Credit derivatives: Banks' behaviour, financial stability and banking regulation

Received (in revised form): 5th July, 2008

Konstantinos N. Karras
works at the Risk Management Division of Emporiki Bank, Athens, Greece, where he manages the Basel II and the risk & IT interface projects. He is also a visiting lecturer at the Department of Accounting and Finance at Athens University of Economics and Business. He has previously worked as a senior risk analyst and economic analyst at Emporiki Bank, and as a researcher at the Research Centre of Athens University of Economics and Business. He holds a PhD in economics, a master's degree in money, banking and finance from University of Birmingham, UK, and a BA in economics. He is also a member of the Greek chapter of the Professional Risk Managers' International Association.

Risk Management Division, Emporiki Bank, 11, Sophocleous Str., 102 35 Athens, Greece
Tel: +30 210 328 4331; Fax: +30 210 328 4836; E-mail: karras.k@emporiki.gr

Abstract This paper studies the emergence and development of credit derivatives, and how they have significantly changed the area of credit risk management. In studying the behavioural effects of credit derivatives on banks' behaviour, the theoretical analysis incorporates the modelling of optimal bank capital reserves with the use of credit derivatives by employing an inventory management framework. It is shown that credit derivatives can lead banks to reduce their capital buffer stock, which can have multiple effects on banks' behaviour. By considering these effects in parallel with the existing literature, this paper investigates the implications of credit derivatives with respect to financial stability and banking regulation.

Keywords: *banking firm, credit derivatives, inventory management, financial stability*

INTRODUCTION

In a world of innovations, it is not surprising that, after the management of interest, equity and foreign exchange risk, it was the turn of credit risk management. The high volume of defaults since 1999 has meant that credit risk management has become more important than ever. As Altman has reported, banks, regulators and bank practitioners are now concentrating their credit risk management efforts due to: (1) the emphasis of Basel II capital regulation on more advanced credit risk management techniques; (2) the improvement in credit risk modelling techniques; (3) the development of robust credit databases; (4) the development of corporate bonds markets; (5) the development of new credit risk management instruments such as securitisations, credit derivatives etc; and (6) the development of credit portfolio risk/return analysis.[1]

Credit derivatives are considered as financial innovations that have had a significant impact on credit markets by separating the origination and funding

of credit from the holding and management of credit risk, and by insuring and protecting against adverse movement in the credit quality of the counterparty.

The Bank of England has stressed the importance of credit derivatives by identifying a range of influences on banks' and credit markets' behaviour:

> '— CDs [credit derivatives] can reduce credit concentration and manage loan assets and credit exposure on a portfolio basis.
> — new assets and exposures can be created to widen investment opportunities.
> — credit views can ultimately be traded and arbitraged across instruments.
> — banks can use CDs to reduce exposures to relationship borrowers without damaging that relationship.
> — banks which cannot achieve direct access to certain types of borrower or which lack infrastructure to service loans can use CDs to assume credit risk to a wider range of borrowers. Thus, CDs seem to offer considerable benefits of managing credit risk between parties in isolation from other forms of risk.'[2]

Credit derivatives appear to have become a popular tool for efficient and flexible risk management at banks (as explored in the next section) and a means for distributing idiosyncratic and market credit risks within an economy, affecting the stability of financial markets and financial systems. Nonetheless, academics and practitioners are taking a keen interest in these instruments for a number of reasons, including the change in the structure of incentives, which may affect market participants' risk appetite; the high concentration of credit derivatives in the market; the soundness of their pricing; and issues of transparency and standardisation.

Due to credit risk events that have cast doubts over whether the banking system or the banks themselves can absorb the losses and protect the stability and efficiency of the financial system, the banking industry has suffered a number of severe problems. As will be seen in the following section, the credit derivative market, in particular, has been growing rapidly over the last decade, and the various credit events during this period have served to highlight both the benefits and problems of credit derivatives. Certainly, one can turn to the literature to see the behavioural effects on banks' behaviour and financial stability and fragility. In aiming to understand credit derivatives, it is important to stress that without understanding both the microeconomic context of the individual banking firms as well as the financial stability of the macroeconomic situation, it is impossible to see the complete picture. In this framework, it is worth analysing the bank's capital policy towards credit derivatives in connection with its risk management potentials. Thus, if credit derivatives are used for hedging purposes on a one-to-one position base or on a portfolio positions base, the bank has to reconsider its capital levels. Any such change in capital levels also has a more global impact on the banking system. As will be seen, various works in the literature show that banks have a more credit-expansive behaviour, which is only possible by maintaining control over capital levels.

This paper will discuss the literature pertaining to the interaction of credit

derivatives and banking. Within this framework, the paper will also analyse banks' incentive to reduce capital buffer stock by using credit derivatives for hedging purposes. The multiplicative effects of this incentive can be connected to the existing literature. This issue is addressed by incorporating the modelling of optimal bank reserves with the use of credit derivatives using a simple inventory management framework. These effects are closely related to the evolution of bank capital regulation (notably Basel II) and the stability of the banking system.

The first section of the paper provides information on the rationale and use of credit risk management instruments and other credit risk management alternatives and describes the development of credit derivative markets in the international banking environment, as credit derivatives are one of the fastest-growing markets. The second section involves an overall review of the relevant literature. The implications of credit derivative use on banks' behaviour are then illustrated by developing a model of a bank's precautionary capital reserves. The final section examines the banking system stability issues associated with credit derivatives.

THE SCOPE, THE USE AND THE INTERNATIONAL DEVELOPMENT OF CREDIT DERIVATIVES

Since the 1980s, a number of new credit risk-sharing financial instruments have emerged to make credit risk more manageable.[3] Banks can pool assets with credit risk and sell parts of the pool. This asset securitisation or creation of asset-backed securities has seen considerable growth in areas such as home mortgages, car financing and small business loans, where underlying loan contracts and payment schedules are standardised with similar risk characteristics. Loan sales are another credit risk-sharing technique, where a bank originates a loan and sells it in smaller shares to other banks. Such techniques have reached the stage of maturation. Credit derivatives are the most recent tools for financial contracts to provide insurance against credit-related losses. Credit derivatives may be considered as the most significant financial innovation of the 1990s. The concept of credit risk derivatives was introduced in 1992 at a conference of the International Swap Dealers Association (ISDA) and was born in New York in the same year. The reason for the emergence of credit derivatives was the major banks' need to manage the high credit risk of over-the-counter swaps. The major banks repackaged and sold on a basket of credit risks, paying very large premiums, but helping to free up capital which could then be used for new business.

