b> 1979:03–1992:03 <b>P1:</b> 1979:03–1989:06	<b>P2:</b> 1986:01–1998:12 <b>P2:</b> 1990:06–1992:11 <b>P4:</b> 1993:08–1998:12 <b>P2:</b> 1989:07–1992:10	<b>P4:</b> 1999:01–2000:11 <b>P3:</b> 1999:01–2000:11 <b>P5:</b> 1999:01–2000:11
Netherlands							
Norway							
Portugal <sup>a</sup>			<b>P2:</b> 1992:04–1992:11	<b>P3:</b> 1992:12–1993:07			
Sweden		<b>P3:</b> 1992:11–2000:11					
Switzerland <sup>b</sup>		<b>P0:</b> 1979:03–2000:11					

Notes:

<sup>a</sup> Both Greece and Portugal pursued 'crawling-peg' regimes during the greater part of the 1980s, and into the 1990s; a distinction is made here between a regime following a pre-announced target path (in which case the regime is classified as 'unilaterally inflexible'), and a regime where the depreciation rate was essentially handled at the discretion of the monetary authorities (in which case the regime is classified as 'flexible/managed float').

<sup>b</sup> The Swiss National Bank introduced a temporary exchange-rate target in October 1978 (see text), which was quietly abandoned in the spring of the following year, that is, at approximately the start of the period covered; for lack of a better assumption, we assume that an effective floating-rate regime did in fact start at that point.

Sources: See references to the main text (including footnotes).

comparability over time and across countries. The correct variable to observe may be the primary policy instrument, over which the monetary authorities *do* have direct control, for example a policy interest rate. It may also be the operational variable, over which the monetary authorities *seek* to exert control in order to steer monetary policy in the desired direction to reach its final goals, for example price or exchange-rate stability.

Unfortunately, the correct variable to observe is not the same in all countries, nor has it remained the same over time within any given country. It is not even always clear what the 'correct' variable is, particularly in historical data. Sometimes it is not revealed, and even where it is, it is not necessarily the officially declared targets that matter most at any given moment – there is a considerable discretionary element involved. That the choice of variable can critically influence the results is shown by previous research on the subject (see, e.g., Uctum, 1999).

The most important indicator is an interest rate (see Choi and Ratti, 2000).<sup>9</sup> Most of the studies referred to in Section 1 use one-month, three-month or some unspecified (short-term) interest rate. However, studies of central-bank operations in different countries and over different time periods covered by our sample (Kneeshaw and Van den Bergh, 1989; Batten et al., 1990; Bernanke and Mishkin, 1992; Kasman, 1992; Goodhart and Viñals, 1994; and Borio, 1997) suggest that a shorter-term interest rate (such as the overnight rate) would, on balance, be a more appropriate indicator of monetary policy (although not ideal for every country and time period – see Moschitz, 2004). The choice of interest rates, when comparing several countries over an extended period of time, will necessarily reflect a tradeoff between consistency, comparability, and availability. Sometimes, due to availability constraints, there is little *choice* involved at all in the equation (such is the case for several of our focus countries during the earlier part of the sample period).

We have chosen, in this paper, to use two different interest rates as policy indicators: in Section 4, we test policy interest rates, because the approach taken in that section favours the use of an indicator that is changed in discrete steps at a less frequent basis; in Section 5, we use interbank interest rates for overnight and up to one-week contracts, according to availability.

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<sup>9</sup> Monetary aggregates may be an important complementary indicator. Some of our case countries targeted money supply even into the 1990s (notably Switzerland). However, others did not, and the problems of finding an aggregate with policy content for *all* the countries, and the fact that these aggregates on a monthly basis are likely to be erratic and subject to revisions, have convinced us that money supply is a less adequate policy indicator than interest rates in the context of the methodology employed in this paper. Results on tests equivalent to those in Section 5 for narrow money supply growth rates (monetary base and M0) are available from the authors on request, but not reported here.

Because of the potential speed of transmission and, particularly in dealing with short-term interest rates, the case can effectively be made for using data of higher frequency than monthly (see, e.g., Bajo-Rubio et al., 2001). Going back over 20 years – considerably longer than any available high-frequency study – even monthly data take some effort to come by, let alone data of higher frequency. Thus, due mainly to data-availability constraints, a priority for consistency of data over time and across countries, and a focus on general patterns over the short-to-medium term rather than on day-to-day events, we use monthly data.<sup>10</sup>

Finally, knowing what to compare with is obviously a major consideration. In terms of relating the degree of monetary-policy autonomy to the degree of rigidity of the exchange-rate regime, some tradeoff must be made. Theory, or common wisdom, does not predict that a country pegging its currency to, say, the DEM will be subject to asymmetric influence by US monetary policy but only, in principle, by the policy of the anchor country. The difficulty, in practice, is the multitude of different anchors used by the different case countries over time. The ideal way of dealing with the problem of knowing what to compare with would have been to measure variability *vis-à-vis the actual anchors used in each country in each sub-period*. Problems of comparison would have remained, however, and it is not evident that such an approach – to the extent that it would at all be possible to reconstruct time series with indicators for each exact anchor – would provide better grounds for analysis than a more general benchmark. Several previous papers have thus proxied a ‘global policy’ as the benchmark; others have added to the main benchmark (usually Germany) a complementary benchmark (usually the United States). This paper follows the latter convention and thus follows a double-benchmark approach, arguing that the accumulated indications given by benchmarking Germany and the United States (the US dollar being an important anchor for some of the case countries in the 1970s and 1980s) should provide grounds for some passably solid conclusions as to the degree of ‘foreign’ influence over our case countries’ monetary policies.

#### 4. ANALYSIS OF CROSS-COUNTRY RESPONSIVENESS OF POLICY INTEREST-RATE CHANGES

In this section, we calculate the responsiveness of policy interest-rate changes, that is the responsiveness to changes in the interest rate that is set directly by the

<sup>10</sup> Using monthly data if one month is a longer time horizon than that at which agents form their expectations can present temporal-aggregation problems. One way to remedy this is, as noted, to run the model on daily data. In the absence of such data, a possible solution could be to include a moving-average (MA) term. However, we still could not be certain if the aggregation problems are solved. Moreover, this would present us with problems of interpretation.

monetary authority (central bank). This requires that we make the *a priori* assumption that a benchmark country ‘leads’ monetary policy with respect to the small focus countries. We then analyse how responsive the small countries’ policy interest rates are to changes in the benchmark countries’ policy interest rates. This is done by calculating the elasticity of policy-interest-rate changes and the average lag for each focus country and sub-period. The definitions are as follows:

$$\text{Elasticity} = \frac{\Delta I_a}{\Delta I_b} \cdot \frac{I_b}{I_a}, \quad (1)$$

where the upper-case *I*’s refer to the levels (not the logarithms) of the policy interest rates. The elasticity measures the average percentage response in the small country’s (*a*’s) policy interest rate to a one percentage point change in the benchmark country’s (*b*’s) policy interest rate. The average lag is defined as the average number of periods that pass between a change in the benchmark country’s policy interest rate and the next change in the policy interest rate of the small country.<sup>11</sup> Thus, we have two measures: one that measures the responsiveness in terms of the *magnitude* of the response, and one that captures the *time* aspect of responsiveness.

We calculated elasticities and lags for each sub-period of each case country on monthly data *vis-à-vis* Germany and the United States. The specific interest rates used varied as no country exhibited a consistent time series of one single representative policy interest rate over the entire 22-year period. Over most of the 1980s, discount rates as reported in IMF *International Financial Statistics* were used. In later sub-periods, various central-bank rates were used, with (pairwise) comparability as a primary selection criterion. Since the early-to-mid-1990s, most countries included (with the exception mainly of Switzerland) have had a specific interest rate – usually a repurchase rate – as explicit primary policy instrument, which facilitated the job of matching different rates in later periods.

The results are summarised in Table 3a–b.<sup>12</sup> Judging by the averages in this table, exchange-rate regime is not a good predictor of policy autonomy. The most striking result, perhaps, is that not a single one of the average elasticities is significantly different from zero, indicating some degree of autonomy even for

<sup>11</sup> The indications of ‘average lag’ should be interpreted with caution since an *active* but *gradual* interest-rate policy by the small country with frequent policy-rate changes in periods where few changes are made in the benchmark-country rate will give the impression of a ‘long lag’, while, in effect, the indicator simply reflects the average of several changes spread over a long time. It is not evident that this type of policy is necessarily less responsive to foreign influences than one which follows a different strategy; the frequency of interest-rate changes by the central bank also depends on the bank’s exact operational framework.

<sup>12</sup> Country-by-country results are available from the authors on request.



TABLE 3  
Responsiveness of Policy Interest Rates, Summary

a. Average elasticity of interest-rate changes for all countries/sub-periods according to exchange-rate regime; standard deviations in parentheses

		Exchange Rate			
		Flexible/ Managed Float	Cooperative/ Semi-fixed	Unilaterally Inflexible	Superfix (EMU)
Restrictions on Capital Movements	Yes	vis-à-vis DE	vis-à-vis DE	vis-à-vis DE	—
		0.12 (0.75)	0.38 (1.73)	0.29 (0.94)	
		vis-à-vis US	vis-à-vis US	vis-à-vis US	
	No	0.38 (1.05)	0.61 (1.81)	0.37 (1.30)	
		vis-à-vis DE	vis-à-vis DE	vis-à-vis DE <sup>b</sup>	vis-à-vis DE
		0.69 (1.96)	1.16 (5.46)	0.73 (1.17)	1.00 (0.00)
vis-à-vis US		vis-à-vis US <sup>a</sup>	vis-à-vis US	vis-à-vis US	
0.77 (3.80)		0.69 (1.82)	0.62 (2.20)	1.83 (2.17)	

b. Average lag (number of months)

		Exchange Rate			
		Flexible/ Managed Float	Cooperative/ Semi-fixed	Unilaterally Inflexible	Superfix (EMU)
Restrictions on Capital Movements	Yes	vis-à-vis DE	vis-à-vis DE	vis-à-vis DE	—
		3.75	2.91	3.92	
		vis-à-vis US	vis-à-vis US	vis-à-vis US	
	No	6.59	2.96	6.34	
		vis-à-vis DE	vis-à-vis DE	vis-à-vis DE <sup>b</sup>	vis-à-vis DE
		3.79	1.13	3.84	0.00
vis-à-vis US		vis-à-vis US <sup>a</sup>	vis-à-vis US	vis-à-vis US	
5.65		4.33	5.71	1.57	

Notes:

<sup>a</sup> IE P2 and PT P3 have been left out of the calculation of averages, since no changes in the US rate were undertaken during those periods.

<sup>b</sup> FI P4 has been left out of the calculation of averages, since no changes in the German rate were undertaken during that period.

countries/periods with fixed exchange rate arrangements and no capital controls. However, none of the elasticities is significantly different from unity, either (and for regimes without capital controls are consistently closer to one than to zero), so in some sense, the conclusion depends on the choice of null-hypothesis. Another general observation is that elasticities with respect to German and US policy are close in levels, although German policy presumably better approximates the actual anchor policy pursued (where there is one). However, German policy innovations do generate a quicker response than US innovations for all



TABLE 4  
Elasticities of Policy Interest Rate Changes: Comparisons of Mean Elasticities  
(*t*-Statistics)

a. *Vis-à-vis* German interest rates

<i>Regime</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>
1a	1.99**	0.96	1.33	1.13	3.35***
1b		0.90	0.78	1.94*	0.18
2a			0.86	0.41	1.39
2b				1.59	0.74
3a					3.00***

b. *Vis-à-vis* US interest rates

<i>Regime</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>	<i>4</i>
1a	0.79	0.85	0.92	0.05	0.18	3.28***
1b		0.31	0.09	1.26	0.34	0.82
2a			0.16	1.10	0.03	1.84*
2b				0.95	0.13	1.44
3a					1.15	3.15***
3b						1.58

Note:

\*/\*\*/\*\*\* Null hypothesis that sample means are equal is rejected at 10/5/1 per cent significance level, respectively.

regimes. Since the policy interest rate is the same since January 1999 for all EMU countries, the elasticity of policy interest rates of all EMU countries with respect to Germany is (trivially) unity with lag time zero in the last period.

In the context of comparing the degree of autonomy offered by different regime types, and in order to extract the full information content of the results shown in Table 3, we look for significant *differences* in elasticities across regimes. To do so, we performed pairwise two-sample *t*-tests across all regimes. The outcomes of these tests are shown in Table 4a–b. Pairwise comparisons of ‘a-regimes’ and ‘b-regimes’ separately indicate that exchange-rate regimes do not influence policy autonomy regardless of whether capital controls are in place or not, and regardless of benchmark. We find no significant differences between regimes 1, 2 and 3, when the capital-mobility dimension is controlled for.

Comparing the same exchange-rate regime across the capital-mobility dimension (i.e. 1a–1b, 2a–2b, and so on), we see that lifting capital controls significantly increases the elasticity *vis-à-vis* German policy, except for EMS countries. When US policy interest rates are the benchmark, however, this result does not hold (because the variability of elasticities *vis-à-vis* the US is too high). The EMU policy rate, finally, is not significantly more responsive to US policy rates than were the individual focus countries’ policy rates after capital controls had been lifted.

We will further discuss the implications of these results in the concluding section. The next section looks at *market* interest rates.

#### 5. ANALYSIS OF CROSS-COUNTRY RESPONSIVENESS OF MARKET INTEREST-RATE CHANGES

In this section, we calculate multipliers for market interest rates on the basis of bivariate Granger causality tests in order further to empirically assess our hypothesis of asymmetry in the transmission of monetary-policy indicators between the benchmark countries and the focus countries. The interpretation of these multipliers is equivalent to that of the elasticities in Section 4. The Granger-causality technique (with variations) is applied for similar purposes in for instance Fratianni and von Hagen (1990), Karfakis and Moschos (1990), Katsimbris and Miller (1993), Henry and Weidman (1995), Hassapis et al. (1999) and Uctum (1999) (see Section 1 above).

The choice of lag-length is a crucial step in the choice of model to be evaluated, particularly in a simple bivariate setting such as that used here. We here apply a model-determination procedure based on the Granger concept of causality and the final prediction error (FPE) criterion, as originally proposed by Hsiao (1981). The advantage of the FPE as compared to most other criteria is that it does not require that the number of lags of the variables that enter into the model be the same.<sup>13</sup> The basic estimated equation takes the form:

$$X_t = \alpha + \sum_{m=1}^{m^*} \beta_m X_{t-m} + \sum_{n=1}^{n^*} \gamma_n Y_{t-n} + \delta Z_{t-1} + v_t, \quad (2)$$

where  $X$  and  $Y$  are first-differences of the logs of the tested variables,  $m^*$  and  $n^*$  are the 'optimal' lags as chosen by the model-selection criterion and  $Z$  is the error-correction term (whose coefficient is zero in case the two tested series are not cointegrated in levels). If the model-selection procedure implies a one-way model, just one equation is estimated; if a bilateral system is implied by the procedure, two equations are estimated, and if the procedure implies non-causality between the variables, then, of course, no equation is estimated. The models were estimated with generalised least squares (GLS) regressions. We then calculated multipliers based on the regression parameters from the above models.<sup>14</sup>

<sup>13</sup> A similar motivation for the use of the FPE criterion is given, for instance, in Erenburg and Wohar (1995) and Bajo-Rubio and Montáñez-Garcés (1999).

<sup>14</sup> For more details on how to compute multipliers, see, e.g., Lütkepohl (1991) or Gardner and Perraudin (1993).

TABLE 5  
Long-run Multipliers for Market Interest-rate Changes  
(Standard errors in parentheses)<sup>a</sup>

		Exchange Rate			
		Flexible/ Managed Float	Cooperative/ Semi-fixed	Unilaterally Inflexible	Superfix (EMU)
Restrictions on Capital Movements	Yes	vis-à-vis DE	vis-à-vis DE	vis-à-vis DE	—
		0.22 (0.21)	−0.08 (3.61)	0.45 (0.80)	
		vis-à-vis US	vis-à-vis US	vis-à-vis US	
	No	−0.03 (0.12)	−0.08 (1.14)	0.08 (0.12)	
		vis-à-vis DE	vis-à-vis DE	vis-à-vis DE	vis-à-vis DE
		1.74 (6.76)	0.84 (1.40)	0.43 (0.83)	1.00 (0.00)
vis-à-vis US		vis-à-vis US	vis-à-vis US	vis-à-vis US	
	0.31 (3.78)	0.26 (3.78)	−0.67 (1.13)	1.92 (2.12)	

Note:

<sup>a</sup> The average multipliers shown in this table are potentially influenced by a number of outliers in the country-by-country results. We therefore made the same calculations (including the two-sample *t*-tests shown in Table 6) with outliers suppressed from the sample. These calculations show that the results are qualitatively robust to the inclusion or non-inclusion of outliers.

The calculated multipliers are summarised in Table 5.<sup>15</sup> Again, none of the regime averages of the multipliers turns out significantly different from zero. Some are, however, significantly different from unity this time; all under capital controls, and – in the one such case which refers to a multiplier measured against German interest rates – under a flexible exchange rate. Without capital controls, however, multipliers *increase* the more flexible the exchange rate: totally opposite the common wisdom. But variability also increases along with the averages, and overall the errors are too large to be able to pin down the size of the multipliers to a particular level. The fact that, under an open capital-account regime, the *variability* of the average multipliers is larger for more flexible exchange rates, could of course in itself be interpreted as (weak) evidence that more flexible exchange rates do afford more short-term autonomy.

Table 6a–b shows the result of pairwise two-sample *t*-tests which are performed across all regimes to test if average long-run multipliers from regime subsamples deviate from each other. When we compare exchange-rate regimes within one and the same capital-account regime, we find no significant difference between regime 1 and regime 2, but we do find it between regime 3 and the others. Regime 3 (unilateral fix), then, is the odd man out. This result is robust to the choice of benchmark and to the imposition or not of capital controls.

<sup>15</sup> Again, country-by-country results are not reported, but are available on request from the authors.

TABLE 6  
Long-run Multipliers for Market Interest-rate Changes: Comparisons of Mean Multipliers  
(*t*-Statistics)

a. *Vis-à-vis* German interest rates

<i>Regime</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>
1a	−3.96***	1.51	−7.50***	−5.01***	−4.28***
1b		4.29***	1.34	5.27***	4.88***
2a			−2.49**	−3.91***	−3.41***
2b				4.08***	4.08***
3a					0.55

b. *Vis-à-vis* US interest rates

<i>Regime</i>	<i>1b</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>	<i>4</i>
1a	−1.56	0.80	−1.32	−13.49***	8.88***	−16.13***
1b		1.70*	0.13	1.67*	6.21***	−5.27***
2a			−1.35	−3.88***	6.78***	−13.07***
2b				1.29	4.75***	−4.61***
3a					16.33***	−24.01***
3b						−19.95***

Note:

\*/\*\*/\*\*\* Null hypothesis that sample means are equal is rejected at 10/5/1 per cent significance level, respectively.

Oddly, however, under capital controls, the average multiplier for regime 3 – as compared to regimes 1 and 2 – is significantly higher, and in the absence of capital controls it is significantly lower. Comparing the same exchange-rate regime across the capital-mobility dimension, we find that capital controls matter, except under a fixed exchange rate. Multipliers are mostly (but not consistently) significantly higher when no capital controls are imposed

The euro-area short-term market rate, finally, is significantly more responsive to the development of the US rate than the corresponding previous national rates, regardless of exchange-rate and capital-account regime. This result differs from what we previously found for policy interest rates.

## 6. CONCLUSION

The main results are as follows. Firstly, our calculations of measures of foreign influence over interest-rate policy in 11 small European countries in the 1980s and 1990s (two kinds of foreign interest-rate multipliers) typically give reasonable values, mostly between zero and unity, but quite variable. Secondly, comparing these measures pairwise across different exchange-rate regimes

indicates little difference in the degree of nominal monetary-policy autonomy enjoyed by those countries that pursue flexible exchange-rate regimes as compared to those that have kept their exchange rates fixed: the latter countries are not more exposed to foreign influences in any systematic way. Thirdly, comparing these measures across capital-account regimes (are capital controls imposed or not?) indicates mostly – but not consistently – higher measures of foreign influence and higher variability of the multipliers for countries/periods without capital controls.

The overall conclusion is that we cannot reject our hypothesis of no systematic relationship between exchange-rate regimes and monetary policy autonomy. This conclusion is also in line with some previous findings for other countries, over different time periods, using different estimation techniques (see Fratzscher, 2002; and Frankel et al., 2002). A reasonable interpretation of the results is that the small countries investigated here have been able to enjoy a degree of monetary policy autonomy even with a fixed exchange rate, and even after they abolished capital controls. *With* capital controls, they were offered an extra layer of protection against foreign influence (at least temporarily), but the capital-control instrument may have been an unreliable one when it was best needed (under various types of peg arrangements). This is the conservative conclusion – the one that emphasises the result that no multiplier is significantly different from zero. The source of autonomy in this case may have been: that the pegs were adjustable enough to allow such autonomy, imperfect capital mobility, real shocks upsetting the equilibrium relationship between the countries tested, or a combination of all three.

There is, however, an alternative interpretation which is equally consistent with the results, but somewhat more speculative, namely that over the medium and long term following an ‘independent’ target for monetary policy (an inflation target, say), which does not deviate much from the targets of those countries to which one is closely financially integrated, is as constraining as locking the exchange rate to some particular level. Another way of putting the same idea is to say that for a central bank setting interest rates to control price developments in the medium or long run, purchasing-power parity must basically hold. No *exploitable* degree of autonomy other than that which results in an ‘autonomous’ rate of inflation is possible for the type of time horizons central banks work with. Actual nominal exchange-rate fluctuations in the short run and – particularly – exchange-rate regimes pursued, on the other hand, are of secondary importance in terms of autonomy.

The second of these interpretations rests on the result that with a liberalised capital account, we could not reject the hypothesis that multipliers equalled unity (in fact, they were on average closer to one than to zero), and that in no single case were the average multipliers higher for countries with fixed exchange rates. The difference between these interpretations can be viewed mainly as a difference

in the understanding of autonomy, and more particularly in the *time* aspect of it (short-term or long-term autonomy); alternatively, one could say that it is a question of the choice of null hypothesis: is the glass half-full or half-empty?

It is also worth repeating that our results are based on actual outcomes in terms of transmission of policy. By not having the opportunity to compare with the hypothetical *ex ante* preferred policy, we may be exaggerating the role of actual, historical autonomy at the expense of the *potential* for autonomy.

