V. The road to a more resilient banking sector

The financial system is gradually recovering from the crisis, and banks are moving forward in strengthening their balance sheets, albeit at an uneven pace across countries. The future stability of the system depends on banks' completing this process. It also depends on policymakers' completing the regulatory reform agenda and ensuring its consistent implementation across jurisdictions.

Although bank profits have generally recovered from the low levels of the crisis, earnings capacity is still weak and unreliable in a number of countries. In adapting their business models to the post-crisis environment, successful banks will be those that purge crisis-weakened assets, convincingly repair their balance sheets and establish a reliable earnings base.

The progress to date in regulatory reform is providing the foundations for a more resilient financial system. New standards address gaps identified in the crisis and more general weaknesses in the financial system. Success hinges on rapid implementation, however, and so international standard setters are paying increased attention to progress in individual jurisdictions.

In ensuring systemic stability, the prudential framework must address the increasingly intricate organisation of financial firms, and it must stay abreast of the growing complexities of financial transactions and risk assessment. Policies that simplify the organisational structure of institutions can deal with only one aspect of the problem. A more general and effective approach sets prudential capital and liquidity requirements that are aligned with bank risk.

Given the uncertainties of risk measurement, simple gauges of bank solvency risk used in combination with more elaborate risk-sensitive metrics can improve risk capture. Regulation can also improve risk assessment by setting higher standards of quality for banks' internal risk models. Finally, the supervisory framework can strengthen market discipline by requiring more specific disclosures of the characteristics and performance of those internal models.

Capital, profitability and balance sheet repair

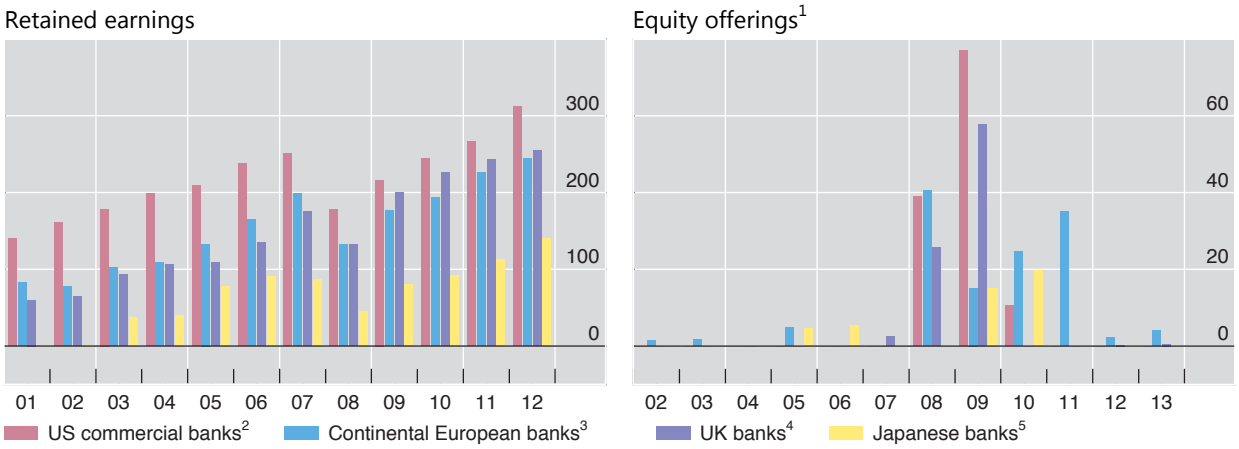
The need to repair balance sheets has dominated banking sector developments in recent years. Banks' financial strength deteriorated abruptly after the prolonged financial boom turned to a bust and the economy entered a balance sheet recession. The disruption to financial intermediation highlighted the need to restore bank solvency and profitability. The repair of banks' balance sheets involves the recognition of legacy losses, the disposal of impaired assets, and the build-up of robust capital buffers supported by a reliable earnings capacity.

Banks have made progress in charging off bad loans, with US banks generally leading their European peers. Uncertainty about asset quality remains a greater concern in Europe. The forthcoming asset quality review and stress tests of European banks will be critical in ensuring completion of the loss recognition and balance sheet repair process, which will also require that appropriate backstops be put in place.

At the same time, banks worldwide have improved their capital ratios at a faster pace than set out in the Basel III phase-in arrangements. In the 12 months to mid-2012, the average Common Equity Tier 1 (CET1) capital of large, internationally

Balance sheet repair

In billions of US dollars — Graph V.1



[1] Total rights offerings. [2] Bank of America, Citigroup, JPMorgan Chase and Wells Fargo. [3] Banco Santander, BNP Paribas, Commerzbank, Credit Suisse, Deutsche Bank, UBS and UniCredit. [4] Barclays, HSBC and Lloyds TSB Group. [5] Mitsubishi UFJ Financial Group, Mizuho Financial Group and Sumitomo Mitsui Financial Group.

Sources: Bloomberg; BIS calculations.

active banks had risen from 7.1% of risk-weighted assets to 8.5%. It was thus considerably higher than the 2019 minimum of 4.5% CET1 plus a 2.5% conservation buffer.

During the same period, banks still below the 2019 benchmark reduced their capital shortfall by almost 60%, to €208.2 billion. That remaining gap is roughly equivalent to half of their collective profits (after tax and before distributions) for the period. For a group of smaller banks, the corresponding capital shortfall was €16 billion, or 70% of the same profit measure.

Retained earnings are at present the main source of capital for banks. A stable earnings environment would be instrumental in closing the gap in required capital before the 2019 deadline. Retained earnings of major global banks have generally risen above pre-crisis levels (Graph V.1, left-hand panel) and have made a major contribution to capital, although in many cases with the help of volatile trading income. By contrast, new capital offerings have played a lesser role (Graph V.1, right-hand panel). In the euro area, sovereign debt problems have been seen as potentially limiting the ability of lenders there to access new capital.

