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"Capital regulation, Risk-Taking and Monetary Policy: A Missing Link in the Transmission Mechanism ?"

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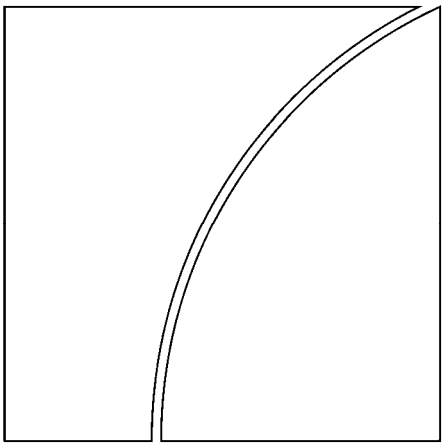

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Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism?

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Abstract

Few areas of monetary economics have been studied as extensively as the transmission mechanism. The literature on this topic has evolved substantially over the years, following the waxing and waning of conceptual frameworks and the changing characteristics of the financial system. In this paper, taking as a starting point a brief overview of the extant work on the interaction between capital regulation, the business cycle and the transmission mechanism, we offer some broader reflections on the characteristics of the transmission mechanism in light of the evolution of the financial system. We argue that insufficient attention has so far been paid to the link between monetary policy and the perception and pricing of risk by economic agents – what might be termed the "risk-taking channel" of monetary policy. We develop the concept, compare it with current views of the transmission mechanism, explore its mutually reinforcing link with "liquidity" and analyse its interaction with monetary policy reaction functions. We argue that changes in the financial system and prudential regulation may have increased the importance of the risk-taking channel and that prevailing macroeconomic paradigms and associated models are not well suited to capturing it, thereby also reducing their effectiveness as guides to monetary policy.

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Introduction[1]

Few areas of monetary economics have been studied as extensively as the transmission mechanism.[2] The literature on this topic has evolved substantially over the years, following the waxing and waning of conceptual frameworks and the changing characteristics of the financial system.

The evolution driven by conceptual frameworks is of older vintage; at the cost of some oversimplification, it can roughly be characterised as follows. In the now seemingly distant days of the battles between monetarists and Keynesians, there was a consensus that a key channel through which monetary impulses affected aggregate expenditure was through their impact on the relative yields of imperfectly substitutable assets. The main bone of contention at the time had to do with the degree of relative substitutability between money and other assets and, relatedly, with how large the set of those assets should be to adequately capture the effects. Monetarists highlighted a low elasticity and often envisaged a much broader set than Keynesians, including real assets and possibly human wealth.[3] In fact, in the simplest IS-LM framework, which monetarists often found so constraining, the only relevant distinction was between "money", an asset whose nominal yield was exogenously fixed (normally at zero), and "bonds". This way of approaching the issue was a natural consequence of conceptual frameworks that emphasised stock equilibrium.

Subsequently, the main emphasis shifted to the distinction between internal and external funding. The bone of contention here has been whether informational imperfections ("frictions") in financial markets are such as to drive a quantitatively significant wedge between the two sources of funding, or indeed between different forms of external funding. In other words, how significant are the "broad credit" (or "balance sheet") and "bank lending" channels compared with the interest rate channel, defined to include any inter-temporal substitution and wealth (permanent income) effects on expenditures?[4] This literature has

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[1] This paper was prepared as the basis for a keynote presentation at the ECB conference on "The implications of changes in banking and financing on the monetary policy transmission", 29-30 November 2007, Frankfurt. It has been only slightly revised and updated since then, with no attempt to cover the implications of the financial crisis which has been unfolding since the autumn of 2007. We would like to thank Ethan Cohen-Cole, Piti Disyatat, Matthias Drehman, Ingo Fender, Andy Filardo, Peter Hördahl, Júlia Király, David Laidler, Pat McGuire, Frank Packer, Pierre Syklos, Camilo Tovar, Kostas Tsatsaronis, Christian Upper, Bill White and Feng Zhu for their comments. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

[2] For present purposes, the transmission mechanism is defined narrowly to include the journey of monetary impulses to expenditures. Except in cases where the distinction is necessary, we thus exclude the factors that affect the split between prices and output.

[3] See, for example, Friedman (1956), Brunner and Meltzer (1975), Meltzer (1995), and Tobin (1961). This, of course, is a simple characterisation. In fact, the monetarist view of the transmission mechanism is more multifaceted. For example, Laidler (2002, 1999) distinguishes between the "money channel" and the "credit channel" of monetary expansion. The "credit channel" refers to the first-round effects of a cut in interest rates, that directly influence spending plans and are implemented through borrowing from the banking system; the "money channel" refers to the secondary effects on expenditure of the excess supply of money that is created as a by-product of bank lending, regarded as a form of "buffer stock" adjustment towards an underlying portfolio equilibrium. The strength of the money channel is seen as weaker to the extent that banks adjust their non-monetary liabilities. If the credit channel harks back to Wicksell, the money channel has intellectual antecedents in Fisher and Hawtrey.

[4] See, for instance, Bernanke and Blinder (1988), Bernanke and Gertler (1995), Stein (1998), Kashyap and Stein (1994, 2000), Fazzari et al (1988), Hubbard (1998). For cross-country work examining the impact of financial structure on the transmission mechanism paying particular attention to some of these aspects, see BIS (1995a), Borio (1997) and Angeloni et al (2003). The focus here on these channels, of course, does not exhaust the literature, but simply points to its central tendency. For example, for an analysis that focuses more

drawn strength from major advances in the formal theory of contracts in the presence of asymmetric information. In spirit, the approach is intellectually closer to the loanable funds theory of the interest rate, in so far as it focuses more on flows rather than stocks.

The changing characteristics of the financial system have recently encouraged a shift of focus in the analysis from the role of monetary controls to that of prudential controls in the transmission mechanism, especially to that of capital regulation. A few decades back, a variety of restrictions were in place in several countries on intermediaries' balance sheets as part of credit allocation and overall credit control policies. Over time, as these restrictions were lifted, the only constraint receiving attention became minimum *reserve* requirements. This was viewed as an integral part of the bank lending channel, with shifts in the non-bank public's portfolios between capital market instruments ("bonds") and reservable deposits seen as impinging on the supply of bank lending. More recently, with the increasing influence of minimum *capital* requirements on bank behaviour, a growing literature has started to consider the corresponding implications for the transmission mechanism based on the differential cost of equity funding (the "bank capital" channel).

In this paper, taking as a starting point a brief overview of the work on the interaction between capital regulation, the business cycle and the transmission mechanism, we offer some broader reflections on the characteristics of the transmission mechanism in light of the evolution of the financial system. The analysis is very much of a speculative, exploratory nature. We do not develop any new specific model or present new econometric evidence, but simply highlight what appear to us as under-researched aspects of the issues.

We put forward three core propositions.

First, the influence of capital regulation and supervision on the behaviour of the financial system and on the characteristics of the business cycle has arguably been increasing. This in part reflects the higher risk-sensitivity of the minimum capital threshold and the more pervasive impact of the corresponding framework on how financial firms measure, manage and price risks. Together, these factors suggest that the role of prudential constraints in the transmission mechanism of monetary policy may be growing.

Second, more generally, insufficient attention appears to have been paid so far in the transmission mechanism to the link between monetary policy and the perception and pricing of risk by economic agents – what might be termed the "risk-taking channel". Both directly and indirectly, changes in interest rates and the characteristics of the central bank's reaction function can influence risk-taking, by impinging on perceptions of risks and risk tolerance. We will argue that it is in the context of the risk-taking channel that notions of "liquidity", best thought of as the ease with which perceptions of value can be turned into purchasing power, acquire added significance. The self-reinforcing link between liquidity and risk-taking could potentially have a material effect on the strength of the transmission of monetary policy impulses, akin to a "multiplier" effect. In turn, the importance of measures of risk and valuation points to the relevance of accounting practices in shaping the transmission. To be sure, our point is not, and *cannot* be, that the risk-taking channel is the most important channel of monetary policy; far from it. It is simply that its exploration would give us a fuller understanding of the transmission mechanism, especially as its prominence is likely to have increased in the wake of financial liberalisation and innovation and of changes in prudential frameworks.

Finally, against this background, significant aspects of the overall shape of the transmission mechanism can potentially be missed if one does not endogenise the reaction function of the central bank within a general equilibrium framework. The argument is that there is an

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on the transactions role of bank deposits, while still building on informational imperfections, see Diamond and Rajan (2006).

interaction between this reaction function and the cumulative strength and shape of the transmission chain. Most of the time, the risk-taking channel should be expected to act purely as a "persistence-enhancing" mechanism, qualitatively akin to a kind of "financial accelerator". But under some conditions, especially if risk is underestimated and individual incentives are not aligned with desirable outcomes in the aggregate, the self-stabilising properties of the economy may not suffice to guarantee a fully benign increase in persistence. If so, one potential concern is that failure by the central bank to take into account the build-up of risks in the financial system and to properly assess the policy stance in the light of the mechanisms just described could *occasionally* have unwelcome implications on the broader dynamics of the financial system, the economy and inflation. As a result, even "locally linear" effects could contribute to "globally non-linear" dynamics in the economy, in the form of boom-bust cycles, possibly accompanied by serious financial strains – a form of (unconditionally) low-probability but high-cost outcomes.

If one accepts these propositions, further research would be desirable to achieve a better understanding of these phenomena. Despite recent welcome progress, there is considerable room for further analysis. The work on the interaction between prudential regulation and the transmission mechanism is still rather limited and some of it actually deals with "risk" only tangentially. The work on the interaction between monetary policy and risk-taking is equally limited, as in the models the channels through which monetary policy is assumed to influence risk-taking are restricted. As far as we are aware, there is no analysis of the implications of accounting for the transmission mechanism, although a number of basic elements to explore it are in place. And the current generation of benchmark dynamic stochastic general equilibrium (DSGE) models has had difficulties embedding a financial sector, let alone endogenising the disruptive consequences of defaults on the economy. For example, even when financial factors do play a role, as in the case of the "financial accelerator", at best these act as benign mechanisms to enhance the "persistence" of shocks. They fail to generate the types of highly non-linear financial-sector amplified boom-bust business cycles, followed by serious financial strains, with which policymakers seem to be occasionally, but increasingly, confronted.

