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CHAPTER 1

ASSESSING RISKS TO GLOBAL FINANCIAL STABILITY

What began as a fairly contained deterioration in portions of the U.S. subprime market has metastasized into severe dislocations in broader credit and funding markets that now pose risks to the macroeconomic outlook in the United States and globally. This chapter first examines the deepening of losses in the U.S. subprime mortgage market and the potential breadth of credit deterioration amid significant economic slowing along with declines in real estate prices. Estimates of potential losses and an analysis of their systemic effects are discussed next, including the potential reverberations through financial guarantors, and spillovers to emerging market countries. The linkages through the credit channel to output growth are empirically examined and two potential downside scenarios are explored. Against the backdrop of continued weakness in global credit markets and threats to financial stability, the chapter concludes with some immediate policy measures to help foster counterparty confidence and to contain further downside risks.

Overall risks to financial stability have increased sharply since the October 2007 *Global Financial Stability Report* (GFSR). The crisis that originated in a small segment of the U.S. mortgage market has spread to broader cross-border credit and funding markets through both direct (via exposure to subprime mortgage markets) and indirect (via perturbations in banking and funding markets) channels. A broadening deterioration of credit is likely to put added pressure on systemically important financial institutions. The risks of a credit crunch have increased, threatening economic growth. In turn, the potential for spillovers to emerging markets has increased through funding channels and trade linkages.

Global Financial Stability Map

The global financial stability map (Figure 1.1) presents an overall assessment of how changes in underlying conditions and risk factors bear on global financial stability in the period ahead.[1] Nearly all the elements of the map point to a degradation of financial stability, with credit and macroeconomic risks having deteriorated the most.

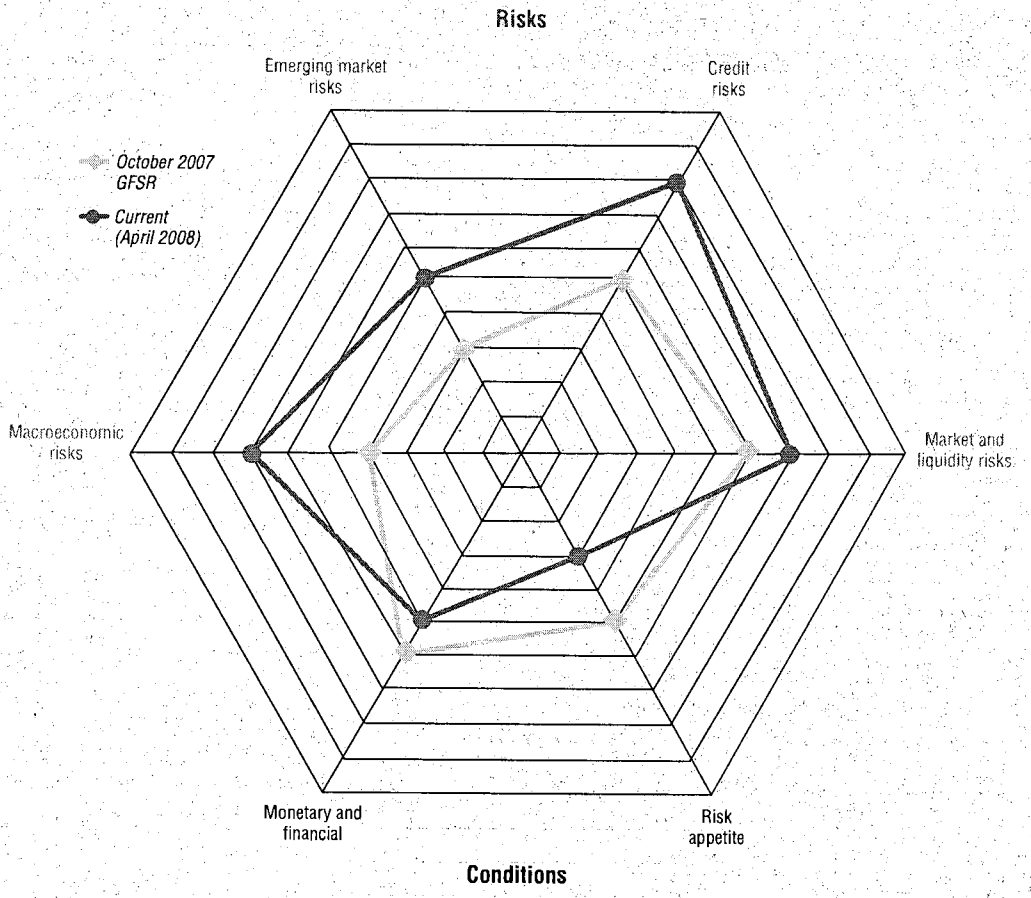
Downside risks to the macroeconomy...