Stable profits will be critical to the resilience of the banking sector. Profits have rebounded from the lows registered during the financial crisis, but recovery remains uneven across countries (Table V.1). In the United States, pre-tax bank profits improved further last year, in large part because of a fall in loan loss provisions. However, the combination of accommodative monetary policy and competitive lending conditions continued to squeeze net interest margins. The profits of banks in China and India increased substantially, owing to higher net interest margins and strong loan growth. In Australia, Canada and Sweden, banks consolidated the gains made in previous years. Profitability in Russia improved mainly because of a sharp drop in loan loss provisions.

Profits in other jurisdictions remained lacklustre. In the euro area, sovereign debt strains compromised asset quality, while a stagnating economy lowered revenues. Non-performing loans increased, especially in Italy and Spain, leading to

Profitability of major banks[1]

As a percentage of total assets — Table V.1

Country[2]	Pre-tax profits			Net interest margin			Loan loss provisions			Operating costs[3]		
	2000–07	2008–11	2012	2000–07	2008–11	2012	2000–07	2008–11	2012	2000–07	2008–11	2012
Australia (4)	1.58	1.07	1.18	1.96	1.81	1.82	0.19	0.33	0.21	1.99	1.20	1.19
Canada (6)	1.03	0.80	1.07	1.74	1.57	1.65	0.24	0.27	0.19	2.73	1.87	1.77
France (4)	0.66	0.29	0.19	0.81	0.96	0.90	0.13	0.26	0.20	1.60	1.10	1.06
Germany (4)	0.26	0.06	0.09	0.68	0.81	0.83	0.18	0.17	0.13	1.38	1.10	1.33
Italy (3)	0.83	–0.03	–0.06	1.69	1.86	1.65	0.40	0.60	0.95	2.27	1.83	1.63
Japan (5)[4]	0.21	0.36	0.56	1.03	0.92	0.84	0.56	0.19	0.07	0.99	0.84	0.75
Spain (3)	1.29	0.94	0.08	2.04	2.31	2.36	0.37	0.81	1.49	2.29	1.58	1.73
Sweden (4)	0.92	0.56	0.68	1.25	0.93	0.92	0.05	0.18	0.09	1.34	0.88	0.81
Switzerland (3)	0.52	–0.05	0.03	0.64	0.52	0.60	0.05	0.06	0.01	2.39	1.82	2.02
United Kingdom (6)	1.09	0.19	0.20	1.75	1.14	1.08	0.31	0.59	0.34	2.02	1.24	1.37
United States (9)	1.74	0.42	0.96	2.71	2.53	2.34	0.45	1.23	0.41	3.58	3.00	3.06
Brazil (3)	2.23	1.61	1.50	6.56	4.77	4.42	1.24	1.42	1.46	6.21	3.79	3.33
China (4)[5]	1.62	1.56	1.83	2.74	2.32	2.39	0.31	0.30	0.25	1.12	1.02	1.01
India (3)[6]	1.26	1.34	1.45	2.67	2.35	2.90	0.88	0.46	0.60	2.48	2.52	2.25
Russia (3)	3.03	1.46	2.39	4.86	4.70	4.09	0.87	1.90	0.36	4.95	2.72	2.78

[1] Values for multi-year periods are simple averages. Cross-country comparisons may be limited by differences in accounting standards. [2] In parentheses, number of banks included in 2012. [3] Includes personnel and other operating costs. [4] Excludes personnel costs; 2012 figures for one of the banks are estimated on the basis of half-year results. [5] Data start in 2007. [6] Data start in 2002.

Sources: Bankscope; BIS calculations.

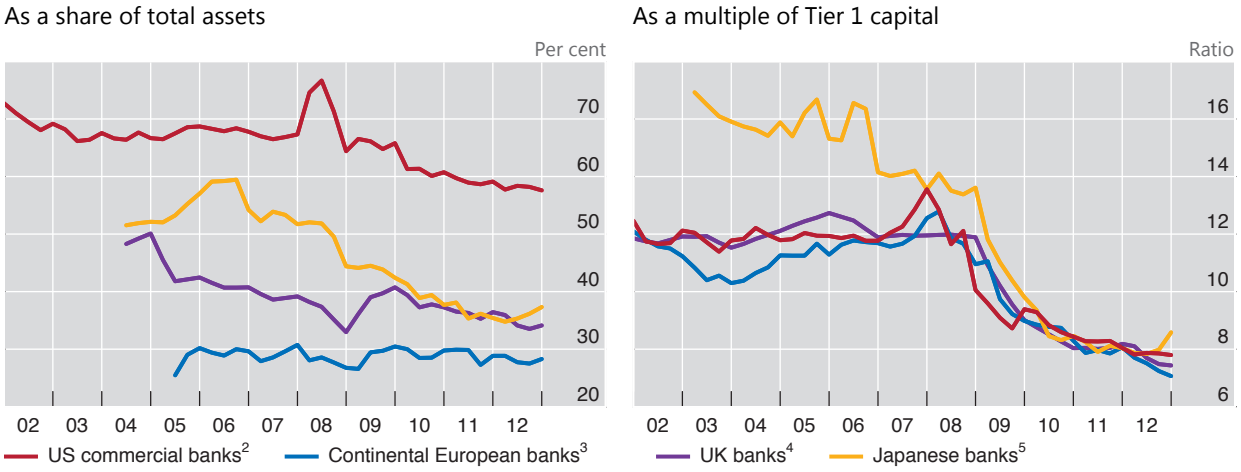
a sharp rise in loan loss provisions. Profits in Brazil continued to slide, in line with larger loan loss provisions and despite lower costs.