Finally, certain shortcomings to estimating the multipliers just pairwise the way we have done here, warrant a few suggestions of how this research could be developed. Firstly, if transmission runs in some more intricate way between the variables, the bivariate approach will not give an adequate representation of actual co-dependencies. Also, if some important influencing variable is left out (for instance, a possible effect of real shocks), the results may overstate the relationship between the variables that are kept in. Secondly, by splitting up the full sample period into shorter periods, some of these sub-periods become too short to get reliable results. Moreover, the role of exchange rates may not be accurately reflected just by splitting up the whole sample period into discrete sub-periods according to exchange-rate regime for each country: since exchange-rate variability moves along a gradual scale, the choice of where to draw the line between different regime types will always contain a discretionary element. The same argument of discretion can, in principle, be made when it comes to capital controls.

Finally, we may note that the adherence to a larger currency area has not necessarily provided the euro-area countries with more insulation *vis-à-vis* 'global' influences and autonomy at a regional level: our tests on market interest rates indicate that the euro-area short-term rate is significantly more responsive to the development of the US rate than were the corresponding previous national rates, and that this result is robust to the choice of exchange-rate and capital-account regime.

## APPENDIX

*Data Specification and Sources*

The following data and sources were used for the analysis in Section 5.

*Market interest-rate series:*

<i>Country</i>	<i>Series</i>	<i>Source(s)</i>
Austria (AT)	Day-to-day money-market rate 1979:03–1998:12	IMF <i>International Financial Statistics</i> / Oesterreichisches Nationalbank
Belgium (BE)	Overnight interbank-deposit rate 1999:01–2000:11 Call-money rate 1979:03–1991:01	Reuters IMF <i>International Financial Statistics</i>
Denmark (DK)	One-week treasury-certificate rate 1991:02–2000:11 Call-money rate 1979:03–1996:12	Banque Nationale de Belgique IMF <i>International Financial Statistics</i>
Euro Area	'Tomorrow/next' deposit rate 1997:01–2000:11	Danmarks Nationalbank
Finland (FI)	EONIA 1999:01–2000:11 Liquidity credit rate 1979:03–12	ECB OECD <i>Main Economic Indicators</i>
Germany (DE)	Call-money rate 1980:01–1993:11 Overnight interbank-deposit rate 1993:12–2000:11	Bloomberg Suomen Pankki/Reuters
Greece (GR)	Day-to-day money-market rate 1979:03–1998:12	IMF <i>International Financial Statistics</i>
Ireland (IE)	EONIA 1999:01–2000:11 Overnight interbank-deposit rate 1985:01–2000:11 <sup>a</sup>	ECB Bank of Greece
Netherlands (NL)	Overnight call-money rate 1979:03–12	OECD <i>Main Economic Indicators</i>
Norway (NO)	Overnight interbank-deposit rate/DIBOR 1980:01–2000:11 Overnight interbank-deposit rate 1979:03–2000:11	Bloomberg/Central Bank of Ireland De Nederlandsche Bank/Reuters
Portugal (PT)	Call-money rate 1979:03–1985:12 NIBOR 'tomorrow/next' rate 1986:01–2000:11	IMF <i>International Financial Statistics</i> Norges Bank
Sweden (SE)	1–5-day interbank deposit rate 1983:01–1998:12 <sup>b</sup>	Banco de Portugal
Switzerland (CH)	'Tomorrow/next' deposit rate 1999:01–2000:11 Overnight interbank-deposit rate 1979:03–2000:11	Banco de Portugal Sveriges Riksbank
United States (US)	Call-money rate, Zürich 1979:03–1980:01 Day-to-day money-market rate 1980:02–2000:11 Federal funds rate 1979:03–2000:11	OECD <i>Main Economic Indicators</i> Schweizerische Nationalbank Federal Reserve

Notes:

<sup>a</sup> No market interest rate available before 1985.

<sup>b</sup> No market interest rate available before 1983.

APPENDIX *Continued**Dummy variables:*<sup>a</sup>

- 
- Austria: none;
  - Belgium: 1993:08–1994:01;
  - Denmark: 1979:12, 1993:08–10, 1995:03–04;
  - Finland: 1979:10–11, 1980:04–05, 1981:09–10, 1982:05–06, 1982:10–12, 1986:03–05, 1991:11–1992:01, 1992:09–11;
  - Greece: 1994:05–06, 1997:10–11, 1998:03–05;
  - Ireland: 1983:04–05, 1986:08–09, 1992:11, 1993:02–03;
  - Netherlands: none;
  - Norway: 1981:10–11, 1982:05–06, 1982:08–11, 1986:05–06, 1987:11–1988:01, 1992:12–1993:01;
  - Portugal: 1980:02–04, 1982:06–08, 1983:06–08, 1983:10–11, 1986:08–1987:01, 1988:02–03, 1993:07–08, 1995:04–05;
  - Sweden: 1981:09–11, 1982:10–1983:01, 1992:11–1993:02;
  - Switzerland: none;
  - Benchmarks: none.
- 

## Note:

<sup>a</sup> The use of dummy variables has been restricted to a minimum, but were in many cases necessary to eliminate outliers, and to achieve convergence in the calculation of multipliers for market interest rates. Market, as well as policy, interest rates took on extreme values in several instances during currency crises or during periods of extreme deflationary pressures for the case countries.

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## **6 On the interplay between money market development and changes in monetary policy operations in small European countries, 1980–2000**

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The implementation, as well as the underlying ‘philosophy’, of monetary policy has undergone radical changes in most industrial countries during the last few decades. These changes have been paralleled by a similarly radical development of financial markets – including money markets (short-term debt markets), which are the main ‘forum’ for the implementation of monetary policy. The instruments available to a central bank usually fall into one of three categories: direct regulations (e.g. interest-rate regulations and credit ceilings), standing facilities (deposits and loans at the central bank available to banks at their own initiative), or discretionary operations (e.g. repurchase transactions, foreign-exchange swaps, issuance of central-bank securities or outright transactions in short-term markets). In the post-war period, up to the early or mid-1980s, central banks used to rely primarily on the former two categories. The financial deregulation wave of the 1980s and 1990s largely coincided with, or was conditional on, a general reorientation of monetary-policy operating procedures toward the third category. Both the tools used by central banks and the variables on which the tools were designed to operate shifted – essentially from a Keynesian demand-side-oriented monetary policy operating on monetary aggregates, to an inflation-oriented monetary policy operating on interest rates and playing on market terms.

In this chapter, we study the parallel processes of financial market deregulation and development on the one hand, and reform of the operative frameworks of monetary policy on the other, and the extent and nature of the association between the two processes, in 11 small, European countries from the beginning of the 1980s and up to the launch of EMU. We focus on the development of domestic money markets, and address aspects of this development such as the size and structure of various market segments, and institutional and regulatory changes, besides empirically examining the extent of reorientation of monetary policy instruments. We hypothesise that the parallel processes are intertwined and that developments in any one particular country are best described as a continuous interplay of market outcomes and policy choices.<sup>1</sup> We also provide tentative empirical evidence to that effect.

The 11 countries in our study are basically just a complete list of the developed European countries that *unambiguously* fitted the ‘small, open economy’ criterion

(and had their own currencies) during the 1980s and 1990s. The countries are: Austria, Belgium, Denmark, Finland, Greece, Ireland, the Netherlands, Norway, Portugal, Sweden and Switzerland. The diversity of these countries in terms of monetary policy regimes pursued (from hard-currency countries such as Austria, to countries with near-emerging-market status, such as Greece) and level of institutional integration (from core EMU countries such as the Netherlands to *sonderweg*, non-EU countries such as Norway) also make them an excellent laboratory as regards the link between money market development and the conduct of monetary policy. The choice of study period is based on previous research on the financial-market ‘transformation’ process (Oxelheim 1996).

The chapter is structured in the following way. We begin by reviewing the main developments in domestic money markets. These largely comprise two interlinked processes: deregulation and liberalisation on the part of authorities, and innovation and growth on the part of ‘markets’. These two processes are treated in separate sub-sections. The next section mirrors the first in that it analyses the changing operative procedures of central banks along two lines: the decreasing role of direct controls (closely related to the general deregulation of financial markets), and the increasing role of market operations. In the following section, we identify the main drivers of the changes in central-bank operations. Thereafter, we empirically examine the sources and effects of fluctuations in money-market liquidity in the case countries and tentative evidence of a determinant of the intensity of open market operations. A final section concludes.

### **General developments in domestic money markets**

The countries covered in this chapter all followed the general trend among industrial countries of broad-based financial-sector deregulation in the 1980s and 1990s. Below, we make a brief summary of that process. We go on to recount the main developments in money market innovation, differentiation and growth, in each of the countries.

#### ***Financial deregulation***

The regulations in force in a majority of European countries until the 1970s or, in most cases, the 1980s were of four major types: interest-rate controls, quantitative credit and investment regulations, restrictions on the issuance of financial instruments and market-entry/branching or ownership restrictions. These ‘repressive’ regulations typically served multiple purposes but the major ones were to achieve monetary control and to achieve broader social/economic policy objectives.

As can be seen from Table 6.1, which summarises the situation around 1980 in terms of regulation in the sample countries, several countries applied all major types of regulation. Portugal, for instance, was in 1980 very much still marked by the effects of the nationalisation of financial sector in 1974 and a system whereby the Banco de Portugal was equipped with almost limitless authority to intervene

Table 6.1 Financial repression in 1980

	<i>Interest-rate restrictions</i>	<i>Specific credit controls<sup>a</sup></i>	<i>Overall credit growth limit</i>	<i>Investment obligations</i>	<i>Issuing restrictions</i>	<i>Branching restrictions</i>
Austria	✓	✓	✓	✓	✓	✓
Belgium	✓	✓	— <sup>b</sup>	✓	✓	✓
Finland	✓	✓	—	—	✓	✓
Greece	✓	✓	✓	✓	✓	✓
Ireland	✓	✓	✓	n.a.	n.a.	n.a.
Netherlands	—	✓	✓	—	✓	✓ <sup>d</sup>
Portugal	✓	✓ <sup>e</sup>	✓	✓	✓	✓
Denmark	✓	✓ <sup>c</sup>	✓ <sup>c</sup>	—	✓	—
Sweden	✓	✓	—	✓	✓	✓
Norway	✓	✓	✓	—	✓	✓
Switzerland	✓	—	—	—	✓	✓

n.a.: Information not available.

Notes:

a Quotas or ceilings imposed on individual banks or groups of banks/financial institutions, and similar detailed credit controls.

b Abolished in 1978.

c Formally guidelines.

d No real restrictions, but a separation in a legal sense of different types of credit institution was made, and the rules on prudential supervision varied accordingly.

e Abolished in 1980.

Sources: Edey and Hviding (1995); OECD *Financial Market Trends* (various); Oxelheim (1990, 1996); Vihriälä (1997); Wyplosz (2001); various national sources.

in all aspects of financial intermediation. All or most regulation types were also used, in Austria, Greece, Norway and Sweden for instance.

(a) *Interest-rate regulations* were in force in all countries in the sample except the Netherlands at the start of the study period (see Table 6.1). Administrative control over interest rates – in particular, keeping interest rates at low levels – was used as a general monetary-policy instrument, as a way to boost demand and as a means of providing cheap financing for the government.

Interest-rate controls began to be dismantled in the late 1970s in Austria, Denmark, Ireland, Norway and Sweden. By the mid-1980s, interest rates in Denmark, Ireland, Norway and Sweden (as well as the Netherlands) had been essentially liberalised. In most of the continental-European countries, the main steps were taken in the second half of the 1980s.

By 1990, Austria, Finland and Switzerland had also completely liberalised interest rates; Belgium had, in principle, also deregulated interest rates, but retained some minor controls on specific categories or types of credit. The last among the survey countries to abolish interest-rate regulations, Greece and Portugal, completed the process a few years into the 1990s, in accordance with their gradual implementation of European Community directives (see Rautava 1994; Edey and Hviding 1995).

The typical sequencing pattern was that the liberalisation of wholesale interest rates occurred first, followed by lending rates and deposit rates.<sup>2</sup> The process was mostly gradual, and sometimes hesitant on the part of the authorities. An illustration of this is that formal rules and restrictions (a ceiling, a quota etc.) were often initially followed by *implicit* regulations in the form of recommendations or various types of agreement before being *de facto* liberalised. Such was the case in Austria, Belgium, Denmark, Greece, Ireland, Norway, Portugal and Sweden. These implicit regulations were enforced through the understanding that the central bank could, and would, enforce its goals by means of the reinstatement of formal regulations if deemed necessary; see, e.g., Grønvik (1994).<sup>3</sup>

(b) *Quantitative credit and investment restrictions*, in one form or another, were employed in a majority of the countries (again, see Table 6.1). The low-interest-rate policies pursued by several of the countries which, in combination with high inflation rates, led to very low (or even negative) real interest-rate levels. This, in turn, led to high credit demand, indicating that credit had to be rationed and the market as a whole had to be regulated in detail, as regards both prices and quantities.

As an effect of the co-dependence of various types of regulation, credit controls to some extent became obsolete or irrelevant as interest rates were being liberalised.<sup>4</sup> Hence, most of these regulations were abolished in Austria, Denmark, Finland, Ireland, Netherlands and Sweden in the first half of the 1980s. Belgium had initiated the deregulation of credit in 1979 but the process took more or less the entire 1980s to be completed. Of the other countries, Switzerland had not applied quantitative controls since the 1970s. Norway abolished credit regulations in 1988, Portugal around 1990, and Greece a few years into the 1990s.

(c) *Issuing restrictions* on securities were used to control the extension of credit through direct channels (i.e. through issues in the open market). Usually, rules and regulations on minimum maturities etc. were combined with various authorisation requirements.

The initial emergence of short-term securities markets in several countries was directly conditional on the abolition of one or several restrictions on the issuance of debt securities. Conversely, where such deregulations did not occur, or occurred late, an important condition for the emergence and growth of markets was lacking. Controls on (debt) securities issuance were mostly in place for slightly longer than interest rate and credit controls. Exceptions are Denmark (which had a relatively free and internationally oriented bond market based on private debt already in the 1970s), and the Netherlands, where regulation was comparatively limited. Switzerland was low on formal regulation but the growth of the domestic market was hampered by business practice, as well as by tax policy and other factors. Finland, Ireland, Sweden and Switzerland lifted issuing controls in the first half of the 1980s. In some countries important liberalisation measures were implemented in the mid-1980s (for instance in Norway – see Norges Bank, *Penger & Kreditt*, 26:1, 1995). The Netherlands, although comparatively liberal in several respects, applied rules on minimum maturities which constrained the development of short-term markets and were fully abolished only in 1990.

In other countries, important steps toward the opening-up of securities markets occurred in the context of a reform of government-financing systems. Such is the case, for example, in Austria and Belgium - around 1990 - (De Broeck *et al.* 1998) and Greece - early/mid-1990s - (Soumelis 1995). Generally, however, the liberalisation of markets for private debt was slower than other categories. For instance, the Portuguese fixed-income market was not formally opened to all domestic issuers until 1994 and to foreign issuers 1995 (de Pinho 2000). Also, as previously mentioned, market development was in some cases stifled by the existence of various types of more or less informal authorisation requirement. For instance, Switzerland abolished numerous cartel-like conventions and permanent securities-issuance syndicates of banks in 1990.

(d) *Market-entry rules or line-of-business regulations* — the separation of banking and securities businesses, the separation of commercial banking from investment or savings banking, and other branching restrictions — limited the segmental integration within the financial system. A similar effect is implied by regulations limiting *ownership* linkages between different types of financial institution, between financial institutions and other industry sectors, and between domestic and foreign institutions. In addition, one sort of ‘ownership restriction’ was the indirect control by the government of the financial sector through the dominance of state-owned banks in combination with market-entry restrictions. This applies primarily to the countries with previously entirely nationalised financial sectors (Greece and Portugal) but also, to some extent and during some periods, in other countries. In Norway, for instance, ownership of major banks was one consequence of the banking crisis around 1990.

Regulations within this category were partly or wholly lifted in the 1980s and early 1990s in some countries, including Austria, Belgium, Denmark (where de-compartmentalisation of the banking sector had occurred already in 1975), Finland, Norway and Sweden. Moreover, a ‘spontaneous’ functional market integration (taking place, for instance, through banks establishing subsidiaries within the securities-trading business, or purchasing finance companies) is often considered a major feature of the financial-market transformation process undergone by the industrial countries in the 1980s; see e.g. the survey in OECD (1989). To some extent, this implies a diminishing practical importance of remaining regulations.

Restrictions on foreign-bank entry should also be included in this category. In the sample, Finland, Norway, Portugal and Sweden were among those countries that opened their domestic markets for foreign banks during the 1980s. In some other countries, including the Netherlands and Switzerland, rules on foreign-bank access to the domestic market were already relatively liberal at the start of the 1980s, whereas in much of the rest of the continental European countries significant steps were taken only with the implementation of the EU’s Second Banking Directive (effective in 1993).

In the area of ownership control, the deregulation wave made a comparatively modest impression in the 1980s and 1990s, and several such regulations remained in the mid-1990s (Herring and Litan 1995). State-ownership of a large proportion of domestic financial institutions also outlived financial integration in some countries. The Greek banking sector, for instance, was still completely



dominated by state-owned banks when ownership regulations were abolished. In terms of assets, the government's ownership share was about 75% (see Hope 1993). In other countries, state-ownership of banks became an effect of banking crises in the early 1990s: after the crises, the governments of Norway and Finland ended up with ownership shares of 52% and 35%, respectively; see the *Banker* (1993); also see the *Economist* (1992) and Warner (1993) for short background articles on the deregulation and privatisation of Portuguese banks.

The deregulation process in the 11 focus countries is summarised in Table 6.2.

Table 6.2 Summary of the financial deregulation process

	<i>Deregulation initiated in... (item(s) first liberalised):</i>	<i>Financial sector lastly liberalised by... (item(s) last deregulated):</i>
Austria	1979 (some interest rates liberalised)	1990s (authorisation requirement for securities issues lifted)
Belgium	1978 (credit ceiling abolished)	1992 (decompartmentalisation / decartellisation of banks)
Finland	1983 (some interest rates liberalised)	1991 (authorisation requirement for securities issues lifted etc.)
Greece	1987 (some interest rates liberalised)	Mid-1990s (deregulation of banking)
Ireland	1984 (some interest rates liberalised; credit guidelines lifted)	Late 1980s <sup>a</sup>
Netherlands	1981 (credit controls lifted) <sup>b</sup>	c 1990 (minimum-maturity requirement for securities abolished)
Portugal	1984 (some interest rates liberalised; market-entry rules eased)	1994 (securities markets fully opened for private issuers)
Denmark	1980 (bank lending ceilings lifted) <sup>c</sup>	1989 (issuing controls on securities completely abolished)
Sweden	1978 (some interest rates liberalised)	1985 (ceilings on bank lending lifted)
Norway	c 1980 (some interest rates deregulated)	1990 (all quantitative controls and most issuing controls abolished by this time)
Switzerland	Early 1980s (interest rates on bonds liberalised) <sup>d</sup>	c 1990 (issuing restrictions abolished; permanent securities-issuance syndicates dissolved)

Notes:

a Minor interest-rate 'rigidities' (in the shape of informal agreements) remained until the mid-1990s.

b Less regulated overall at the start of the 1980s than most other markets here included; interest rates were essentially already free in the 1970s.

c Less regulated overall at the start of the 1980s than most other markets here included: a decompartmentalisation of banking had already been carried out in 1975; some interest rates were free during the 1970s (but partly reregulated in 1979), etc.

d Most other interest rates already free.

Sources: See Table 6.1.



***Money market growth and development***

The money market is usually defined as a market for short-term debt, generally with original maturities of up to one year (Stigum 1983). One main segment of money markets is the interbank market. The other segments are primary and secondary markets for various short-term securities, and a derivatives market. The foreign-exchange (FX) markets and domestic money markets are also closely interlinked through the existence of markets for forward-exchange contracts and swaps, which make certain types of FX transaction equivalent to single-currency transactions.

Because the interbank segment is defined *in terms of participants* and the 'open-market' segments usually *in terms of instrument* there is a considerable overlap between these segments. The interbank market is sometimes taken to mean the market for very short-term, that is, overnight up to a few weeks, deposits and loans. Central-bank facilities for such deposits and loans are included. Virtually all types of instrument – including derivatives – are traded interbank. The segmental structure is therefore not wholly clear, and tends to vary from country to country.

Table 6.3 summarises the starting years for the main segments in all 11 countries. It indicates a progressive convergence during the 1980s and 1990s of the *presence* of different types of money-market instrument.

The most traditional money-market segment is the interbank deposit market. It includes the central bank's deposit and loan facilities and its structure and function are, as a consequence, to a high degree determined by the incentives regarding banks' liquidity management implied by the central bank's choice of operative framework. Deposit markets turned up in most countries as monetary policy instruments changed during the 1980s and 1990s. The segment largely retained its importance throughout the 1990s in spite of the emergence of alternative instruments (such as repurchase agreements in particular). For instance, transactions in the uncollateralised segment were estimated at about twice the size of collateralised transactions in the euro area in 1999 (Santillán *et al.* 2000).

In the short-term securities markets, considerable dissimilarities can be seen between the focus countries, both in terms of the relative total size of the market as well as in terms of the relative importance of specific segments of the market, as evidenced in Figure 6.1 and Table 6.4.

In the short-term securities segment, Treasury bills or equivalent short-term government securities are typically the most important sub-market. In several countries (Austria, Belgium, Ireland and Sweden, for example), short-term government securities have existed for a long time, but were traditionally non-marketable, and sold directly to final holders at regulated rates until a decade or two ago. True markets for T-bills mostly emerged in connection with relaxations or complete abolition of issuing restrictions (years are shown in Table 6.3).