A significant increase in risks to financial stability stems from an increase in our assessment of *macroeconomic risks*. Since the October 2007 GFSR, concerns about the potential for a significant economic slowdown have been reinforced by a string of weaker-than-expected economic data and weaker confidence in

Note: This chapter was written by a team led by Peter Dattels and comprised of Sergei Antoshin, Sean Craig, Martin Edmonds, Kristian Hartelius, Phil de Imus, Rebecca McCaughrin, Ken Miyajima, Michael Moore, Chris Morris, Mustafa Saiyid, Ian Tower, and Chris Walker.

[1]Annex 1.1 details how indicators that compose the rays of the map are measured and interpreted. The map provides a schematic presentation that incorporates a degree of judgment, serving as a starting point for further analysis.

Figure 1.1. Global Financial Stability Map



Source: IMF staff estimates.
Note: Closer to center signifies less risk or tighter conditions.

the United States and other mature markets, underscored by a sharp dip in leading global growth indicators. The *World Economic Outlook* (WEO) baseline projection is for global growth to moderate to 3.7 percent in 2008. However at this juncture, the macroeconomic outlook is clouded by a great deal of uncertainty, and risks to the baseline case are skewed to the downside. The key risk to the economic outlook appears to be unfolding. In particular, the dislocations in credit and funding markets are beginning to restrict the overall provision and channeling of credit.

Downside macroeconomic risks that are concentrated in the U.S. economy have a significant impact on systemically important financial institutions that may spill over to global markets. Of particular importance for financial stability are the linkages between the real and financial sector, including the effects of credit or financial decelerators on the real economy, the extent of balance sheet adjustments, and the absorptive capacity of financial markets. Our analysis indicates that a contraction in the supply of private sector credit and market borrowings could bring a significant slowdown in U.S. output growth in

the following several quarters, as some securitization markets are functioning poorly in the wake of the crisis and banks are seeking to repair their balance sheets (see the section entitled "Credit Squeeze or Credit Crunch?"). Europe is also at risk, given the size of bank losses and disruptions in bank funding and securitization markets.

...threaten a deeper and wider deterioration in credit beyond subprime mortgages, weakening the capital and funding positions of systemically important financial institutions.

The increase of macroeconomic risks contributes to raising our assessment of *credit risks.*[2] This assessment reflects the potential for a sharper slowdown in U.S. and global growth, which, coupled with past credit indiscipline, has heightened strains on the capital of systemically important financial institutions.

Credit deterioration has widened beyond subprime mortgages, and mark-to-market losses have mounted as markets anticipate a more difficult economic and financial environment. Nonprime mortgage losses have continued to rise, while the credit performance of higher-quality residential mortgages, commercial mortgages, and consumer credit products has also begun to weaken (see the section entitled "Systemic Risks Have Risen Sharply").

An area of specific concern is the leveraged segment of the corporate debt market. As flagged in prior GFSRs, weak credit discipline in the mortgage market had also figured in leveraged corporate financing in recent years, as reflected by elevated low-tier corporate debt issuance and the marked rise in covenant-lite loans, fewer creditworthy deals, and high leverage and price multiples in the leveraged buyout sector. Defaults have already begun to rise on U.S. and European high-yield corporate debt, albeit from historically low levels, as higher spreads and diminished liquidity have put pressure on stressed companies.