Credit derivatives can be classified first according to whether they transfer credit risk associated with an individual borrower (single name) or a number of borrowers (portfolio); and secondly according to whether or not the transfer of credit risk is funded. The main four types of contracts are: credit default swaps, total return swaps, credit-linked notes, and a set of spread, basket and index products. Their main aim is to assume or lay off credit risk on loans and other assets, sometimes only to a limited extent, in return for either payments or payment of premium. The transfer of credit risk may be for the whole life of

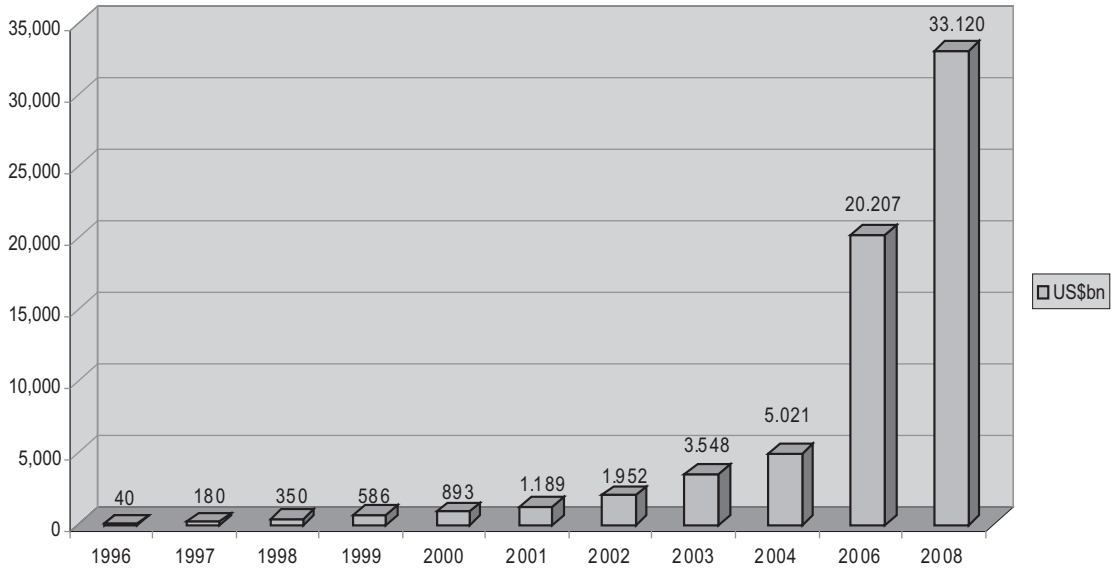
the asset or for a shorter period, and it may be a complete or partial transfer of credit risk. Finally, there are basket and index products which enable the transfer of credit risk on more than one reference asset. For instance, index products may enable the trading and hedging of credit risk across different economic sectors and asset classes. In the context of basket swaps, as Rule presents, new portfolio instruments are created with correlation, risk and return characteristics resembling securitisation techniques.[4] This form of portfolio transaction belongs to the market of collateralised debt obligations (CDOs). However, these portfolio instruments are more diversified than asset-backed securitisation of homogeneous pools of assets. These new financial engineering products belong to the market of new structured CDOs. Rule presents and analyses this set of portfolio transactions (CDOs) and their distinguishing characteristics.[4] Synthetic CDOs (portfolios of credit derivatives) are considered as the most recent credit transfer instruments.[5] It is also obvious that these new instruments require adequate and effective methods of pricing and valuation. Most approaches are familiar from the existing literature on credit risk modelling (default-based models, rating transition models, stochastic models, the replication pricing approach, etc). The Bank for International Settlements (BIS) has considered many insights of the pricing element in its review of current methods.[6] It is accepted that the pricing of credit risk-transfer instruments is an ongoing dynamic process.

Although market size is small relative to other over-the-counter derivative markets, there is rapid growth in global credit derivative transactions, and this will rise due to bankruptcies, defaults and debt restructuring, which create a real need for hedging products. The main sources of statistical information regarding credit derivatives are the reports from the British Bankers' Association[7] (BBA) and the surveys from BIS.[8]

The market for credit derivatives grew from almost nothing in 1993 to an estimated $40bn in 1996, with the BBA 2006 report estimating that the market would grow to $20trn by the end of 2006 and $33trn by the end of 2008 (Figure 1). As BBA has indicated, it is not just the size of the market that has continued to grow, but also the diversity of products. The expansion of index trades, tranched index trades and equity-linked products — to highlight but a few — has created an unprecedented variety of traded products in the credit derivative market (Table 1). Similar results are demonstrated in the statistics of ISDA and other authorities.

Single-name credit default swaps are the most popular credit derivative products and are the basic building blocks of more complex portfolio trades. Generally, CDOs have gained the attention of market participants, and their growth depends on investors' risk preferences and the expected effects of continuing diversification. Index trades have become the second largest product.

All sources show that concentration in credit derivative intermediation is very high and it is stressed that the credit derivative market is highly internationalised as large players are international institutions involved in cross-border transactions. Due to sovereign debt crises such as those in Argentina, Russia, Asia etc, a large portion of credit derivatives were, in the



Source: BBA
Figure 1: Global credit derivative market growth

Table 1: Products in the credit derivative market

	2000	2002	2004	2006
Basket products (%)	6	6	4	1.8
Credit linked notes (%)	10	8	6	3.1
Credit spread options (%)	5	5	2	1.3
Equity linked credit products (%)			1	0.4
Full index trades (%)			9	30.1
Single-name credit default swaps (%)	38	45	51	32.9
Swaptions (%)			1	0.8
Synthetic CDOs (%)			16	16.3
Tranched index trades (%)			2	7.6
Others (%)	41	36	8	5.7

Source: BBA

early stages, linked to sovereign assets. More recently, however, the increase in corporate credit events has seen most credit derivatives written on corporate assets. Corporate credit events such as Delphi, Dana Corp, Delta, Enron, WorldCom, Swissair, Parmalat, Marconi, Railtrack and British Energy represent the credits most frequently referred to as triggering events. These credit derivatives have so far proven their effectiveness in buffering shocks to the global financial system. As BBA has reported, the highest number of credit events occurred in the high-yield risky sector.[7] This can be linked to the rating of underlying assets for credit derivatives, as the good-quality category has declined and conversely the low-quality category has expanded. In the same vein, the emerging credit market is considered attractive because banks are looking for higher yields and greater portfolio diversification on an international basis. On the other hand, the emerging credit market is considered to have lower credit quality than the traditional OECD market, thus credit

derivatives can provide hedging on credit quality.

The main players in the credit derivative markets are banks, securities houses, hedge funds, insurance companies, broker-dealers, special-purpose vehicles, non-financial companies and investment funds. It has emerged that many banks have already sold parts of their exposures on to other institutions. Most of the banks' derivatives volume is due to trading and a small part is related to their loan book. A potential benefit of credit derivative use by non-bank institutions (which will act as investors) is the systemic risk diversification, as can be seen in the related literature. Hedge funds have become a major participant in the credit derivative market. On the other side, the use of credit derivatives in terms of selling protection can cause losses and distress. There are many cases where financial institutions acting as insurers have expressed their concerns about losses on credit derivative products.