Two other main cash-instrument types — commercial paper (generally issued by non-bank entities) and certificates of deposit (a securitised bank liability) — were introduced in several countries in the mid-1980s but, as revealed by Table 6.4, their importance varies greatly. In some cases (for example Finland and Sweden), the introduction of CDs preceded the introduction of tradable

Table 6.3 Money-market innovations, domestic market (year of introduction or year of deregulation of various money market segments)

	Interbank deposit market/ ‘-IBOR’, reference rate	Treasury bills or treasury notes	CDs/ central-bank CDs	Commercial paper	Single-currency interest-rate futures	Single-currency interest-rate swaps and/or options	Foreign- exchange or currency swaps <sup>d</sup>	Repo market/ repos adopted by central bank
Austria	n.a./1989	1987 <sup>b</sup>	../1995	..	1993	1994	c 1990	../1995 <sup>c</sup>
Belgium	1988/1988	1990 <sup>d</sup>	1992/..	1990	1988	1991	1980s	n.a./n.a. <sup>e</sup>
Finland	1986/1987	1991	1982/1987	1986	1992	1988	1980s	../1991
Greece	n.a./1994	1985	../..	..	g	g	g	c 1995/1997
Ireland	1978/1993	1960s <sup>h</sup>	n.a./..	1989	1989	1989	c 1990	1997/1997
Netherlands	n.a./1986	1970s	1986/1994	1986	1987	1994 <sup>i</sup>	1976	n.a./n.a.
Portugal	1989/1992	1985 <sup>m</sup>	1993/1994	1994	1996	1993	1987	n.a./c. 1992
Denmark	1970s <sup>f</sup> /1988	1975	../1992	..	1988	1988	1970s	1993/1992
Sweden	1985/1987	1982	1980/1992	1983	1984	1985	n.a.	1980s/1984
Norway	1993/1993 <sup>j</sup>	1985	1985/..	1985	1993	n.a.	1970s	1996/.. <sup>k</sup>
Switzerland	n.a./n.a.	1981	../..	..	1990	1994 <sup>i</sup>	1970s <sup>n</sup>	1998/1998

.. Not applicable / a viable market in the instrument does not exist.

n.a.: Data not available.

Notes:

a Refers to ‘interbank swaps’: central banks have been using swaplike instruments for considerably longer — the German Bundesbank, e.g., since 1958 (Hooyman, 1994).

b Refers to the year from which government debt is issued by competitive bidding.

c The OeNB started to make advances against securities in 1985, but began to make systematic use of repos only in 1995.

d Refers to the year from which treasury certificates are issued by competitive bidding.

e The BNB has been conducting advances against collateral for a long time.

f The market remained inactive until the reform of the monetary-policy operating framework in 1992.

g A limited derivatives market has existed since 1994.

h Exchequer bills.

i Options.

j Refers to the domestic reference rate NIDR; an ‘international’ reference rate (NIBOR) also exists.

k Norges Bank conducted ‘temporary bond purchases’ between 1984 and 1986.

l Refers to the year of liberalisation of the interbank market.

m Treasury bills; so-called ‘negotiable cash bonds’ were introduced in 1983.

n The SNB has been using swaps for monetary-policy-making purposes for a longer time.

Sources: Alworth and Borio (1993); BIS (1999); Batten *et al.* (1990); De Broeck *et al.* (1998); *Euro money* country surveys (various); Holbik (1991); Khoury (1990); Kullberg (1991); Lahdenperä (1995); Norges Bank (1995); OECD *Financial Market Trends* (various); Oxelheim (1996); Pinto (1996); and sources to Table 6.4.

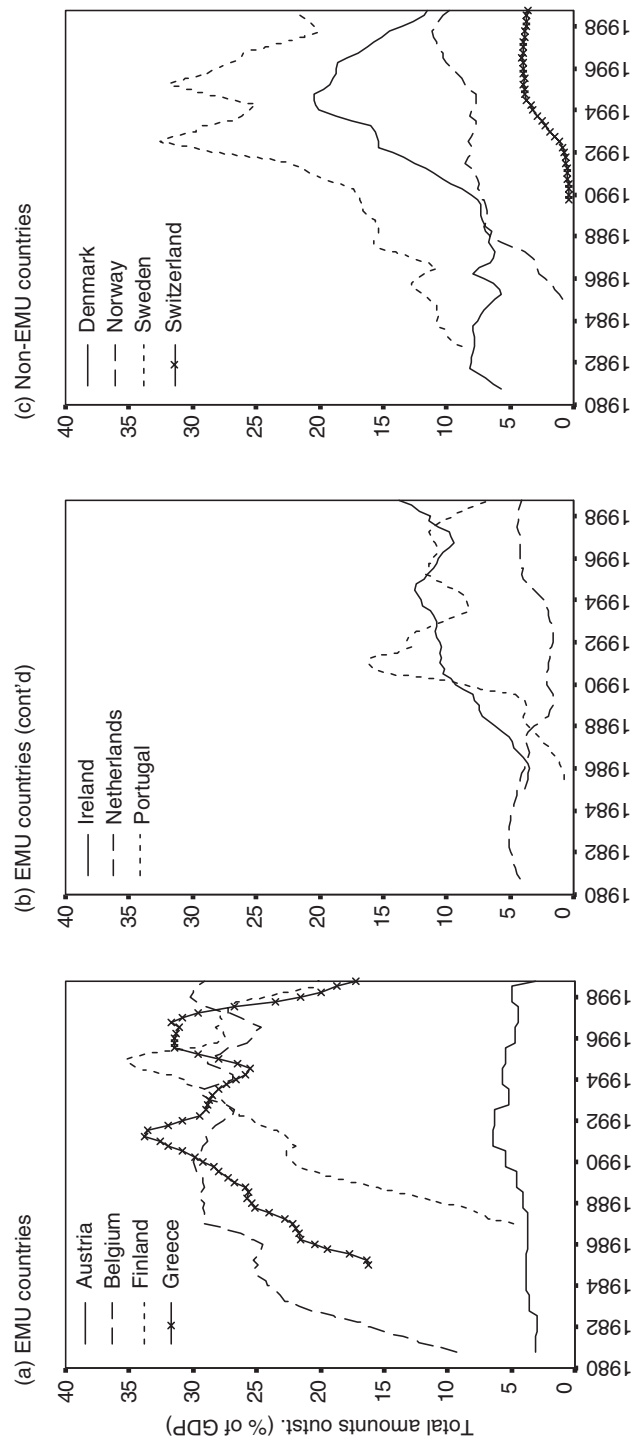


Figure 6.1 Total outstanding amounts of short-term securities (% of GDP); one-year moving averages of quarterly, end-of-period data (except Austria: annual data). *Notes and Sources*, see Table 6.4.

Table 6.4 Short-term securities markets, outstanding amounts (% of GDP at year-end)

	1985				1992				1998						
	T-bills/ notes	CDs	CB CDs	CP/ other	Total	T-bills/ notes	CDs	CB CDs	CP/ other	Total	T-bills/ notes	CDs	CB CDs	CP/ other	Total
AT	3.7				3.7	5.2				5.2	3.2				3.2
BE	24.0				24.0	24.0	1.8		3.1	28.8	16.9	5.9		4.0	26.8
FI <sup>a</sup>					0	3.1	16.9	1.0	3.8	24.8	2.3	16.0	0.8	1.7	20.7
GR	24.3				24.3	29.8				29.8	15.0				15.0
IE	1.5	2.1 <sup>b</sup>			3.6	0.4	4.5 <sup>b</sup>		4.8	9.7	2.2	4.2 <sup>b</sup>		9.5	16.0
NL <sup>c</sup>	4.0				4.0	0.0	1.3		0.7	4.0	2.1	0.8	0.0	0.5	3.4
PT <sup>d</sup>	0.8				0.8	8.4				8.4	2.1	0.2		2.3	4.5
DK	4.7	3.9			8.6	14.3		0.6		14.9	9.2		3.0		12.3
SSE <sup>e</sup>	11.5	1.2			12.7	20.5	0.8		8.2	29.4	12.9	1.1		6.6	20.7
NO <sup>f</sup>	1.6	0.1		1.1	2.8	4.7	0.0		1.9	6.6	2.4	3.9		2.8	9.1
CH					0	2.0				2.0	3.7				3.7
Mean					7.7					14.9					12.3
(sd)					(9.0)					(11.1)					(8.2)

Notes:

a 'CP/other' includes industrial paper and local authority paper.

b Saving certificates.

c Incomplete data on CDs before 1990; CP: annual data until 1990.

d T-bills: amounts for 1985 include only T-bills held by banks and other monetary institutions; CDs: includes only certificates held by non-financial corporations.

e 'CP/other' includes certificates issued by mortgage credit institutions, industrial paper, finance-company promissory notes, and local-government paper.

f 'CP/other' includes notes of mortgage credit institutions and financial institutions, and other short-term paper.

Sources: Austrian Federal Ministry of Finance (BMF) and Austrian Federal Financing Agency (BFA); Ministère des Finances Belge, Administration de la Trésorerie; Danmarks Nationalbank; Suomen Pankki; Bank of Greece; Central Bank of Ireland; De Nederlandsche Bank; Norges Bank; Banco de Portugal; Sveriges Riksbank; Banque Nationale Suisse; BIS, *Quarterly Review: International Banking and Financial Market Developments* (various); GDP figures from IMF *International Financial Statistics*.

government securities. In other cases, diversification of the market to other than government issues occurred several years after a T-bill market had been established (Ireland, the Netherlands, Portugal).

Commercial-paper markets gained importance in some (but far from all) countries toward the late 1980s (Norway, Sweden) or further into the 1990s (Belgium, Ireland). There seems to be some indication that where commercial-paper markets could be benchmarked against a liquid government-bill market (or other instrument with a market-supporting role), their development came earlier and was more extensive (Alworth and Borio 1993).

In addition to these cash instruments, various derivative instruments play an important role, as do repurchase agreements (repos), which – according to BIS estimates – was the fastest growing instrument/transaction type internationally during the 1990s. However, data are scarce. Reporting in different countries is also such that available historical data are not readily comparable (BIS 1999). Existing data indicate considerable variations in derivatives as well as repo markets. For example, in Belgium, repos became the main financing tool for domestic banks in the 1990s and largely replaced more traditional interbank transaction types (Commission of the European Communities 1999). Similar trends were visible in other countries (particularly those with ample stocks of collateral). Others were partly stifled by thin debt markets (the Netherlands, Norway), ambiguities with regard to regulatory policies, legal status and tax treatment (Ireland, Portugal, Switzerland), or excessive concentration of market participants.

### **Changes in central-bank operations 1980–2000<sup>5</sup>**

Until the mid-1980s central banks relied largely on traditional deposit and loan facilities (standing facilities), supported by various direct controls, for the conduct of monetary policy. The ordinary credit facilities were mostly supplemented by some sort of tranche-division system (Denmark, Finland), penalty-rate system (Austria, Sweden), or a combination of both (Belgium, the Netherlands) to allow central-bank control of the marginal cost of banks' borrowing under the facilities, and thereby of the supply of liquidity to the banking system.

All our focus countries reformed their operative frameworks for monetary policy substantially during the 20 years we study. In some countries, the revision of the monetary-policy operating framework took the form of comprehensive reforms (Denmark 1992, Switzerland 2000); in others, developments proceeded more piecemeal (see Table 6.5). In several countries (Belgium, Finland, the Netherlands) the trend toward a gradually increasing diversification of liquidity-supply instruments became visible toward the mid-to-late 1980s. Others followed suit during the 1990s (Denmark, Portugal, Austria).

#### ***The diminishing role of quantitative controls***

The diversification of instruments used by central banks as well as by other money-market participants during the 1980s and 1990s was paralleled with the

Table 6.5 Some major changes in central-bank operating procedures between repression and EMU<sup>a</sup>

Country	Year	Change of monetary policy (instruments)/main components of change
AT <sup>b</sup>	1995	Reform of liquidity-management arrangements: introduction of repurchase transactions for liquidity provision and of central-bank CDs for liquidity absorption; reduction of reserve ratios.
BE <sup>b</sup>	Mid-1970s	Abolition of reserve requirements.
	1985	Introduction of a more flexible discount-setting system, and revision of the central bank's credit and deposit facilities (resulting ultimately in the emergence of an efficient day-to-day interbank market).
	1991	Tender procedures introduced for the issuance of government paper, leading to more market-oriented procedures for monetary policy, including the gradual adoption of repurchase transactions as the main liquidity-management instrument.
FI <sup>b</sup>	1983	Quotas for central-bank credit abolished; banks asked to manage liquidity through call-money market.
	1987	Open-market operations in CDs initiated.
	1991	Repurchase transactions introduced by the central bank.
	1992–95	Several adjustments in the technical design of the central bank's credit and deposit facilities, as well as that of the minimum-reserve system.
GR <sup>b</sup>	c 1990	The central bank switches its operational regime from direct regulation to indirect instruments.
	1997	Repurchase transactions initiated by the central bank.
IE <sup>b</sup>	Mid-1980s	The exchequer-account overdraft facility is abolished; collateralised operations introduced.
	Mid-1990s	The central bank stops discounting exchequer bills, and adopts repurchase transactions as its keynote operation; minimum reserve ratios substantially reduced.
NL <sup>b</sup>	1994	Reform of liquidity-policy framework; central-bank CDs introduced.
	1998	Reform of liquidity-policy framework.
PT <sup>b</sup>	1985	The central bank starts to issue treasury bills on behalf of the government.
	1986	The central bank is formally authorised to issue short-term securities and to pay interest on the government's and the credit institutions' deposits.

*Continued*

*Table 6.5 cont'd*

<i>Country</i>	<i>Year</i>	<i>Change of monetary policy (instruments)/ main components of change</i>
DK	1992	Repurchase transactions initiated by the central bank.
	1994	Revision of liquidity-policy framework: central-bank CDs introduced; the central bank's credit facilities still relatively complex, with some facilities subject to quotas, some available at penalty rates.
	1992	Comprehensive reform of monetary-policy instruments: revision of the central bank's credit and deposit facilities (so as to stimulate money-market activity); introduction of central-bank CDs for liquidity absorption and of repurchase transactions for liquidity provision; no reserve requirements.
	1999	Extension of collateral basis for the central bank's repos and some other minor changes of technical nature.
SE	1985	Reform of the central-bank's credit and deposit facilities: the fixed-quota-and-penalty-rate system was abolished, and an 'interest-rate ladder' was introduced.
	1988	Changes in operating procedures: liquidity may be supplied to banks by lending on market terms.
	1990	Reserve requirements lifted (formally set to zero).
	1993–97	The central bank issues its own CDs to soak up liquidity.
	1994	New interest-rate-management system introduced (motivated largely on the new monetary-policy regime—the inflation target), based on <i>Bundesbank</i> -type repos, with the fixed repo rate serving as target for the overnight interbank rate.
NO	1984–1987	The central bank conducts 'temporary bond purchases'—effectively a form of repurchase transactions.
	1985	The certificates market was launched, expressly for the purpose of involving the public more directly in the money market, increasing the control of the central bank over the supply of liquidity and enhancing the efficiency of monetary-policy transmission.
	1987	Reserve requirements abolished.
	Mid-1990s	Simplification of the central bank's credit and deposit facilities; (re)introduction of repurchase transactions for liquidity provision.

Table 6.5 cont'd

Country	Year	Change of monetary policy (instruments)/main components of change
CH	1998	Repurchase transactions initiated by the central bank.
	2000	Reform of monetary-policy framework: interest-rate targeting strategy replaces the traditional monetary-targeting strategy; repurchase transactions become the central bank's keynote operation.

Notes:

a All EMU countries' central banks together with the ECB make up the ESCB (European System of Central Banks) and have shared a common policy framework since 1999 (Greece since 2001); the main

refinancing operations of the ESCB are executed by the national central banks.

Selected sources: BIS (1997b); Schweizerische Nationalbank, Bulletin Trimestriel 4 (1999); Borio (1997); Danmarks Nationalbank (1992, 1999); Hasko (1996); Hasko and Kuisma (1995); Hörngren (1994); Kasman (1992); Kneeshaw and van den Bergh (1989); Kuosmanen (1996); Mehbye and Topp (1996); Norges Bank (1995); Oxelheim (1996); Pinto (1996); Sveriges Riksbank (1994).

lifting of most direct regulations. This sub-section therefore focuses on one direct control that remained in use by many central banks — the minimum reserve requirement.

During the 1990s, practically all our case countries followed an international trend among industrial countries toward lowering or completely abolishing reserve requirements (see Table 6.6). The major arguments behind these reforms were to reduce the tax effect of reserve requirements and to neutralise the competitive disadvantage of subjected depository institutions vis-à-vis other financial institutions — domestic or foreign (Bank of Japan 1995).

The original objectives of the reserve-requirement instrument were to maintain banks' liquidity even in the case of large deposit withdrawals, and to influence liquidity for monetary-policy purposes. The function of reserve requirements as a mechanism to control monetary-aggregate quantities on an ongoing basis was largely abandoned during the late 1980s or early 1990s. Nowadays, reserve requirements serve three main purposes. One is as a means of providing for banks' ongoing liquidity needs (having banks in a position of reliance on the central bank facilitates the conduct of monetary policy). A second purpose is to improve the flexibility of banks' liquidity management (reserves can be used to settle interbank payments). Finally, reserve requirements (particularly if unremunerated) can provide seigniorage income for the central bank, thereby contributing to its profitability and (economic) independence (Grønvik 1994; Bank of Finland Bulletin 12 1996; BIS 2003).

Countries that abandoned the use of reserve requirements more or less entirely relatively early on include Belgium (mid-1970s), Norway (1987) and Sweden (1990). In Norway, for example, both primary reserves (that is, cash-reserve requirements) and secondary reserves (compulsory bond holdings by banks and



Table 6.6 Reserve requirements

	1970s		Late 1980s <sup>a</sup>			Late 1990s <sup>b</sup>		
	RRIF	Max.	RRIF	Max.	Diff.	RRIF	Max.	Diff.
Austria	✓	10.5 <sup>c</sup>	✓	9.0 <sup>d</sup>	✓	✓	5.0	✓
Belgium	✓	6.2 <sup>e</sup>	×	×	×	×	×	×
Finland	✓	3.2 <sup>f</sup>	✓	7.8	×	✓	2.0	✓
Greece	✓	n.a.	✓	n.a.	n.a.	✓	12.0	×
Ireland	✓	13.0 <sup>f</sup>	✓	10.0 <sup>g</sup>	–	✓	3.0	×
Netherlands	✓	7.0 <sup>h</sup>	✓	var.	✓	✓	var.	✓
Portugal	✓	15.0 <sup>e</sup>	✓	17.0 <sup>i</sup>	×	✓	2.0	×
Denmark	✓ <sup>j</sup>	3.0	×	×	×	×	×	×
Sweden	✓	5.0 <sup>e</sup>	✓	4.0	×	×	×	×
Norway	✓	5.5 <sup>l</sup>	×	×	×	×	×	×
Switzerland	✓	n.a.	✓	2.5	✓	✓	2.5	×
<i>Memo:</i>								
Eurosystem <sup>m</sup>	..	..	..	..	..	✓	2.0	×

RRIF: Reserve requirements in force

✓ Yes

× No

Max.: Maximum reserve ratio applied.

Diff.: Different ratios for different types of liabilities/deposit (this information was unavailable for a majority of countries for the 1970s; therefore the column has been left out for that decade).

.. Not applicable

N.a. Not available

Notes:

a 1988 unless otherwise indicated;

b Individual country ratios of EMU countries refer to ratios applied before the launch of the Eurosystem;

c 1972;

d 1990;

e 1974;

f 1979;

g 1986;

h 1973;

i 1989;

j Temporarily in force 1975–76;

k The required reserve ratio was set to zero in April 1994, and has not been used as a policy instrument since;

l 1976;

m since 1999.

Sources: BIS (1997b); Bank of Japan (1995); Borio (1997); Central-bank bulletins (various); ECB (1998); Holbik (1973); Kneeshaw and Van den Bergh (1989); OECD Financial Market Trends (various); Pinto (1996).

insurance companies) had been used since the 1960s. From 1971 only the primary reserve requirements were used in Norway, but they were altered often and by a lot.

Minimum reserve requirements were in use as a liquidity-management instrument until the late 1990s in the Netherlands, Austria, Finland, and Ireland;

but the only country where they played a significant role for active liquidity management until the late 1990s was Greece (until its entry into the EMU), where the instrument was deemed necessary to retain control over the liquidity supply in the face of large capital inflows (this parallels earlier experiences in, for instance, Portugal).

### ***The increasing role of market instruments in central-bank operations***

Three main types of discretionary instrument predominate: short-term (cash) securities, repurchase operations, and swaps. Effective open-market operations to some extent presuppose an existing market to operate in. Thus, central banks have typically, at some point or other, come to favour the creation of markets, and have often stimulated and supported their development. This holds for interbank deposit markets as well as for short-term securities markets.

The absence of an efficient interbank market is bad news because banks may then rely on central-bank facilities to gain access to liquidity even when other banks are very liquid, creating a situation of excess liquidity in the banking system and poorer monetary transmission.<sup>6</sup> For monetary policy to bite, banks' *marginal* liquidity needs must be settled with the central bank. Hence, when – as a consequence of financial deregulation – direct controls (such as specific credit quotas to individual banks) can no longer be used to deal with excess-liquidity problems, there appears an incentive for central banks to create adequate instruments to drain liquidity and to stimulate the formation of markets for alternative short-term assets. Examples are the establishment of efficient day-to-day interbank markets in Belgium and Sweden (1985–88), both of which were anticipated effects of changes in the layout of monetary-policy operating procedures (BNB 1985; Kneeshaw and Van den Bergh 1989). More generally, the initial emergence of a markka money market was stimulated by the Bank of Finland's decision to withdraw its presence from the forward exchange market (around 1980). Parallels exist in, for example, Denmark and Portugal (Danmarks Nationalbank *Monetary Review*, August 1996; Pinto 1996).

The emergence of short-term securities markets adds a dimension to liquidity management for central banks. In practice, cash operations in short-term securities by central banks are relatively rare, even where the size of these markets is sufficiently large to make such operations feasible (Borio 1997). One reason is that other types of operation are more flexible. Other reasons which have carried some weight in several countries are the wish to avoid potential conflict with other public-policy objectives – notably public-debt management (for example in Denmark and Portugal) and tax policy, and the wish to avoid circumvention of limits on central-bank lending to the government. These problems are particularly relevant in emerging stages of money-market development (Mehran *et al.* 1996; Kneeshaw and Van den Bergh 1989).

To avoid conflicts of interest and to increase the effectiveness of monetary policy, it has been relatively common for central banks in small countries to issue their own securities (central-bank CDs) in the primary market in order to

absorb liquidity from the banking system. In some cases, this was one of the main strategies of the central bank. Countries where the issue of central-bank paper played an important role during shorter or longer periods include Finland (from 1987 onward, but particularly during the 1990s), the Netherlands (1994–9), and to some extent Ireland and Portugal among the EMU countries; and Denmark (1992 onward) and Sweden (1992–6) among the non-EMU countries.