Difficulties faced by institutions that underwrite credit risk have exacerbated systemic concerns. Financial guarantors that sold credit enhancements on mortgage-related products containing subprime assets have come under pressure as losses on structured securities have mounted. This poses risks for the municipal bond market, where half of the market is insured by financial guarantors, and for banks and other markets that rely on insurance provided by financial guarantors.

Higher market and liquidity risks underscore the uncertainty surrounding economic and systemic spillovers...

Reflecting the exposure of systemically important financial institutions to credit markets and the potential rise in market losses, we have raised our assessment of *market and liquidity risks* (signifying higher risks to financial stability).[3] Strains in interbank money markets have intensified since the October 2007 GFSR, and the composite indicator of funding and market liquidity risks indicates that pressures exceeded levels observed during the market turbulence in 1998. Coordinated central bank actions have eased some of the liquidity strains, but pressures in term money markets have recently intensified, reflecting growing concerns about counterparty credit risk. Meanwhile, volatility has continued to rise across major asset classes to a level comparable to earlier in this decade, reflecting uncertainty associated with the size and location of credit losses as well as valuations of structured products. This leaves financial institutions—most recently hedge funds—vulnerable to mutually enforcing funding and market liquidity spirals, in which investors sell assets to meet funding requirements, creating price declines, a loss of confidence, and further funding pressures (see Chapter 3).

[2]Credit risks measure changes in credit quality that have the potential for creating losses resulting in stress to systemically important financial institutions.

[3]Indicators on market and liquidity risks measure the potential for instability in funding and pricing risks that could result in broader spillovers and/or mark-to-market losses.

...and risk appetite has continued to retrench, restricting flows of global capital and forcing a further deleveraging in the financial system.

Investor *risk appetite* has diminished partly owing to greater uncertainty over the economic outlook, but also in reaction to a loss of confidence in structured finance and a collapse in some funding markets, which has forced a broad deleveraging in the financial system and threatens a disorderly adjustment of markets and further strains on bank balance sheets.

Monetary policy easing has been offset by a tightening of financial conditions.

Since the October 2007 GFSR, real short-term interest rates have declined across a range of economies, owing to a combination of the easing in monetary policy and actions by global central banks. As a result of the weaker economic outlook, markets are pricing in even more monetary policy easing across a range of economies. However, the easing in monetary policy to date has been offset by the sharp repricing in credit and funding markets, resulting in slightly tighter *monetary and financial conditions* overall.[4] The repricing has been triggered by tighter lending conditions across the major economies, making credit more difficult to access for corporates and households. Faced with the increasing probability of unintended balance sheet expansion and losses, banks have become increasingly reluctant to extend credit while securitization markets may remain impaired. Combined with widening spreads, this increases the risks to the economy of a credit crunch.

Emerging markets have so far been resilient, but strains are already evident in those economies most vulnerable to a repricing of credit risks and restricting of external funding.

Unlike past financial crises, emerging markets have remained relatively resilient, supported by solid fundamentals, prudent macroeconomic policies, and financial cushions built up over recent years. However, we have raised our assessment of *emerging market risks*, as the market turmoil has exacerbated vulnerabilities in a number of emerging markets—notably in some countries in emerging Europe that had relied excessively on foreign bank credit or wholesale funding to finance rapid domestic credit expansion (see the section entitled "Will Emerging Markets Remain Resilient?").

The risk of potential funding pressures stemming from over-reliance on external portfolio inflows and bank loans was a key theme in the October 2007 GFSR (IMF, 2007a), and these risks have since become more pronounced. Broader emerging sovereign risks have also risen, albeit from historic lows, primarily due to deterioration in financial fundamentals. Markets are concerned that emerging economies will become increasingly linked to mature economies if the latter's growth continues to slow.