Since the onset of the crisis, banks have also been improving their regulatory capital ratios by reducing risk-weighted assets (Graph V.2, left-hand panel) through a combination of divestments and portfolio reallocations. The process broadly stabilised in 2012 for most major banks. Global banks have reportedly sold about $720 billion in assets since the start of 2007, with European banks accounting for more than half that amount.[1] The crisis in the euro area has weighed heavily: European banks have been net sellers of assets, while banks from the United States and other advanced economies have been net buyers. At the same time, banks have increased their holdings of low risk-weight assets, including government-guaranteed debt. By so doing, however, they have become more sensitive to changes in the valuation of government debt.

Moreover, the continued reduction in risk-weighted assets through the post-crisis period suggests that impaired assets have still not been fully recognised. Market commentary has suggested that much of this trend reflects banks' optimisation of risk-weighted assets – the redesign of transactions in order to lower

[1] See eg McKinsey Global Institute, "Financial globalisation: retreat or reset?", *Global Capital Markets 2013*, March.

Risk-weighted assets[1] Graph V.2



[1] Values are averages weighted by total assets. Cross-country comparisons may be limited by differences in accounting standards. [2] Bank of America, Citigroup, JPMorgan Chase and Wells Fargo. [3] Banco Santander, BNP Paribas, Commerzbank, Credit Suisse, Deutsche Bank, UBS and UniCredit. [4] Barclays, HSBC and Lloyds TSB Group. [5] Mitsubishi UFJ Financial Group, Mizuho Financial Group and Sumitomo Mitsui Financial Group.

Sources: Bankscope; Bloomberg; company financial reports; BIS calculations.

capital requirements – rather than a genuine increase in loss absorption capacity. Such window-dressing raises questions about the use of internal risk assessments for the determination of regulatory capital requirements, as discussed below.

The progress in balance sheet repair has also resulted in a steady decline in leverage, especially for those banks that have made considerable progress in the resolution of legacy assets (Graph V.2, right-hand panel). The pressure from regulators and investors has been a key factor in driving leverage down.

Balance sheet restructuring is necessary to improve banks' willingness and ability to provide new lending. By the same token, it lays the basis for a stronger economic recovery. In fact, the cost and availability of credit are more favourable in those jurisdictions where banks have been most successful in rebuilding capital.

Progress with global regulatory financial reform

In 2009, policymakers set an ambitious regulatory reform agenda to address weaknesses highlighted by the financial crisis. They aimed to set the financial sector on more robust foundations and to support sustainable economic growth by reducing the risk of future crises.[2] The agenda includes tightening the requirements for capital and liquidity buffers for banks, improving the resolvability of financial firms, enhancing the transparency and resilience of the infrastructure of the over-the-counter (OTC) derivatives market, and addressing the risks posed by shadow banking, broadly understood as credit intermediation involving entities outside the regular banking system. With many elements of the new standards already in place, emphasis is gradually shifting to monitoring the pace of implementation.

[2] For detailed information on financial reform initiatives involving the BIS, see the chapter "The BIS: mission, activities, governance and financial results".

The Basel III framework, developed by the Basel Committee on Banking Supervision, is a central element of the reform agenda. It sets significantly higher requirements for loss absorption, puts greater emphasis on a higher quality of capital, and better captures the full scope of bank risk. Innovative aspects of the framework include a leverage ratio, a capital overlay for systemically important banks, a countercyclical capital buffer and standards for a liquidity coverage ratio (LCR). The final version of the LCR was published in January 2013.

The LCR promotes the resilience of banks by ensuring that they maintain an adequate stock of high-quality liquid assets to withstand reversals in funding conditions. The LCR requirements are being phased in, like the new capital adequacy requirements, to support the gradual strengthening of the banking system and the supply of finance for economic activity. Work is progressing on other elements, including a net stable funding ratio, the review of trading book rules, the treatment of securitisation, and large exposures.

A globalised banking system will reap the benefits of the framework only through its full, timely and consistent implementation across all jurisdictions. Basel Committee members have agreed to assess both the alignment of national regulations with the Basel III standards and the consistency of the framework's outcomes on banks. The Committee's implementation monitoring programme assesses the timeliness of adoption of Basel III; domestic regulatory consistency; and the consistency of outcomes, including banks' calculations of risk-weighted assets.

Weaknesses in the resolution procedures for banks at the point of failure, especially for those with more complex business models and international operations, significantly increased the costs of the global crisis. Resolution schemes that enable authorities to quickly deal with failing financial institutions would reduce spillovers to the financial system and the exposure of taxpayers to losses. The Financial Stability Board (FSB) provided guidance with its November 2011 publication *Key attributes of effective resolution regimes for financial institutions*. The implementation of the FSB guidance is at an early stage. Many countries still need to adopt legislation to enable the efficient resolution of global systemically important banks and other internationally active banks.

Another major area of regulatory reform focuses on financial market infrastructure. The crisis revealed major shortcomings in the post-trade processing of OTC derivatives, notably the inadequate reporting of transactions and an insufficient collateralisation of bilateral counterparty exposures. Commitments to improve standards in OTC derivatives markets have covered three principal areas. First, the centralised clearing of standardised contracts: robust legal and regulatory frameworks that place a central counterparty (CCP) between transacting parties will reduce interconnectedness across the financial system. Second, mandatory reporting of customised transactions: reporting to trade repositories of transactions not channelled through a CCP will improve transparency in OTC markets. Third, non-centrally cleared contracts: these will be singled out and subjected to more exacting prudential capital requirements.