Finally, credit derivatives can make a bank's exposure to entire industries or even countries (sectoral and geographical diversification) more manageable. Thus, the product allows banks to stay within their internal credit limits for specific countries, even for counterparts and credit ratings. For instance, the decline in the quality of the Japanese banking system led several international lending institutions to consider credit derivatives as a way to reduce their exposure to Japan.

THE LITERATURE ON BANK BEHAVIOUR AND CREDIT DERIVATIVES

Based on BBA's market surveys, it is argued that market participants have been engaged in credit derivatives because they provide great applicability in many cases such as management of credit lines (risk and client–bank relationships), diversification of credit risk (geographic, sectoral concentration and correlation risk diversification), management of economic capital (efficient management of the opportunity costs of risk provision), management of regulatory capital (reduction in risk-weighted assets), generation of income fee and balance-sheet optimisation.[7] These challenges and opportunities for credit derivatives are reflected in several contributions in the academic literature stressing the role of credit derivatives in affecting banks' behaviour and hence the stability of the banking system.

Credit derivatives and informational asymmetries

Credit derivatives essentially affect the relationship between lenders and borrowers and create new relationships between lenders, borrowers and the buyers and sellers of credit protection. Thus, the incentives of these credit transaction parties are influenced in terms of asymmetric information, principal/agent problems and incomplete contracts, making it interesting to examine whether credit derivative contracts can affect the incentives for participants in the credit derivative market.

Issues of information asymmetries, such as adverse selection and moral hazard, are deterministic in the behaviour of banks on credit risk management. In this context, Duffee and Zhou consider that, as the magnitude of asymmetric information varies during the life of the loan (information

asymmetries between the lender and the outsiders are greater near the maturity of the loan and smaller in the early period), credit derivatives can be used by banks to reduce their risk of financial distress by transferring the loan's risk when the market for lemons is smallest[9] (the relationship between the credit protection buyer/lender and seller/borrower can become a principal/agent problem if the protection buyer acts as an agent of the protection seller). Duffee and Zhou construct a model of a bank that makes a loan with adverse selection or moral hazard problems and may use credit derivatives or loan sales with recourse (ie the ability of a loan buyer to sell the loan back to the originator if it goes bad).[9] This flexibility can be used to mitigate adverse selection problems where, due to the asymmetric information problem, the credit protection buyer/lender knows more than the credit protection seller/borrower regarding the creditworthiness of the reference asset and the probability of a credit event (a limited provision of information regarding the creditworthiness of the reference asset from the credit buyer in order to reduce the premium). Here, the lender buys protection on low-quality assets, driving up the cost of protection on high-quality assets. As Rule observes, if both buyer and seller only have access to public information about the reference asset (the asset is not unrated or has publicly traded debt), then the credit derivative premium in a competitive market would be fairly priced, reflecting the expected probability of a credit event and the expected recovery rate.[4]

In this context, Goodhart *et al*. and Duffee and Zhou also compare the implications of credit derivatives for banks' risk-sharing versus loan sales with recourse.[10,9] They stress the hazard of other markets breaking down due to credit derivatives, because that may lead to the weakening, or even disappearance of, other risk-sharing markets (eg loan sales, securitisation) and consequently to the deterioration of risk allocation. If the bank's main strategy is credit derivatives on high-quality loans, this enables it to refrain from selling other parts of its risk (of low-quality loans). This strategy destroys the equilibrium in the loan sale market where the risks of banks making high and low-quality loans are pooled. Furthermore, credit derivatives may reduce risk-sharing by discouraging banks from selling high-quality loan second-period risk, as credit derivatives are considered to be an innovative instrument because they are the only tool available to trade the risk of borrower default in the early period of the loan when loan sales cannot be applied. The bank that makes high and low-quality loans can use loan sales (with recourse) to pool risks and therefore transfer credit risk for the full term of the loans. In this case, the problem of the market for lemons may lead to issues of severe adverse selection.

From the perspective of the moral hazard problem, there may be a reduced incentive for the lender (credit protection buyer) to monitor the borrower (credit monitoring). Morrison argues that, in general, credit derivatives weaken monitoring incentives,[11] thereby developing an intermediation model. This reduced incentive can affect the borrower's choice regarding the 'second best project', as the benefits of bank monitoring are limited — borrowers forgo the benefits of bank certification when they want to issue corporate

bonds, thus causing disintermediation and welfare costs. Another dimension of the problem is when the borrower considers that, by purchasing protection for its debt, the lender creates negative credit signals about its quality with reputational effects. Further, the moral hazard considerations of Duffee and Zhou strengthen the case for credit derivatives,[9] because, by the use of credit derivatives, the bank holds the loan and weakens the loan sale market, and thus tends to monitor loans more aggressively. However, the reduction in use of loan sales may increase the likelihood of the bank's own insolvency, although this effect is offset by the value of the increase in monitoring efforts. In the same vein, Pelizzon and Nicolò use a model of banks with different levels of loan screening ability and credit portfolio risk, and consider how different types of credit derivatives (CDO, first-to-default basket) can deal better with problems of information asymmetry, such as adverse selection and moral hazard, signalling the quality of loans to be hedged with credit derivatives rather than credit default swaps, given the capital requirements that hold for credit derivatives.[12]

BIS also has identified a moral hazard case where the probability of a credit event can be influenced by the protection buyer's behaviour after the agreement with credit derivatives[6] (premature credit event triggering; this is one reason why credit restructuring was proposed to be limited as a credit event). This behaviour can raise incomplete contracting problems where the credit protection seller can refuse to fulfil the contingent payouts; however, in this case moral hazard problems can be identified. Their creditors and shareholders monitor banks' involvement in credit derivative markets and changes in their risk profiles. However, the relationship between credit protection buyers/sellers and creditors/shareholders can be eroded if these changes are not all disclosed adequately and properly.

Rule and BIS present a set of options for reducing these problems of information asymmetry.[4,6] These include: enhancement of public financial information regarding corporate and sovereign names (involvement of independent third parties in credit assessment); random selection of pooled assets (monitored by third parties); the possible reputational risk that banks may face; documentation of reputational risk; limitations on restructuring; credit monitoring; verification of credit events and assessment of the severity of losses; and more intensive use of bank internal ratings.

Credit derivatives and banks' risk-taking incentives

A part of the literature analyses bank risk-taking behaviour with the presence of CDs for hedging purposes. Indeed, it is interesting to investigate whether a bank can change its credit policy in the presence of credit derivatives.