The outline of the rest of the paper is the following. The first section examines the nexus between capital regulation and supervision, business fluctuations and *traditional* channels of the transmission mechanism. It reviews how capital regulation influences banks' behaviour; a key issue here is the degree to which capital regulation both reflects and influences the measurement, management and pricing of risk. And it summarises what is known about the "bank capital" channel, ie the impact on the transmission mechanism that operates through the threat of breaching minimum capital requirements; a key issue here is the extent to which the requirements vary over the business cycle owing to their risk sensitivity (their "procyclicality").[5] The second section develops the concept of the risk-taking channel of monetary policy. It compares it with extant views of the transmission mechanism, explores its mutually reinforcing link with "liquidity" and argues that changes in the financial system and prudential regulation may have increased its importance. The third section considers the implications of the monetary policy regime for the transmission mechanism in a general equilibrium context. It highlights the interaction of the regime with the risk-taking channel, the possibility of globally non-linear effects and the inability of current macroeconomic paradigms to capture these effects. The conclusion summarises the main points and identifies what is needed to make further progress in understanding the processes at work.

[5] Throughout the paper, to avoid confusion, a variable is said to move procyclically if its movement is such as to amplify the cycle. The definition, that is, captures the first derivative with respect to economic activity. Thus, for instance, risk premia are said to be procyclical if they fall during booms and rise during downswings.

I. Minimum capital standards and the transmission mechanism

In exploring the potential impact of minimum capital standards on the transmission mechanism, it is useful to consider sequentially two questions. First, how can minimum capital standards affect bank behaviour? Second, how can they affect *at the margin* the impact of monetary policy?

Capital standards, bank behaviour and the business cycle

A minimum capital standard can affect bank behaviour in at least two ways. The first is through the costs associated with breaching the minimum threshold, and hence of the actions needed to prevent this, especially in terms of the costs of raising external funding – the "capital threshold effect". The second, and more subtle, way is through the broader influence of the capital framework on how the bank conducts its business – the "capital framework effect".

The ***capital threshold effect*** arises because breaching the minimum threshold is extremely costly for a bank. Breaching it is likely to trigger restrictive supervisory actions; more generally, it can result in serious reputational costs and adverse market reactions. Nowadays, crossing the minimum capital threshold would, for all intents and purposes, be regarded as the kiss of death. The minimum capital requirement can therefore have a significant effect on bank behaviour. Faced with an increasing threat of a breach, the institution would take defensive action to limit it.

Importantly, the capital threshold effect can also be operating when banks face no immediate risk of breaching the minimum capital requirement. Its impact is better regarded as a cost (tax) that varies with the size of the cushion above the minimum and with its potential volatility, very much like the value of an option varies with the difference between the market and its exercise price and with the volatility in the market price. The cost is positive but relatively low when the option is far out of the money (the cushion, and hence the distance from the threshold, are high); it increases at an increasing rate as the market price approaches the exercise price and/or volatility increases (the cushion shrinks). In turn, the size of the cushion may vary with exogenous factors, such as the state of the business cycle and idiosyncratic shocks to the bank's balance sheet, and with actions of the bank designed to optimise it (Chami and Cosimano (2001) and Zicchino (2005)).

The measures taken to address the threat of a breach in turn depend on the specific nature of the constraint and on the costs of alternative courses of action. Of particular concern is the possibility that the minimum threshold can limit the bank's ability to extend credit.[6] This can occur whenever increasing the capital base is more costly than alternative funding sources at the margin (eg, as compared with the deposit base or other capital market funds). There are a number of reasons why this is likely to be the case. By analogy with the funding of other firms, informational frictions may make such funding particularly costly, as suggested by the "pecking order" theory of funding sources and investment (Myers (1984)). For instance, cutting dividends may signal relatively poor performance ("adverse selection"); more generally, external equity finance may be regarded as more vulnerable to the misuse of funds by managers unless it provides sufficient control ("agency problems"). Taxation may favour debt over equity. For banks specifically, debt instruments in general, and deposits in particular, may benefit from public sector subsidies ("deposit insurance") or pay a below-market yield owing to the liquidity and payment services that they provide. Because of this differential cost, the threat of a breach will affect the availability, price and non-price terms of

[6] At the same time, the sale of assets, by depressing their price, can have similarly contractionary effects on expenditures.

the funding granted to customers.[7] Indeed, in practice, and as underlined by recent events in the wake of the financial turmoil in the summer of 2007, there is a great reluctance on the part of banks to issue new equity or cut dividends, especially at times when overall economic conditions may point to signs of weakness.

The ***capital framework effect*** operates primarily through the way in which the framework influences how the bank actually perceives, manages and prices risks. This can happen whenever banks borrow elements from the framework in order to upgrade their own practices or to align them more closely with existing regulation. The extent to which this is be the case depends on the characteristics of the framework. The closer the intended alignment of the capital framework with gradations of risks, the higher is the scope for this second channel to operate. Similarly, supervisors may require that the framework be properly embedded in the risk management processes of the institution so as to avoid gaming.

Minimum capital regulation has evolved substantially over the years, largely under the influence of the standards set internationally by the Basel Committee on Banking Supervision (BCBS). In the late 1980s, the Committee agreed on a set of standards that linked minimum capital requirements to assets in a rather coarse fashion, making very limited distinctions through risk weights between differences in credit risk ("Basel I"). At the time, the priority was to raise capital requirements from what were regarded in some countries as imprudently low levels and to do so in such a way as to level the playing field internationally. More recently, the Committee has agreed on a new capital framework whose fundamental characteristic is to make minimum capital standards more risk-sensitive ("Basel II") (BCBS (2006)). In particular, the new framework makes much finer distinctions among assets of differing credit quality. Moreover, to varying degrees, it allows banks to use their own inputs in the calculation of the required minima, subject to validation requirements that include the need for the standards to be properly embedded in a bank's risk management systems.[8] In addition to rule-based quantitative minima ("pillar 1"), Basel II has also strengthened the ability of supervisors to require higher capital targets above the minima based on an assessment of the underlying risks and effectiveness of the risk management processes of a bank ("supervisory review, pillar 2") and has improved the public disclosure of the corresponding risks ("market discipline, pillar 3").

This evolution of minimum capital regulation from Basel I to Basel II has tended to increase the influence of prudential regulation and supervision on bank behaviour, both with respect to the threshold and framework effects.

Other things equal, ie. for a *given* portfolio, the minimum threshold should be expected to vary more over the business cycle.[9] Risk measures naturally tend to vary procyclically, ie to be comparatively low during economic expansions and to be comparatively high during economic contractions. This arises because, to a degree that depends critically on the specific methodology, estimates of probabilities of default, loss given default, asset and

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[7] More generally, of course, it will affect also other funding and pricing decisions, including on liabilities, as well as hedging decisions of the institution. We focus here on credit extended because we regard this channel as being especially important, as also stressed in the economic literature.

[8] At one end of the spectrum, banks are allowed to determine the various inputs (probabilities of default, loss given default, exposure at default) – the so-called "internal ratings based advanced approach". At the other end, credit quality is largely based on the ratings of rating agencies – the "standardised approach". In between, some of the inputs are set by the supervisors themselves (eg, loss given default, exposure at default) – the "internal ratings based foundations approach". Validation requirements call for minimum capital standards to be embedded in the risk management process of the firm.

[9] The greater procyclicality of the minimum capital requirement on a given portfolio does not necessarily imply greater procyclicality in the impact of the overall capital framework; see Box 1 for a discussion of this issue.

default correlations as well as volatilities tend to decline in rising markets or good times and to rise in falling markets or bad times.[10]

While the empirical literature is somewhat divided over the degree of the increased procyclicality of the minimum threshold *for a given portfolio*, on balance it points to an economically significant rise (but see below). The extent depends on the specific methodologies, portfolios and samples used.[11] Typically, the greater the reliance on market inputs, the higher is the degree of procyclicality. This is because asset prices and risk premia tend to be procyclical,[12] and, moreover, filtering risk premia out of estimates of default is not straightforward. In addition, by construction, minimum capital levels based on banks' internal rating models tend to be more procyclical than those based on rating agencies' ratings. The reason is that the former are conditional measures of risk, ie. they seek to estimate the probability of default over a given horizon based on all the available information ("point-in-time" estimates); by contrast, the latter are more akin to unconditional measures, ie. they seek to abstract from the business cycle ("through-the-cycle" estimates), although they tend to do so only imperfectly (Amato and Furfine (2004), Altman and Rijken (2004, 2005)**).**

A key consequence of the greater variability of the threshold is that the bank needs to manage it much more actively (eg Borio et al (2001)), thereby implying a larger effect on its portfolio decisions – a stronger threshold effect. Using the analogy with an option price noted above, this means that, by comparison with Basel I, the exercise price of the option will be more sensitive to economic conditions. The increased risk-sensitivity, together with the relatively short horizons over which risk is measured (typically hardly longer than one year), make this almost tautological.

But beyond the widely recognised effect, the arguably more pervasive, but often neglected, impact of Basel II is through the much closer integration of the overall capital framework in the day-to-day risk management of the banks – the framework effect. One of the objectives and no doubt most enduring merits of Basel II is precisely that of hard-wiring and extending best-practice risk management within the banking community. Basel II has given a major impetus to banks' efforts to upgrade their databases on credit loss histories[13] and to adopt sounder risk management processes. The closer alignment of measures of "economic" capital and "regulatory" capital has not only been achieved through an adjustment of the latter to best practices in the former, but also through a widespread adjustment in the opposite direction. By the same token, the influence on business decisions, including on the availability and terms of the extension of credit to customers, is bound to have increased. The strengthening of the supervisory review pillar should have further increased the relevance of this factor.

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[10] For example, it is well known that short-term volatility across a broad spectrum of asset classes is directional, in that it tends to fall in rising markets and rise in falling markets (for instance, for equity returns, see the classic article by Schwert (1989); for bonds, see Borio and McCauley (1996)). Similarly, for the directional nature of equity correlations, see Longin and Solnik (1995) and Ang and Joe (2002) (equities) and Borio and McCauley (1996) (bonds).