In 2009, the G20 agreed to implement central clearing and electronic trading of standardised derivatives instruments by the end of 2012. Few jurisdictions have met this deadline, but legislative frameworks are in place in key jurisdictions, and some progress has been made in implementing the necessary standards. Market regulators are developing detailed rules and addressing issues of cross-border consistency and applicability.

The reform agenda is also advancing with regard to applying oversight and regulation to the shadow banking system, which provides financial services that complement those of regulated banks. Reforms focused on banks may spur the

migration of certain financial activities to the shadow banking sector, producing a build-up of systemic vulnerabilities in the form of leverage and liquidity mismatches. The FSB has provided policy recommendations and guidance for further regulatory steps aimed at mitigating this risk. Specific areas include money market funds; banks' exposures to shadow banks; and measures to address risks in repurchase agreements and securities lending.

National initiatives on bank structure regulation

Acting parallel to the international regulatory reform process, a number of individual jurisdictions are implementing or considering initiatives on the regulation of bank structure.

The various initiatives involve different ways of separating commercial banking activities – deposit-taking and credit intermediation in the real economy – from the risks inherent in investment banking (see Box V.A). The initiatives have implications not only for the business models of universal banks but also for the effectiveness of the global prudential framework as they interact with international regulatory standards.

The proposals would protect commercial banking directly by shielding it from losses incurred elsewhere. The structural separation that achieves this shielding can itself provide an indirect form of protection for commercial banks by reducing their complexity and, arguably, also their size. Separation also makes them easier to manage, supervise and resolve, as well as more transparent to outside stakeholders. In addition, structural separation may prevent the aggressive risk-taking culture of investment bankers from infecting the more utility-like business of commercial banking. And it can reduce moral hazard because it prevents public sector support of protected activities (deposit guarantees and central bank lending) from indirectly subsidising other business activities.

Structural reform initiatives are not without challenges. Defining and enforcing the lines that separate commercial and investment banking activities is a notoriously difficult task, and it is rendered more so by an increasingly complex financial marketplace. Another challenge is to avoid an unintended shift of intermediation activities outside the perimeter of consolidated supervision. An open question is how structural reform initiatives would interact with each other. In particular, will national differences in structural regulation complicate the supervision and resolution of internationally active banks? Avoiding that outcome puts a premium on international coordination in order to ensure a level playing field.

Structural banking reforms proposed at the national level differ from international regulation, notably Basel III. The former impose constraints on specific activities, while the latter takes banks' business models and structure as given and sets capital and liquidity requirements that depend on the riskiness of the consolidated group. From this perspective, the two approaches can be seen as complementary. Indeed, certain aspects of structural regulation – restrictions on leverage for ring-fenced institutions – may reinforce elements of Basel III.

However, structural regulation could lead to different capital and liquidity requirements for the core banking and trading entities within a single banking group. Although this may be intended, it complicates regulation at the consolidated level. Hence, there are limits to the substitutability between structural reform regulation on the one hand, and capital and liquidity regulation on the other. Restrictions in bank structure may support the stability of individual firms, but their benefits are less clear for the system as a whole. Buffers that are robust to uncertainty and reflect the complexities in risk assessment can help at the level of both the firm and the system.

Box V.A: Recent proposals for the structural reform of banking

Proposals for changing the structure of banking activities are in varying stages of implementation across jurisdictions. They include the Volcker rule (United States); the proposals of the Vickers Report (United Kingdom); and the Liikanen Report (European Union).① The common rationale of these initiatives is to protect financial stability by shielding core functions of commercial banks from losses related to investment banking and securities markets activities. The initiatives vary, however, in their diagnoses and prescriptions.

A stylised comparison of selected structural reform proposals

Table V.A

	Volcker: institutional separation	Liikanen: subsidiarisation	Vickers: ring-fencing
Permissible activity and structure	Remove certain investment activities from bank holding companies	Proprietary and higher-risk trading activity have to be placed in a separate legal entity	Structural separation of activities via a ring fence for retail banks
Deposit-taking institution			
• deal as principal in securities and derivatives	No	No	No
• invest in hedge funds and private equity	No	No	No
• engage in market-making	Yes	No	No
• provide underwriting	Yes[1]	Yes	Restricted
• hold non-trading exposures to other financial intermediaries	Unrestricted	Unrestricted	Restricted (inside the group)
Holding company with banking and trading subsidiaries	Not permitted	Permitted	Permitted
Geographic scope	Unrestricted	Unrestricted	Limitations on the ability of UK ring-fenced banks to provide services outside the European Economic Area[2]

[1] Underwriting in response to demand from clients and counterparties. [2] The European Economic Area is the European Union plus Iceland, Liechtenstein and Norway.

The Volcker rule considers that certain trading operations are non-core activities and therefore should be kept outside the financial sector safety net. It prohibits proprietary trading by commercial banks and prevents them from investing in or sponsoring hedge funds and private equity funds, even within the same business group. A holding company with a commercial bank subsidiary would not be permitted to also have a trading subsidiary.

The proposals in the Liikanen Report are mainly designed to address the too-big-to-fail problem. The report sees the growing investment banking and wholesale funding activities of universal banks as the root cause of banking system distress. It strives to prevent contagion and cross-subsidisation within banking groups by compartmentalising risk. It recommends placing riskier trading activities in specific subsidiaries within the same holding company, thus improving the resolvability of banking firms.

Like the Volcker rule, the Vickers Report considers core banking activity to be like a public utility – an essential but low-return business that should be shielded from excessive risk. In contrast, however, it proposes ring-fencing of core banking activities and moving trading and underwriting activities to separate entities within the same holding company.

① Draft legislation with similar objectives has been proposed in France and Germany.