Even in the absence of outright transactions in securities, the existence of a liquid securities segment in the money market is often argued to facilitate the central bank's operations by providing collateral for repurchase agreements and similar collateralised transactions. To the extent that it does so, the varying degrees to which short-term securities markets have emerged in the focus countries imply correspondingly varying possibilities for the respective central banks to exploit the flexibility and other advantages of repurchase agreements and similar instruments.<sup>7</sup> During the course of the 1990s this type of instrument was adopted as a main liquidity-management instrument in Austria (1995), Finland (mid-1990s), Denmark (1992), the Netherlands (refers to 'special loans'), Sweden (1994), Switzerland (1998), and then, from the time of its inception in 1999, in the whole Eurosystem (see Table 6.7).

In principle, of course, any type of security — not just short-term securities — may be used to underpin collateralised transactions. The common argument that efficient short-term securities markets are needed for the conduct of open-market operations by central banks is therefore not necessarily particularly strong (see, however, below). Recent developments, in which the ECB has gradually expanded its palette of security types eligible for collateral in repurchase operations, are also an illustration of this. In the US (BIS 2001) and the UK (Bank of England 2002), where that palette is somewhat narrower, the debate in recent years has been more concerned with the 'quality' (rather than the original maturity) of the collateral: more specifically, the concern has been with the feasibility of open market operations and the eligibility of private securities for central bank operations in an environment of declining government issues (McCauley 2001, and Wojnilower 2000).

Nonetheless, the introduction of the common monetary-policy framework in the euro area in 1999 altered the use of *short-term* paper as collateral for central-bank operations quite substantially. In most EMU countries, the use of short-term paper (particularly T-bills) as collateral for the ECB's refinancing operations increased as compared to the pre-EMU collateralised transactions of the respective national central banks. In Belgium, Ireland and the Netherlands, the proportion remained largely unchanged, whereas in Portugal and Finland, it decreased.<sup>8</sup>

Some countries without liquid short-term markets relied on foreign-exchange operations (particularly swaps) for liquidity management. The pre-eminence of swaps over spot or regular forward-exchange operations simply reflects the greater importance of swaps in the interbank market. Swaps are the major instrument by which banks cover their forward foreign-exchange commitments to customers (Hooyman, 1994). Countries where FX swaps played a significant role for liquidity management by the central bank and/or by the banking system as a whole include

Table 6.7 Targets and main open-market operations before the launch of EMU

Country	Orientation/ main target	Main operating variable	Key instrument	Collateral for repurchase transactions	Other open-market operations
Austria	Exchange rate	Overnight rate	Repurchase agreements	Government and private securities	Foreign-exchange swaps
Belgium	Exchange rate	1–3-month rate	Repurchase agreements	Trade bills; government securities	Interbank operations; foreign-exchange swaps; etc.
Finland	Inflation (formally)/ exchange rate	1–3-month rate	Repurchase agreements	T-bills; government bonds; central-bank and bank CDs; AMCA notes <sup>a</sup>	Outright money-market operations; sales of central-bank CDs; foreign-exchange operations
Greece	Inflation/ exchange rate	M3/M4N growth rate and total credit expansion are 'tentative' targets	Deposit tender operations	Government securities	Reverse repos; foreign-exchange swaps
Ireland	Inflation/ exchange rate	1-month rate	Repurchase agreements	Government securities	Foreign-exchange swaps
Netherlands	Exchange rate	1-month rate	'Special loans' (repo-equiv.)	Government and private securities	Sales of short-term paper; foreign-exchange swaps; etc.
Portugal	Inflation/ exchange rate	Overnight rate	Repurchase agreements	Government securities <sup>b</sup>	Central-bank CDs; TIM <sup>c</sup>

*Continued*

Table 6.7 cont'd

Country	Orientation/main target	Main operating variable	Key instrument	Collateral for repurchase transactions	Other open-market operations
Denmark	Exchange rate	1–14-day rate	Secured loans (repo-equiv.); central-bank CDs	Government securities; mortgage bonds	Foreign-exchange operations
Sweden	Inflation	Overnight rate	Repos/reverse repos	Government and mortgage securities	Interbank operations
Norway	Exchange rate	1-week rate	Deposits and loans	T-bills and government bonds	Foreign-exchange operations; repos; T-bill issues
Switzerland	Reserves ('M0')	Giro deposits	Foreign-exchange swaps	Treasury bills	Repurchase agreements; transfer of government deposits

Notes:

a Notes issued by the Asset Management Company Arsenal.

b Private securities introduced in May, 1998, as a step in preparation for stage 3 of EMU.

c Títulos de Intervenção ao Monetária (Monetary Intervention Bills).

Sources: Banco de Portugal, *Economic Bulletin* 1 and 2 1998, and *Annual Report* 1998; Bank of Greece, *Monetary Policy Interim Report* November 1998 and March 1999, and *Annual Report* 1998; Borio (1997); Central Bank of Ireland, *Annual Report* 1998; Danmarks Nationalbank, *Monetary Review* 2, 1999; Norges Bank, *Penger & Kredit* 1998/4, and *Annual Reports* 1997 and 1998.

Austria, the Netherlands and Denmark. In Switzerland, USD-CHF swaps were the principal market operation of the National Bank during the period between the early 1980s and the late 1990s.<sup>9</sup>

There was a clear trend from the mid-1990s onward in the EMU group of countries toward a ‘non-spontaneous’ convergence in the arsenal of instruments used by the central banks, in the explicit anticipation of adopting a unified operational framework. This becomes clear from studying which instruments were adopted by the central banks, and also from the motivations given for the specific reforms made to the national, pre-EMU operational frameworks by the monetary authorities themselves in annual accounts and other official documents. However, there is also a case for arguing that the choice of instruments for the Eurosystem to some extent reflected broader international trends in central-bank operations: an argument which is somewhat strengthened by the observation that the non-EMU countries in our sample have largely undergone similar changes in this respect (often prior to corresponding changes in the EMU countries, as in the case with the adoption of repos in Denmark and Sweden).

### **Changes of central-bank operating procedures: main drivers**

Because financial market regulations were partly designed as monetary policy instruments, the deregulation process is in itself sufficient reason for reformation of the operational framework of central banks: as some policy instruments are taken away, others must replace them. Therefore, the main drivers of changes in central bank operating procedures largely coincide with those of financial deregulation in general. Beyond this somewhat trivial explanation, the literature and the central banks’ own accounts offer five main reasons.

*First*, monetary-policy instruments were changed in several countries in order to adapt the operational frameworks of the respective monetary authorities to new regimes and/or new targets for monetary (and exchange-rate) policy. The examples are manifold: the Austrian central bank, on embarking on its new ‘hard-currency’ policy in the late 1970s, put weight behind the new policy formulation by entering (and keeping a permanent presence in) the foreign-exchange market (Glück 1994); the Bank of Finland’s 1994 revision of intervention procedures and clearer focus on interest rates were motivated by the new inflation target for monetary policy (Kuosmanen 1996; Finland at this time adopted an inflation target); the same goes for the new interest-rate management system adopted by the Swedish Riksbank the same year (Hörngren 1994) and that of the Swiss National Bank which has been in force since January, 2000.

*Second*, structural factors outside the central banks’ control made some of the traditional instruments outdated and the adoption of new ones necessary. Such structural factors may be quite varied. One of the primary reasons, for instance, given by the Norwegian central bank for the revisions of its operational framework in the 1990s was the need to adapt to the change in the underlying structural liquidity position of banks (from a deficit throughout the 1980s and up to 1992–3

to a surplus in the years around 1995), which, in turn, was attributed primarily to the weakening government budget; see Norges Bank (1995) and various issues of the *Economic Bulletin* of the Bank of Norway. More important, however, were the structural changes resulting from the general transformation of the financial system — a trend affecting all countries. The expansion of the financial overhang in the economy occurred more or less entirely outside the central banks' balance sheets, and therefore reduced the share of the financial system over which monetary authorities could exert direct control. The result was an increasing need for indirect ways to exercise control over the non-monetary components of the money supply. In other words, the development produced (among other things) alternative liquid assets which continually challenged the precision and purpose of a policy relying heavily on, for example, regulating the growth rate of such or such a monetary aggregate. One consequence was that *interest rates* emerged as a more relevant operating variable (prominent exceptions to the rule were, importantly, countries with largely bank-based financial systems such as Germany and Switzerland). To that extent, this second reason for central banks to change their instruments is related to the first one: structural changes outside the central banks' control indirectly called for new instruments by requiring that policy operate on different variables.

A *third* factor relates both to the expansion and diversification of financial markets domestically and to the increasing international integration of financial markets. Greater interest-rate flexibility and narrowing differentials between rates of return in different currencies gave rise to the need for instruments whereby liquidity (and thereby interest rates) could be managed more *flexibly* in time and in magnitude, and with a greater measure of *accuracy* than that offered by, say, discounting, interest-rate controls, and lending ceilings.<sup>10</sup>

*Fourthly*, the increasing importance of *expectations* in a world of free financial markets favoured the adoption of instruments better suited for *signalling* the central bank's monetary policy stance. By this token, the need for the possibility of more flexibly adjusting short-term interest rates and the need for tools appropriate and effective for signalling medium- to long-term policy intentions were among the reasons mentioned for the change of operational targets in Sweden in 1994 (BIS 1997b; Sveriges Riksbank 1994). Similarly, on introducing repurchase transactions as one of its key operations and the lending rate for secured transactions as the new main policy interest rate, the Danish Nationalbank gave the motive that changes of the discount rate had become too 'powerful' (in other words, too blunt) to be a useful tool (Danmarks Nationalbank, *Monetary Review* 2, 1999).<sup>11</sup>

A *fifth* broad category of reasons relates to the wish more generally on the part of central banks to stimulate money-market activity and improve monetary-policy transmission, and to achieve a clearer separation of monetary policy implementation from government-debt management, and from other social-policy goals (favouring certain sectors in the economy by granting access to cheap credit etc.) which were auxiliary reasons for the imposition of financial-market regulations. Because financial regulations were often of a multiple-purpose variety, and because the central bank was typically responsible for the implementation of

the regulatory policy, the distinction between monetary policy and other ‘types’ of policy had previously not always been very clear-cut. For instance, the experience of the Portuguese central bank was that the controls used to attain monetary-policy goals up to around 1990 increasingly conflicted with other public-policy objectives and with the ambition to achieve effective policy transmission. The consequence was increased uncertainty and frequent unexpected changes of variables used to calculate credit ceilings and quotas, rendering credit control less and less useful or relevant (Pinto 1996). In Norway, the sentiment at the central bank around 1980 was that direct controls were no longer effective and, in fact, only made the credit market more difficult to control and the interpretation of information more problematic (Vale 1995).

### **Sources and effects of fluctuations in money-market liquidity and the scope for open market operations**

In order to analyse broad changes in monetary-policy stances and instruments over the 20-year period from around 1980 up to the launch of EMU, we extracted the principal sources and uses of money-market liquidity as well as the main instruments used to influence liquidity from the central banks’ balance sheets over three shorter periods: one in the early 1980s, one in the late 1980s (or early 1990s), and one period in the late 1990s. The general methodology closely follows that suggested by Borio (1997; Annex I). The frequency is weekly where available, otherwise monthly (see the notes to Table 6.8). This somewhat impedes comparability between periods and/or across countries. Still, we considered it better to use the weekly-frequency data where such were available. The lower-frequency (monthly) data may to an extent over-/understate some items because operations of central banks often have shorter maturities than one month.<sup>12</sup>

Table 6.8 shows the principal sources of liquidity in our survey countries over the three different periods. The variability of the autonomous position was consistently much higher than the average position. This indicates that autonomous factors did not generally have permanent ‘structural’ effects. More generally, it implies that we cannot make statistically significant conclusions about the average size of the positions.

Policy can be assumed to work against the autonomous position (to have the opposite sign), so as to offset its net effect on liquidity supply (banks’ reserves at the central bank). This assumption is supported by the data but, as with the autonomous position, the *variability* of the policy position far exceeded its size, leaving little or no room for conclusions about the average stance of policy. Generally, policy appears to have offset autonomous influences imperfectly — that is, the average size as well as the standard deviation (variability) of autonomous factors are mostly higher than that of policy.

The resulting effect varies. Overall, fluctuations in net liquidity changes were comparatively low in Belgium and the Netherlands. Per contra, average net liquidity changes were more variable in Denmark and Norway. Comparing data



Table 6.8 Principal sources of liquidity

	Autonomous sources of liquidity			Policy position			Net liquidity		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
AT	n.a.	0.32 (3.67)	0.56 (2.44)	n.a.	-0.30 (2.45)	-0.30 (3.21)	n.a.	0.02 (4.87)	0.26 (3.28)
BE	0.39 (2.90)	-0.69 (2.26)	0.19 (2.24)	n.a. (2.83)	0.51 (2.45)	-0.17 (2.25)	n.a. (0.29)	-0.17 (0.70)	0.01 (0.16)
FI	-0.35 (4.96)	-0.14 (3.51)	-0.50 (6.54)	0.12 (9.99)	0.74 (3.36)	-0.08 (10.25)	-0.24 (9.05)	0.59 (1.72)	-0.59 (12.28)
GR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IE	2.83 (5.81)	0.63 (15.25)	1.57 (10.53)	-1.90 (6.21)	0.01 (13.05)	0.23 (6.67)	0.93 (3.78)	0.63 (4.79)	1.80 (7.75)
NL	-0.57 (5.22)	-0.31 (8.99)	-0.25 (1.21)	0.56 (5.20)	0.40 (8.19)	0.18 (1.61)	-0.01 (0.10)	0.10 (3.72)	-0.07 (1.18)
PT	2.31 (5.90)	2.08 (6.78)	-0.82 (15.51)	-0.47 (5.75)	1.44 (13.83)	1.09 (17.68)	1.85 (4.07)	3.52 (12.07)	0.27 (5.39)
DK	0.88 (24.77)	-0.83 (20.48)	-8.62 (32.04)	-0.97 (23.41)	1.92 (12.55)	6.77 (44.71)	-0.10 (3.40)	1.09 (15.41)	-1.85 (23.39)
SE	-1.54 (21.18)	-0.70 (8.57)	0.04 (5.30)	0.35 (17.47)	1.26 (8.13)	-0.10 (5.24)	-1.19 (9.67)	0.56 (2.96)	-0.05 (1.89)

Table 6.8 cont'd

	<i>Autonomous sources of liquidity</i>		<i>Policy position</i>		<i>Net liquidity</i>	
NO <sup>b</sup>	n.a.	3.49 (40.40)	-2.77 (19.22)	n.a. (38.40)	n.a. (7.66)	-1.01 (14.64)
CH	n.a.	n.a.	0.54 (7.38)	n.a.	n.a.	-0.36 (6.43)

The table shows average weekly (monthly)<sup>a</sup> changes/positions as a percentage of the average level of base money, and variability of positions (standard deviations) in parenthesis.

Positive positions ⇒ liquidity injection; negative positions ⇒ liquidity absorption.

*Definitions:*

In the central bank's balance sheet, the column headings in the table consist of the following summary items:

- Autonomous sources of liquidity (or autonomous position) – changes in net foreign assets + changes in net lending to the government + changes in other net assets – changes in outstanding currency (i.e. notes and coin);
- Policy position = changes in the central bank's net lending to the banking system;
- Net liquidity = changes in the amount of liquidity in the banking system (= autonomous position + policy position).

<sup>a</sup>Net lending to banks' comprises the net of claims on and liabilities to banks over which the central bank exerts control (except liabilities due to reserve requirements); the amount of liquidity in the banking system can be understood as any remaining liabilities to the banks (i.e., the banks' reserve holdings with the central bank, including deposits due to reserve requirements).

n.a.: data not available.

*Notes:*

a Weekly data were available for the following countries and periods: Austria P2 and P3; Belgium P1, P2 and P3; Finland P1, P2 and P3; Netherlands P1, P2 and P3; Sweden P3; and Switzerland P3.

The periods used are the following:

Austria P2: Oct. 31, 1989–Jan. 31, 1990; P3: Jan. 7, 1998–May 31, 1998.  
 Belgium P1: Jan. 7, 1980–June 30, 1980; P2: Jan. 2, 1989–June 26, 1989; P3: Jan. 5, 1998–May 29, 1998.  
 Finland P1: Jan. 8, 1980–May 30, 1980; P2: Jan. 6, 1989–May 31, 1989; P3: Dec. 31, 1997–May 29, 1998.  
 Ireland P1: 1979:12–1981:02; P2: 1988:12–1990:06; P3: 1997:12–1998:12.  
 Netherlands P1: Jan. 5, 1981–May 25, 1981; P2: Oct. 2, 1989–Feb. 26, 1990; P3: week 1, 1998–week 25, 1998.  
 Portugal P1: 1980:01–1981:12; P2: 1988:01–1989:12; P3: 1996:07–1998:06.  
 Denmark P1: 1979:01–1980:12; P2: 1988:01–1989:12; P3: 1997:12–1998:11.  
 Sweden P1: 1980:01–1981:10; P2: 1987:01–1988:10; P3: Dec. 31, 1998–May 31, 1999.  
 Norway P2: 1991:12–1992:12; P3: 1997:12–1998:12.  
 Switzerland P3: Sept. 30, 1999–Apr. 10, 1999.

b Balance sheets on a monthly or shorter frequency are only consistently available from 1992.

Sources: The figures are calculated on the basis of data from the respective central banks' balance sheets, mostly taken from annual and/or interim reports; in some cases obtained as spreadsheet documents directly from the central bank.

within countries but across periods, there also appears to have been an upward trend in liquidity fluctuation in these two latter countries, possibly along with Ireland. The opposite trend seems to apply to Sweden. In Finland, liquidity fluctuation dropped between periods one and two, then rose again. For Portugal, this pattern is inverted. These differences with regard to the variability of net liquidity changes reflect differences in the variability of the autonomous position fairly well. That can be taken as another indication that policy smoothed out liquidity fluctuations though only imperfectly.

Finally, the reasonable expectation of seeing more activist policy in latter years is not invariably borne out by the data; rather, the standard deviation of the policy position (which can be used as an indicator of policy activism) seems to have covaried strongly with that of the autonomous position. Taken together, this reinforces the indication that the job of the central banks in the sample was primarily to forecast and offset factors outside its direct control that influence the domestic market.<sup>13</sup>

The variability of the main autonomous factors is shown in Table 6.9. Note that Tables 6.9 and 6.10 contain only variability (standard deviations), not the average positions (again, these are generally statistically insignificant). Seen over all countries and periods, the two most important autonomous sources of fluctuation in money-market liquidity (and thus the major factors that the central banks have had to counter in their policies) were net foreign assets and net lending to the government. Of these, the latter in many cases almost ceased to be a source of fluctuation in the last period, since central-bank lending to the government was prohibited for members of the European Union. For these countries, this item continued to influence liquidity only through marginal holdings of government securities and through the government's deposits at the central bank.

*Table 6.9 Autonomous sources of liquidity—contribution of different components*

	<i>Net foreign assets</i>			<i>Net lending to government</i>			<i>Other net assets</i>			<i>Currency</i>		
	<i>P1</i>	<i>P2</i>	<i>P3</i>	<i>P1</i>	<i>P2</i>	<i>P3</i>	<i>P1</i>	<i>P2</i>	<i>P3</i>	<i>P1</i>	<i>P2</i>	<i>P3</i>
AT	n.a.	3.28	2.71	n.a.	0.08	0.19	n.a.	0.36	2.07	n.a.	2.19	1.29
BE	1.90	2.82	0.33	2.87	2.70	0.07	1.09	2.83	0.42	1.41	0.84	2.28
FI	3.92	3.51	6.45	1.43	0.72	0.01	1.30	0.96	1.00	1.63	0.35	1.16
GR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IE	7.00	10.45	10.77	6.30	12.05	8.38	2.89	1.27	5.05	2.48	3.21	3.11
NL	3.12	0.83	0.63	3.91	8.97	0.05	3.65	0.57	0.80	0.88	0.89	0.80
PT	5.00	6.11	7.64	6.75	5.88	12.28	3.21	3.34	3.57	2.38	1.69	2.69
DK	14.26	19.28	28.89	20.59	17.77	26.89	9.54	6.88	3.30	2.89	2.77	1.86
SE	3.93	5.12	4.64	20.75	13.57	0.85	2.74	6.21	1.16	2.82	3.11	1.76
NO	n.a.	30.89	13.09	n.a.	19.43	16.59	n.a.	4.28	6.44	n.a.	4.13	2.52
CH	n.a.	n.a.	4.38	n.a.	n.a.	6.31	n.a.	n.a.	0.95	n.a.	n.a.	3.48

The table shows the variability (standard deviations) of average weekly (monthly) changes as % of the average level of base money. Definitions, notes and sources, see Table 6.8.

Table 6.10 Policy position—contribution of different components<sup>a</sup>

	<i>Standing facilities</i>			<i>Market operations</i>		
	<i>P1</i>	<i>P2</i>	<i>P3</i>	<i>P1</i>	<i>P2</i>	<i>P3</i>
AT <sup>b</sup>	n.a.	0.64	0.18	n.a.	2.79	3.21
BE	2.83	2.45	1.09	0.00	0.00	2.56
FI	10.13	2.96	0.02	30.78	30.09	100.25
GR	n0.a0.	n0.a0.	n0.a0.	n0.a0.	n0.a0.	n0.a.
IE	6.21	8.53	1.42	.00	11.77	6.40
NL	5.90	3.00	1.47	2.43	6.88	0.75
PT <sup>c</sup>	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
DK	23.41	12.55	0.00	0.01	0.00	44.71
SE <sup>d</sup>	17.47	5.98	5.58	0.00	8.59	7.61
NO <sup>c</sup>	n.a.	30.52	n.a.	n.a.	19.79	n.a.
CH	n.a.	n.a.	0.33	n.a.	n.a.	11.39

The table shows the variability (standard deviations) of average weekly (monthly) changes as % of the average level of base money. Definitions and sources, see Table 6.8.

Notes:

- a The precision of the designation of the various instruments used by the central banks to inject/withdraw liquidity into the categories of 'standing facilities' and 'market operations', respectively, is constrained by the limits of the information contained in the regularly published balance sheets of the respective central banks; no in-depth analysis of the de facto nature of the various instruments used has been possible.
- b The 'Market operations' component includes certain types of foreign-exchange operation; operations in the domestic market were negligible until 1995.
- c Lack of data due to the fact that the Central Bank's balance sheet does not discriminate among different policy instruments (NO, P3), or makes only a functional categorisation (liquidity-absorbing/-injecting assets/liabilities: PT, P1–P3).
- d The series for Period 2 are not completely consistent due to changes in operating procedures in August, 1988; figures are estimates.