Due to the phenomenon of credit rationing, the size of the credit market is not determined by supply and demand and the use of a range of interest rates or prices. An equilibrium credit rationing occurs whenever 'some borrower's demand for credit is turned down, even if this borrower is willing to pay all the price and nonprice elements of the loan contract'.[13] As Freixas and Rochet argue, credit rationing is expressed by the backward-bending credit supply curve due to adverse selection and moral

hazard. However, credit rationing disappears if collateral can be used as a screening device.[13] The existence of credit derivatives as a credit risk-hedging instrument can lead banks to expand their credit businesses (eg through lending to less developed countries) without concern for the additional credit exposure that this generates. As Goodhart *et al*. suggest, the introduction of credit derivatives in credit risk-management, separating the underlying lending relationship from the actual credit exposure and associated hedging benefits, may resolve a credit paradox, and, furthermore, can enhance the efficiency of risk allocation and the disappearance of arbitrage opportunities due to differences between credit market segments, making them more complete.[10] Indeed, credit derivatives can facilitate the bank's management of credit lines, freeing up credit lines to enable new business opportunities.

The question that arises is whether the bank increasing its credit portfolio via credit derivatives undertakes significant additional credit risk. Santomero and Trester suggest that the use of financial innovations has led banks to hold more risky asset portfolios,[14] using an imperfect asymmetric information framework. Thus, as assets have become more liquid, banks are willing to provide credit. In that sense, banks may have greater incentive for risk-taking, but the portfolio of banks has smaller asset liquidation risk in a crisis. On the other hand, this action from the bank, namely the asset side increase, creates the need for the bank to manage the liability side. Money centre banks can finance any insured (through credit derivatives) expansion on their asset portfolio by borrowing from the money market and other non-deposit markets for funds. Insterfjord, using a credit markets model, suggests that credit derivatives have increased the overall bank risk and that credit derivatives can be considered a destabilising factor for the banking sector, especially when the credit markets have high price elasticity, making banks more aggressive investors in credit markets.[15] In the same vein, Wagner argues that increased asset liquidity due to credit derivatives during normal times encourages banks to improve their stability by transferring their risk, but at the same time encourages banks to increase their risk-taking.[16] Using an unregulated economy model, Wagner finds banking stability equilibrium introduces increased asset liquidity and regulation. However, as banks face smaller asset losses and costs using credit derivatives during times of distress, banks have a reduced incentive to avoid crisis (eg bank run or credit crunch). However, if this liquidity is reduced due to macroeconomic factors or risk-aversion preferences, this can cause a sharper fall in asset prices.

The literature includes little empirical work on this question, although a relationship between credit risk-hedging via credit derivatives and an increase in credit supply, and consequently risk-taking, has been suggested. Using US bank data and probit regressions, Minton *et al*. test the determinants (predictors) for banks that are more likely to use credit derivatives for credit protection. They find that banks with higher shares of commercial and industrial loans (a suitable underlying instrument for a credit derivative contract) are more likely to purchase credit protection and are also more likely to use other credit risk-transfer techniques (loan sales and

securitisation).[17] This suggestion is also supported by Hirtle, where greater use of credit derivatives is associated with greater supply of bank credit for corporate long-term loans and commercial and industrial lending.[18] Hirtle uses data from US commercial banks and conducts panel data regression analysis relating credit supply to credit derivative use, loan demand and credit standards. Goderis *et al*. also find that banks adopting credit derivatives observe an increase in their loan levels.[19] They use international bank panel data and implement the generalised method of moments (GMM) in order to relate loan portfolio levels to collateralised loan obligations and other bank ratios.

Another important factor in using credit derivatives for the credit risk management of individual credit lines is the effect on the lending relationship with clients. Arping develops a model of credit protection and bank monitoring in the corporate loan market and considers the effects of credit derivative protection on banks' relational and informational incentives.[20] Arping suggests that credit protection through credit derivatives strengthens the bank when it has to intervene due to the problematic behaviour of the borrower (in the worst case, exiting from the relationship). This can create positive implications for borrower managerial incentives. Goderis and Wagner agree that banks have stronger negotiation power in the case of sovereign financing.[21] They develop a model of sovereign debt financing incorporating the bondholder (bank) that has bought credit protection and investigate the effects on the potential crisis and the restructuring efforts of the sovereign. In the case of emerging markets' debt, Ranciere notes that credit derivatives can affect debt default and restructuring following credit events, as a moral hazard phenomenon[22] (also noted by BIS[6]). This work uses an analysis with a bonds/credit derivatives basis, the default probability term function and a stress scenario. However, the case of Argentina shows that credit derivatives can prevent serious financial contagion.[23] Using a model based on the industrial organisation approach, Pausch and Schweimayer investigate possible strategic credit derivative hedging effects of management decisions concerning interest rates for loans and deposits, which seem to have an increasing effect. Competitors may react similarly in order to maintain equilibrium and optimality.[24]

Credit derivatives and banks' capital management

It would be interesting to identify any relationship between the use of credit derivatives as asset insurance and the capital stock held by the bank to offset credit losses, reinforcing capital management. Based on their probit regression estimates, Minton *et al*. find that banks with more capital are less likely to be net buyers of credit protection, and the ones that have less regulatory capital are more likely to use credit derivative protection.[17] Goderis *et al*. also find some indications that credit derivative banks tend to hold lower equity capital as a proportion of total assets compared with non-credit derivative banks.[19] However, size may be an important factor in this, as a large bank's use of advanced credit risk management tools can make it able to hold less capital. As credit derivatives can offset credit risk effectively, banks

can reduce the capital stock they hold for unexpected losses (for that reason, shareholders may prefer to use credit derivatives rather than periodic build-ups of loan loss reserves, as the latter reduce dividend pay-off), and also can lower expected losses (loan loss provisions). In this context, Moser compares the costs of credit derivative protection and loan loss provisioning using an insurance contract function and shows the credit derivatives that can replicate provisioning for loan losses.[25] If the cost of credit derivative insurance is below the loan provision amount, the bank can expand its credit. Thus, the bank finds credit derivatives preferable when the returns from investing in loans are greater than the risk-adjusted opportunity cost of the loan provisioning.

In this framework, the following section will present another aspect of the capital management interaction between credit derivatives and banks.

PRECAUTIONARY CAPITAL RESERVES

McKenzie has called for a distinction between expected and unexpected loan losses, on the basis that provisions (general provisions) for unexpected (possible) loan losses should be made and count as capital as they satisfy the traditional role of regulatory bank capital as a precautionary buffer stock against unexpected declines in asset values.[26] Specific provisions, formed against expected (actual) asset quality declines, are usually only marginally different from those that have been identified. In other words, specific provisions contain less uncertainty than do general provisions.

In the sense that provisions for unexpected loan losses may occur, banks hold general loan loss reserves and any other amount of capital in order to cover any losses due to the credit uncertainty. Loan losses may be unexpected (unpredictable); nevertheless, provisions are made in an environment of uncertainty where losses may be expected to increase. Therefore, loan loss reserves and any other amount of capital can be considered as precautionary reserves to trade off the provisions caused by asset quality uncertainty.