Complexity in risk measurement and prudential rules

Policymakers are working to improve consistency in the application of the new, more stringent capital standards. The monitoring of how the regulatory framework is performing in practice has revealed a higher than expected range of variation in risk weights across banks. Observers have suggested that these differences are both systematic and persistent. The range of variation indicates that the interaction of risk-sensitive rules with the complexity of risk modelling has created a wide scope for inconsistency, which can seriously weaken both the credibility and the effectiveness of the framework.

The relevance of the concern and possible remedies depend on the factors that drive this variation in internal risk measurement outcomes. Some factors are inherent in statistical risk modelling; others largely reflect the practicalities of risk measurement and the specifics of implementing the prudential framework. Both types of factors can hinder the ability of outsiders to interpret the predictions of risk models and to understand differences between banks. The response of policy, including the calibration of the balance between risk-based and risk-insensitive elements of the prudential framework, should reflect the relative importance of these factors.

Sources of variability in internal risk models: observability and bias

The calculation of regulatory capital largely depends on banks' internal risk models. However, the outcomes of these models can differ across banks at a given time and within a bank across time for reasons other than changes in underlying risk. The sources of these differences can be classified into five broad categories, which differ in their transparency (their observability by an outsider) and in the extent to which they distort risk measurement in ways detrimental to financial stability.

The first category consists of differences in what risk models actually measure – that is, the risk parameter of interest. For example, in calculating the probability of default, some banks may measure the ability of the borrower to repay in the prevailing macroeconomic environment; others may assess the average ability to repay over the course of the cycle. Likewise, the tail risk in trading portfolios could be estimated under either prevailing or stressed market conditions, and the probability of tail losses can be set at more or less stringent levels. If not clearly flagged, such differences can produce spurious variation in the calculated size of safety buffers across banks and reduce comparability.

The second category consists of more fundamental differences in the structure of the risk models. Models are stylised descriptions of the real world that rely on assumptions and statistical estimation. While some models may be inferior to others, no single model is unambiguously better than the rest. Models based on different assumptions can provide different risk assessments even when applied to the same data. This does not invalidate their outcomes. On the contrary, two models both fully supported by existing evidence can produce two different assessments of risk, and the difference will simply reflect a legitimate diversity in views.

In the absence of a single objective gauge of risk, such diversity is desirable: the ability of market participants to form independent judgments on risk and to base business decisions on those judgments is a key source of market liquidity and systemic resilience. From a financial stability perspective, imposing a single view on risk can be counterproductive, as the market provides a mechanism to balance the views of bulls and bears.

A third category is estimation noise. Statistical noise in the data used to estimate risk models can produce different outcomes even for models that are

Box V.B: Statistical noise in risk estimates

Risk measurement is subject to estimation noise, which can be quite significant when estimation focuses on rare events such as extreme losses in a securities portfolio or the default of a highly rated borrower. The exercise in this box illustrates the potential size of estimation noise in the context of credit exposures. It shows that in some cases noise can be comparable to the size of the underlying risk and that, while it cannot be eliminated, it can be reduced by calibrating the model with data drawn from a longer historical period.

The exercise is deliberately stylised to ensure that statistical noise is the only source of deviation of estimated risk from the true underlying risk. It is akin to the exercise a bank would perform to assess the default risk in a portfolio of similar loans; it does not examine the range of risk variation across the entire credit portfolio of the bank. It also cannot address the issue of how estimates differ across banks without further assumptions about the data that each bank uses to form the estimate of risk.

The bank is assumed to hold a portfolio of 200 loans for a period of one year. The bank knows that the loans are drawn from a distinct larger population, or class, of borrowers with identical characteristics, and in particular with the same probability of default (PD).

Default risk for each loan is driven by two factors, one systematic and the other idiosyncratic, as in Vasicek (2002).① Random variations in the systematic factor affect all loans similarly and cannot be diversified away; by contrast, the impact of the idiosyncratic factor is loan-specific and diversifiable in large portfolios. The relative strength with which the two factors drive risk depends on the correlation of loan performance with the systematic factor: the higher the correlation, the closer the similarities in borrower performance across loans.

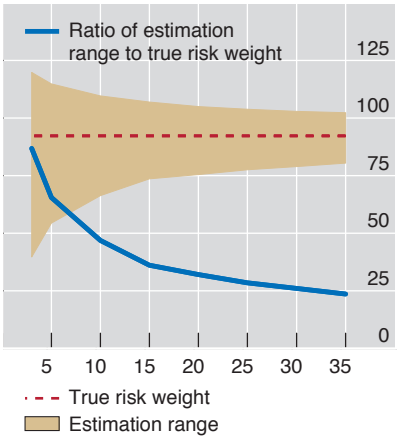
There is no model uncertainty: the bank is assumed to know the underlying model of risk. But there is statistical uncertainty because the model is estimated on the basis of the historical performance of loans of this type. The bank observes the default rate in similar portfolios in previous years. On that basis, it estimates the one-year PD and assigns a risk weight to the exposure according to the Basel framework's internal ratings-based approach for credit risk. The exercise is illustrated across the three panels of Graph V.B, in which the horizontal axis measures the sample size, namely the length of the historical period of loan performance over which the model is calibrated.