The net-foreign-assets portion of the autonomous position should — all else equal — be more variable in countries with far-reaching exchange-rate commitments, where the central bank was active in the foreign-exchange market or in other ways made more extensive use of foreign-exchange reserves to uphold that commitment (such as Austria and the Netherlands). Conversely, it should be less variable in countries where exchange-rate commitments were absent, or secondary to monetary policy (such as Switzerland, or Sweden in Period 3). However, no clear such pattern can be discerned, although Denmark fits well into the picture. For the other countries in the study there was a tendency for net foreign assets to be a more important source of liquidity fluctuation in 'weak-currency' countries — regardless of exchange-rate regime — and a less important one in 'hard-currency' countries. (This tendency, however, must be considered very tentative, given the imprecision of any categorisation of hard- and weak-currency countries; for evidence of the influence of exchange-rate regimes on short-term interest rates, see Forssbäck and Oxelheim 2006.)

In some countries (Denmark, Norway, and to some extent also Ireland, Portugal and Sweden), foreign influences along with net lending to the government were

consistently and by far and away the most important source of liquidity fluctuation (and thereby domestic short-term interest-rate fluctuations). The historical development of the foreign-assets position is varied: its contribution to liquidity fluctuations increased between the early 1980s and the late 1990s in Denmark, Finland (though at a lower level), Ireland, Portugal, and (slightly) in Sweden; it decreased in Belgium and the Netherlands. Similarly, it decreased between the late 1980s/early 1990s in Austria and Norway. Net lending to the government was particularly variable for the Scandinavian non-EMU countries (Denmark, Norway and Sweden). This might well be interpreted as an illustration to what has been said about the unclear separation of various forms of public policy; notably the unclear separation of the central bank function from other public-policy issues, such as financing of the government. It would, in that case, indicate that the Scandinavian central banks were among the least economically independent among those covered here. This corresponds rather well to the indicators of central-bank independence reported elsewhere (see Grilli *et al.* (1991) for one of the original contributions in this field).

Table 6.10 shows the respective contributions of standing facilities and market operations to the central banks' liquidity-policy positions. The data largely confirm the indications given earlier in this study, and results of earlier cross-country studies, of an increased market-orientation of monetary policy operating procedures. The variability of that portion of the policy position which is made up of standing facilities has decreased across the board, and in most cases this decrease finds a corresponding increase in the variability of the position stemming from market operations.

The results from Table 6.10 provided us with a measure of the extent, or intensity, of open market operations in the different countries at different periods. In order to test the hypothesis of a relationship between choice of instrument type and the degree of market development, we performed a series of tests, the results of which are reported in Table 6.11 and Figure 6.2. The dependent variable is given by the 22 observations of the variability of the market operations component of the policy position in Table 6.10; the independent variable is the relative size of the short-term securities market (as shown in Figure 6.1) at the periods corresponding to the observations of the dependent variable. In order to counteract the problem of a limited number of observations as much as possible we performed both least-squares and non-parametric regressions. Caveats are still warranted, both because of the imprecision and comparability problems of the data generated from the central banks' balance sheets, and because of the questionability of using the size of short-term securities markets as a yardstick for the feasibility of open market operations (as discussed above); finally because the limited number of observations still provide limited degrees of freedom for elaborating the model tested.

As seen in Table 6.11, a simple linear regression does not indicate any significant correlation between the two variables, but a quadratic specification provides some support for the notion of a positive, but marginally decreasing, association between the intensity of open market operations and market development. Given

Table 6.11 Results of regression of the intensity of market operations<sup>a</sup> on relative market size (*p*-values in parentheses)

	<i>Least squares estimation</i>		<i>Wilcoxon non-parametric estimation</i>	
	I	II	I	II
Intercept	5.644 (0.102)	−0.361 (0.930)	4.334** (0.032)	0.276 (0.912)
Market size	0.094 (0.707)	1.725** (0.040)	0.038 (0.789)	1.046** (0.040)
(Market size) <sup>2</sup>		−0.058** (0.041)		−0.033* (0.054)
Adjusted <i>R</i> <sup>2</sup>	−0.042	0.123		
Wilcoxon robust <i>R</i> <sup>2</sup>			0.004	0.208
<i>F</i> -statistic	0.146 (0.707)	2.470 (0.111)	0.080 (0.781)	2.489 (0.110)
No. of obs.	22	22	22	22

Note:

a As measured by the variability in the policy position due to discretionary operations, see Table 6.10.

the limitations mentioned above, however, and some difficulty with the intuition of a quadratic specification to the right of the optimum (see Figure 6.2), the results must be considered tentative.

## Conclusion

Up to the late 1970s and early 1980s, in our case countries' money markets (as well as the financial sectors in general) were typically underdeveloped and highly regulated (possibly with a couple of exceptions). Since then, policy, primarily through the effect of a general deregulation of the financial sectors, has been one of the main determinants of money-market development. However, beyond motives and reasons for *financial deregulation* that are valid for the financial sector as a whole (such as technological advances, increasing internationalisation of business activities and financial innovation – the combination of which factors led to ever increasing opportunities to evade or circumvent existing national financial regulations and restrictions –, an increasing realisation on the part of policy makers of the incompatibility of highly repressed financial systems with efficient resource allocation, and international 'peer pressure' in the context of international organisations and institutions for international economic cooperation), we would argue that there are also additional 'policy' motives for promoting the formation of efficient *money markets*, specifically. In particular, we found motives in terms of the need of the central banks for an arena in which to conduct open market operations and in other ways to control the supply of liquidity to the banking system, as regulations, controls and restrictions became increasingly ineffectual or unavailable as instruments for monetary-policy implementation.

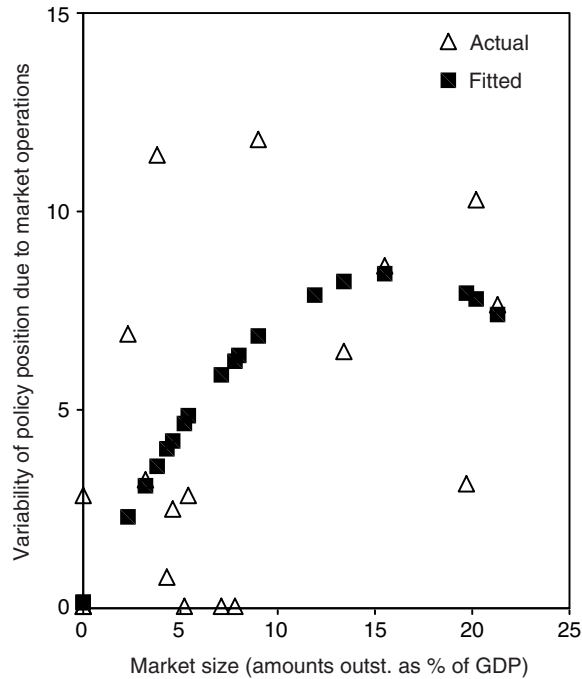


Figure 6.2 Estimated relationship between the intensity of open market operations and the relative size of short-term securities markets (Wilcoxon non-parametric estimates as in Table 6.11).

Such generalisations, however, cannot explain the significant differences in the path of money market development among the countries we study. These differences – in terms of the size of the market in total, as well as the structure and relative importance of the main market segments – instead largely seemed to persist during the entire period studied. A rough division, for instance, can be made between countries with and countries without a significant short-term securities segment. However, in those countries that do have such segments, these segments still vary substantially with regard to size, liquidity and the relative importance of different types of securities. For example, the development of Finland's short-term securities market was based on bank CDs, while most other countries' markets were based on government bills; in Greece, the government T-bill market, though large, did not give rise to a significant market for other types of short-term paper, and the market long remained very illiquid; from a relatively small market toward the late 1990s Ireland developed a market for commercial paper which remains unparalleled in relative size in any of the other countries (possibly with the exception of the Swedish CP market).

We therefore conclude that the development over time may best be characterised as a continuous interplay between policy decisions and market outcomes. The development process is thus highly *path-dependent*, and largely reflects *ad hoc* policy decisions, which are often, in themselves, responses to market developments. There may also be considerable potential spill-over effects from other policy areas, such as taxation and competition policy, to the extent that such policies may indirectly act restrictively, even in the absence of explicit financial-market regulations and controls, or impose certain – possibly unforeseen – incentives upon market participants.

Such country-specific, path-dependent interactions may also apply to the influence that central banks have had on the development of money markets in the respective countries. Financial-market innovation in general, and the emergence of increasingly sophisticated money-market instruments in particular, should, all else equal, weaken monetary policy transmission by the continuous supply of substitutes to central-bank money. In other words, our findings of a development towards more sophisticated and efficient domestic money markets should on balance weaken the effects of monetary policy. However, if there is anything to the story of an interplay between market formation and the operative framework of monetary policy — the simple mechanics that as markets change, central-bank operations change, and *vice versa* — then the timing and sequencing of financial deregulation/the abolition of direct controls, as well as more subtle aspects of central bank policy may bring home some important lessons.

We found five main reasons, or sets of reasons, why monetary-policy operating procedures changed during the period of study. First, monetary-policy instruments were adapted to changes in the targets or goals of monetary policy (for example, from an exchange-rate target to an inflation target). Second, central banks adapted their operative frameworks to structural changes outside their control (for example, the reliance on the part of central banks on certain types of regulation became outdated as innovation in the money market increased opportunities for market agents to circumvent such controls). Third, the development of money markets domestically as well as a stronger international integration of these markets increased the central banks' need for instruments that allowed them to manage liquidity supply more flexibly and with a greater degree of accuracy. Fourth, the growing importance of expectations in a deregulated financial system increased the need for instruments which could be used to signal the central bank's policy stance. The fifth set of reasons was a general wish to stimulate money-market activity in order to improve monetary-policy transmission, and to clarify the separation of monetary policy from other types of public policy (such as government financing).

These five broad categories, which account for the often substantial revisions of central-bank policy strategies in the focus countries over the period studied, are clearly not independent of each other, and often overlapping, but they do indicate that central banks had an influence on money-market development that was significant (in some cases it appears to have been decisive). However, the relationship goes the other way too. There seems to be some connection between comparatively radical changes in domestic money-market development (in terms



of innovation, market growth and regulatory changes) and greater changes in monetary-policy instruments. In addition, we also found tentative evidence in favour of the hypothesis of a correlation between market development and the intensity of open market operations.

Although the structure of money markets in the countries studied remained highly varied during the study period and the interplay between policies and market outcomes may have carved out different paths of development for the countries, in terms of the instruments which came to be increasingly favoured by central banks during the period, however, there are more signs of convergence from the mid-1990s onward: in the EMU countries as a matter of course (since they have, both *de jure* and *de facto*, adopted a unified operational framework) but also in the non-EMU countries, as well as many other industrialised countries. A salient feature of this particular development is that, in recent years, repurchase agreements and variations on collateralised lending/borrowing have become the dominant instrument used by central banks to implement monetary policy. A general explanation for this is that this type of instrument answers well to many of the needs of central banking – for example flexibility and the possibility to effectively signal the policy stance to financial markets. By and by, central banks have also typically broadened their collateral base (that is, the list of securities types that they will accept in a buy/sell-back operation), which diminishes the need for a large short-term securities markets for repo transactions, thus making this type of operation feasible even in countries where the short-term securities segment is ill-developed.

If there are substantial similarities in the adoption and abandonment, respectively, of monetary-policy instruments, there seem to be larger differences in the sources and effects of fluctuations in money-market liquidity across the different countries. We studied changes in the sources and effects of fluctuations in money-market liquidity over the 1980s and 1990s in our focus countries by analysing the respective central banks' balance sheets. A general conclusion is that the greatest influence on liquidity fluctuations is factors outside the central banks' control, and that the main effect of monetary policy is to offset these factors (which central banks typically do imperfectly). The overall, as well as the relative, importance of the autonomous factors (primarily the influence of capital flows through net foreign assets and net lending to the government), however, vary considerably between the countries and periods although the net-foreign-assets component is the most important source in almost all our case countries. Based on our results, we argued that these differences could be explained by simple institutional factors, such as the exchange-rate regime. Further, our data indicate a credibility issue.

## Notes

- 1 The cross-country comparisons of central bank operating procedures that exist – e.g., Kneeshaw and Van den Bergh (1989), Batten *et al.* (1990), Bernanke and Mishkin (1992), Kasman (1992), Goodhart and Vinals (1994), Hooyman (1994), Bisignano (1996), Borio (1997), BIS (1986; 2001), Kopcke (2002) – consistently indicate that

changes in the operative frameworks of central banks have been both effects and drivers of broader changes in financial markets. This is the link we focus on here. For more general considerations of the political economy of financial market development, see, e.g. Pagano and Volpin (2001) and Rajan and Zingales (2003).

- 2 The usual argument given for this sequence of events is that agents in wholesale markets are assumed to be more professional, thus better qualified to handle market-determined rates; see, for example, Mehran *et al.* (1996).
- 3 The 'empirical' relevance of implicit interest rate regulations is illustrated by Pech's (1994) estimation that in the early 1990s almost half of all credit extended to industry in Austria, though formally free from regulations, was in fact subsidised.
- 4 Temporary regulations have been resorted to in extreme cases even in recent years. The latest example is the imposition by the Bank of Greece of a 12% credit-expansion ceiling on commercial banks in 1999 after consumer credit had expanded more than 30% *p.a.* in 1998 and 1999 (Bank of Greece, *Monetary Interim Report*, 1999).
- 5 General references for this sub-section not cited elsewhere include BIS (1986; 1997a), and Aspötsberger (1996).
- 6 In Switzerland, for instance, the underdeveloped domestic money market, the unaccommodative attitude of the National Bank with regard to reserve imbalances (resulting from its long-standing reserves target — now abolished) and the comparatively high cost of Lombard (overdraft) facilities led Swiss banks to hold reserves substantially in excess of those required under reserve requirements (Kasman, 1992).
- 7 Several advantages are perceived with repos as an instrument for monetary policy relative to more orthodox cash instruments (Turner and van 't dack, 1996; BIS, 1999). One advantage is that they do not directly influence the underlying asset prices. A second is their flexibility: they break the link between the maturity of the asset and the transaction, and can essentially be tailored to suit prevailing liquidity conditions. Thirdly, because repo transactions are backed by (high-quality) collateral, the risk involved is typically very low. This also means that they convey relatively accurate information on the market's interest-rate expectations over the short term. Finally, repos are seen as appropriate for signaling the central bank's monetary-policy stance.
- 8 In Portugal, the decline in short-term paper as collateral refers primarily to T-bills, which decreased from initially very low levels (3% ). In Finland, however, collateral paper mostly consisted of bank CDs, the use of which dropped from about 30 to 20% after the adoption of the common monetary-policy framework in the euro area. See Santillán *et al.* (2000).
- 9 By 1987, the National Bank's holdings of currency swap contracts amounted to approximately half of its foreign-currency assets, which in turn amounted (together with gold) to almost 90% of its total assets. Roughly that situation remained until 1998, when the Nationalbank began to broaden its arsenal of instruments (Banque Nationale Suisse, *Bulletin Trimestriel* 4, December, 1999). Also see Zurlinden (1996).
- 10 As financial integration between countries increases, the narrowing interest-rate differentials vis-à-vis other countries imply that even very small interest-rate movements can generate considerable cross-border capital flows, making exchange-rate or money-supply targets increasingly difficult to meet. Hence the increasing need for instruments which would enable the central bank to influence domestic short-term rates with greater flexibility and accuracy.
- 11 One additional motive for the Nationalbank to increasingly use secured transactions in its operations to extend liquidity to the banks was to lower the risk involved in these operations. A reason for wanting to do so may have been concern with the solvency of the banking system (Finland, Norway and Sweden experienced rather severe banking crises at the time).
- 12 The average size of the positions as well as their variability tend to increase with the total length of the period covered, and therefore tend to be higher for those countries

for which *monthly* rather than *weekly* data are used: an indication that the data should be interpreted with caution.

- 13 One potentially complicating factor here is that if we believe that the central bank's policy measures can in and of themselves give rise to 'innovations', we have an endogeneity problem of the 'autonomous' factors: the central bank influences these factors *indirectly* through its own actions.



# The transition to market-based monetary policy: What can China learn from the European experience?

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## Abstract

We discuss the prospects for Chinese money market development and transition to market-based monetary policy operations based on a comparative historical analysis of the present Chinese situation and the development in 11 European countries from 1979 up to the launch of the European Economic and Monetary Union (EMU). Central banks in the latter group of countries typically had an incentive to encourage the formation of efficient benchmark segments in the domestic money markets for the conduct of open market operations as traditional quantity-oriented instruments became increasingly ineffective. China is displaying many of the same symptoms as the European countries in the 1970s and 1980s, including poor monetary transmission due to excess liquidity and conflicts of interest due to unclear priority among multiple policy goals. We conclude that in a number of aspects, current Chinese monetary policy operations are counter-productive to efforts to develop an efficient money market that can serve as arena for an effective market-based monetary policy, and provide policy recommendations.

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## 1. Introduction

The practical implementation, as well as the targets and the underlying objectives of monetary policy underwent significant changes in most industrial countries during a period from the late 1970s until the late 1990s. These changes were paralleled by a transformation of financial

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markets – including money markets as the main ‘forum’ for the implementation of monetary policy – consisting essentially of broad-based deregulation of credit systems on the one hand, and a rapid growth of alternatives to central-bank money as sources of financing on the other. The parallel processes of financial market development and reorientation of monetary policy are intertwined<sup>1</sup> and mutually reinforcing, and have their roots in domestic historical and political-economy factors as well as in increased international financial integration (Forssbäck & Oxelheim, 2003).

The weakness of the financial system is often argued to be an Achilles heel of the Chinese economy, and China is committed under its World Trade Organization (WTO) accession agreement to further opening up its financial system. This implies the removal of a large number of administrative restrictions, controls and regulations. Required reforms include opening up the capital account, liberalizing interest rates, and allowing foreign banks full access to the domestic market. There is a large (and growing) literature on the fragility of the Chinese banking sector, Chinese capital flows and capital flight, China’s exchange rate regime, etc. However, the co-dependence between financial market development and increased effectiveness of monetary policy in the face of increased international integration – through a reorientation of the targets as well as the arsenal of instruments used by the central bank – is a less explored area of study. Because the money market is a key link between a country’s financial system and its real economy, and the primary arena for the conduct of monetary policy, a poorly functioning money market is presently a key problem in China, as the development toward a market economy in other sectors and commitments under the WTO accession agreement have taken the need for reforms of beyond the point of no return. We argue in this paper that remnants of a traditional ‘dirigiste’, direct-control approach presently thwarts the effectiveness of monetary policy, and that with a more open financial system these problems are likely to persist, or even accelerate.

We further argue that in several key respects – e.g. initial financial repression, increased capital mobility, poor transmission, and multiple targets – relevant to this line of inquiry, the present situation in China is comparable to that of several European countries in the 1980s. Although potentially an economic giant, the size of the Chinese economy and its dependence on external markets during the 1990s and early 2000s make it more comparable with small and open, rather than with larger, developed economies.

The paper thus builds on research on money market development and monetary policy reform in a sample of small or medium-sized, open European countries<sup>2</sup> and extracts lessons for China from the experiences of these countries. Apart from their dependence on external markets, the choice of benchmark countries is also motivated by the fact that the money markets for these countries’ currencies were virtually non-existent at the beginning of the 1980s, but then went through phases of emergence, growth, sophistication and international integration over a period of approximately 20 years. The process is thus in some sense ‘completed’, rather than still ongoing, as in most other Asian countries (except Japan, which, however, is a special case for other reasons), or in alternative possible benchmark countries. The countries also represent the full

<sup>1</sup> Existing cross-country comparisons of monetary policy operating procedures – e.g., Kneeshaw and Van den Bergh (1989), Batten, Blackwell, Kim, Nocera, and Ozeki (1990), Bernanke and Mishkin (1992), Kasman (1992), Goodhart and Viñals (1994), Hooyman (1994), Bisignano (1996), Borio (1997), BIS (2001), Kopcke (2002), Forssbäck and Oxelheim (2006) – consistently indicate that changes in central banks’ operative frameworks are causes as well as effects of changes in the functioning and structure of the financial system.

<sup>2</sup> The benchmark countries are the following European countries: Austria, Belgium, Denmark, Finland, Greece, Ireland, the Netherlands Norway, Portugal, Sweden and Switzerland.

spectrum with regard to the level of ambition of exchange-rate policy and ‘reputation’: from hard-currency, low-interest-rate countries to countries with a near-emerging-market status. Due to this diversity, our eleven benchmark countries constitute an excellent ‘laboratory’ with regard to the link between money market development and the conduct of monetary policy.

The paper is organized as follows. In Section 2 we briefly summarize Chinese monetary policy in recent years. Section 3 describes the development of money markets in the benchmark countries and puts China into that perspective. In Section 4 we address changes in central-bank operations and the increasing role of open market operations. Section 5 considers the main drivers behind these changes, whereas in Section 6 we provide an empirical evaluation of Chinese monetary policy in light of the European experience. In Section 7, we discuss options for Chinese monetary policy based on our empirical results. Finally, Section 8 summarizes our findings and provides policy recommendations for China.

## 2. Chinese monetary policy in recent years – main contours of the development and current problems

A brief summary of the People’s Bank of China’s (PBC) recent policies and performance runs as follows. After the abolition of the dual exchange rate system in the mid-1990s, a fixed exchange rate regime was adopted whereby the RMB was pegged to the USD. Four main objectives of macroeconomic policy were attached to the reorientation of policy: economic growth, price stability, full employment, and balance of payments equilibrium (Ping & Xiaopu, 2003). Current account convertibility was adopted in 1996, and restrictions on capital inflows were partially removed, whereas the enforcement by the State Administration of Foreign Exchange (SAFE) of remaining capital controls was strengthened (Ping & Xiaopu, 2003). Monetary policy was to some extent designed to support a more general policy to attract foreign direct investment (FDI) inflows (for an extensive analysis, see Prasad & Wei, 2005).

In 1998–2001, the PBC made (largely unsuccessful) attempts to increase credit growth through open market operations and lowering of minimum reserve requirements. From 2003 onward, the attempts have rather been to tighten monetary policy, however with equally limited effects of the ‘standard’ arsenal of instruments. The PBC has frequently had to resort to moral suasion and various forms of *ad hoc* administrative measures to steer banks’ behavior in the desired direction (BIS, 2005; Green, 2005; PBC, various; Roach, 2005; Van der Linden, 2005).