This section attempts to construct a model of bank behaviour that incorporates credit uncertainty (uncertainty in asset quality and repayment of invested funds). An inventory (precautionary reserves) theoretical framework is applied to determine the bank's capital holdings under the assumption that a certain stock of capital is held for absorbing asset losses. In other words, it is an analysis of a bank's optimal capital account based on costs associated with portfolio rearrangements (ie debt instrument production, and other costs generated from the possibility of bankruptcy and the bank's efforts to avoid it). As Baltensperger notes, the capital account performs an essential economic function, similar to that of liquidity reserves, namely protection against certain types of uncertainty (asset quality uncertainty, which leads to credit risk) and the associated possibility of emergency adjustments and costs.[27]

Scenario setup

Consider the following scenario, which draws on Baltensperger:[27]

- A bank has invested an amount A in assets yielding i_A, with $d\pi / dA > 0$ and $d\pi / di_A > 0$, where π is a profit

function. The bank's liabilities consist of D deposits, which are assumed to be known with certainty (it is assumed that any distortion in deposits and loans is faced by the bank which holds the necessary reserve requirements, rD). Finally, K is the capital holdings (as quantity) of the bank where $K = E + C$. E is the equity capital of the bank yielding i_E to shareholders. C can be considered as the total buffer stock of capital, which includes the capital requirements (cA). Thus, $C - cA$ is the excess capital reserves.

- In the same manner, loan quality can change due to alterations in borrowers' quality or other macroeconomic factors.
- The credit uncertainty is expressed as I, which is the income generated by the bank's assets. Following Baltensperger's framework,[27] I is known *a priori* in probabilistic form only, with density function $g(I)$ due to credit. In this analysis, credit uncertainty is expressed as negative income (asset losses) $z = n(I)$ with density function $f(z)$.
- Thus, whenever $-\infty \leq z \leq C$, the bank does not face any necessity of adjustment. Otherwise, if $K > z > C$, the bank has to adjust its asset portfolio, reducing the capital holdings of the bank (net worth of the bank).
- Moreover, the bank faces the probability of insolvency whenever the amount of assets plus the bank's income from assets is less than its debt $D(1 + i_D)$. Thus, whenever $A + I - D(1 + i_D) < 0$, the bank is in a state of insolvency. This can happen whenever $z \geq K$, where K can be considered as the economic net worth of the bank or $D(1 + i_D) - Ai_A > K$. It is clear that the probability of this event is related positively to the size of D, or negatively to $(A - D)$ or K. For simplicity, it must be made clear that insolvency costs concern both the case of insolvency and the costs caused by the bank's efforts to avoid insolvency.
- To avoid this state, the bank makes costly portfolio rearrangements, which can be expressed by a cost per unit of deficiency (d) multiplied by the size of the capital deficiency, $[(i_D + 1)D - A - I]$. However, consider that the bank may not face an actual capital deficiency, but may face the situation where its capital position falls below some critical level. The portfolio rearrangements will take place on the liability side of the bank's balance sheet. This means that the bank will try to attract more D, paying high i_D, or increase equity capital, generating opportunity cost.

Optimal capital stock in the absence of credit derivatives

In the case where the bank decides to use equity capital instead of liability funds (paying i_D) in order to avoid or, in the worst case, to face the capital deficiency, as Baltensperger stresses,[27] the bank suffers an opportunity cost of equity funds, p, where $p > i_D$. Thus, the marginal cost of increasing equity capital E is $(p - i_D)$. For simplicity in this analysis, as it does not affect the final outcome, it is assumed that the cost per unit of using new equity capital or borrowing is denoted as m. Thus, to include all these concepts, consider the following:

$$E(\pi) = i_A(A - C) - i_D D(1 - r) - d\int_{C-cA}^{C-cA+E} [z - (C - cA)]f(z)dz - dE\int_{C-cA+E}^{A} f(z)dz - m\int_{C-cA+E}^{A} [z - (C - cA) - E]f(z)dz \quad (1)$$

Maximising with respect to C, the optimal stock of capital (loan loss reserves and others) can be found:

$$F(C - cA) = \frac{(d - i_A) + (m - d)[1 - F(C - cA + E)] + m(F(A) - 1)}{d} \quad (2)$$

Thus, increases in the rates of costs of portfolio rearrangements, issuing equity capital and borrowing, and decreases in the economic value of the bank, E, all increase optimal total capital stock. Increases in c or A will raise optimal capital stock but leave optimal excess capital stock unchanged.

Credit protection through credit derivatives: The costs and benefits of hedging

Taking the above into consideration, the bank may adopt different practices, which can be expressed by considering the following reactions of the profit function variables:

- The bank using the credit derivatives (U_{CD}) will form an asset portfolio as follows. The amount of A assets that the bank holds consists of an amount which is hedged from credit risk, A_H, and the rest which is not, A_N, thus, $A = A_H + A_N$. However, the bank must hold precautionary capital stock C.
- The bank's next concern is to consider how it can increase its investment in assets (credit expansion, new asset opportunities). As the credit derivatives are applicable, the bank can invest more funds in assets. Thus, $A(U_{CD})$ can be assumed, with $dA(U_{CD}) / dU_{CD} > 0$. The credit expansion action can be absorbed by freeing up capital (buffer capital stock) or attracting more deposits, D, or money market and other non-deposit market funds. Thus $dC / dU_{CD} < 0$ and $dD / dU_{CD} > 0$.
- The bank will earn extra income by reducing the opportunity cost of holding capital reserves $i_A(C - C')$.
- The bank will earn extra income from the credit expansion led by the use of credit derivatives. This additional income can be expressed as $[A' - A](i_A - i_D)$, as the bank's cost in order to finance the new assets by borrowing from liability markets is i_D.
- Credit derivatives will change the behaviour of z (bank's asset income losses due to declines in asset quality). Due to asset portfolio diversification and the asset income insurance provided by credit derivatives, the bank's asset income losses will decline, improving bank asset profitability.
- As z decreases, the $(K - z)$ factor increases, thus the bank's capital position increases while its probability of insolvency consequently declines.
- Another issue is how the cost of buying credit insurance (P_{CD}) can be expressed. Three main factors can influence the cost: the assets amount for insurance, A_H, the quality of the assets, Q_A (which essentially is a function of z), and their maturity, T_{CD}.