[11] For a detailed discussion of these studies, see Taylor and Goodhart (2004). See also Kashyap and Stein (2004), table 3, for a list of empirical studies that estimate the magnitude of the procyclical movement in regulatory capital under Basel II. These include, inter alia, Segoviano and Lowe (2002), Catarineau-Rabell et al (2003), Jordan et al (2003), Corcóstegui et al (2003), Carling et al (2002), Kashyap and Stein (2004) and Gordy and Howells (2006).

[12] The procyclicality of the equity premium has been amply documented (eg, Campbell et al (1997)). For the procyclicality of term premia, see Piazzesi and Swanson (2006) and for that of corporate credit risk premia, see Amato and Luisi (2006). On the importance of risk premia for sovereign debt, see Remolona et al (2007).

[13] In fact, one reason for delaying the implementation of the framework was precisely that many banks did not meet the minimum data requirements on historical data on credit losses to estimate reliable default and loss given default parameters, which may cause significant errors in measures of portfolio credit risk (Tarashev and Zhu (2007)).

Capital standards and the transmission mechanism

But what about the impact of capital standards on the transmission mechanism of monetary policy per se? Specifically, how are they likely to affect the elasticity of expenditures to changes in policy rates? Here, the literature has focused exclusively on the "bank capital" channel of monetary policy, whereby changes in policy rates influence the wedge between bank capital and the threshold which, in turn, influences the banks' business choices, in particular their credit policies.

A few points deserve highlighting in this context, drawing on the previous analysis and the corresponding theoretical literature (Table 3). These points appear to be broadly confirmed by empirical evidence (Table 4).

First, the impact of changes in interest rates on the capital cushion is multifaceted. It operates directly, through the effect of changes in nominal interest rates on cash flows, net interest margins, earnings and the valuation of assets (via the discount factor). And it operates indirectly, through induced changes in the balance-sheets of non-banks and the macro-economy, which in turn can have a first-order effect on asset quality and on of the adequacy of the size of the buffer. The theoretical literature initially focused on the impact on net interest margins, but has increasingly and rightly shifted the attention to the broader effect of changes in asset quality.[14]

Second, the impact of changes in interest rates on the capital cushion and on behaviour is likely to vary substantially with background macroeconomic and financial conditions as well as with characteristics of the banks' balance sheets. This in part reflects the option-like nature of the threshold effect, as the (statistical) distance from the minimum affects the value of the marginal tax. The effect will be smaller further away from the threshold (when the buffer is higher). But, even more fundamentally, it reflects the option-like nature of the payoffs that affect risk-weighted assets and capital. In general terms, the value of claims on enterprises and households is itself equivalent to that of an option on the underlying assets, and is especially sensitive to fluctuations in their value close to the default boundary. Other things equal, this would suggest that the impact of changes in policy rates would be stronger when financial conditions are weak.

Third, the impact of changes in interest rates may be asymmetric as between increases and decreases, partly depending on background conditions. Again, the option-like nature of the capital constraint is relevant here. For example, in a context of weak balance sheets, a tightening of policy may precipitate generalised retrenchment, as default thresholds are attained. By contrast, an easing may simply do little to increase buffers in a significant way.

Finally, for given balance sheet conditions, the size of the effect may vary depending on the extent to which banks may themselves be sensitive to external financing constraints. In a cross-section, as with non-financial firms, a larger size and longer track record may signal a lower sensitivity to financing constraints and hence to changes in policy rates.

At the same time, the above analysis so far does not quite tell the full story. While it captures the threshold effect, it ignores entirely the framework. In other words, it ignores how the capital framework, by helping to shape the perceptions and pricing of risks, might influence the mapping of monetary policy impulses into portfolio and lending decisions. In order to explore this possibility, however, it is necessary to consider first in more depth the possible link between monetary policy actions and risk-taking more generally, ie the risk-taking channel.

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[14] In fact, the empirical evidence on the impact of interest rate risk on bank's net interest margin is somewhat mixed; see Banking Supervision Committee (2000) and English (2002).

II. Risk-taking, liquidity and the transmission mechanism

A "risk-taking channel" of monetary policy?

The debate surrounding the introduction of the new minimum capital framework, with its emphasis on "risk sensitivity", has focused attention on how market participants measure risk and on their attitudes towards risk. An obvious insight from this work is that these aspects are central to the behaviour of financial intermediaries. More generally, though, they are bound to be central to the behaviour of *all* economic agents – financial and non-financial, households and enterprises – even where the methods of measurement or the influence on actions may be less transparent.

At the same time, the way the "finance" and "economics" disciplines treat risk differs substantially.[15] In what follows, we will argue that a proper understanding of the implications of risk for the workings of the macro-economy generally, and for our understanding of the transmission mechanisms in particular, would benefit from a marriage of these two perspectives. At the cost of some obvious oversimplification, the two perspectives could be characterised as follows.

The measurement and pricing of risk is the basic staple of finance. Here, a burgeoning literature has sought to both measure risk and explain how it is priced (or *should* be priced). The work on measurement, taken forward primarily by practitioners, has yielded a variety of techniques to measure the risk of individual instruments or combinations thereof. Think, for instance, of Value-at-Risk and stress testing, that are now commonplace in financial institutions. The work on pricing has developed techniques to price those instruments, given the risks involved, in both partial and general equilibrium. A key characteristic of much of this work is that it relies on a "no-arbitrage" framework, in which financing constraints resulting from imperfect information play no role (Ross (1988), Campbell et al (1997), Cochrane (2001)). From a macroeconomic perspective, as already noted, it is this work that has documented the strong variability of measures of risk and risk premia as well as their inherent procyclical tendencies, with both variables falling in good times and rising in bad times.

By contrast, the economic literature on the transmission mechanism, even the strand based on financing constraints, has tended to assign a less central role to risk as such (see also Table 3).[16] It is not that elements of risk are absent; indeed, investment projects can succeed or fail, and asymmetric information is critical. But, by and large, the models restrict considerably the range of mechanisms through which risk perceptions and tolerance can influence behaviour. Sometimes, the only source of risk is idiosyncratic to firms. More often than not, users of funds treat the risk of projects as exogenous and have no incentive to insure against losses from bankruptcy.[17] Similarly, providers of funds, be these the ultimate providers or the intermediaries, are often assumed to be risk-neutral or to be able to diversify risks perfectly. Hence, often risk premia are either absent or exogenously given. Importantly,

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[15] This section focuses primarily of credit and market risks, although it the reasoning is quite general and applies to all forms of risk. Moreover, the distinction between market and credit risk partly depends on the form of measurement. For example, it is harder to draw in the case of fair value (marking-to-market or marking-to-model) measurement methods, as it depends on a rather arbitrary distinction between the sources of risks.

[16] There is a large literature on the impact of capital standards on risk-taking, see Santos (2001), Van Hoose (2007) and Table 5 for reviews. However, no formal work of which we are aware considers *explicitly* the impact of monetary policy on risk-taking.

[17] This, however, does not remove the motive to hedge cash flows and changes in balance sheet valuations as long as financial frictions are present, since these can induce risk-averse behaviour. On firms' motives to hedge, see Smith and Stulz (1985) and, especially for the implications of financial frictions, see Froot et al (1993).

if and when default and bankruptcy take place, because of technical complications, assumptions are made to ensure that while their possibility may influence behaviour ex ante, their actual materialisation does not affect risk-taking and the macroeconomy ex post. And, of course, – and in this the prevailing paradigms of the two disciplines do not differ – the simplifying assumptions of model-consistent (rational) expectations and absence of co-ordination failures rules out the dynamics of over-exuberance and disappointment.

To be sure, exceptions to this general pattern do exist. A small number of papers have traced the implications of corporate hedging strategies for the transmission mechanism, focusing on their potential dampening properties, as they protect cash flows and capital from (unexpected) changes in policy rates (eg BIS (1994), Fender (2000a, b)). Greenwald and Stiglitz (1988, 1993) highlight how a firm's effective risk aversion is negatively related to the equity base.[18] A welcome budding literature is seeking to establish a link between finance models of the (default-free) term structure and monetary policy rules (Söderlind (2006)). But, in the big scheme of things, these are truly exceptions and fall well short of covering the range of realistic possibilities. Likewise, some attempts have been made to model more carefully in a general equilibrium setting the risk-taking behaviour of banks and the implications of bank defaults on the macroeconomy, but this work has as yet not been extended to discuss explicitly monetary policy (Goodhart et al (2006)).

This suggests that the literature may so far not have focused enough on what might be termed the "***risk-taking channel***" in the transmission mechanism, defined as the impact of changes in policy rates on either risk perceptions or risk-tolerance and hence on the degree of risk in the portfolios, on the pricing of assets, and on the price and non-price terms of the extension of funding. There are *at least* three ways in which such risk-taking channel may be operative.

One set of effects operates through the impact of interest rates on *valuations, incomes and cash flows*. This set is closest in spirit to the familiar financial accelerator, and may be thought of as a way of strengthening its impact (see Box 2 for a comparison). Lower interest rates, for instance, boost asset and collateral values as well as incomes and profits, which in turn can reduce risk perceptions and/or increase risk tolerance. The procyclical behaviour of estimates of probabilities of default, loss given default, volatilities and correlations is a concrete manifestation of the influence on risk perceptions. The common assumption that risk tolerance increases with wealth points to an influence on risk tolerance. All this can encourage risk-taking. For example, and rather mechanically, as measured volatility declines in rising markets, it releases risk budgets of financial firms and encourages position-taking. The widespread use of Value-at-Risk methodologies for economic and regulatory capital purposes is one way of hard-wiring this effect (Danielsson et al (2004)).[19]

A second set of effects operates through the relationship between market rates and *target rates of return* (BIS (2004), Rajan (2005)). For example, reductions in interest rates can interact with "sticky" rate-of-return targets, especially in nominal terms, so as to increase risk-tolerance – the "search for yield" effect narrowly defined. Sticky target rates of return may reflect the nature of contracts, as with pension funds or insurance companies that have nominal liabilities at predefined long-term fixed rates, sometimes reinforced by regulation. Alternatively, they may reflect deeper behavioural features, such as money illusion or difficulties in adjusting expectations following periods of "exuberance" in markets. All this

[18] Similarly, Dell' Arriccia and Marquez (2006) show how lower interest rates may cause banks to relax lending standards and increase their risk-taking when there are information asymmetries across banks; this mechanism relies on a switch between a separating and a pooling equilibrium.