Steps have been taken toward further deregulating capital inflows, relaxing restrictions on capital outflows and expanding permissible foreign exchange transactions since the early 2000s. As a step toward gradually increasing the flexibility of the exchange rate (after intensive international debate – see, e.g., Eichengreen, 2005; Goldstein, 2004; Prasad, Rumbaugh, & Wang, 2005; Yang, Yin, & He, 2004), the US dollar peg was abandoned in July, 2005, the RMB revalued by 2.1% and henceforth linked to a currency basket through a managed float system.

There is increasing attention to the poor transmission of monetary policy in China (PBC, various; Ping, 2004). The problem is due to deficiencies both in the step between the central bank and the banking system, and between the banks and the public. Five such deficiencies can be identified: (1) The non-responsiveness of the banking system to the central bank’s policy (in particular, their insensitiveness to interest-rate changes) is largely due to the excess supply of liquidity. If banks do not have to borrow in the money market to meet their liquidity needs, they do not care about the price at which money can be borrowed there. (2) As a consequence of banks’ own insensitiveness to the pricing of money, they do not appropriately pass on variations

in these prices to their customers; hence, central bank policy has a very limited effect on the consumption and investment behavior of firms and households. (3) Even if interest rate changes are passed on by banks on the margin, the effect is diluted, since the banks have limited ability and incentive to adequately price risk and differentiate the price of credit to different categories of borrowers accordingly (cf. governance problems within the banking sector below). (4) Borrowers are themselves insensitive to variations in the cost of funds because they do not face any consequences in the event of failure to service the debts (state-owned enterprises), and because credit-driven consumption is still extremely limited (households). (5) The continuing habit of the PBC to exert control over the price, quantity, and direction of credit through informal measures ('window guidance', moral suasion) as a means to achieve policy objectives, and – more generally – the remaining political influence over large parts of the banking sector, distort the market mechanism in the bank loans market, leading to continuing mispricing and misallocation of credit.

The current policy dilemmas faced by Chinese monetary authorities are by no means unique in historical perspective. The way out of them in those industrialized countries that have preceded China has been three-fold: the parallel processes of financial deregulation, formation of efficient domestic short-term securities markets (money markets), and reform of central bank operating procedures. These processes are not only parallel, but intertwined and partially overlapping, and have all been initiated in China. In order to 'position' the current Chinese situation vis-à-vis our benchmark countries, the following two sections make a comparative analysis of the development in the European countries and progress so far in China.

### 3. Financial deregulation and money market development: China and Europe compared

The European benchmark countries in this paper all followed the general trend among industrial countries of broad-based financial-sector deregulation in the 1980s and 1990s. Below, we make a brief summary of that process.<sup>3</sup> We then go on to describing major trends in financial innovation, differentiation, and market growth, with a focus on money markets. The findings are used for comparisons with the present state of affairs in China.

#### 3.1. Deregulation of the financial sector

Financial regulations and restrictions can be divided into a few main categories:

- pricing regulations (mostly various types of interest-rate regulations);
- quantitative credit restrictions (specific or general);
- investment obligations and liquidity requirements (the requirement on financial institutions to hold minimum quantities of certain assets);
- restrictions on the issuance of financial instruments; and
- market-entry rules and ownership (asset) restrictions.

<sup>3</sup> For a more comprehensive account of the process of financial deregulation in the Nordic countries, see Oxelheim (1996); a survey of this process for a large number of countries, including many emerging-market countries, is provided in Williamson and Mahar (1998); beyond these, the best sources for specifics on deregulation in particular countries are usually publications from the central bank of the country in question. OECD's *Financial Market Trends* is also a useful source.



Table 1

Financial-market regulation in China 2005 and in the European benchmark countries 1980

	Interest-rate restrictions	Specific credit controls <sup>a</sup>	Overall credit growth limit	Investment obligations	Issuing restrictions	Market-entry and ownership restrictions
China	•	• <sup>b</sup>	• <sup>b</sup>	• <sup>c</sup>	•	•
11 benchmark countries	• (10) – (1)	• (10) – (1)	• (7) – (4)	• (6) – (4) n.a. (1)	• (10) n.a. (1)	• (9) – (1) n.a. (1)

(•): Regulation in force; (–): Regulation not in force; n.a.: Information not available. Figures in parentheses refer to number of countries. Sources: Edey and Hviding (1995), OECD Financial Market Trends (various), Forssbäck and Oxelheim (2003), Hope and Hu (2006), Oxelheim (1990, 1996), Ping and Xiaopu (2003), Vihriälä (1997), Wyplosz (2001), PBC (2005) and other various national sources.

<sup>a</sup> Quotas or ceilings imposed on individual banks or groups of banks/financial institutions, and similar detailed credit controls.

<sup>b</sup> Quotas have formally been scrapped but the central bank exerts/exerted discretionary control of credit growth through ‘guidelines’ or ‘moral suasion’.

<sup>c</sup> State-owned commercial banks were relieved from directed credit in 1994 by the creation of three so-called ‘policy banks’; the latter, and possibly the former as well, remain subject to this type of regulation.

Table 1 summarizes the regulatory state of affairs for China in the mid-2000s and around 1980 in the benchmark countries, and illustrates the comparability of the situation. In spite of steps toward deregulation having been taken in China since the mid-1990s, the financial system is still repressed and largely based on regulatory infractions in financial market activity. Similar steps toward deregulation had been taken in several of the benchmark countries during the 1970s (of which, among others, the Scandinavian countries and the Netherlands), but a majority of the countries still applied at least some regulations within most of the categories.

### 3.1.1. Interest-rate regulations

In China, interbank interest rate ceilings were abolished in 1996, the central bank rediscount rate liberalized 2004, and the lending interest rate ceilings for banks were removed in 2004. The interest rate liberalization process is still ongoing, however, and administrative influence over price-setting is still exerted—both directly (as regards, e.g., deposit rates) and implicitly (Green, 2005; Liu, 2005).

Interest-rate deregulation had begun in the late 1970s and was completed by the mid-1980s in Scandinavia, Ireland and the Netherlands. The last among the benchmark countries to abolish interest-rate regulations, Greece and Portugal, completed the process a few years into the 1990s, in accordance with their gradual implementation of European-Community directives (see Rautava, 1994; Edey & Hviding, 1995).

The general pattern in our benchmark countries was that the liberalization of wholesale interest rates occurred first, followed by lending rates and deposit rates. The process was mostly gradual, and sometimes hesitant on the part of the authorities. An illustration of this is that formal rules and restrictions (a ceiling, a quota, etc.) were often initially followed by recommendations or various types of agreements before being *de facto* liberalized. These ‘implicit’ interest rate regulations were enforced through the understanding that the authorities could, and would, enforce their goals by means of the reinstatement of formal regulations if deemed necessary (see, e.g., Grønvik, 1994).

### 3.1.2. Credit controls and other quantitative regulations

In China, credit quotas were formally abolished in 1998. However, the PBC still routinely controls the quantity of credit on a more discretionary basis, and is to some extent able to influence both the quantity and the direction of bank credit through informal means (see, e.g., BIS, 2005). Clearly, *de facto* credit controls are still being applied, which – although presumably a handy instrument for monetary authorities to apply to adjust short-run imbalances – is, as we shall later argue, a major impediment to the long-run development of a more effective indirect, market-based operational framework for monetary policy.

The link between prices and quantities implies complementarity of various types of regulations. In combination with interest-rate regulations, quantitative credit and investment restrictions, in one form or another, were employed in a majority of our benchmark countries, both as a general monetary-policy instrument, as a tool to ration and control the allocation of credit, and to provide cheap financing for the government.

Conversely, however, complementarity also implies that quantitative regulations to some extent become obsolete or irrelevant as interest rates are being liberalized. Consequently, most credit rules were abolished in our benchmark countries over about the same time span as, and usually with a short lag to, interest-rate liberalization.

### 3.1.3. Issuing restrictions

Also complementary to interest-rate restrictions and controls on bank credit, issuing restrictions on securities are used to control the transfer of credit through direct channels (that is, through market issues). Typically, rules and regulations on minimum maturities, etc., have been combined with various authorization requirements.

In China, securities issuance (both debt and equity) remains surrounded by formal and informal restrictions. Before the mid 1980s, resource allocation was entirely in the hands of the central government; State Owned Enterprises (SOEs) were financed over the government fiscal budget and the central government used state-owned commercial banks as fiscal agents. A few local, unofficial and unregulated markets for equity and bonds began to develop spontaneously in the 1980s (Green, 2003), but only by the opening of the stock exchanges in Shanghai and Shenzhen in December 1990 did the Chinese government begin to pay attention to the regulation and supervision of such markets. A two-way approach was adopted, by which basically a formal central regulatory framework was introduced, combined with cautious segment-by-segment liberalization of financial markets and state bank reforms (largely motivated by declining fiscal revenues and the accumulation of bad loans in the state-owned banks, which limited the government's ability to meet SOEs' financing needs). In 1992, the China Securities Regulatory Commission (CSRC) was established, and a quota system was introduced to control securities issuance. Further reforms have been undertaken since the mid-1990s, and new instruments successively introduced (see Section 3.2), but the government's characterization of the existing exchanges as 'controlled experiments' is illustrative of the general attitude of the authorities and of the cautious and gradualist approach adopted by the Chinese government.

In our benchmark countries, the regulation of debt securities issuance was mostly in place for slightly longer than interest-rate and credit controls. About half the countries in the benchmark sample lifted issuing controls in the early-to-mid-1980s. In others, important steps toward the opening-up of securities markets occurred in the context of a reform of government-financing systems only toward the early-to-mid-1990s (De Broeck, Guillaume, & Van der Stichele, 1998; Soumelis, 1995). Generally, however, the liberalization of markets for private debt was slower than other categories. In addition, market development was in some cases stifled by the existence

of various types of more or less informal authorization requirements—a sort of parallel to the ‘implicit’ interest-rate controls mentioned above.

### 3.1.4. Market-entry rules and ownership regulations

State-owned banks dominate the financial sector in China. The four state-owned banks had a market-share of 57% in 2003. Local banks (20%), 10 joint stock commercial banks (14%), three policy banks (8%) and foreign banks (1%) constitute the rest of the Chinese banking sector (Van der Linden, 2005). Institutional reforms of PBC and state-owned banks have been undertaken since 1993, but were initially largely unsuccessful, because they did not fundamentally alter incentive structures and remove soft budget constraints within the banking sector (see, e.g., Park & Sehn, 2001). A 5-year time-table for a gradual opening of the banking sector was announced in 2001, and reform thereafter has included the transfer of power over banking regulation and supervision from the PBC to the China Banking Regulation Commission (CBRC), financial restructuring of the largest state-owned banks – both through Asset Management Companies (AMCs) and through recapitalization directly over the government budget – and a full abolition of line-of-business, ownership and foreign-entry restrictions in the banking sector as a result of WTO negotiations (still ongoing; see Hope & Hu, 2006; Liu, 2005). In 2006, we have also witnessed the privatization of some of the largest state-owned banks.<sup>4</sup>

In some of our benchmark countries, branching regulations were partially or wholly abolished in the 1980s and early 1990s. Moreover, a ‘spontaneous’ functional market integration (taking place, for instance, through banks establishing subsidiaries within the securities-trading business, or acquiring finance companies) is often considered a major feature of the financial-market transformation process undergone by the industrial countries in the 1980s.<sup>5</sup> To some extent, this implies a diminishing practical importance of remaining regulations.

To this category may also be counted restrictions on foreign-bank entry. In the benchmark sample, about half of the countries opened their domestic markets for foreign banks during the 1980s or earlier, whereas in much of the rest of them, significant steps were taken only with the implementation of the EU’s 2nd Banking Directive (effective in 1993).

In the area of ownership control, the deregulation wave made a comparatively modest impression in the 1980s and 1990s, and several such regulations remained in the mid-1990s (see, e.g., Herring & Litan, 1995). State-ownership of a large proportion of domestic financial institutions also outlived financial deregulation in some benchmark countries. This applied primarily to the countries with previously entirely nationalized financial sectors (Greece<sup>6</sup> and Portugal), but state-ownership of banks also became an effect of system-wide banking crises in the early 1990s in a few of the countries.<sup>7</sup>

To summarize, the deregulation of domestic financial sectors in the European benchmark countries began between the late 1970s (Austria, Scandinavian countries) and the mid-1980s (Greece, Ireland), and was completed mostly around 1990, or a few years into the 1990s. In

<sup>4</sup> Including that of Industrial and Commercial Bank of China (ICBC), which, as of mid-October 2006, is expected to be the biggest IPO in history so far.

<sup>5</sup> See, for example, the survey in OECD (1989).

<sup>6</sup> The Greek banking sector, for instance, was still completely dominated by state-owned banks when ownership regulations were abolished. In terms of assets, the government’s ownership share was about 75 percent (see Hope, 1993).

<sup>7</sup> Thus, the government’s ownership share of banks in Norway and Finland were 52 and 35 percent, respectively, in the early 1990s (Banker, 1993). Also see the Economist (1992) and Warner (1993) for short background articles on the deregulation and privatization of Portuguese banks.

China, liberalizations began in the mid-1990s. It is difficult to measure the level of repression, but based on the categories of restrictions still in *de facto* use in the mid-2000s, it would appear as though the process still has some way to go.

### 3.2. Money market growth and development

Table 2 summarizes starting years for some of the main money market segments in the European benchmark countries and in China. In the former, during the 1980s and 1990s a certain convergence in terms of the *presence* of different types of money-market instruments occurred. Considerable dissimilarities remained, however, in terms of the relative total size of the domestic market as well as in terms of the *relative importance* of specific segments of the market (see Table 3).

The most traditional money-market segment is the interbank deposit market, whose importance is largely determined by the monetary authorities' choice of operative framework and by the existence of alternative segments. Deposit markets turned up in most countries as monetary-policy instruments changed during the 1980s and 1990s. In China, the CHIBOR interbank market was established in 1996 and opened to foreign banks in 1998.

In the short-term *securities* markets, treasury bills or equivalent short-term government securities are typically the most important sub-market. In several benchmark countries, short-term government securities had existed for a long time before the 1980s, but were traditionally non-marketable, and sold directly to final holders (usually banks) at regulated rates. In none of the benchmark countries did true markets for t-bills turn up until after 1980.

The Chinese t-bill market is so far insignificant. The aggregate supply of tradable government bonds was in 2003 equivalent of about 32 percent of GDP—a low figure as compared with the average for developed markets, which is about 100 percent. The maturity structure of bonds is such that less than 5% are 2-year or less, indicating a short-term (government) bill market of somewhere around 1% of GDP. According to other sources, trade in (long-term) government bonds amounted to 95% of all traded debt in 2002 (Bottelier, 2004).

Two other main cash-instrument types – commercial paper (CP, generally issued by non-bank entities) and certificates of deposit (CD, a securitized bank liability) – were introduced in several benchmark countries in the mid-1980s, but as revealed by Table 3 their importance varies greatly. A CD market does not exist in China beyond the PBC's own central bank bills, which were introduced in 2003. The development of this segment has been fast, however, with an increase of outstanding amounts to an estimated 7% of GDP in March 2005.

Commercial-paper markets emerged in far from all the benchmark countries. In many cases, the markets have also shrunk somewhat from their peaks in the early 1990s. There seems to be some indications that where commercial-paper markets could be benchmarked against a liquid government-bill market (or other instrument with a market-supporting role), their development came earlier and was more extensive (see Alworth & Borio, 1993).

In China, the PBC announced rules for issuance of 'short-term financing bills' in late 2004 but the market for corporate debt (including longer-term corporate bonds) has remained insignificant. Other types of traded debt assets include banks' non-performing loans (NPL) through four state-owned Asset Management Companies (AMCs, established in 1998).

Beyond the above reported cash instruments, various derivative instruments play an important role, as do repurchase agreements (repos), which – according to BIS estimates – was the fastest growing instrument/transaction type internationally during the 1990s. Data, however, are scarce. Reporting in different countries is also such that available historical data are not readily comparable (for a survey of repo markets in G-10 countries, including data availability, see Bank

Table 2

Money-market innovations, money-market development in different benchmark countries

	China	11 benchmark countries
Interbank deposit market	1996	1978 <sup>a</sup> –1993 n.a. (4)
‘-IBOR’ reference rate	1996	1987–1994 n.a. (1)
Treasury bills or treasury notes	1986 <sup>b</sup>	1975 <sup>c</sup> –1991
Certificates of deposit (CDs)	2004 <sup>d</sup>	1982–1993 – (4) n.a. (1)
Central-bank CDs	2003	1987–1995 – (5)
Commercial paper (CP)	2004 <sup>d</sup>	1983–1994 – (4)
Single-currency interest-rate futures	2006	1984–1996
Single-currency interest-rate swaps and/or options	–	1985–1994 n.a. (1)
Foreign-exchange or currency swaps <sup>e</sup>	1980	1976–1990 n.a. (1)
Repo market	1991	1980s–1998 – (2) n.a. (2)
Repos adopted by central bank	1998 <sup>f</sup>	1984 <sup>g</sup> –1998 – (1) n.a. (2)

Years refer to year of introduction, year of deregulation of market, or year of establishment of a viable market. (–): Not applicable/a viable market in the instrument does not exist; n.a.: Information not available. Figures in parentheses refer to number of countries. *Sources*: Alworth and Borio (1993), BIS (1999), Batten et al. (1990), De Broeck et al. (1998), De Teran (2004), Euromoney country surveys (various), Forssbäck and Oxelheim (2003), Green (2005), Holbik (1991), Hope and Hu (2006), Khoury (1990), Kullberg (1991), Norges Bank (1995), OECD Financial Market Trends (various), Oxelheim (1996), Ping and Xiaopu (2003), Pinto (1996), Yang et al. (2004); various national sources.

<sup>a</sup> A market existed in Denmark since the 1970s but remained inactive until the reform of the monetary-policy operating framework in 1992.

<sup>b</sup> Refers to year when limited trading was first permitted.

<sup>c</sup> Irish ‘Exchequer bills’ were marketed since the 1960s.

<sup>d</sup> Refers to ‘short-term financing bills’.

<sup>e</sup> Refers to ‘interbank swaps’: central banks have been using swaplike instruments for considerably longer—the German Bundesbank, e.g., since 1958 (Hooyman, 1994).

<sup>f</sup> Operations have since largely seized due to inadequate supply of underlying instruments.

<sup>g</sup> Some central banks were making ‘repo-like’ advances against collateral before this year.

for International Settlements, 1999). Existing data indicate considerable variations in derivatives as well as repo markets (see Forssbäck & Oxelheim, 2003). In some benchmark countries, repo markets were partly stifled due to thin debt markets (the Netherlands, Norway), ambiguities with regard to regulatory policies, legal status and tax treatment (Ireland, Portugal, Switzerland), or an excessively high degree of concentration of market players (see Commission of the European Communities, 1999).

Table 3

Short-term securities markets in China, 2004, and in benchmark countries in 1985 and 1995

	T-bills	CDs	CB CDs	CP/other	Total
China in 2004	<1.0	–	6.7	n.a.	7 (est.)
11 benchmark countries, 1985					
-range	0.8–24.6 (9)	0.1–3.9 (4)	–	1.1 (1)	0.8–24.3 (9)
-mean	8.5	1.8	–	1.1	9.4
–	(2)	(7)	(11)	(10)	(2)
11 benchmark countries, 1995					
-range	2.0–31.1 (11)	0.2–12.9 (8)	1.7–4.9 (3)	0.5–8.2 (7)	4.0–31.3 (11)
-mean	10.0	3.3	3.7	3.2	15.5
–	(0)	(3)	(8)	(4)	(0)

Outstanding amounts (% of GDP at year-end); (–): Not applicable/a viable market in the instrument does not exist; n.a.: Data not available. Figures in parentheses refer to number of countries. *Sources:* Austrian Federal Ministry of Finance (BMF) and Austrian Federal Financing Agency (BFA); Ministère des Finances Belge, Administration de la Trésorerie; Danmarks Nationalbank; Suomen Pankki; Bank of Greece; Central Bank of Ireland; De Nederlandsche Bank; Norges Bank; Banco de Portugal; Sveriges Riksbank; Banque Nationale Suisse; People's Bank of China; BIS, Quarterly Review: International Banking and Financial Market Developments (various); Green (2005); GDP figures from IMF International Financial Statistics and Deutsche Bank.

A repo market was established in China in the early 1990s; since 1997, it is split up into an interbank market and a corporate market (hosted by the Shanghai Stock Exchange). Available evidence indicate that repo transactions in government bonds are by far the most important contract type traded interbank (PBC, various; Ping, 2004), but it is not clear to what extent these are transactions with the central bank; nor is it possible to directly compare the importance of this market with other central bank facilities for the settling of liquidity imbalances (see Section 5). A first set of rules to govern Chinese banks' derivatives trading was introduced in 2004 (De Teran, 2004), but a viable market does not yet exist. However, the establishment of the Financial Futures exchange in September 2006 may mean an essential step forward.

#### 4. Changes in central-bank operations<sup>8</sup>

Until the mid-1980s central banks in our benchmark countries relied largely on traditional credit and deposit facilities (standing facilities), supported by various direct controls, for the conduct of monetary policy. The ordinary credit facilities were mostly supplemented by some sort of tranche-division system (for example, Denmark, Finland), penalty-rate system (Austria, Sweden), or a combination of both (Belgium, the Netherlands) in order to allow central-bank control of the marginal cost of banks' borrowing under the facilities, and thereby of the supply of liquidity to the banking system.

All our benchmark countries reformed their operative frameworks for monetary policy quite substantially during the 20 years we study. In some countries, the revision of the monetary-policy operating framework took the form of comprehensive reforms (for example, Denmark 1992, Switzerland 2000); in others, developments proceeded in a more piecemeal manner. In several countries (Belgium, Finland, the Netherlands) the trend toward a gradually increased diversification of liquidity-supply instruments became visible toward the mid-to-late 1980s. Others followed suit during the 1990s (Denmark, Portugal, Austria).

<sup>8</sup> General references for this sub-section not cited elsewhere include BIS (1986, 1997a), and Aspötsberger (1996).

#### 4.1. The diminishing role of quantitative controls

The diversification of instruments used by central banks as well as by other money-market agents in our benchmark countries during the 1980s and 1990s was paralleled with the lifting of most direct regulations. This sub-section therefore focuses on one direct control that remained in use by many central banks—the minimum reserve requirement.