Credit protection, banks' profit function and optimal capital stock

The question now is how these can be expressed. Modifying the above simple model, the paper now attempts to demonstrate how credit insurance through credit derivatives can be expressed in the profit function:

$$E(\pi) = i_A A_H + i_A(A_N - C) - i_D D(1 - r) - d \int_{C - cA_N}^{C - cA_N + E} [z - (C - cA_N)] f(z) dz - dE \int_{C - cA_N + E}^{A_N} f(z) dz$$

$$-m\int_{C-cA_N+E}^{A_N}[z-(C-cA_N)-E]f(z)dz \quad (3)$$

In this case, the profit function contains a factor of hedged assets. Thus, the bank may consider it unnecessary to hold capital stock for this fraction of assets. Moreover, the insured assets can be expressed as follows:

$$A_H=\int_{-\infty}^{0}A(z)f(z)dz+\int_{0}^{\bar{A}}[A(z)+V_{CE}(z)]f(z)dz-P_{CD}(\bar{A},Q_A(z),T_{CD})=\int_{-\infty}^{\bar{A}}A(z)f(z)dz+\int_{0}^{\bar{A}}V_{CE}(z)f(z)dz-P_{CD}(\bar{A},Q_A(z),T_{CD}) \quad (4)$$

Here, $dA(z)/dz<0$, which means that the value of assets declines as asset losses increase; $V_{CE}(z)$ is the value of the compensation obtained by the use of credit derivatives after the credit event; and $dV_{CE}(z)/dz<0$, which means that as the asset losses (the cost of credit event) increase, so the benefits from credit derivative insurance increase. Thus, from Equation 4, the first integral represents the value of the asset with respect to asset losses, the second one the value of offsetting compensation from credit derivatives, and the third factor is the cost of insurance.

Maximising with respect to C, the optimal stock of capital (loan loss reserves and others) can be found:

$$F(C-cA_N)=\frac{(d-i_A)+(m-d)[1-F(C-cA_N+E)]+m(F(A_N)-1)}{d} \quad (5)$$

Some implications of Equation 5 are straightforward and agree with outcomes from the literature reviewed previously, but certain points need further analysis and consideration. First of all, it is necessary to consider some points, which are assumed in the analysis:

- Most bank regulators are prepared to allow banks not to calculate the required capital (partially or totally) for assets, which are hedged with credit derivatives. This is applied in Equation 5 and leads to a decrease in optimal total capital stock but not in optimal excess capital stock, as the volume of assets considered for calculating the required capital decreases.
- The same result can reduce the capital requirements rate, c. This can happen only if the regulatory body recognises the other positive effects of credit derivatives (increased diversification etc).
- The question that arises is how the use of credit derivatives can influence optimal excess capital stock. As discussed previously, credit derivatives may have implications for bank management behaviour, such as credit expansion (new asset opportunities and more investments led by the decrease in optimal total capital stock), and increased profitability due to the reasons discussed previously. It is generally accepted that all the above factors can influence the economic value of a banking firm, and hence the value of its equity capital, E. Thus, an increase in E caused by the use of credit derivatives leads automatically to a decrease in optimal excess capital stock under Equation 5, which leads to further positive effects. A change in capital levels and credit expansive behaviour can have a broader impact regarding the capital regulatory framework and financial system. This is discussed in more detail below.

Further discussion regarding credit derivatives and the regulatory capital environment

In the run-up to the introduction of credit derivatives, as a supervisory approach for UK incorporated banks was still to be established, the Bank of England published a discussion paper addressing both risk management considerations and the range of possible supervisory capital requirements. Indicating the new regulatory challenge that credit derivatives would create, the Bank of England stressed that 'the more effective credit derivative products are in transferring risk, the lower the capital requirements which may be set'.[2] It added that it expected 'these capital requirements to change as banks develop more sophisticated approaches to managing credit risk, and as supervisors attempt to reflect such credit risk-management practices in the capital adequacy framework'.[2] In other words, the Bank of England felt that credit derivatives can enforce the regulatory capital management affecting regulatory capital cost. Thus, as credit derivatives become more established, there will evidently be an enforcement of credit analysis leading to internal credit risk models, as a liquid credit derivative market provides price information with the potential to improve the allocation of credit, which will be beneficial for financial stability.

The Basel II framework recognises regulatory capital relief with the use of credit derivatives in the banking book and deals with trading book and basis, residual and specific risks. More particularly, as Basel II introduces enhanced risk-sensitive capital rules, the use of credit derivatives as a hedging technique can significantly lower loss given default (LGD) values.[28] However, the Basel II framework does not realise any capital relief from one of the most important economic risk benefits of credit derivatives, and that is the portfolio default correlation and diversification effects. The Basel II framework is likely to give more flexibility to national supervisors to work with the banking industry in their own country and develop standards regarding the economic capital required for each bank. These could be based on each bank's strategy, risk preference, internal controls and management efficiency. The Basel II implementation framework contains issues worth examining, such as how the new exposure risk weights will influence banks' incentive to generate capital relief through credit derivatives, how the new guidelines will affect participants in the credit derivative market, and what type of instrument will be chosen to obtain capital relief.

While regulated institutions often focus on capital standards, all leading regulators are becoming more explicit about the need for good risk management and transparency, mainly because of the complexity of credit derivatives. Regulators provide high-level guidance, emphasising the need for vigorous controls, designed and applied by the regulated institutions. Regulators state the requirement for risk management and transparency according to Pillars II and III of the Basel II framework (ie improved published data on credit derivative positions and net exposures). Interestingly, market participants have started building mechanisms to increase transparency (ISDA documentation, international accounting standards) and market

monitoring tools. For example, two single European and US credit default swap indices (iTraxx and CDX) were launched in 2004, and three banks active in the credit derivative market (Deutsche Bank, JP Morgan Chase and Goldman Sachs) have evolved a pooled database of companies on which credit derivative contracts are made (RED: Reference Entity Database). Moreover, through the publication of special reports, credit-rating agencies (Standard & Poor's, Moody's and Fitch-IBCA) have tried to monitor the asset quality of corporates and the like in order to increase investors' ability to monitor the performance of credit derivatives and CDOs.

INTERACTIONS BETWEEN CREDIT DERIVATIVE MARKETS, FINANCIAL STABILITY AND OTHER REGULATORY ISSUES

Credit derivatives and systemic risks

Another potential implication of credit derivatives for financial stability is with regard to bank systemic risk. Goodhart *et al*. support that the improper application of credit derivatives can increase systemic risk.[10] This may happen when banks pursue highly-aggressive credit expansion leading to concentrated credit risk positions and less incentive to monitor the creditworthiness of borrowers (although Rule argues that a less dependent supply of credit impacts on banks' willingness and ability to take credit risk and makes credit crunches less likely[4]). Goodhart *et al*. also suggest that, as credit derivatives can be used by banks to take highly-leveraged positions, so improper internal capital allocation by a limited number of banks as market makers may have negative effects on the banking system when one of them defaults. That said, the improper use of credit derivatives by small and medium-sized banks (due to the lack of highly-sophisticated risk management techniques) may also lead them to financial distress and raise a problem for deposit insurance funds, but without any systemic concerns.