[19] Similarly, Adrian and Shin (2007) note a positive feed-back loop between higher asset values and risk-taking, based on leveraged targets for financial firms and their link to Value-at-Risk measures, and find some empirical evidence based on repo activity of securities dealers and subsequent changes in the volatility premium.

suggests that the impact of this channel may be stronger when the gap between market and target rates is unusually large. Moreover, to the extent that very low nominal rates have a negative impact on profits, not least given the presence of (quasi-)fixed costs, it may be particularly powerful when nominal rates are close to zero.[20] And, it may be highly dependent on the history of background economic conditions, eg, being larger following a period of disinflation and/or of sustained high returns on a particular asset class, and weaker otherwise.

A third set of effects operates through aspects of the characteristics of the *communication policies and the reaction function of the central bank.* For instance, the degree of transparency about, and perceived commitment to, future policy decisions that may accompany decisions today can influence their impact on behaviour. By increasing the degree of transparency or commitment accompanying specific moves, and hence removing uncertainty about the future, the central bank can compress risk premia – a "transparency effect", adding an extra kick to the effect of those moves.[21] Similarly, the perception that the central bank reaction function is effective in cutting off large downside risks, by "censoring" the distribution of future outcomes, can imply that changes in rates have an asymmetric impact on behaviour, with reductions encouraging risk-taking by more than equivalent increases would curtail it – an "insurance effect".

Casual observation would suggest that the risk-taking channel deserves closer exploration. Clearly, its possible presence is more easily visible to the naked eye in business fluctuations where background conditions are more extreme. Thus, the prolonged boom in global economic activity that started in 2002 has seen a coexistence of low policy rates, particularly elevated prices across a broad spectrum of asset classes and unusually low readings of measures of short-term volatility, suggesting that the first set of effects discussed above may have been operative. Similarly, the widespread "search for yield" that has characterised the behaviour of the financial system during much of this period has often been closely linked by market observers to the comparatively low level of interest rates – the second set of effects associated with sticky target rates of return. Independent footprints of the transparency effect are harder to identify, since so far periods in which central banks have been giving clearer policy signals about the future have generally coincided with situations in which policy rates have been unusually low and protracted (BIS (2007)). By contrast, market participants' reference to anticipations of a central bank easing of policy in the face of financial disruptions as a factor supporting risk-taking provides some indirect evidence of the empirical relevance of an insurance effect.[22]

Beyond casual observation, the few pieces of empirical work that have begun to test for a risk-taking effect confirm that further analysis is warranted. Amato (2005), for example, finds

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[20] Other things equal, at very low interest rates levels, profits may be compressed because it becomes harder to cover labour and other costs, which are either related to the overall size of the portfolio or are fixed (eg, the information technology infrastructure). Similarly, as the zero lower bound approaches, interest margins are squeezed as the room to reduce interest payments on the lowest-earning liabilities, typically retail deposits, disappears (a version of the well known "endowment effect").

[21] The effect here should be expected to depend on the nature of the communication. For example, it should be expected to be weaker if the purpose is to provide guidance while stressing the conditional nature of the information, as when central banks publish regular projected paths for their policy rate; it should be stronger when the purpose is in fact to remove some of the conditionality from the path, as when the Federal Reserve announced that it would continue to tighten policy at a "measured pace" between August 2003 and December 2005.

[22] The perception of this form of support has proved very hard to fight by central banks. The reason is that even if the central bank focuses squarely on macroeconomic performance, it is difficult to distinguish ex post pre-emptive actions designed to maintain macroeconomic stability in the face of rising risks to the outlook from those that limit financial losses incurred by market participants. After all, the limitation of losses is a mechanism through which the interest instrument works.

suggestive evidence that the monetary policy stance has an impact on measures of the pricing of credit risk as estimated from CDS spreads. Jiménez et al (2007), who use a unique micro-level data set for Spain, also find evidence of a risk-taking channel, where risk-taking is approximated by ex ante loan characteristics (including internal credit ratings) and ex-post loan performance; similar evidence has been found more recently by Ionnadou et al (2008) on Bolivian data.[23] Going further back in time, and taking a more global perspective, it is hard to believe that the link found between lower US policy rates and higher capital flows to emerging market economies does not reflect, at least to some degree, an effect on higher risk-taking (Clark and Berko (1997)). And, fast forwarding again, the very recent budding literature of macro-finance models of the term structure finds some evidence of a positive effect between (unanticipated) declines in policy rates and lower term premia (Dewachter et al (2006), Palomino (2006), Rudebusch et al (2007)).[24]

The role of "liquidity"

While the analysis so far has outlined the key features of the risk-taking channel, a fuller understanding calls for an exploration of its link to "liquidity". For present purposes, it is best to think of liquidity as the *ease* with which perceptions of value can be turned into purchasing power. This definition captures two closely related notions of liquidity. One is "funding (cash) liquidity", or the ability to realise ("cash in") value and hence meet cash flow commitments, either via the sale of an asset or access to external funding. The other is "market liquidity", or the ability to trade an asset at short notice and with little impact on its price. Seen from this perspective, the degree of "liquidity" in markets is an unobservable variable that denotes a key dimension of the impact of financial conditions on the real economy. Higher liquidity weakens spending constraints.

To make this notion more concrete, it is useful to draw parallels with some of the extant theoretical literature. Most directly, in terms of the promising framework developed by Kiyotaki and Moore (2001), one can think of the degree of liquidity as being captured by the two parameters which define the fraction of income/assets which are pledgeable (ie can be borrowed against – what might be termed the "external funding constraint") and the loss of value incurred in transferring assets (ie. claims on other agents) to unrelated parties (what might be termed the "saleability or transferability constraint").[25]

In that framework, however, as in some others, liquidity, so defined, is taken as exogenous.[26] That is, changes in borrowing capacity, for instance, are solely driven by the fluctuation in collateral values or profits rather than movements in the two parameters. The point we would like to stress is that liquidity should be partly regarded as endogenous. And this endogeneity does not just apply at secular frequencies, reflecting changes in institutional arrangements, as in the work of Kiyotaki and Moore (2005). More importantly for present purposes, it applies at *cyclical* frequencies, reflecting economic conditions and its link to monetary policy.

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[23] In addition, since this paper was written, Adrian and Shin (2008) document the link between lower interest rates and risk-taking for investment banks in the United States, which they rationalise based on the use of target leverage ratios and value-at-Risk methodologies, as in Adrian and Shin (2007).

[24] By contrast, based on combined Germany-euro area data, Hördahl et al (2006) find a negative relationship between monetary policy shocks and term premia, in particular for short horizons.

[25] In the Bernanke et al (1999) financial accelerator model, which draws on Townsend's (1979) costly state verification framework, liquidity is captured by the fraction of inside wealth that needs to be "pledged" to access external funds.

[26] This is not the case in the financial accelerator of Bernanke et al (1999), as what is set exogenously is the state verification cost parameter. The factors driving the constraints, however, are more limited than in our analysis.

In particular, liquidity and risk-taking are tightly interconnected, and can reinforce each other. For instance, lower perceptions of risk and greater risk tolerance weaken external funding and transferability constraints. In turn, weaker constraints can support higher risk-taking. In other words, by analogy with the notion of effective demand in macroeconomics[27], weaker constraints increase "effective" risk tolerance, by allowing agents to engage in projects or investment strategies with higher risk, and normally higher expected return, than would otherwise be possible. The opposite is true when perceptions of risk increase, risk tolerance wanes and liquidity conditions tighten, with the deterioration in market and funding liquidity potentially reinforcing each other.[28]

The implication is that the link between liquidity and risk-taking can add to the strength of the monetary policy transmission mechanism - a sort of "liquidity multiplier". And as is typical of the processes that connect financial and real activity, its strength can vary considerably with background conditions. Think, for instance, of the seemingly outsized impact on the "repricing of risk" and on "liquidity conditions" which can follow apparently small changes in the monetary policy stance, not least when exiting prolonged periods of unusually low interest rates in which leveraged positions may have built up. The impact on bond markets in early 1994 when the Federal Reserve exited such a period is an extreme case in point (BIS (1995b), Borio and McCauley (1996)) – one which has made central banks wary of such potential reactions.

The implications of financial change, accounting and the distribution of risk

Four additional observations are worth highlighting.

First, while a risk-taking channel has always been present, the evolution of the financial system may well have been adding to its prominence. Financial liberalisation and innovation have greatly increased both the possibility and the incentive to obtain external finance, or to economise on it through the use of leverage instruments and strategies such as "originate and distribute".[29] The corresponding relaxation of liquidity constraints has also increased the potential for perceptions of wealth and risk, as opposed to current incomes and cash flows, to drive spending decisions. And the collateral underlying those decisions may be as

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[27] See, in particular, Clower (1965), who explores the microeconomic foundations of effective demand.

[28] This is especially evident in pathological manifestations of these mechanisms at times of financial distress, including banking crises as well as episodes of serious market strains with potentially significant macroeconomic consequences. Typically, on those occasions, as stressed in Borio (2003a), given heightened concerns about counterparty risk, the evaporation of market liquidity reinforces, and is reinforced by, sudden contractions in funding liquidity (eg, cuts in credit lines and increases in margin requirements). The result is typically a surge in the demand for central bank funding. The market turmoil since the summer of 2007, following a prolonged period of ample availability of "liquidity" and risk-taking and unusually low measures of risk, is but the latest reminder of these tight interactions. While the theoretical literature has begun to explore the link between market and funding liquidity (eg, Brunnermeier and Pedersen (2007)), it has so far ignored the role of counterparty risk. For a survey of the theoretical literature, see Shim and Von Peter (2007). Acharya and Schaefer (2006) also discuss the highly non-linear nature of (market and funding) liquidity risk, together with its relationship to correlation risk, and its implications for the pricing of securities, based on Acharya and Pedersen (2005).