Credit Deterioration—How Deep and Widespread?

The U.S. nonprime mortgage sector continues to deteriorate.[5]

As detailed in the April 2007 GFSR, the deterioration in the U.S. nonprime mortgage market initially reflected a combination of lax underwriting standards, "risk layering," and

[4]Monetary and financial conditions represent a broader measure than that presented in the WEO, in that they incorporate both quantity and price aspects, whereas the WEO metric only captures price effects. See Annex 1.1 for further details and Figure 1.4 in the April 2008 WEO (IMF, 2008).

[5]Nonprime refers primarily to subprime and alt-A mortgages. Subprime loans are typically made to borrowers that display one or more of the following characteristics at the time of origination: weakened credit histories that include payment delinquencies and bankruptcies; reduced repayment capacity as measured by credit scores or debt-to-income ratios; or incomplete credit histories. Alt-A mortgages, though of higher quality than subprime mortgages, are considered lower credit quality than prime mortgages due to one or more nonstandard features related to the borrower, property, or loan.

adverse trends in employment and income in certain U.S. regions (IMF, 2007b).[6] Since then, delinquency rates on subprime mortgage loans originated in 2005–06 have continued to rise, exceeding the highest rates recorded on any prior vintage (at comparable seasoning). Mortgages originated in 2007 are on track to perform even worse, based on their current trajectory. With declines in U.S. home prices, recent vintages will have lower (and possibly negative) equity cushions, a greater probability of becoming delinquent, and lower recovery rates on foreclosure. Within recent cohorts, the deterioration has been primarily associated with the least creditworthy borrowers defaulting on adjustable-rate mortgages (ARMs).[7] Going forward, as initial "teaser" rates on ARMs expire, the rise in interest payments is likely to cause a further rise in delinquencies.[8]

Lax underwriting standards also played a role in higher-quality segments of the U.S. mortgage universe, but downward real estate prices and the employment rate are now the key drivers.

The same pattern of weakly performing recent vintages has emerged in higher-quality alt-A and nonagency prime ("jumbo") sectors, although the degree of underperformance is much lower (Figure 1.2).[9] Delinquencies on prime mortgages are more significantly driven by weakness in underlying economic fundamentals.[10] However, most prime borrowers have more equity cushion to withstand possible future headwinds, including interest rate resets. Even with the declines in nationwide home prices, on average, outstanding mortgage equity stands at 40 to 50 percent of home value on ARMs extended to prime borrowers, compared with less than 5 percent for subprime borrowers. Going forward, however, if home prices continue to fall and other macroeconomic fundamentals weaken, there is a risk of higher defaults on prime mortgages, especially on recent vintages. Reflecting the deterioration in the underlying collateral, prices have continued to slide on nonagency securitized mortgages (Figure 1.3).

Some similar features are beginning to emerge in Europe, as housing cycles start to turn.

European housing and mortgage markets have unique characteristics that vary considerably from country to country. Signs of a downturn are becoming evident in certain European housing markets. Market pricing of property derivatives points to outright home price declines in the United Kingdom, following

[6]"Risk layering" refers to the practice whereby mortgage lenders combine nontraditional mortgages with weaker credit controls, for instance, by accepting high combined loan-to-value ratios, reduced documentation, and little or no downpayment.