A point that concerns financial regulators is whether and how credit derivatives spread risks to other financial sectors. Generally, it is argued that credit derivatives can spread risks from the banking sector to the non-bank sector. Goodhart *et al*. contend that if some banking risks can be offloaded onto non-banks (insurance companies, securities houses, hedge funds, pension funds, corporates, etc), this should decrease systemic risk, because non-banking systems do not demonstrate systemic risk characteristics.[10] However, this transfer of risk makes it more difficult for creditors, credit-rating agencies, regulators and central banks to investigate the actual credit risk level of the individual banking firm or the banking system as a whole. Thus, if banks hold more diversified credit portfolios, they will be more flexible in terms of offsetting idiosyncratic or sectoral asset prices shocks. Indeed, this is an aspect of efficient credit risk allocation which is separate from banks' credit policy. However, some financial regulators and supervisors have voiced concern that credit derivatives could create concentrations of risk, built up in alternative financial institutions or sectors of the financial system, or where the risk might not have been transferred adequately. In such cases, corporate and

country-level failures with contagious effects can send out an amplified shock to all sectors of the financial system. As Rule points out, it is hard to track and monitor this transfer of risk because risk is not accompanied by flows of funds; there is no adequate information about the volume of loans and other debt transferred or hedged by banks.[29] Certainly, credit risk transfers from banks to insurance companies have been found. However, this transfer does not suggest that the financial system is in immediate danger. Chan-Lau and Ong indicate that the credit derivative market does not implicitly pose a substantial threat to financial sector stability in the UK as the diversification of exposures across financial institutions is sufficient to limit any shock effects.[30] They implement vector autoregressions in order to examine the impact of volatility in the credit derivative market (iTraxx) on the stock price returns of selected financial companies. In the same vein, Wagner and Marsh suggest that the transfer of credit risk from the banking sector to other financial sectors is preferable and improves financial stability better than reallocating additional risk within the sector, which is a destabilising factor.[31] They employ a financial intermediation model with both market and bank financing in an economy where credit derivatives can transfer credit risk from bank to bank and bank to non-bank financial institutions. Wagner suggests that, by undertaking more risk through increased asset liquidity, banks have a negative impact on stability within the banking system[16] as increased bank asset liquidity means lower costs for the individual bank when a crisis takes place.

Given this transfer procedure, some five issues arise: first, the interdependence between banks and insurance companies through counterparty risk; secondly, the impact of high credit losses on financial stability for those financial institutions that sell extreme 'excess of loss' credit protection; thirdly, the behavioural consequences of external ratings-based regimes; fourthly, the incentive for regulatory arbitrage; and finally, the possibility of credit risk returning to the banking sector.[29]

Other regulatory issues

BIS has investigated how different risk management approaches and different regulatory designs in different financial sectors can affect risk redistribution.[32] Wagner and Marsh conclude that the different designs (which cause regulatory arbitrage opportunities) create the right incentive to form an optimal allocation of risk across sectors.[31] However, Insterfjord notes that any regulatory effort without substantial analysis in order to face systemic risk from credit derivatives can have a negative impact on the potential benefits to consumers of credit.[15] From the perspective of a central bank, Trichet stresses strongly that credit derivatives can enhance financial stability only if credit risks are priced and managed efficiently; furthermore, there must be heterogeneity in the behaviour and risk profile of market participants in order to avoid herd behaviour during bad market conditions as this will cause systemic liquidity stress.[33] Based on the above analysis, one can see that banks have altered their credit decision-making process and their business model as providers of credit risks and assets to other market participants, sometimes with different characteristics, causing a

more general transformation of how the financial system operates. Indeed, Trichet calls for further investigation into whether credit derivatives can affect monetary policy conduct, especially given that credit default swap premia may be sensitive to financial conditions, making the economy more sensitive to credit markets.[33]

Regulators should also consider that credit derivatives, as a form of derivatives instrument, expose the user to new risks (but already identified by the use of the interest rate, equity and foreign exchange rate derivatives). These risks are operational risks (including strategic and reputational risks); counterparty risk (the main concern regards the correlation between the credit quality of reference asset and counterparty during economic slowdowns or financial crisis when financial fragility may occur for both counterparts)[4]; liquidity risk (by not being able to sell or offset a previously established position); price risk (because of the lack of historical performance information available); transaction and legal risks; model risks; and rating agency risks.[34] In the manner of Basel II, regulators could impose increased capital requirements for credit derivatives, but as Wagner explains, as asset liquidity increases, banks can make capital requirements less effective.[16] As such, it may be more effective to adopt sanctions such as reducing compensation for bank owners in the event of a bank closure.

CONCLUSIONS

The evidence indicates that, as credit risk derivatives provide effective insurance on the assets of banks, so they will have an impact on the behaviour of banks. As unexpected losses and economic risks are manageable through portfolio rearrangements in order to reformulate capital structure and enforce asset diversification in cases of geographical and sectoral concentration, so credit derivatives make it possible to reduce the level (and therefore opportunity cost) of capital precautionary reserves (eg capital adequacy levels). In the same vein, the expected losses caused by asset quality declines generating reduced general and specific provisions. Additionally, these products promote bank–customer relationships, allowing the bank to preserve the client, even if its limit is fully covered.

However, the use of credit derivatives by banks creates opportunity for further risk-taking through aggressive credit expansion and, due to different characteristics concerning informational asymmetries, may create disequilibrium in other credit risk-transfer markets. For the individual bank, the high cost of rearranging its portfolio sufficiently quickly to avoid the loss of public confidence will adversely affect its regular activities and may affect financial stability, increasing the probability of insolvency. On the other side, credit insurance generates a cost (due to information asymmetries between the insured and the insurer — adverse selection problems — and so a premium may be charged for insurance contracts that fail to protect the insurer against the information disadvantages). Many banks are unwilling to pay for such protection because it can cost more than the amount charged to the customer.

A dynamic of credit derivatives is the promotion of refinements in credit portfolio management. This effect, in addition to the phenomenon of credit risk that is more widely shared among

banks and other financial institutions, may change the nature of prudential bank regulation. This can be reflected in capital standards that should reflect the influence of the regulatory authorities (eg Financial Services Authority) as well as consider the implications of diversification and credit risk concentration following credit derivative use. Looking more widely, the growth of credit derivatives may change the nature of banking due to the existence of market weaknesses such as inadequate pricing or information inefficiencies creating large systemic transaction costs for all market participants. As Hirani and McEvoy argue, only the most significant and sophisticated financial institutions participate as end users in the market because many issues should be required, such as mechanisms of risk transfer, internal and regulatory capital treatment, accounting and documentation treatment and infrastructure costs (eg high-quality human resources and labour intensiveness).[35]

This paper has demonstrated how credit derivatives affect the behaviour of banks. When combined with proper hedging design, portfolio management techniques, default modelling and other credit transfer techniques, credit derivatives enhance traditional credit risk management practices. Given their role in enhancing portfolio diversification and increasing return on capital, and the accelerating liquidity in the credit markets, the evolution of contributions on credit derivatives is certain to continue in the future.