[29] For example, there is a growing literature, both theoretical and empirical, documenting how risk transfer instruments (credit derivatives) can impact on lending decisions, including the possibility of increasing lending capacity eg ECB (2004), Hänsel and Krahnen (2006), Acharya and Johnson (2007), Ashcraft and Santos (2007), Nicolò and Pelizzon (2007), Cerasi and Rochet (2008) and Chiesa (2007). There is, of course, a broader literature on the impact of financial innovation, often noting its dampening effect on the real economy; see, for instance, Kuttner and Mosser (2001), Estrella (2002), Sellon (2002), Dynan et al (2006), Cecchetti et al (2006), Jermann and Quadrini (2007).

transparently intangible as a future earnings stream from a unit of capital or labour, or as sometimes deceptively tangible as a piece of property or a financial asset.[30]

Second, it stands to reason that in so far as the framework of capital standards is becoming more important in shaping the measurement, pricing and management of risk of regulated firms, it should also be expected to be increasing its influence on the chain from monetary policy actions to ultimate expenditures. For example, to the extent that the framework encourages longer horizons for the assessment of risk, it may instill greater prudence (Borio (2003b), which in turn could weaken the impact on risk-taking of unusually low policy rates. Similarly, encouraging the use of parameters based on through-the-cycle experience, such as conservative (downturn) loss-given-default estimates or statistical loan provisioning, could make banks less sensitive to the direct and indirect effects of changes in policy rates.

Third, the risk-taking channel underscores the importance of how valuations are measured and of their link to the measurement of risk. This, in turn, highlights the often neglected role of accounting practices. In the same world of imperfect information that underlies financial frictions, accounting valuations can have a first-order effect on behaviour (Beaver (1997), Borio and Tsatsaronis (2004, 2006)). And accounting practices differ widely in terms of the way they measure valuations and reflect risks. As a result, they can affect the strength of the risk-taking channel. For instance, the greater sensitivity of fair value measures compared with historical cost accounting to changes in interest rates can heighten the strength of the transmission mechanism in general, and that of the risk-taking channel in particular. Its high sensitivity to risk premia is especially relevant here. Oddly, while some thinking has gone into the implications of the major shift under way towards fair value accounting for its impact on the financial system and the macroeconomy, especially in terms of the potential increased procyclicality,[31] to our knowledge its implications for the transmission mechanism have remained unexplored.

Finally, the risk-taking channel also highlights the importance of how risk is distributed in the economy. Since agents can differ in terms of their ability to measure and bear risk, this can influence their responsiveness to changes in policy rates. For example, over the last decade or so we have witnessed a shift of risk to the household sector, in the sense that households have now become more directly responsible for the management of financial risks than before, with fewer layers in between (eg, BIS (2005), CGFS (2006), Borio (2007b)). Reflecting this, a larger proportion of household assets are now held in the form of instruments more vulnerable to market risk, the share of home-ownership has tended to rise and balance sheets have grown significantly, including an increase in both debt and assets in relation to current incomes. The weakening of financial constraints associated with financial innovation and with greater competition in the financial sector has played a key role. Households' response to their changing financial constraints as filtered by their risk perceptions can be quite different from that of other agents. Moreover, as stressed by Shiller (2007), this risk transfer can test households' ability to measure and manage risks to the full. In turn, this can make the effects of monetary policy more discontinuous, as the recent experience with sub-prime mortgages in the United States has highlighted. From this perspective, for instance, the nature of contractual arrangements, such as the balance between fixed-rate and variable-rate lending or collateral practices, acquire particular significance (BIS (1995), Borio (1997), Campbell and Cocco (2003), Tsatsaronis and Zhu (2004)).

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[30] Metaphorically speaking, one could say that we have been shifting from a "cash flow-constrained" to an "asset-backed" economy (Borio (2007a)).

[31] On the increased procyclicality of fair value accounting, see Borio and Tsatsaronis (2004 and 2006), Enria et al (2004), Goodhart (2004), Taylor and Goodhart (2006) and Shin (2006).

III. The monetary policy regime and the transmission mechanism

So far, our analysis of the transmission mechanism has pointed to the potentially growing relevance of the minimum capital standards and of the risk-taking channel. And it has emphasised that the impact of changes in policy rates is highly dependent on background macroeconomic and financial conditions and on the state of balance sheets.

The analysis, however, has only briefly referred to the relevance of the monetary policy regime, defined as the set of objectives that the central bank pursues together with the norms and patterns of behaviour through which it pursues them, including notably the central bank's reaction function. This has been in keeping with much of the literature on the transmission mechanism, narrowly defined in terms of the impact of monetary impulses on expenditures. That literature has tended to analyse the effect of one-off (unanticipated) changes in policy rates without considering explicitly its link to different reaction functions.

There are a number of understandable reasons why the literature has followed this approach. Much of the work has been carried out in a partial equilibrium context, so as to better highlight the nature of the channels involved. To retain simplicity, the models used may often be static or have no explicit role for expectations about future policy. And in general equilibrium forward-looking macro models, the transmission mechanism assumed has by and large been rather rudimentary, with a focus on the impact of nominal rigidities in prices and wages rather than of financial frictions. For example, as discussed further below, with few notable exceptions, the prevailing approach in the current generation of DSGE models has been to restrict monetary policy to affect expenditures through the neoclassical interest rate channel, in the form of inter-temporal substitution effects on consumption and the service cost of capital for investment (eg Woodford (2003)).

Yet, the previous analysis suggests that the role of the monetary policy regime can be significant. Beyond the transparency and insurance effects noted above, there can be broader implications arising from the extent to which the central bank takes, or fails to take, risk-taking into account in its reaction function. In particular, under some conditions, it may be possible that what are "locally linear", or at least benign, effects may, cumulatively, give rise to "globally non-linear" effects, ie may contribute to, or fail to offset, boom-bust dynamics in business fluctuations.

A useful way to think about this possibility is as follows. The risk-taking channel is first and foremost just another normal channel through which monetary policy impulses are transmitted to the economy. The mechanism is entirely benign if risk perceptions are correct and if incentives are such as to align individually rational actions with socially desirable outcomes or if these are reasonable approximations to reality. Moreover, even if they are not, the mechanism may still be benign as long as the confluence of background economic conditions is not such as to lead to a sustained and marked departures from local stability. We would expect this to be the case most of the time.

But there can be situations in which stabilising forces may be less effective. On these occasions, higher risk-taking could, after a point, turn into "excessive" risk-taking, resulting in a build-up in risk-taking that does not find sufficient resistance in institutional characteristics of the financial system, including prudential policy, and possibly from monetary policy too. As a result, rather than acting as a benign "persistence-enhancing" mechanism, risk-taking can cumulatively lead to overextension in balance sheets and to the corresponding build-up of financial imbalances that at some point unwind. Depending on circumstances, this unwinding, in turn, can result in serious output weakness, unwelcome disinflation, if not outright deflation, and possibly broader financial stress.

From local to global effects

As extensively argued elsewhere, experience does suggest that overextension in risk-taking and balance sheets can contribute to occasional boom-bust cycles in the macro-economy (Borio (2003b)). Two factors can arguably help to transform higher risk-taking into excessive risk-taking, so that the physiological procyclicality of the financial system can turn into occasional episodes of "excessive" procyclicality. The first factor relates to limitations in risk perceptions. For a number of reasons it seems much harder to measure the time dimension than the cross-sectional dimension of risk, especially how risk for the financial system as a whole evolves over time. The second factor relates to limitations in incentives. As is well known, actions that are individually rational and compelling need not result in desirable aggregate outcomes. Familiar economic notions such as herding, coordination failures and prisoner's dilemmas are obvious examples of the genre. This implies that even when risks are recognised, it may sometimes be difficult for market participants to withdraw from the fray, as the short-term pain is not seen as offset by future potential gains. As recently famously put by Charles Prince, Citigroup's now ex-Chief Executive Officer, at a time of recognised aggressive risk-taking in the leveraged loan market: "as long as the music is playing, you've got to get up and dance" (Financial Times, 9 July 2007).[32]

These limitations in risk perceptions and incentives can arguably help to explain a number of regularities. First, market indicators of risk, such as risk premia, tend to be comparatively low precisely before the peak of the financial cycle, when, in retrospect at least, it turns out that risk was highest. As Greenspan (2005) so aptly put it, "…history has not dealt kindly with the aftermath of protracted periods of low risk premiums". Second, there is a widespread perception that underwriting standards tend to become looser during particularly benign conditions in the more mature stages of credit booms, with the loans granted during those stages having the worst ex post default performance. Some empirical work has documented this tendency as well as the broader tendency of rapid credit growth to go hand-in-hand with deterioration in credit quality (Jiménez and Saurina (2006), Foos et al (2007)). Finally, and probably most telling, there is also evidence that *real-time* indicators of financial imbalances, in the form of the coexistence of unusually rapid expansion in credit and asset prices, have useful predictive content for subsequent widespread financial distress, output weakness and disinflation, over horizons of two to four years ahead, depending on the calibration (Borio and Lowe (2002, 2004)). Moreover, such macro indicators can also help to improve the predictive content of popular micro models of default risk, including those widely used in the financial industry (Tarashev (2005)).

The problem for monetary policy is that these boom-bust fluctuations can also take place in the absence of overt inflationary pressures. For instance, broadly low and stable inflation characterised the booms in Japan in the late 1980s-early 1990s and some East Asian countries in the 1990s which preceded the subsequent banking crises. In fact, as documented in Borio and Lowe (2002), on average, across a broad spectrum of countries inflation has tended to fall during the boom phase, supported by positive supply-side developments and, especially in very open economies, by appreciating pressure on the exchange rate linked to strong capital inflows. Moreover, in one respect the establishment of credible anti-inflation regimes may actually contribute to this type of business fluctuations, by delaying the emergence of inflationary pressures which would otherwise signal the

[32] One problem is that the conjunction of limitations in risk perceptions and incentives can result in situations in which risk looks unusually low by traditional measures even if tail risk is rising. For a discussion of these mechanisms, see Knight (2007) and Rajan (2005).

unsustainability of the economic expansion – the "paradox of credibility" (Borio and Lowe (2002)).[33]

If anything, this type of business fluctuations, while still infrequent, appear to be becoming more common. There may be good reasons for this. As argued elsewhere, such fluctuations may be regarded as one of the less pleasant side-effects of the otherwise highly beneficial conjunction of three deep-seated shifts in the economic environment, viz. financial liberalisation, the establishment of credible anti-inflation regimes and the globalisation of the real economy (Borio (2007)). Their end-result may well have been to increase the "elasticity" of the economy, so that booms may be longer than in the past, but their end may well involve a higher likelihood of financial strains, even if inflation does not rise markedly. The strains in the financial system of mature economies which emerged in August following the sub-prime problems in the United States are consistent with this view.