In the left-hand panel, *the shaded area* shows the range of estimates of risk weights for this class of loans for different sample sizes. The plotted estimation range excludes the most severe risk weight estimates (top 5%) and the

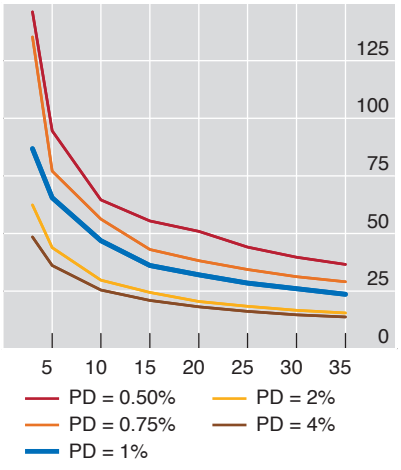
Noise and sample size in estimating risk weights[1]

In per cent — Graph V.B

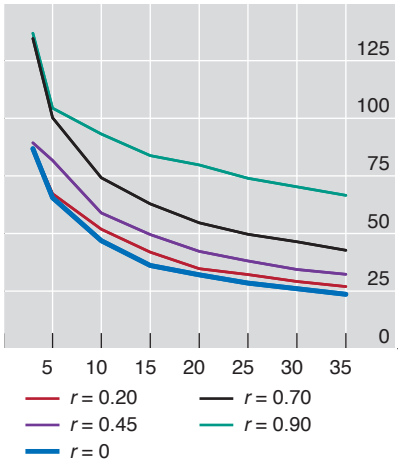
Changing only the sample size (number of years)[2]



Changing the sample size with different probabilities of default[3]



Changing the sample size with different levels of cyclical persistence[4]



[1] Risk weights are computed on the basis of the Basel framework's internal ratings-based approach for credit risk for a given probability of default (PD). [2] Estimation based on cyclical persistence, r (measured as the year-on-year serial correlation of the systematic risk factor) = 0 and PD = 1%. [3] r = 0. [4] PD = 1%.

Source: BIS calculations.

most benign (bottom 5%). The *dashed line* depicts the true underlying risk weight for the class of borrowers that has a PD of 1% and from which the 200 loans were drawn. *The blue line* is the size of estimation noise relative to true risk, calculated as the ratio of the range of the estimated risk weight to the true risk weight, expressed in per cent.

Estimation precision increases with the length of the calibration period (ie the sample size). For the shortest sampling period, the width of the range of risk weight estimates in the left-hand panel is about four fifths of the true risk weight of 92% for a PD = 1%. Lengthening the sample period to about 15 years produces sizeable gains in precision; gains from further increases in sample size are smaller. The remaining two panels show noise curves for similar exercises performed on draws of 200 loans from populations with different characteristics.

The centre panel shows the relative noise measures for separate sets of 200 loans that differ only in terms of the PD of the populations from which they were drawn. At a given sample size, the range of estimates (and hence the statistical noise) increases as the riskiness of the loans declines. This is because the historical performance of higher-quality loans includes more periods with no defaults – periods that are thus not very informative. For instance, with 20 years of historical data, the noise on loans with 1% PD (matching the riskiness of the loans in the left-hand panel and indicated by the blue line) is about one third of the true value of the risk weight for these loans. For the loan portfolio drawn from a population with the lower PD of 0.50% (the uppermost curve in the panel), the noise jumps to 50% of the risk weight. These differences in noise across variations in PD narrow (again, to a progressively lesser extent) as the estimation sample increases.

The right-hand panel shows the effect of drawing loans from populations with varying degrees of cyclical persistence, ie the year-on-year serial correlation of the systematic factor, denoted by r (and with PD = 1%, as in the left-hand panel). If historical samples are not fully random but are strongly influenced by the most recent cyclical experience, they will tend to underestimate risk in good times and overestimate it in bad times; this increases estimation noise with respect to underlying risk. At a given sample size, estimation noise rises with the correlation. And as in the other panels, the level of noise declines with increasing sample length, but to a progressively lesser extent. Taking again the estimates based on a 20-year history, the noise in the most persistent cycle (r = 0.90) is almost three times higher than the noise in the absence of a cyclical effect (the blue line). This suggests that minimum required sample sizes should be much longer in the presence of persistent cycles in credit defaults.

① O Vasicek, "Loan portfolio value," *Risk*, vol 15, December 2002, pp 160–62.

quite similar in structure. Depending on the underlying risk characteristics and the size of the sample used to estimate the model, the magnitude of the range of estimates can match the underlying risk being measured.

Variation due to estimation noise is unavoidable. While the noise can be reduced, for instance through the use of larger samples of historical data, it cannot be eliminated (see Box V.B). This means that the prudential framework must account for this source of variability. Fortunately from the perspective of systemic stability, the noise in statistical estimation is by nature unbiased: deviations across banks and over time tend to cancel out, thus mitigating the impact on system-wide behaviour.

A fourth source of variation in outcomes stems from bankers' incentives, which favour optimistic views on risk and low regulatory capital. The natural entrepreneurial proclivity for risk-taking can inject an optimistic bias in model calibration, as the views of the risk management units may take a back seat to those of the front office. More importantly, banks want to economise on their funding costs. While in theory the mix between debt and equity should not affect the overall cost of funding, in reality a number of distortions make debt cheaper. The tax deductibility of debt costs and the funding advantages from the presence of the safety net are cases in point. In addition, banks have specific incentives to economise on regulatory capital. For any given level of bank capital, the lower the regulatory capital requirement, the less likely it is that the supervisory judgment will constrain business decisions. Moreover, a capital level higher than the regulatory minimum projects an image of a safe and sound bank.

Differences due to strategic choices by banks are unwelcome because they undermine regulatory efforts. Unlike the effect of purely statistical factors such as estimation noise, the effects of which cancel out across banks, management interventions in the models skew risk assessments downwards by understating potential loss. They arguably account, at least in part, for the secular decline in the industry-wide ratio of risk-weighted assets to total assets (Graph V.2).