Note

The views expressed here are those of the author and do not represent those of Emporiki Bank.

References

1 Altman, E. I. (2002) 'Managing credit risk: A challenge for the new millennium', *Economic Notes-Banca Monte dei Paschi di Siena*, Vol. 31, No. 2, pp. 201–214.

2 Bank of England (1996) 'Developing a supervisory approach to credit derivatives', Supervision and Surveillance Discussion Paper, November, Bank of England, London.

3 Neal, R. S. (1996) 'Credit derivatives: New financial instruments for controlling credit risk', *Economic Review*, Second Quarter, Federal Reserve Bank of Kansas City, Kansas City.

4 Rule, D. (2001) 'The credit derivatives market: Its development and possible implications for financial stability', *Financial Stability Review*, No. 10, Bank of England, London, pp. 127–140.

5 Goodman, L. S. (2002) 'Synthetic CDOs: An introduction', *Journal of Derivatives*, Vol. 9, No. 3, Spring, pp. 60–72.

6 Bank for International Settlements (2003) 'Credit Risk Transfer', BIS, Basel.

7 British Bankers' Association (1996, 1997/1998, 1999/2000, 2001/2002, 2004, 2006) 'Credit Derivatives Report', BBA, London.

8 Bank for International Settlements, 'The global OTC derivatives market — Triennial central bank survey of foreign exchange and derivatives market activity', press release, BIS, Basel.

9 Duffee, G. R. and Zhou, C. (2001) 'Credit derivatives in banking: Useful tools for managing risk?', *Journal of Monetary Economics*, Vol. 48, No. 1, pp. 25–55.

10 Goodhart, C., Hartmann, P., Llewellyn, D., Rojas-Suarez, L. and Weisbrod, S. (1998) 'Financial Regulation: Why, How and Where Now?', Routledge, London.

11 Morrison, A. D. (2005) 'Credit derivatives, disintermediation and

investment decisions', *Journal of Business*, Vol. 78, No. 2, pp. 621–647.
12 Pelizzon, L. and Nicolò, A. (2005) 'Credit derivatives: Capital requirements and strategic contracting', Working Paper No. 6, Dipartimento di Scienze Economiche 'Marco Fanno', Universita Degli Studi di Padova.
13 Freixas, X. and Rochet, J. C. (1997) 'Microeconomics of Banking', MIT Press, MA.
14 Santomero, A. M. and Trester, J. J. (1998) 'Financial innovation and risk taking', *Journal of Economic Behaviour and Organisation*, Vol. 35, No. 1, pp. 25–37.
15 Insterfjord, N. (2005) 'Risk and hedging: Do credit derivatives increase bank risk?', *Journal of Banking and Finance*, Vol. 29, No. 2, pp. 333–345.
16 Wagner, W. (2007) 'The liquidity of bank assets and banking stability', *Journal of Banking and Finance*, Vol. 31, No. 1, pp. 121–139.
17 Minton, B. A., Stulz, R. and Williamson, R. (2005) 'How much do banks use credit derivatives to reduce risk?', NBER Working Paper No. 115–79, National Bureau of Economic Research, MA.
18 Hirtle, B. (2007) 'Credit derivatives and bank credit supply', Federal Reserve Bank of New York Staff Report No. 276, Federal Reserve Bank of New York, New York, NY.
19 Goderis, B., Marsh, I. W., Castello, J. and Wagner, W. (2007) 'Bank behaviour with access to credit risk-transfer markets', Bank of Finland Discussion Paper No. 4, Bank of Finland, Helsinki.
20 Arping, S. (2005) 'Playing hardball: Relationship banking in the age of credit derivatives', paper presented at workshop on Applied Banking Research on 'Accounting, Transparency and Bank Stability', organised by the Basel Committee on Banking Supervision, Vienna, 17–18th May, 2004.
21 Goderis, B. and Wagner, W. (2005) 'Credit Derivatives and Sovereign Debt Crises', Cambridge University Press, Mimeo.
22 Ranciere, R. (2001) 'Credit derivatives in emerging markets', International Capital Markets, IMF Policy Discussion Paper, International Monetary Fund, Washington, DC.
23 Beattie, J. (2000) 'Contagion in Latin America: An analysis of credit derivatives', available at: www.defaultrisk.com/pp_crdrv_10.htm (accessed 1st November, 2007).
24 Pausch, T. and Schweimayer, G. (2004) 'Hedging with credit derivatives and its strategic role in banking competition', Discussion Paper No. 260, Institut fur Volkswirtschaftslehre, University of Augsburg, Augsburg.
25 Moser, J. T. (1998) 'Credit derivatives: Just-in-time provisioning for loan losses', *Economic Perspectives*, Fourth Quarter, Federal Reserve Bank of Chicago, Chicago, IL.
26 McKenzie, G. (1996) 'Loan loss provisions and bank buffer stock capital', *Applied Financial Economics*, Vol. 6, No. 3, pp. 213–223.
27 Baltensperger, E. (1980) 'Alternative approaches to the theory of the banking firm', *Journal of Monetary Economics*, Vol. 6, pp. 137.
28 Basel Committee on Banking Supervision (2005) 'A New Capital Adequacy Framework', BIS, Basel.
29 Rule, D. (2001) 'Risk transfer between banks, insurance companies and capital markets: An overview', *Financial Stability Review*, No. 11, December, Bank of England, London, pp. 137–159.
30 Chan-Lau, J. A. and Ong, L. L. (2006) 'The credit risk-transfer market and stability implications for UK financial institutions', Monetary and Financial Systems Department, IMF Working Paper, International Monetary Fund, Washington, DC.
31 Wagner, W. and Marsh, I. (2006)

'Credit risk transfer and financial sector stability', *Journal of Financial Stability*, Vol. 2, No. 2, pp. 173–193.

32 Bank for International Settlements (2001) 'Risk Management Practices and Regulatory Capital: Cross-Sectional Comparison', Joint Forum, Basel Committee on Banking Supervision, November, BIS, Basel.

33 Trichet, J. C. (2007) 'Some reflections on the development of credit derivatives', Keynote Address at the 22nd Annual General Meeting of the International Swaps and Derivatives Association, European Central Bank, Boston, MA, 18th April, 2007.

34 Weithers, T. (2007) 'Credit derivatives, macro risks and systemic risks', *Economic Review*, Fourth Quarter, Federal Reserve Bank of Atlanta, Atlanta, GA.

35 Hirani, G. S. and McEvoy, J. P. (1999) 'Challenges and opportunities for the credit derivatives market', *The Journal of Lending & Credit Risk Management*, Vol. 82, No. 4, December, pp. 82–88.