This analysis can have significant implications for monetary policy. Under these conditions, if the reaction function of the monetary authorities does not restrain risk-taking and the corresponding expansion of financial imbalances even if near-term inflation remains low and stable, it can sometimes unwittingly accommodate the build-up of the imbalances.[34] While the ultimate source and driver of risk-taking need not be, and very often is not, monetary policy itself, its failure to adjust may eliminate a potential brake on this pattern of behaviour. It is in this context that the risk-taking channel may show dysfunctional aspects, especially if its cumulative strength is not recognised. And it is in this context, too, that the extent to which prudential regulation may alter the procyclical properties of the financial system acquires particular significance.

At the same time, the current generation of benchmark DSGE macro-models cannot quite capture these types of business fluctuations, or indeed the risk-taking channel more generally. The common assumption of model-consistent (rational) expectations and of a representative agent rules out key limitations in risk perceptions and incentives, and makes it harder to incorporate cross-sectional and inter-temporal coordination failures. The models have no or a very limited role for "liquidity", as defined above; and when they do, they treat it as exogenous. The same is true for risk perceptions. As a result, changing perceptions and attitudes towards risk, and hence risk premia, are not considered. Typically, the models are linearised and have no significant non-linear dynamics. They can best be thought of as representing the business cycle as short-run deviations from a steady-state, whereas in the fluctuations discussed above it is hard to make a clear distinction between cycle and trend, as the two tend to be closely intertwined. Moreover, even when the financial sector is modelled, the first-order non-linearities associated with default are not meaningfully included (Goodhart et al (2006) is a notable exception).[35]

To be sure, welcome efforts are being made to address some of these shortcomings. Most notably, there have been attempts to enrich the treatment of the financial sector, either building on the work by Bernanke et al (1999), (eg, Carlstrom and Fuerst (1997),

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[33] More specifically, what we mean here is that the establishment of credible anti-inflation monetary policy regimes can make it less likely that signs of unsustainable economic expansions show up first in the form of rising inflation and more likely that they emerge in the form of financial imbalances.

[34] The point, of course, is not that monetary policy should "target" risk-taking, which would make little sense; rather, it is simply that monetary policy may sometimes fail to take properly into account its implications for the outlook for the real economy and for the inflation path over a sufficiently long horizon. Moreover, to the extent that economic agents perceive (rightly or wrongly) a kind of central bank "put", a strategy that took such risk-taking into account would be a way of charging a positive cost for it. For an interesting treatment of the long history of the evolution of economic thinking on the relationship between price and financial stability and its link to macroeconomic stability, see Laidler (2007). See also White (2006).

[35] Even in this case, however, the analysis is only partial, as it assumes an economy without endogenous production (an "endowment" economy).

Christiano et al (2003 and 2007))[36] or pursuing avenues that place greater emphasis on notions of "liquidity", in this case linking the value of different assets as collateral with the cost of producing loans and transaction services (Goodfriend (2005), Goodfriend and McCallum (2007)). Similarly, considerable efforts have been made to weaken the assumption of model-consistent expectations, such as through learning. Even so, this work has fallen short of addressing the shortcomings that prevent the modelling of boom-bust fluctuations while assigning a central role to the nexus between financial frictions and risk-taking. For example, in an interesting paper Christiano et al (2007) model some boom-bust type business cycles in a DSGE setting. However, in that model the inclusion of a financial sector actually dampens the cycle.[37] All this leaves ample room for improvement in what remains an important but difficult under-researched area.

Conclusion

Over the last three decades the financial landscape has gone through radical structural change. As a result of financial liberalisation and innovation, heavily controlled, segmented and "sleepy" domestic financial systems have given way to a lightly regulated, open and vibrant global financial system. The main regulatory constraints that remain are of a prudential nature.

The world that has emerged from this transformation is one where finance naturally plays a bigger role in macroeconomic dynamics. Financing constraints have structurally been eased but have by no means disappeared. The measurement, management and pricing of risk have moved from the periphery to the core of financial activity. The link between valuations and risk perceptions has tightened. The mutually reinforcing feedback between perceptions of value and risk, on the one hand, and financing constraints and "liquidity", on the other, has arguably become more prominent. Under some circumstances, it may therefore also contribute to amplifying business fluctuations more than in the past.

There are reasons to believe that this transformation may also have had an impact on the transmission mechanism of monetary policy. In this essay, we have argued that its impact could be multifaceted. To the extent that a further-reaching and more risk-sensitive prudential framework increases its influence on the workings of the financial system and the macro-economy; it may also become more important in shaping the impact of monetary policy impulses. To the extent that risk perceptions and risk tolerance become more pervasive influences on behaviour, the direct and indirect impact of monetary policy on expenditures through its nexus with risk-taking may well grow. To the extent that procyclical forces in the economy increase, unless the monetary policy regime allows for the possibility of responding to the build-up of risk even if near-term inflation remains subdued, the likelihood of occasional but costly boom-bust business fluctuations may be higher than in the past.

One could see the risk-taking channel as a natural evolution, in some ways a synthesis, of older and newer views of the transmission mechanism. The relative-yield channels on which monetarists and Keynesians had focused did, at bottom, rely on the influence of monetary

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[36] For a more recent effort along these lines, see De Fiore and Tristani (2008), who consider the impact of potential default on the "cost channel" (arising from the need to borrow to finance current production). Cúrdia and Woodford (2008), by contrast, model financial frictions through a reduced-form specification of the link between the credit spread and economic conditions.

[37] They follow the practice of postulating an anticipated *future* shock to productivity that, ex post, fails to materialise so as to mimic disappointed expectations (over-exuberance) without abandoning the rational expectations assumptions. Together with the assumption of wage stickiness and that monetary policy following a traditional Taylor rule, this allows the model to exhibit a boom-bust-type cycle. The reason is that, by focusing on inflation, the authorities prevent the necessary upward adjustment in the real wage.

policy on risk (including liquidity) premia, although the determinants of those premia were largely left unexplored. That literature, however, did not pay much attention to financing constraints. The broad credit (balance-sheet) and bank lending channels, grounded on the economics of imperfect information, subsequently highlighted financing constraints, but tended to relegate risk perceptions and pricing to a rather secondary role. The risk-taking channel highlights the role of the measurement, management and pricing of risk, alongside its nexus with financing constraints and liquidity. To be sure, we are by no means arguing that this is *the* main channel; this would obviously be wrong. Rather, we are arguing that it is a channel that deserves closer exploration, especially since it may be becoming more prominent.

The exploration of the risk-taking channel, in both its micro and macro aspects, calls for a blending of different intellectual strands. It draws from finance its close attention to the measurement and the pricing of risk. It draws on the foundations of monetary economics to differentiate between nominal and real phenomena. It draws on the economics of imperfect information to better understand the nature of contracts and financing constraints as well as potential coordination failures. It could usefully draw on behavioural economics to understand more fully limitations in risk perceptions and incentives. And it draws on macroeconomics to embed these factors into a general equilibrium framework – the only one in which the dynamic, tight and highly non-linear link between the financial system and the broader economy can be properly assessed. Incorporating financial distress in a meaningful way in our macroeconomic tools should be a high priority. All this is a tall order. But even if a holistic approach is bound to remain beyond reach, it should not prevent us from trying to chip away at the questions, through more targeted analytical and empirical exercises.

The stakes are not inconsequential. Central bankers are increasingly confronted with the need to better understand and respond to economic fluctuations in which protracted surges in risk-taking and withdrawals from it are more and more apparent, and in which long periods of seeming financial stability give way to the sudden, potentially highly disruptive, emergence of financial strains. The turbulence in the financial system that erupted in the summer of 2007, and that is still unfolding, is but the latest reminder of this evolution. Exploring how monetary policy interacts with risk-taking is a necessary step to provide policymakers with a sounder analytical basis for their responses.

Table 1
Procyclicality in Basel II

Study	Descriptions	Main conclusions	Comment
Erwin and Wide (2001); Carpenter et al (2001)	Empirical estimates based on US data	Basel II can cause a maximum change of 20% in capital charges over the cycle.	It focuses on regulatory capital and uses a fixed portfolio.
Segoviano and Lowe (2002)	Large Mexican banks	Basel II can cause a maximum change of 70% in capital charges over the cycle.	It considers foundation IRB and standardised approach.
Ayuso et al (2004)	Spanish data (1986-2000)	An increase of one percentage point in GDP growth reduces capital buffers by 17%.	The overall implication for the procyclicality of Basel II is not clear.
Stolz and Wedow (2005)	German data (1993-2003)	Capital buffer decreases in economic upturns, mainly driven by fluctuations in risk-weighted assets.	The overall implication for the procyclicality of Basel II is not clear.
Peura and Jokivuolle (2004)	A dynamic optimisation problem	The procyclicality impact is dampened by up to 50% if endogenous capital buffers are taken into account.	Loan risk is exogenous.
Kashyap and Stein (2004)	A simulation exercise	The procyclicality impact is significant, and it depends on the selection of sample portfolios.	The study focuses on regulatory capital and uses a fixed loan portfolio.
Estrella (2004)	A dynamic optimisation problem	A binding risk-based capital requirement can be procyclical.	Loan risk is exogenous.
Catarieneu-Rabell et al (2005)	Based on a parameterised GE model	Using “through-the-cycle” rather than “point-in-time” ratings can dampen the procyclicality impact.	Endogenously determined loan rates and defaults. The capital requirement is always binding.
Pederzoli and Torricelli (2005)	A static model of banks	Using a forward-looking capital requirement can dampen the procyclicality impact of Basel II.	It focuses on regulatory capital.
Koopman et al (2005)	Empirical estimates based on US data	Banks’ capital buffer decision will dampen the procyclicality effect	
Gordy and Howells (2006)	A simulation exercise	The procyclicality impact can be dampened by smoothing the input, the capital function, or the output.	It focuses on regulatory capital; Bank portfolio changes with macroeconomic conditions.
Repullo and Suarez (2007)	A dynamic model	Capital buffers are lower (higher) in economic upturns under Basel I (II).	Loan risk is exogenous.
Heid (2007)	A static optimisation problem	Under both Basel I and Basel II, procyclicality exists but can be mitigated by capital buffer decisions.	Loan risk is exogenous.
Zhu (2007)	A dynamic equilibrium model	Basel II does not necessarily cause procyclicality. The effect on lending decisions differs across banks.	Endogenously determined loan risk and capital structure.