Finally, variations in model outcomes can reflect supervisors' scope for intervention in setting specific model attributes. For instance, the supervisor-determined multiplier for estimates of market risk can range from 3 to 5.5 times the model outcome and is not always disclosed. Similarly, weaknesses in a bank's process of risk measurement and management, or peculiarities in the local economic environment, can lead supervisors to make compensatory changes in model outcomes. Like definitional differences in models, supervisory interventions that are not transparent can frustrate analysts' ability to compare outcomes across banks and over time.

The discussion above suggests that, in theory, if the contribution of each source of variation could be identified, it should be treated separately according to its effect on financial stability. But detecting a bias in risk measurement is quite difficult in practice. Real-time estimates of future risks always have a strong element of judgment, and there are limits to model validation based on the model's historical track record. True, the requirement that banks use the same model for internal and regulatory purposes aims at limiting the scope for misrepresentation, but it cannot fully address the problem of incentives. And given the absence of objective benchmarks, peer comparison may be of limited help: market participants tend to form similarly optimistic views of the future during a boom, only to be collectively disappointed by the bust.

The risk sensitivity of the prudential framework

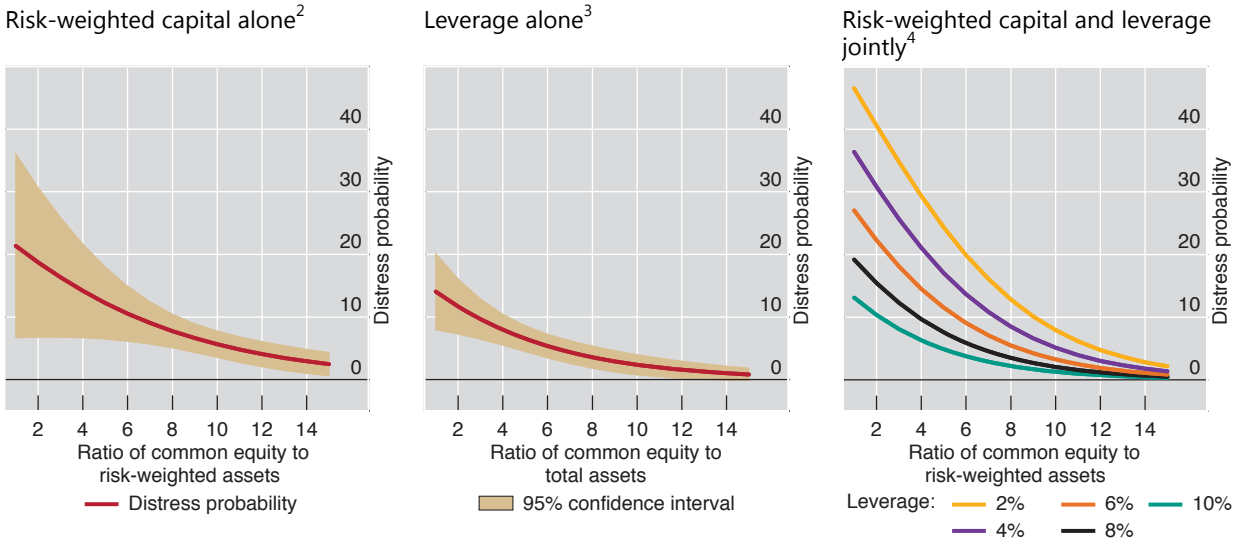
The difficulties of risk measurement raise the question of whether the prudential framework puts too much emphasis on internal measures of risk. Many commentators have argued that minimum prudential requirements should have a less easily manipulated basis, namely the simple ratio of regulatory capital to total assets – the leverage ratio – instead of the ratio of regulatory capital to risk-weighted assets. Indeed, simplicity and transparency are important advantages of the leverage ratio. Nevertheless, the issue hinges on its ability to capture the solvency risk of banks and on how it interacts with incentives.

Risk capture is a key consideration if the prudential framework is to achieve its objective of ensuring a minimum level of solvency for banks. In an ideal world in which risk can be measured objectively and accurately, the minimum ratio of capital to assets will vary across banks depending on their risk profile. In an alternative hypothetical world in which risk measurement is impossible, the prudential requirements will be based on a risk-insensitive metric of solvency such as the leverage ratio. The real world is somewhere between these two ends of the spectrum.

Common equity measured against both risk-weighted and unweighted assets, which are proxies of the corresponding regulatory ratios, can give advance signals of bank weakness (Graph V.3). A low ratio of common equity to risk-weighted assets (CE/RWA) is strongly associated with the likelihood that the bank's operations, net of any external support, will receive a credit rating equivalent to distress or default within one year (left-hand panel). A drop in CE/RWA from 8% to 6% would increase the likelihood of distress from less than 8% to almost 11%; a further drop of the ratio to 4% would boost the distress likelihood to 14%. Since rating agencies'

Signals of banks' distress risk

Estimated probability of distress in one year, in per cent[1] Graph V.3



[1] Estimates based on a logistic regression of an indicator variable denoting a bank's individual rating below D on the variables indicated in each panel, lagged by one year, and a dummy variable to flag observations in the post-2007 period. The sample is an unbalanced panel of annual observations for 66 internationally active banks over the period 2000–12. The vertical axis measures the estimated probability of distress for different values of the explanatory variable. Distress is the likelihood that the bank's operations, net of any external support, will receive a credit rating equivalent to distress or default. [2] Risk-weighted capital is the ratio of common equity to risk-weighted assets. [3] Leverage is the ratio of common equity to total assets. [4] Probability of distress for a given level of risk-weighted capital (horizontal axis) at five different leverage ratios.

Sources: Bankscope; Fitch Ratings; BIS calculations.

assessments of distress and the capitalisation ratios differ from supervisory definitions, these numbers can only be interpreted as being indicative.