During the 1990s, practically all our benchmark countries followed an international trend among industrial countries toward lowering or completely abolishing reserve requirements (see Table 4). The major arguments behind these reforms were to reduce the tax effect of reserve requirements and to neutralize the competitive disadvantage of subjected depository institutions vis-à-vis other financial institutions—domestic or foreign (see European Commission, ‘Minimum Reserve Requirements and Monetary Policy’, *Weekly Review of Financial Market Developments* 37, November, 1997).

The objectives of the reserve-requirement instrument were originally to maintain banks’ liquidity even in case of large deposit withdrawals, and to influence liquidity for monetary-policy purposes. Nowadays, reserve requirements mainly serve three purposes in developed economies. One is as a means of providing for banks’ ongoing liquidity needs (having banks in a position of reliance on the central bank facilitates the conduct of monetary policy). A second purpose is to improve the flexibility of banks’ liquidity management (reserves can be used to settle interbank payments). Finally, reserve requirements (particularly if unremunerated) can provide seigniorage income for the central bank, thereby contributing to its profitability and (economic) independence (see, e.g. Grønvik, 1994; Bank of Finland Bulletin 12, 1996; BIS, 2003).

Benchmark countries that abandoned the use of reserve requirements more or less entirely relatively early on include Belgium (mid-1970s), Norway (1987) and Sweden (1990). In Norway, for example, both primary reserves (that is, cash-reserve requirements) and secondary reserves (compulsory bond holdings by banks and insurance companies) had been used since the 1960s. From 1971 only the primary reserve requirements were used in Norway, but they were altered often and by much.

Table 4

Reserve requirements in China, 1999 and 2004, and in benchmark countries in the 1970s, 1980s and 1990s

	Reserve requirements in force	Maximum reserve ratio applied	Differentiated ratios for different types of liabilities
China, 1999	•	13.0	–
China, 2004	•	7.5	•
11 benchmark countries, 1970s <sup>a</sup>	• (11)	3.0–15.0 (9) n.a. (2)	n.a. (11)
11 benchmark countries, late 1980s <sup>b</sup>	• (8) – (3)	2.5–17.0 (7) n.a. (1)	• (3) – (7) n.a. (1)
11 benchmark countries, late 1990s <sup>c</sup>	• (7) – (4)	2.0–12.0 (7)	• (3) – (8)

(•): Yes; (–) No; n.a.: Information not available. Figures in parentheses refer to number of countries. Sources: Bank of Japan (1995), BIS (1997b), Borio (1997), Central-bank bulletins (various), ECB (1998), Forssbäck and Oxelheim (2003), Holbik (1973), Kneeshaw and Van den Bergh (1989), OECD Financial Market Trends (various), Pinto (1996) and PBC (2005).

<sup>a</sup> Exact years vary; see Forssbäck and Oxelheim (2003) for detailed country-by-country indications.

<sup>b</sup> 1988, except Ireland (1986) and Portugal (1989).

<sup>c</sup> Refers to individual country ratios applied in 1998/1999 before the launch of the Eurosystem.



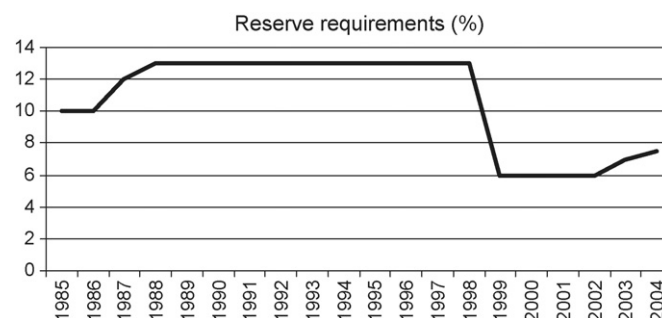


Fig. 1. Minimum reserve requirements in China, 1985–2004. *Source:* People's Bank of China.

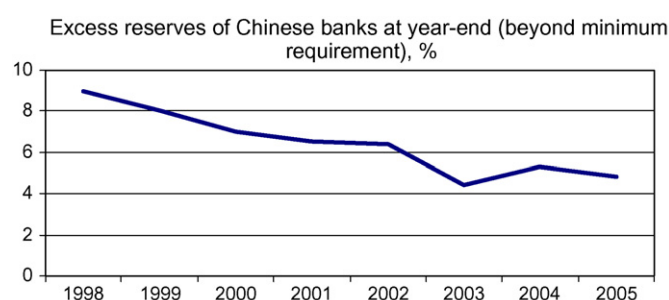


Fig. 2. Excess reserve ratio of Chinese banks, 1998–2005 (average at year-end). *Source:* People's Bank of China.

Minimum reserve requirements did play a role (at least formally) as liquidity-management instrument until the late 1990s in the Netherlands and, to some extent, in Austria, Finland, and Ireland. However, the only benchmark country where they played a significant role for active liquidity management in the late 1990s was Greece (until its entry into the EMU), where the instrument was deemed necessary to retain control over the liquidity supply in the face of large capital inflows. This parallels earlier experiences in, for instance, Portugal, other emerging market economies, and the present situation in China, where since the 1990s the PBC still relies heavily on reserve requirements to manage liquidity.

China has lowered reserve requirement ratios since the 1980s and 1990s (see Fig. 1), but there is no clear-cut trend, and an indication of the PBC's continued reliance on this instrument type is its introduction of a differentiated reserve requirement system in 2004 to increase flexibility and precision. However, minimum reserve requirements do not bite as a monetary policy tool unless a properly functioning pricing mechanism in the money market gives banks an incentive *not* to put their liquidity into reserves (i.e. keep them close to the minimum requirement). This is not the case in China, where the reserve holdings of the banks have more or less consistently been in excess of 5 percent beyond the required ratio (see Fig. 2).

#### 4.2. The increasing role of market instruments in central-bank operations

Three main types of market instruments predominate: short-term securities, repurchase operations, and swaps. The prevalence in our benchmark countries and in China of these main instrument types is examined in the present sub-section.



Effective open-market operations to some extent presuppose an existing market to operate in. Thus, central banks have typically, at some point or another, come to favor the creation of markets, and have often stimulated and supported their development. This holds for interbank deposit markets as well as for short-term securities markets.

The absence of an efficient interbank market is bad news for the central bank to the extent that banks then may rely on central-bank facilities to gain access to liquidity even when other banks are very liquid, creating a situation of excess liquidity in the banking system and poorer monetary transmission.<sup>9</sup> For monetary policy to bite, banks' *marginal* liquidity needs must be settled with the central bank. Hence there is a need for central banks to create adequate instruments to drain liquidity and to stimulate the formation of markets for alternative short-term assets. Instead, traditionally in our benchmark countries, specific credit quotas to individual banks were used to atone for this problem. In the general climate of decontrol in the mid-1980s, however, it seems ultimately to have been widely accepted that stimulating the emergence of efficient markets was a more constructive path to pursue. Examples are the establishment of efficient day-to-day interbank markets in Belgium and Sweden (in both cases around 1985–1988), which were more or less anticipated effects of changes in the layout of monetary-policy operating procedures (BNB, 1985; Kneeshaw & Van den Bergh, 1989). More generally, the emergence of a markka money market was stimulated by the Bank of Finland's decision to leave the forward exchange market to the devices of the banks themselves (around 1980). Parallels exist in, for example, Denmark and Portugal (see Danmarks Nationalbank *Monetary Review*, August 1996; and Pinto, 1996).

The emergence of short-term securities markets adds a dimension to liquidity management for central banks. In practice, cash operations in short-term securities by central banks are relatively rare, even where the size of these markets is sufficiently large to make such operations feasible (see Borio, 1997; BIS, 2003). One reason is that other types of operations are more flexible. Other reasons which have carried some weight in several benchmark countries are the wish to avoid potential conflict with other public-policy objectives (notably public-debt management, for example in Denmark and Portugal, and tax policy), and the wish to avoid circumvention of limits on central-bank lending to the government.<sup>10</sup>

To avoid conflicts of interest and to increase the effectiveness of monetary policy, it has been relatively common for central banks in the benchmark countries to issue their own securities (central-bank CDs) in the primary market in order to absorb liquidity from the banking system. In some cases, this has been one of the main strategies of the central bank. Countries where the issuance of central-bank paper has played an important role during shorter or longer periods include Finland, Ireland, the Netherlands and Portugal among the EMU countries, and Denmark and Sweden among non-EMU countries. This is currently the main type of market operation in China.

Even in the absence of outright transactions in securities, the existence of a liquid securities segment in the money market is often argued to facilitate the central bank's operations by providing collateral to repurchase agreements and similar collateralized transactions. To the extent that it does so, the varying degrees to which short-term securities markets have emerged in the benchmark countries imply correspondingly varying possibilities for the respective central

<sup>9</sup> In Switzerland, for instance, the underdeveloped domestic money market, the unaccommodative attitude of the National Bank with regard to reserve imbalances (resulting from its long-standing reserves target – now abolished –) and the comparatively high cost of Lombard (overdraft) facilities led Swiss banks to hold reserves substantially in excess of those required under reserve requirements (Kasman, 1992).

<sup>10</sup> These problems are particularly relevant in emerging stages of money-market development; see, e.g., Mehran, Laurens, and Quintyn (1996), Kneeshaw and Van den Bergh (1989).

banks to exploit the flexibility and other advantages of repurchase agreements and similar instruments. During the course of the 1990s, repurchase transactions were adopted as a main liquidity-management instrument in Denmark (as from 1992), Sweden (1994) and Switzerland (1998), in Austria (1995), Finland (mid-1990s), the Netherlands (refers to ‘special loans’) and then, from the time of its inception in 1999, in the whole Eurosystem (see Table 5).

In China, the PBC started cash and repurchase operations in government bonds in 1998. Temporary reverse repos in bonds were conducted in 2002 but operations then seized because of inadequate supply of bonds. The question here is not so much the original maturities of the assets,

Table 5

Monetary policy targets and main central bank operations in China, 2005, and in benchmark countries before the launch of EMU

	Exchange rate	Inflation	Orientation/overall target		Employment	Other
			Economic growth	Financial stability		
China	• (official target)	•	•	•	•	•
11 benchmark countries	• (9)	• (5)				• (1)
	Overnight interest rate	1–3 month interest rate	Main operating variable		Credit growth	Other
			Other interest rate	Money supply		
China	•			•		
11 benchmark countries	• (3)	• (4)	• (2)	• (1)	• (1)	• (1)
	Repurchase operations or equiv.	Deposit and loan facilities	Main instrument		Reserve requirements	Other
			Issuance of central bank CDs	Foreign exchange swaps		
China		•	•		•	•
11 benchmark countries	• (7)	• (2)	• (1)	• (1)		
	Government bonds	Treasury bills	Collateral for repurchase transactions		Central bank CDs	CP/other private securities
			Mortgage bonds	Bank CDs		
China	•					
11 benchmark countries	• (10)	• (11)	• (2)	• (3)	• (1)	• (4)
	Repurchase operations or equiv.	Issuance of central bank CDs	Other open-market operations (not main instrument)			
			Sales of other short-term securities	Outright money market operations	Various foreign exchange operations	Other
China	•					
11 benchmark countries	• (2)	• (2)	• (3)	• (2)	• (8)	• (1)

Sources: Banco de Portugal, *Economic Bulletin* 1 and 2 1998, and *Annual Report* 1998; Bank of Finland *Bulletin* 9/1998; Bank of Greece, *Monetary Policy Interim Report* November 1998 and March 1999, and *Annual Report* 1998; Borio (1997); Central Bank of Ireland, *Annual Report* 1998; Danmarks Nationalbank, *Monetary Review* 2, 1999; Norges Bank, Penger & Kreditt 1998/4, and *Annual Reports* 1997 and 1998; BIS (2003); PBC, *China Monetary Policy Report* (various quarters 2002–2005); Ping (2004); Ping and Xiaopu (2003).

but the absence of a market at all. Government issues are all that exists in the medium-to-long-term segments; the short end is dominated by PBC bills, but there is scant demand for either, because the pricing mechanism does not work.<sup>11</sup> The general conclusion in terms of the PBC's open market operations is that debt markets in the mid-2000s are too shallow for effective buy-sellback or sell-buyback operations.

Some benchmark countries without liquid short-term markets have relied on foreign-exchange operations (particularly swaps) for liquidity management. The pre-eminence of swaps over spot or regular forward-exchange operations simply reflects the greater importance of swaps in the interbank market. Swaps are the major instrument by which banks cover their forward foreign-exchange commitments to customers (see Hooyman, 1994). Benchmark countries where FX swaps have played a significant role for liquidity management by the central bank and/or by the banking system as a whole include Austria, the Netherlands and Denmark. In Switzerland, USD-CHF swaps were the principal market operation of the National Bank during the period between the early 1980s and the late 1990s.<sup>12</sup>

A Chinese foreign exchange swap market was established in 1980 after the first restrictions on foreign exchange transactions were removed in 1979, and an interbank foreign exchange market introduced in 1994 as the dual exchange rate system was abolished (Yang et al., 2004). In the mid-2000s, these markets do not play any substantial role for the central bank's liquidity management with the domestic banking sector (BIS, 2003; Ping, 2004).

## 5. Changes in central-bank operating procedures: main drivers

Because financial market regulations were partly designed as monetary policy instruments, the deregulation process is in itself sufficient reason for reform of the operational framework of central banks: as some policy instruments are taken away, others must replace them. Beyond this, the literature and the central banks' own accounts offer five main reasons for the more or less universal reform of central bank operating procedures in industrial countries in the 1980s and 1990s (see, e.g., Mehran et al., 1996, and Forssbäck & Oxelheim, 2003, for elaborations).

*First*, monetary-policy instruments were changed in several benchmark countries in order to adapt the operational frameworks of the respective monetary authorities to new regimes and/or new targets for monetary (and exchange-rate) policy.

*Second*, the financial deepening of the benchmark economies occurred more or less entirely outside the central banks' balance sheets, and therefore reduced the share of the financial system over which monetary authorities could exert direct control. The result was an increasing need for *indirect* ways to exercise control over the non-monetary components of the money supply (price-oriented as opposed to quantity-oriented instruments).

A *third* factor relates both to the expansion and diversification of financial markets domestically and to the increasing international integration of financial markets. Greater interest-rate flexibility and narrowing differentials between rates of return in different currencies gave rise

<sup>11</sup> As an illustration, Green (2005) reports that the mispricing by the market of a long-term government bond issue made underwriters unable to resell the bonds without incurring major losses, forcing the PBC to step in and buy a large portion of the issue—effectively amounting to central bank financing of the government.

<sup>12</sup> By 1987, the National Bank's holdings of currency swap contracts amounted to approx. half of its foreign-currency assets, which in turn amounted (together with gold) to almost 90% of its total assets. Roughly that situation remained until 1998, when the National Bank began to broaden its arsenal of instruments (Banque Nationale Suisse, *Bulletin Trimestriel* 4, December, 1999). Also see Zurlinden (1996).

to the need for instruments whereby liquidity (and thereby interest rates) could be managed more *flexibly* in time and in magnitude, and with a greater measure of *accuracy* than that offered by, say, discounting, interest-rate controls, and lending ceilings.

*Fourthly*, the increasing importance of *expectations* in a world of free financial markets favored the adoption of instruments better suited for *signaling* the central bank's monetary policy stance.

A *fifth* broad category of reasons relates to the wish more generally (on the part of monetary authorities) to stimulate money-market activity and improve monetary-policy transmission, and to achieve a clearer separation of monetary policy implementation from government-debt management, and from other social-policy goals (favoring certain sectors in the economy by granting access to cheap credit, etc.) which were auxiliary reasons for the imposition of financial-market regulations. Because financial regulations were often of a multiple-purpose variety, and because the central bank was typically responsible for the implementation of the regulation policy, the distinction between monetary policy and other 'types' of policy had previously not always been very clear-cut.

Do these five reasons apply to the Chinese situation today? The simple answer is maybe, but not generally. The objectives of monetary policy remain manifold and not necessarily compatible, and the priorities between different goals are unclear – in other words, no major regime shift has taken place; the financial system – as we have seen – is still underdeveloped, and financial intermediation beyond the explicit or implicit control of the central bank is limited; as a result of the former, and due to the remaining financial repression, the role of expectations is still limited. Reasons three and five, however, deserve closer attention in the Chinese case. There *is* a need for more flexible and accurate instruments, and it *is* a declared objective of the PBC to stimulate money market activity and improve monetary policy transmission. The reason is – simply, and in parallel with several of the benchmark countries – that monetary policy presently is ineffective (see Ping, 2004, among others). The reason it does not work, however, is not obviously the same. In the next session, we analyze sources of fluctuations in the liquidity of the Chinese banking system and the effects of Chinese monetary policy against the backdrop of the experience of our benchmark countries.

## 6. Determinants and effects of Chinese monetary policy operations in historical international comparison

In order to analyze the sources and effects of liquidity fluctuations in China we construct the following stylized balance sheets for the PBC and a number of benchmark central banks based on the actual published balance sheets:<sup>13</sup>

$$\text{NFA} + \text{NLG} + \text{NLB} + \text{ONA} = \text{CIC} + \text{BR}, \quad (1)$$

where NFA = net foreign assets; NLG = net lending to the government; NLB = net lending to banks; ONA = other net assets; CIC = currency in circulation; and BR = bank reserves.

The sum of the components on each side of the equality is the monetary base. Differencing gives the possibility to analyze the contributions of the various components to net changes in the liquidity of the banking system. The changes in the components are scaled by the average size of the monetary base over each sample period (in the case of the moving average time series for

<sup>13</sup> The framework for analysis is due to Borio (1997); for a more detailed analysis of the balance sheet of the benchmark central banks, see Forssbäck and Oxelheim (2003).

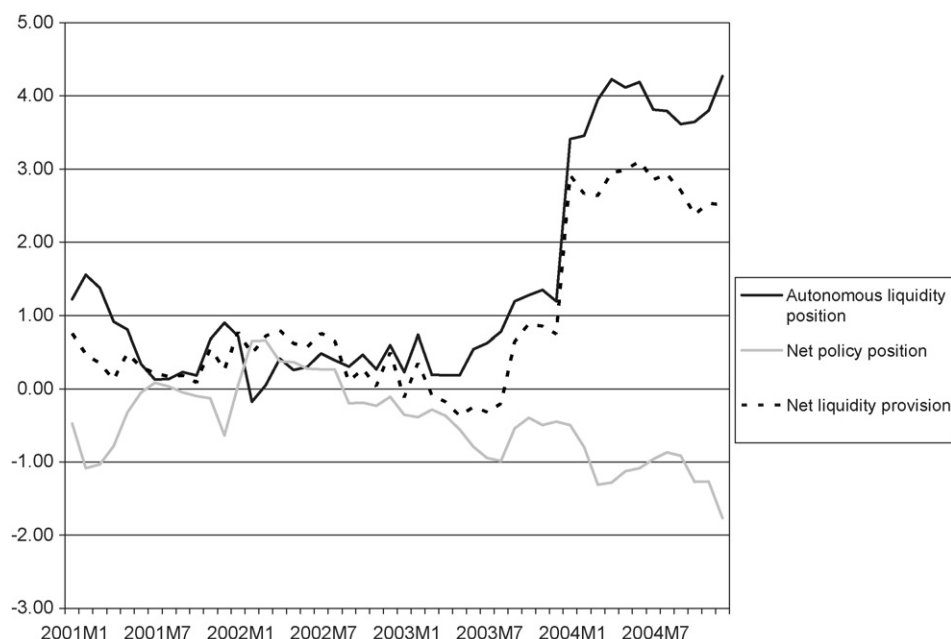


Fig. 3. Autonomous position, policy position, and net liquidity provision in China (in per cent of monetary base; 12 month moving averages, 2001–2004). *Source:* calculations based on data from the People's Bank of China.

China in Figs. 3 and 4, over the 12 preceding months), in order to allow for comparisons over time and across countries.

Define the percentage *autonomous liquidity position* at time  $t + i$ ,

$$ALP_{t+i} = \frac{(\Delta NFA + \Delta NLG + \Delta ONA - \Delta CIC)_{t+i}}{(1/T) \sum_{j=0}^{T-1} (CIC + BR)_{t-j}}, \quad (2)$$

where  $T$  is the number of observations in each sample period (the number of observations over which the scaling factor is averaged), and  $i$  can be zero, positive, or negative, depending on the temporal relationship between a particular observation and the scaling factor.

Correspondingly, let the percentage *net policy position* at time  $t + i$  be defined by

$$NPP_{t+i} = \frac{\Delta NLB_{t+i}}{(1/T) \sum_{j=0}^{T-1} (CIC + BR)_{t-j}}. \quad (3)$$

The sum of the contribution of the autonomous factors and the policy position constitutes *net liquidity provision*, which – in accordance with identity (1) – must then also be defined as

$$NLP_{t+i} = \frac{\Delta BR_{t+i}}{(1/T) \sum_{j=0}^{T-1} (CIC + BR)_{t-j}}. \quad (4)$$

The policy position, finally, can then be broken down into its various components (such as standing facilities, various types of open market operations, etc.) depending on the degree of detail provided by the respective central bank's balance sheets. When it comes to the PBC, this

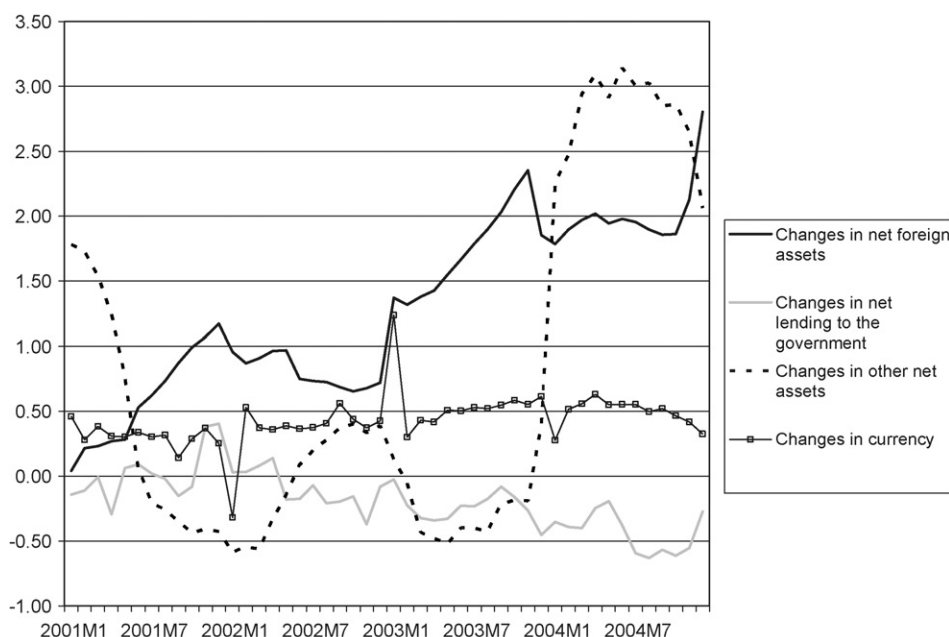


Fig. 4. Contributions to autonomous liquidity position in China (in per cent of monetary base; 12 month moving averages, 2001–2004). *Source:* calculations based on data from the People's Bank of China.

degree is not very high, and it basically just separates between claims on (different types of) financial institutions on the asset side and debt securities issuance on the liabilities side. For some of the European countries' central banks, open market operations (OMOs) in the form of foreign exchange operations were not identifiable. The distinction between standing facilities and OMOs is therefore not entirely watertight in our sample, and it is even likely that the OMOs component is somewhat underestimated as a general rule.