Table 2
Capital regulation and constrained bank lending: empirical evidence

Study	Descriptions	Main conclusions
Bernanke and Lown (1991); Berger and Udell (1994); Peek and Rosengren (1995), Furfine (2001)	US data	Basel I contributes to a credit constraint during the 1990-91 recession; banks subject to formal regulatory requirements curtailed their loans more sharply than those which were not.
Ito and Nagataki (1998)	Japanese data	International active banks, which were subject to a more stringent capital requirement, were more constrained in lending during 1990-92.
Wagster (1999)	Cross-country: 5 countries	There is evidence that Basel I contributes to a credit constraint in Canada and the UK; no such evidence in Germany, Japan and the US.
Jackson et al (1999)	A review article on the impact of Basel I	There is evidence that Basel I contributes to constrained lending in the US and Japan; there is no conclusive evidence on its impact on banks' risk taking and their competitiveness.
Chiuri et al (2001, 2002)	15 emerging market economies	Evidence that Basel I can contribute to a credit constraint; the impact is larger for under-capitalised banks.
Bikker and Hu (2002)	26 developed and developing economies	No evidence that capital regulation exacerbates the credit constraint. Capital requirements do not appear to be binding on loan supply owing to capital buffers.

Table 3
The role of bank capital in monetary transmission: theoretical studies

Study	Model feature[1]	Capital rule[2]	Loan default	Bank default		Main conclusions
				Existence[3]	Impact[4]	
Bernanke and Blinder (1988)	IS/LM	None	No	No	No	Model of three assets: money, bonds and loans. A monetary policy shock reduces the size of bank reserves and bank credit, thus causing reduction in investment and the real economy. No role of bank capital.
Kashyap and Stein (1994)	PE	Basel I	No	No	No	General discussion: a binding capital constraint would weaken the lending channel of monetary transmission.
Blum and Hellwig (1995)	IS/LM	Basel I	No	No	No	A *binding* capital requirement increases the sensitivity of equilibrium output and price to a demand shock, via its impact on loan supply and lending rate. No discussion on the implication of monetary policy.
Chami and Cosimano (2001)	A dynamic banking model	Basel I; non-binding	No	Yes	No	A tight monetary policy reduces the net interest margin and the value of bank capital. This reduces banks' incentive to raise new equity to finance new loans.
Chen (2001)	Dynamic, GE	Capital holding due to financial frictions	Yes	Yes	No	Bank capital and entrepreneurial net worth serve as collateral. Shocks in either of them can generate a propagation mechanism and cause distress in both the asset market and the banking sector. A credit slowdown in economic downturns may result from the optimal response of the market rather than due to the regulatory requirement.
Tanaka (2002)	Static, GE	Non-binding	Yes	No	No	Under-capitalised banks choose bonds over loans and loan supply becomes less sensitive to a monetary expansion. Hence, under Basel II, an expansionary monetary policy will be less effective during a recession because banks are constrained by the capital requirement.
Meh and Moran (2004)	Dynamic, GE	Capital holding due to financial frictions	Yes	Yes	No	Bank capital and entrepreneurial net worth jointly determine aggregate investment and are at the heart of the propagation mechanism. A contractionary monetary policy increases the cost of deposits and generates reinforcing reduction in bank lending, investment, bank capital and firm net worth. The impact is stronger if the information friction that banks face is larger.

Table 3 (continued)
The role of bank capital in monetary transmission: theoretical studies

Study	Model feature[1]	Capital rule[2]	Loan default	Bank default		Main conclusions
				Existence[3]	Impact[4]	
Kopecky and VanHoose (2004a, 2004b)	Static, PE	Basel I; binding	No	No	No	Capital regulation alters the loan transmission mechanism of monetary policy. The short-run and long-run effects of capital regulation can differ.
Zicchino (2005)	Dynamic, PE	Basel I and Basel II; non-binding	Yes	Yes	No	An extension of the Chami-Cosimano model. Under Basel II bank capital is likely to be less variable, and bank lending tends to be more responsive to macroeconomic shocks.
Cecchetti and Li (2005, 2007)	IS/LM, static & dynamic	Basel I	No	No	No	Capital regulation adds to the effect of shocks on economic activity via demand (higher response of real income to an expenditure shock) and supply (the bank capital channel) channels.
Bolton and Freixas (2006)	Static, GE	Basel I	Yes	No	No	A contractionary monetary policy constrains bank lending by reducing the net interest margin and thus reducing banks' incentive to issue new equity to finance new loans. This channel functions only if the capital constraint is binding.
MarKovic (2006)	Dynamic, GE	Basel I; non-binding	Yes	Yes	No	The model includes the interaction between the bank balance sheet and corporate balance sheet effects. Monetary policy can have a stronger effect in times when bank capital deteriorates.
Goodhart et al (2006)	Dynamic, GE	Risk-based; non-binding	Strategic default	Yes	Yes	The effect of monetary policy on investors and banks depends on their portfolio and the regulatory regimes.
Van den Heuval (2007a)	Dynamic, PE	Basel I; non-binding	Yes	Yes	No	A tight monetary policy lowers bank profits (interest margins) and future bank capital, thus reducing bank lending. The bank capital channel is stronger for banks with low capital.

[1] "GE" refers to a general equilibrium model and "PE" refers to partial equilibrium model. [2] "Binding" means that banks are constrained by the minimum capital requirement in equilibrium; "non-binding" means that bank equity is endogenously chosen and it may exceed the minimum capital requirement in equilibrium. [3] "Yes" means that banks can default in equilibrium and this possibility is taken into account in the optimisation problem. [4] Whether the default of a bank (collapse in its equity value) can spread over to other banks or have a feedback effect on the real economic activity.

Table 4
The role of bank capital in monetary transmission: empirical studies

Study	Descriptions	Main conclusions
Gambacorta and Mistrulli (2004)	Italian bank data (1992-2001)	The study disentangles between the bank lending channel and bank capital channel effects. A one percentage point increase in the policy rate leads to a decline of 1.2% in lending for an average bank; the impact is larger for poorly-capitalised banks.
Kishan and Opiela (2006)	US bank data (1980-1999)	Evidence of bank capital channel; the impact is larger for banks with lower level of capital; the impact is asymmetric in that expansionary monetary policy fails to stimulate lending by weakly capitalised banks.
Van den Heuval (2002, 2007b)	US data	Evidence of bank capital channel; An interest rate shock has a higher impact on lendings for low-capitalised banks. The channel operates more strongly for large banks.
Watanabe (2007)	Japanese bank data	Japanese banks cut back their lending in response to a large loss of bank capital in fiscal year 1997. In particular, a 1-percentage-point shortfall in bank capital reduces lending by 2.8%. The study uses instrument variables to resolve the identification problem (demand vs supply effects).

Table 5
Capital regulation and banks' risk-taking

Study	Descriptions	Main conclusions	Notes
Furlong and Keeley (1989)	A static model	For value-maximising banks, capital requirements reduce banks' risk-taking incentive.	The analysis is based on a flat-rate capital rule.
Rochet (1992)	A static model	For utility-maximising banks, capital regulation can reduce banks' risk taking, but only if the risk weights are properly chosen.	
Calem and Rob (1999)	Dynamic portfolio choice for banks; moral hazard arises from a flat deposit insurance scheme	The impact of capital regulation on banks' risk-taking is ambiguous: it depends on the initial capital position of banks and the stringency of capital rules.	No role of monetary policy.
Blum (1999)	A dynamic model; comparative study	Two opposite effects of capital regulation: a current binding capital constraint lowers risk-taking but a future binding constraint increases risk-taking of banks.	Banks maximise the option value of bank equity.
Barth et al (2004)	Survey data from 17 countries	Mixed results. Capital requirements are associated with fewer NPLs, but not related to the likelihood of a banking crisis after controlling for the regulatory regime.	The study provides various quantitative measures of bank regulation.
Decamps et al (2004)	Continuous-time model with interactions between the three pillars of Basel II	The minimum capital requirement is useful to prevent moral hazard; market discipline can act as a substitute and allows for a lower capital requirement.	The study ignores banks' asset allocation.
Repullo (2004)	Dynamic model of imperfect competition in banking	Capital requirement is effective in controlling risk-taking incentive and leads to a prudent equilibrium.	Both Basel I and Basel II are examined.
Repullo and Suarez (2004)	Static, risk-neutral agents; endogenous loan decisions	Equilibrium loan rate is sensitive to PD and capital requirements; the sensitivity is higher under Basel II.	
Cuoco and Liu (2006)	A dynamic model of bank behaviour	Basel II can be effective not only in curbing portfolio risk but also in inducing revelation of the risk.	
Kopecky and VanHoose (2006)	Calibrated model; heterogeneous banks with different monitoring cost	Capital regulation has an ambiguous effect on loan quality: bank lending declines but loan monitoring also decreases.	Capital constraint has to be binding to be effective.
Blum (2007)	A dynamic model; comparative study	Under Basel II, banks may choose excessive risk-taking and under-report risks.	Assume weakness in pillar 2.

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Box 1: Is Basel II more procyclical than Basel I?