The link between the proxy of the leverage ratio – common equity to total (unweighted) assets (CE/TA) – and the likelihood of bank distress shows a similar pattern (Graph V.3, centre panel). A drop in CE/TA (an increase in leverage) from 4% to 2% raises the likelihood of distress from below 8% to almost 12%. In addition, predictions based on the proxy leverage ratio appear more precise than those based on the risk-weighted measure, as evidenced by their narrower confidence band.

Importantly, the two ratios provide signals that are complementary to each other, so when used jointly they improve risk capture, as shown in the right-hand panel of Graph V.3. In particular, the combination of low values for each ratio (a low level of risk-weighted capital and high leverage) shows a much higher likelihood of future distress than does the same low value for each ratio considered separately. For instance, 14% of the banks with common equity equal to 6% of its risk-weighted assets and 4% of its total assets would be in distress within a year's time. This is a higher likelihood than that signalled by either capitalisation ratio in isolation, and it jumps to 30% for the banks with respective proxy capitalisation ratios of 4% and 2%.

Each ratio interacts differently with bank incentives and market discipline. In the ideal world of objective, accurate risk measures, prudential rules based on risk-weighted metrics of solvency deal effectively with bankers' incentives. In the real world, measurement relies on judgment and is subject to estimation noise and model error. Complexity gives rise to uncertainty and distorts the final outcome by providing more room for regulatory arbitrage and optimistic assessments of risk. In

turn, this puts a premium on the ability of supervisors to detect such bias in validating a model, and it strengthens the case for the use of risk-insensitive metrics.

That said, the leverage ratio does not address the problem of incentives because it lumps together positions of very different risk profiles. For a given ratio, banks seeking to minimise regulatory capital can simply reallocate their portfolios towards riskier activities, or shrink their balance sheet without necessarily reducing their potential losses. In order to ensure a minimum level of solvency for all banks, risk-insensitive rules must require higher capital at all banks. Put differently, the simplicity of the leverage ratio improves comparability in the application of prudential rules, but at the cost of not providing information to the market about the underlying risk profile of the bank. Simplicity in this case weakens market discipline.

Policy responses to uncertainty in risk measurement

The policy response to the challenges posed by variability in risk model outcomes must be multifaceted. The overarching objective is to strengthen financial stability by supporting an adequate and credible solvency standard for banks. To fulfil that objective, the policy response needs to seek a balance between several specific but somewhat conflicting goals: enhance the quality of risk measurement in banks by preserving the legitimate diversity of individual firm perspectives; narrow the scope for regulatory arbitrage; and empower market discipline by supporting the ability of outside stakeholders to compare the performance of banks.

The first element of a multifaceted policy response is to strengthen the risk sensitivity of the prudential framework. Somewhat paradoxically, the incorporation of a leverage ratio as an additional element of the framework strengthens its risk capture. As discussed above, harnessing the complementary strengths of the two ratios provides an effective response to the practical and theoretical shortcomings in risk measurement. The argument for a framework that combines the two metrics is also supported by the fact that it is difficult to manipulate one without affecting the other, typically in the opposite direction. For example, an upward shift in portfolio risk might leave the leverage ratio unaffected, but it should increase risk-weighted assets. Conversely, investments in assets with underestimated risk, such as highly rated tranches of collateralised debt obligations prior to the crisis, would increase the denominator of a leverage ratio that incorporates derivatives exposures.

A second facet of the response would be to improve the reliability of internal risk measurement in banks through more stringent requirements for model approval. Tighter requirements can mitigate some of the variability that arises from statistical factors. An obvious example is a minimum length of time over which the model must be estimated, possibly conditioned on whether the sample covers a full credit cycle. Other standards could address the quality of the data and performance when the model is applied to stylised portfolios supplied by the supervisor. More demanding standards of approval also strengthen the confidence of outsiders in model estimates.

A third facet of the policy response is to enhance market discipline by improving outsiders' understanding of risk weight calculations. Doing so requires greater transparency regarding the characteristics of internal models. Greater comparability in the disclosures that banks make about the structure and performance of their internal models will help analysts and outside stakeholders assess the relative strength of banks. Such comparability can be improved with more specific information about the risk measurement technology used by the bank, including its calibration. More importantly, greater standardisation of

information allows outsiders to better compare model performance. This information could include more detailed results of historical performance (comparing model assessments with eventual portfolio performance) and the assessment of the model as applied to standardised portfolios supplied by the supervisor. Greater transparency by supervisors concerning the application of add-ons and multipliers to individual bank outcomes would also work in this direction.

Summing up

Ensuring the stability of an evolving financial system requires continual adaptation by the prudential framework. In response to the crisis, the authorities have tightened prudential rules, and banks are working to meet higher solvency standards. The combined effect of these efforts can make banks more resilient. Banks need to rebuild their franchise on business lines that play to their individual strengths and deliver a steady stream of earnings. Repairing their balance sheets through loss recognition and the build-up of capital are key to future success.

Policy responses to complexity are also important for the overall outcome. Rules that simplify the organisational structure of banks may reduce the complexity at the level of the firm, but their impact on system-wide risk can be ambiguous. This is especially true if national rules take different approaches and result in conflicting requirements for global banks.

Prudential standards that strengthen the capacity of banks to deal with risks represent the most reliable defence against financial instability. Rules requiring ample capital and liquidity buffers that are linked to the underlying risks are key elements of these standards. These rules need to address the complexities of risk measurement in a way that improves transparency and comparability in the financial system. A key step towards that goal is harnessing the mutually reinforcing nature of risk-sensitive and risk-insensitive metrics of solvency. Buffers that are robust to uncertainty and reflect the complexities in risk assessment will enhance the resilience of individual banks and of the financial system as a whole.