Table 6 provides a summary, where the autonomous and policy positions and their various components are averaged over the relevant time periods.

Figs. 3–5 give a more detailed picture of the Chinese case. Fig. 3, first, shows that net liquidity follows the autonomous determinants of liquidity infusion closely, whereas policy generally works in the opposite direction. Both the autonomous position and the policy position became markedly larger as of the beginning of 2003, resulting in a rather sharp increase in net liquidity.

Of the autonomous factors (Fig. 4), changes in cash and in net lending to the government appear relatively stationary, whereas the net foreign assets contribution describes a clear and rather sharp upward trend. The by far most volatile contribution, however (in contrast to the benchmark countries), is that of changes in other net assets. The hike in this series after the end of 2003 is wholly due to a relatively large increase in the balance sheet item 'other assets' between November and December 2003, and – particularly – to the disappearance from the liabilities side of *all* 'savings deposits of non-financial institutions' between December 2003 and January 2004. No explanation is offered in the PBC's quarterly monetary policy reports for the relevant time period(s), so the interpretation remains open.

Fig. 5A and B, finally, illustrates an attempt to trace the development over time in the use of different types of monetary policy instruments. In the figure the solid lines show the variability

Table 6

Sources of liquidity fluctuations, summary (average positions over the respective time periods<sup>a</sup> as percentage of the monetary base; variability of positions shown as standard deviations in parentheses; for the benchmark countries, the variability in the positions is shown as the *average* of country-by-country standard deviations)

	China 2000–2004	7 benchmark countries, early 1980s	8 benchmark countries, late 1980s	10 benchmark countries, late 1990s
1. Autonomous position (=4 + 5 + 6 – 7)	1.76 (4.57)	0.56 (10.11)	0.05 (8.69)	–1.01 (10.24)
2. Policy position (=8 + 9)	–0.63 (2.33)	–0.38 (10.12)	0.75 (8.00)	0.85 (11.49)
3. Net liquidity (=1 + 2)	1.13 (4.21)	0.18 (4.34)	0.79 (5.78)	–0.16 (7.64)
Breakdown of autonomous position				
4. ΔNet foreign assets	1.37 (1.69)	0.84 (5.59)	0.26 (6.43)	0.16 (7.95)
5. ΔNet lending to government	–0.14 (2.12)	1.01 (8.94)	0.21 (7.72)	–0.57 (7.16)
6. ΔOther net assets	0.78 (3.52)	–0.88 (3.49)	–0.27 (2.80)	–0.57 (2.48)
7. ΔCurrency in circulation	0.24 (3.92)	0.39 (2.07)	0.15 (1.88)	0.02 (2.10)
Breakdown of policy position				
8. Standing facilities	–0.18 (1.90)	–0.31 (10.99)	0.37 (5.16)	–0.03 (1.26)
9. Open market operations	–0.44 (1.39)	–0.06 (1.04)	0.28 (4.73)	0.73 (10.86)

<sup>a</sup>The following periods apply:

China: Jan. 2000–Dec. 2004 (monthly data).

7 benchmark countries, early 1980s: Belgium, Jan. 7, 1980–June 30, 1980 (weekly data); Denmark, Jan. 1979–Dec. 1980 (monthly data); Finland, Jan. 8, 1980–May 30, 1980 (weekly data); Ireland, Dec. 1979–Feb. 1981 (monthly data); Netherlands, Jan. 5, 1981–May 25, 1981 (weekly data); Portugal, Jan. 1980–Dec. 1981 (monthly data); Sweden, Jan. 1980–Oct. 1981 (monthly data).

8 benchmark countries, late 1980s: Austria, Oct. 31, 1989–Jan. 31, 1990 (weekly data); Belgium, Jan. 2, 1989–June 26, 1989 (weekly data); Denmark, Jan. 1988–Dec. 1989 (monthly data); Finland, Jan. 6, 1989–May 31, 1989 (weekly data); Ireland, Dec. 1988–Jun. 1990 (monthly data); Netherlands, Oct. 2, 1989–Feb. 26, 1990 (weekly data); Norway, Portugal, Jan. 1988–Dec. 1989 (monthly data); Sweden, Jan. 1987–Oct. 1988 (monthly data).

10 benchmark countries, late 1990s: Austria, Jan. 7, 1998–May 31, 1998 (weekly data); Belgium, Jan. 5, 1998–May 29, 1998 (weekly data); Denmark, Dec. 1997–Nov. 1998 (monthly data); Finland, Dec. 31, 1997–May 29, 1998 (weekly data); Ireland, Dec. 1997–Dec. 1998 (monthly data); Netherlands, week 1, 1998–week 25, 1998 (weekly data); Norway, Dec. 1997–Dec. 1998 (monthly data); Portugal, Jul. 1996–Jun. 1998 (monthly data); Sweden, Dec. 31, 1998–May 31, 1999 (weekly data); Switzerland, Sept. 30, 1999–Apr. 10, 1999 (weekly data).

Sources: The figures are calculated on the basis of data from the respective central banks' balance sheets, mostly taken from annual and/or interim reports; in some cases obtained as spreadsheet documents directly from the central bank.

(measured as 12-month rolling standard deviations) over 4 years (2001–2004) of the PBC's policy position due, respectively, to standing facilities (panel A) and open market operations (panel B). As a comparison the figure also reproduces the average corresponding variabilities for the included benchmark countries at three points/periods in time (cf. Table 6, rows 8 and 9). A 'corridor' of the cross-country variation in these variabilities is also added. We can see that the trend-wise development over time for the benchmark countries clearly shows the gradual demise of standing facilities and corresponding rise of OMOs as main policy instrument over the 20-odd year period.

The considerably shorter time for which the Chinese development is studied shows no similar clear trend. Instead, the variability in the policy position of the PBC is comparatively low and stable, and at the lower standard deviation bound as compared to the benchmark countries. A tentative conclusion would be that OMOs in China are not yet very extensive in international comparison, possibly reflecting the relatively underdeveloped state of financial markets in general and money markets in particular. A further conclusion of the overall analysis – one that



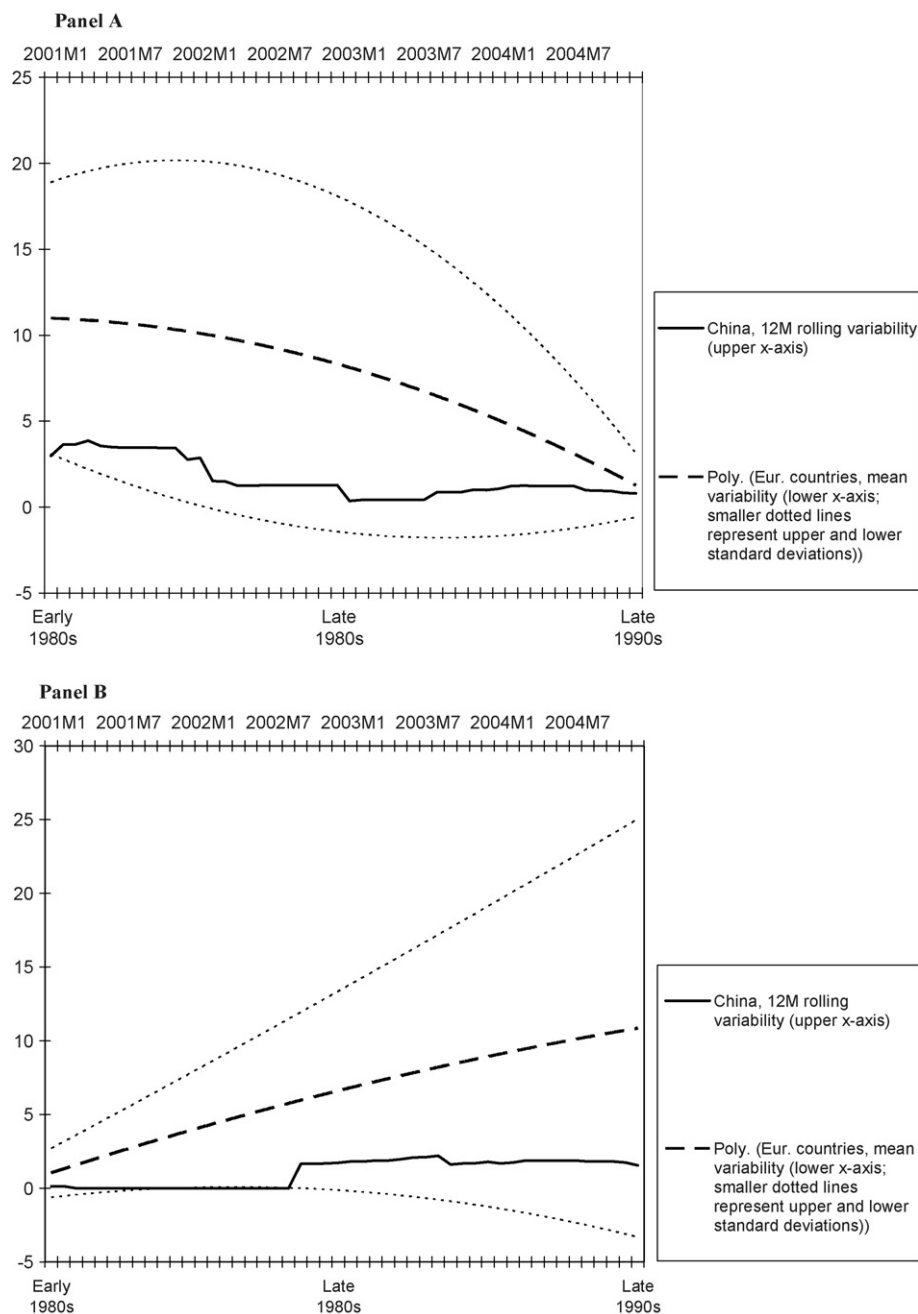


Fig. 5. Variability of policy position in China and the benchmark countries China (12 month rolling standard deviations, 2001–2004, upper *x*-axis) and benchmark countries (three time periods between early 1980s and late 1990s, lower *x*-axis). Panel A: Variability in policy position due to standing facilities. Panel B: Variability in policy position due to open market operations. Sources: See Table 6.



would tend to support previous analyses (e.g., Green, 2005; Ping, 2004) – would be that the policy actions of the PBC in general are comparatively small and ineffectual relative to the effects of autonomous determinants of liquidity and to the overall size of the monetary base. Any conclusion, however, about the form and relative importance of the PBC's various operations has to be delivered with the caveat of what was mentioned above, viz. that the separation between different kinds of operations in the PBC's balance sheets is not very transparent. A more general remark about the direction and speed of the development is that in the perspective of a 20-year development in Europe, it is of course not surprising that China still has some way to go, and appears to still remain in the early stages of this development.

## 7. Effectiveness of monetary policy operations—discussion

In this section we present some conclusions regarding the effectiveness of monetary policy operations during the financial transition period of our benchmark countries based on Forssbäck and Oxelheim (2003) and discuss the relevance of these in terms of Chinese monetary policy options. *First*, autonomous factors are often the most important sources of liquidity fluctuations in the domestic money market. The central bank is frequently 'unsuccessful' in offsetting these influences other than imperfectly. In short, this means that the job of the central bank is primarily to forecast and offset factors outside its direct control that influence the domestic market, and only then (marginally) to 'steer' the money market.<sup>14</sup> The two most important autonomous sources of fluctuation in money-market liquidity (and thus the major factors that the central banks have to counter in their policies) are net foreign assets and net lending to the government. The net-foreign-assets portion of the autonomous position should – all else equal – be more variable in countries with far-reaching exchange-rate commitments, where the central bank has been active in the foreign-exchange market or in other ways made more extensive use of foreign-exchange reserves to uphold that commitment. However, Forssbäck and Oxelheim (2003) instead find that net foreign assets are a more important source of liquidity fluctuation in 'weak-currency' countries (regardless of exchange-rate regime), and a less important one in 'hard-currency' countries.

This leads up to the *second* main conclusion: non-credible policy (for example exchange rate) commitments lead to ineffective central bank operations. If the central bank's target variables are influenced to a great extent by factors beyond its control, then not only is the effectiveness in achieving the desired policy goals impeded, but so also is its choice among the range of instruments at its disposal, as well as its capacity to influence the overall structure of the money market.

Thus, *thirdly*, autonomous factors affect central bank instruments and money market structure. On a more general level, this emphasizes the need for *consistency* in the policy pursued.

The consistency issue links the third conclusion to the *fourth* one. Economic independence of central banks leads to more effective central bank operations and vice versa. If economic independence of the central bank can be approximated by the influence on liquidity fluctuations of net lending to the government, then the central bank's ability to effectively anchor money market interest rates and to stabilize the exchange rate, is increasingly impeded the more it has to counter liquidity fluctuations resulting from the obligation to fulfill other public-policy goals (such as government financing).

<sup>14</sup> One potentially complicating factor here is that if we believe that the central bank's policy measures can in and of themselves give rise to 'innovations', we have an endogeneity problem of the 'exogenous' factors: the central bank influences these factors *indirectly* through its own actions.

Below, we use these four conclusions in order to structure a discussion about the roots of the present ineffectiveness of Chinese monetary policy.

Based on conclusion 1 above: Large capital inflows and resulting build-up of foreign exchange reserves has been the most important source of liquidity in the early 2000s. Base money growth increased trend-wise from 2% to 17% between 1998 and 2003 (Goldstein, 2004). Foreign exchange reserves as a share of GDP increased from 15% in the first quarter of 2001 to 40% at the end of 2004 (Goldstein, 2004). The PBC's operations during the last few years have largely been geared toward offsetting these undesired money-supply effects of capital inflows.

Estimations by Green (2005) show that the PBC's open market operations are almost perfectly correlated with capital inflows. Yet, Green reports that the operations are able to sterilize less than 50% of the effect of these inflows on the money supply. According to the estimates, between mid-2004 and early 2005, foreign exchange inflows added cumulatively to the money base in the order of RMB 100 bn per *month*, indicating an annual growth rate of around 70%. The asymmetry of capital controls giving a bias toward net capital inflows has exacerbated this problem.

Based on conclusions 2 and 4 above: The multiple, and often incompatible, goals of monetary policy – stable dollar exchange rate, inflation, growth, employment, financial stability, etc. – are evidently a major problem for Chinese monetary policy. The very recent problems of the PBC to make monetary policy 'bite' are clearly influenced by the exchange rate regime, for example. Given the level of financial risk in the economy, the possibility of misleading interest rate levels, and other factors, it is not obvious that the currency is/was under-valued (for discussions, see, e.g., Eichengreen, 2005; Goldstein, 2004; Prasad et al., 2005); whether it was or not, however, it would appear as though a revaluation came to be expected for at least 2 years before the modest revaluation was finally implemented in July 2005. This partially explains the troubles of the PBC of conducting a monetary policy which was much too expansionary for domestic conditions, but still not expansionary enough to keep capital inflows at bay (the share of non-FDI capital inflows also significantly increased during this period; see BIS, 2003, 2005; Prasad & Wei, 2005; Van der Linden, 2005). In short, the exchange rate goal was non-credible, which worsened the conditions for monetary policy operations. More generally, an exchange rate stability goal increasingly undermines monetary policy autonomy as capital controls erode, which – by definition – compromises some or several of the other goals. The internal deregulation of the financial sector and the full market access of foreign banks (implying the possibility of interest arbitrage between foreign and the domestic Chinese markets) will further erode the remaining restrictions on the capital account (Liu, 2005).

Not just non-credible exchange rate goals disturb monetary policy; another example may be the attempts to simultaneously achieve the goals to safeguard financial stability and prop up employment in the publicly owned manufacturing sector. Large state-owned enterprises are squeezed by remaining commitment to production planning, and are unable to compete with the private sector. State-owned banks are forced to finance state-owned enterprises (SOE) with successively new loans (which are frequently not repaid), in order to avoid large-scale unemployment and social unrest. Remaining political influence over the banking sector, lack of incentives for adequate credit assessment and monitoring (because of the seemingly unlimited willingness of the government to bail out banks) and lack of legal enforcement of financial contracts, as well as general property-rights and transparency issues, lead to massive mis-allocation of savings (2/3 of savings are channeled to the public sector through the banking system) and to the accumulation of non-performing assets on banks' balance sheets (estimates of non-performing loans range from 20 to 50% of the largest banks' total loan portfolios, or 30 to 80% of GDP; see Van der Linden, 2005).

Based on conclusion 3 above: At least two more reasons for excess liquidity in the Chinese banking system exist. First, the financial system in general is underdeveloped and unable to absorb the large monetary overhang in the economy; i.e., there is a lack of alternative investments, especially for short-term funds (see money market structure, above). Second, there exist *de facto* lending restrictions. There is much to suggest that more or less official administrative control of the quantity and direction of banks' lending is currently the most important instrument at the PBC's disposal to contain money supply growth. At the same time, these practices are counter-productive to the longer-term interests of the PBC to improve the transmission mechanism to the extent that they leave banks awash with liquidity.

## 8. Concluding remarks

Up to the late 1970s and early 1980s, money markets (as well as the financial sectors in general) in our benchmark countries were typically underdeveloped and highly regulated. Since then, politics – through financial sector deregulation, government debt policy, and de-politicization of monetary policy – has been one of the main determinants of money-market development.

We argue that financial deregulation as an 'active' or 'passive' response of politicians to developments beyond their control, the need to find new and more flexible sources of government borrowing, and the need to establish a forum for effective monetary-policy implementation—go a long way to explain the significant cross-country differences among our benchmark countries in terms of money-market size and structure, as well as the timing and direction of various policy decisions and outcomes. A main observation is also that a policy decision, once taken, cannot easily be reversed, as the development over time may be characterized as a continuous interplay between policy decisions and market outcomes. The development process thus becomes highly *path dependent*, and largely reflects political *ad-hoc* decisions, which are often, in themselves, responses to market developments. There are also considerable potential spill-over effects from other policy areas. Therefore, a gradualist approach and 'controlled' financial deregulation like in China is difficult, because – from the point of view of the policy purpose—financial market regulations are complementary (doing away with one undermines the purpose of another), and – more generally – 'controlled' and 'deregulated' are in some sense mutually exclusive.

Chinese monetary policy is largely characterized by this type of spill-over effects, and is full of inherent inconsistencies and conflicts of interest, giving rise to a large degree of discretionary, *ad hoc* policy measures. As a consequence, China will only be able to partially emulate other countries' experiences, but outcomes will reflect exogenous factors affecting its policy and policy responses to those factors, if anything is to be learned from the benchmark countries we study here, where central banks have often had a decisive influence on money-market development. The (possibly) good news is that – according to historical comparison – China remains at an early stage of the development, in terms of basic 'meters' of all the three processes characterizing the path from regulation-based to market-based monetary policy: financial deregulation, market growth, and the intensity of open market operations. The bad news is that the policy tools presently at the authorities' disposal are increasingly blunt and ineffectual.

Some benchmark countries have changed the basic monetary-policy regime one or more times during the period studied (Finland, Greece, Portugal and Sweden are the most obvious examples,

excepting the changeover to EMU). Changes in monetary-policy conditions and operations are correspondingly big in these countries. Among the benchmark countries that essentially stuck to the same policy regime (exchange-rate targets, mostly) throughout the 1980–1998 period, some saw less dramatic changes in the indicators used to analyze monetary policy (Austria, Belgium), while in others, the changes were of average magnitude (Netherlands) or comparatively big (Denmark).

A few lessons (or policy recommendations) for China directly related to the money market could be the following.

- A general recommendation and a clear lesson from the European experience is to focus objectives as well as operative targets of monetary policy.
- One part of this increased focus could be increased flexibility of the exchange rate: As explained above, whether the RMB is under-valued or not, the rigid exchange rate (the *de facto* effects of the modest revaluation and move to a ‘managed float’ in July 2005 remain to be seen) has undermined attempts so far to foment broader and deeper financial markets, not least a functioning money market, and is directly counter-productive to the effectiveness of the PBC’s market operations. With the so-far rigid currency regime, the absence of adjustment to capital movements on the exchange rate effectively implies that adjustments are being ‘passed on’ to a domestic financial system which is not developed enough to handle it. A more flexible exchange rate would also stimulate the development of the foreign-exchange market, including a market for FX derivatives linked to the domestic money market.
- The banks’ continued lack of *de facto* independence as economic entities is distorting the financial intermediation process as well as the PBC’s own capacity for effectively implementing policy. For market operations to work, there must be a market of independent market participants acting on the basis of market criteria—i.e., the PBC must not be able to use its political clout to force the banks to respond to various measures when in fact they have no economic incentive to do so. The privatization of the state-owned banks may work in the right direction to the extent that the government just retains a small stake in the banks and by that reduces its influence.
- Creation of short-to-medium term securities market based on *bank* liabilities, such as a CD market; this could help banks clean up their balance sheets (instead of piling up liquidity or channeling it into speculative fixed investments), as well as providing alternative investments to drain the money market of excess liquidity.
- Create a viable treasury bill (short-term government debt) market; with the present continued weakness of the banking system, it is unlikely that a CD market could function as a benchmark segment for the short end of the debt market.

It should be noted that many of these solutions rely on more broad-based institutional reforms to work properly. China is still largely a ‘command economy’, which – whether that command is explicitly or implicitly exerted – eliminates the proper incentives to reach market clearing outcomes in whatever market. Imbalances will persist without a firmer and more unconditional commitment to market principles.

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