Against the background of the greater sensitivity of the minimum threshold to economic conditions, concerns have been expressed that its higher procyclicality could contribute to the amplification of business fluctuations.[1] A degree of procyclicality was already present under Basel I: losses in the downturn would eat into capital cushions and threaten to violate the minima, inducing banks to retrench and to reduce the availability, or increase the cost, of credit. It could be greater under Basel II, as capital requirements would now actually fall during expansions in line with perceptions of risk and then rise more substantially during contractions, as the perceived risk in the portfolios rose. As long as bank credit is an imperfect substitute for other forms of credit granted by institutions not subject to similar capital requirements, this can fuel the expansion and exacerbate the downturn.[2]

While this effect is quite intuitive, it is not easy to incorporate in a general equilibrium model – the most appropriate context to consider its implications. The rapidly increasing theoretical literature has so far adopted a partial equilibrium approach, focusing on the optimisation problem of banks during the transition of capital regimes (Table 1). The risk of bank loans is often assumed to be identical for all loans and even when banks are able to choose the riskiness of their loan portfolio endogenously, there is no feedback effect of banks' risk-taking or bank failure on the real economy. Hence, the literature is still far from being able to provide a full understanding of the quantitative implications of the procyclicality of capital standards for the macroeconomy.

Moreover, the empirical literature on the macroeconomic effects of capital standards necessarily relates to Basel I, as Basel II will be implemented progressively only starting in 2008. The results are not uniform, but on balance we read them as pointing to an impact of bank capital on economic activity and we infer that regulatory capital may have an additional effect, especially when the banking system is subject to widespread strains (Table 2).

To a large extent, the difficulties in interpretation arise from an identification problem. It goes without saying that, if there is a significant threat of a breach of the minimum capital requirement, a bank will tend to retrench from risk-taking, except perhaps if it attempts to gamble for resurrection in a context of lax supervisory standards. But, by definition, for the retrenchment to be potentially of macroeconomic significance, it has to be rather widespread. This in turn means that it will tend to take place at a time when the economic situation is deteriorating. As a result, two problems arise for the researcher. One is to distinguish declines in the demand for credit from those in its supply. Another, even harder one, is to disentangle the marginal effects of higher capital standards per se from those induced by the destruction of bank capital more generally, ie from those that would take place even in the absence of minimum capital requirements. These would arise because of the imperfect substitutability between funding sources discussed in the main text and of banks' natural retrenchment in the face of tougher times, not least given an aversion to bankruptcy, reinforced by financial markets' concerns. In other words, it is hard to disentangle the incremental impact of the "regulatory capital" constraint from that of the more fundamental "economic capital" constraint. For example, if banks set their economic capital based on a target rating constraint which requires a considerably positive buffer over the minimum and the rating is itself not influenced by the size of buffer over the minimum threshold, then it is the rating that acts as the primary constraint on behaviour.[3]

It would be wrong, however, to conclude from all this that any amplification effects present in Basel I would necessarily be larger under Basel II. The reason is that, in contrast to the vast majority of the studies quantifying the potential increased procyclicality of the standards, other things are not equal. Bank behaviour, and therefore loan portfolios, should not be expected to remain invariant with respect to the adoption of the new standards. As a result, as a package, Basel II need not be more procyclical than Basel I, and could even be less so.

There are at least three reasons for this. First, the Basel II framework has encouraged considerable improvements in credit risk management and now the procyclical nature of risk is much better understood. This should be expected to result in more prudent credit extension during the upswing and an earlier, more gradual recognition of losses than in the past. This, in turn, would dampen the procyclicality of the minimum requirements. Moreover, banks could also be induced to hold higher cushions above the minima in order to guard against the risk of their sudden erosion and reduce their procyclicality, as some exercises indeed indicate (eg, Koopman et al (2005), Heid (2007) and Zhu (2007), in Table 1). Second, greater disclosure could also act as a restraint, as rating agencies could become more suspicious of banks' internal risk management systems that deliver highly

procyclical ratings. Finally, supervisors could reinforce these tendencies, through the supervisory review pillar, by requiring higher cushions during expansions and in the light of the outcomes of stress tests. The number of steps taken to reduce the procyclicality of pillar 1 compared with the original proposals underscores the fact that supervisors are fully aware of the risk of greater procyclicality (Borio and Shim (2007)). Supervisors will no doubt monitor the procyclicality of the arrangements quite closely in future.

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[1] Analogous concerns relate to the capital requirements for market risk, which are based on a Value-at-Risk methodology (eg, Danielsson et al (2004)). For a discussion of this aspect, see Borio (2003a). [2] While we focus explicitly on "banks", the issue is broader, as other financial intermediaries are affected, not least securities firms and insurance companies. The capital standards of insurance companies are also moving in the same direction as those of banks, given the objective of achieving a greater degree of convergence in prudential regulation within the financial sector. [3] The differential reactions to economic and regulatory capital would become even harder to disentangle as the methodologies to calculate them become more closely aligned under Basel II.

Box 2: The financial accelerator and the risk-taking compared

As noted in the text, at least one set of mechanisms underlying the risk-taking channel are similar to those that characterise the credit channel. These operate through the indirect impact that changes in interest rates have on the pricing of risk by affecting asset values, cash flows and profits, and hence also financing constraints. The exact nature of these differences will depend on the specific characterisation of the credit channel. In order to cast more light on them, this Box examines more closely the treatment of risk in the financial accelerator mechanism, as proposed by Bernanke and Gertler (1989) and Bernanke et al (1999). This is probably the most widely used rationalisation of the credit channel in the literature.

Two key assumptions underlie the financial accelerator framework. First, there is asymmetric information between borrowers and lenders. Second, there is a deadweight loss (state-verification cost) if the borrower defaults. Townsend (1979) shows that, given such credit market imperfections, the optimal contract for external finance takes the form of debt and the amount of external finance is positively related to the borrower's "net worth", which is defined as the amount of the project financed with own funds (internally financed).

The key contribution of Bernanke et al (1999) is to introduce such credit market imperfections into a general equilibrium framework. In equilibrium, the demand for capital, the payoff specified in the debt contract and the probability of default are all endogenously determined jointly. And given state-verification costs, there is a wedge between the return on capital and the return to external financers – this wedge is the so-called "external finance premium".[1] First, the lenders (intermediaries), who are assumed to be risk-neutral, need to receive an expected payoff that equals the risk-free rate (the incentive compatibility constraint). Second, borrowers choose the level of external finance such that the expected return on capital equals the marginal cost of external finance. This cost, in turn, increases with the borrower's leverage ratio (as expected default costs, including the likelihood of incurring verification costs, rise). Naturally, the contractual payoff in the debt contract increases with the probability of default and hence leverage as well as with verification costs, so as to offset the lower returns in the case of default.[1] Finally, the expected return to capital (hence the external finance premium) decreases with the aggregate level of capital investment.

Changes in interest rates operate through the financial accelerator mechanism. When the policy rate is reduced, the borrower's net worth increases, which stimulates the demand for investment. The increase in net worth also reduces the expected default probability and, by reducing the incidence of verification costs, allows borrowers to take on more debt and expand the investment. A kind of multiplier effect arises, since the burst in investment raises asset prices, further pushing up net worth and investment. Similarly, changes in business conditions (eg productivity shocks) will also generate endogenous adjustments in firm's borrowing capacity and the external finance premium.

A merit of the financial accelerator mechanism is that the "pricing of risk" is to some extent endogenously determined, in the sense that the external finance premium is jointly determined with the borrower's finance structure and the default probability. At the same time, the framework does restrict considerably the way in which risk can influence behaviour.

First, the modelling of risk-taking is very simplified. Investment projects are homogenous and the external finance premium is solely dependent on the level of aggregate investment. In this framework, it is challenging to incorporate the impact of changes in interest rates on the risk composition of bank credit[2] or, more generally, the choice between return and risk if investors have to choose among heterogeneous projects.

Second, the modelling of the pricing of risk is highly restricted. At the core of the finance literature on the pricing of risk is the determination of the default risk premium, defined as the additional compensation over a risk-free expected return charged by lenders for bearing *uncertainties* in future returns. In the financial accelerator framework, lenders are assumed to be risk-neutral. Intuitively, under such setting the default risk premium equals zero in that lenders charge a rate at which expected payment equals the risk-free rate. More generally, the assumption of risk-neutrality abstracts from the important role of changing risk tolerance of economic agents over the credit cycle, a key element of the "risk-taking" channel.

Finally, default only plays a trivial role in the model. On the one hand, *lenders* cannot go bankrupt. In a standard financial accelerator model, banks are merely intermediaries that pass on payoffs to

households and are able to diversify away idiosyncratic risks. Moreover, to the extent that aggregate risk is allowed for in the model, they can insulate themselves from it by issuing "state-contingent" debt contracts – not quite standard debt. As a result, banks always make zero profit with certainty and never default. On the other hand, default and exit of *borrowers* are treated as two disconnected issues thanks to a technical assumption. In particular, the probability of a borrower's survival into the next period is exogenously given and has nothing to do with his/her current-period performance. The exit of borrowers is replenished automatically to maintain a constant population. More importantly, the default of a debt contract does not cause any disruption to the economy: the lender simply receives a smaller payment. This contrasts sharply with the strong non-linear interaction between corporate defaults and bank stress in the downward phase of the cycle, not least through their impact on risk tolerance and liquidity, as defined in the text.

To sum up, the financial accelerator includes two key sets of assumptions that preclude a fuller treatment of the risk-taking channel. First, they make assumptions about preferences towards risk, the diversifiability of risk and the ability of insulating against risk through contract terms and other ancillary assumptions so as to rule out a time varying pricing of risk and effective risk tolerance. Second, in keeping with standard assumptions in the literature, they enforce model-consistent (or rational) expectations, which prevents the possibility of systematic errors or biases. While natural in the context of these models, this prevents a richer treatment of the measurement of risk as actually practiced by firms and discussed in the main text.

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[1] Correspondingly, when the state verification cost is zero, the return on capital in equilibrium equals the risk-free rate. That is, external finance premium is zero and there is no borrowing constraint. [2] Valuable efforts have been made recently to investigate the impact of financial frictions on the composition of bank credit. For instance, Matsuyama (2007) develops a model in which investment projects differ in productivity and pledgeability. He shows that changes in borrowers' net worth can cause shift in the composition of bank credit. However, the analysis abstracts from the pricing of risk and treats borrowing capacity (financing constraints) as exogenous.