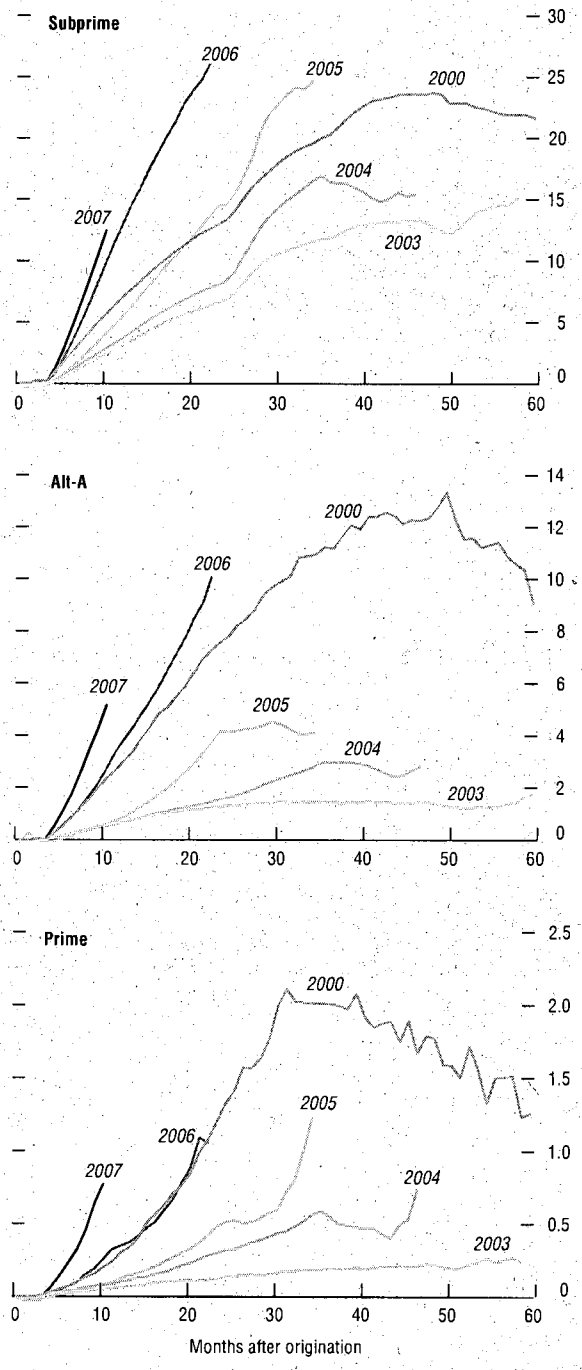
[7]As of the third quarter of 2007, 43 percent of foreclosures were on subprime ARMs, 19 percent on prime ARMs, 18 percent on prime fixed-rate mortgages, 12 percent on subprime fixed-rate mortgages, and 9 percent on loans with insurance protection from the Federal Housing Administration. That foreclosures have been dominated by ARMs likely reflects the shift in the mortgage landscape from fixed to floating rates over the last few years. Indeed, anecdotal evidence suggests that foreclosures have primarily occurred well ahead of the reset period, suggesting that the deterioration thus far has been a function of fraud, speculation, over-extension by borrowers, and the effects of weak underwriting standards.

[8]In 2008, $250 billion of subprime mortgages are scheduled to reset, versus $82 billion in prime mortgages and $29 billion in alt-A mortgages. Easier monetary policy (and hence lower six-month LIBOR rates to which ARMs are traditionally indexed) helps to alleviate, but not fully eliminate, some payment shock as ARMs reset. IMF staff estimates suggest that average monthly payments on subprime mortgages will still rise by roughly 15 percent upon reset, while alt-A and jumbo interest-only ARMs will be subject to even higher payment shock, as borrowers are required to amortize their principal at the initial reset. Moreover, it will be difficult for borrowers to benefit fully from any further monetary policy easing, since most ARMs have floors and caps. Refinancing would be difficult in the current environment of tighter lending conditions or just as costly, since fixed rates on mortgages are still elevated.

[9]The prime mortgage market is comprised of loans, which conform to the standards of government-sponsored entities (GSEs), and jumbo loans extended to creditworthy borrowers who do not conform to the GSEs' criteria for securitization.

[10]Econometric work suggests that the deterioration in lending standards typically contributes only partially to the deterioration in prime mortgage performance, with other factors, especially the unemployment rate, proving to be a more important determinant.

Figure 1.2. Mortgage Delinquencies by Vintage Year
(60+ day delinquencies, in percent of balance)



Sources: Merrill Lynch; and LoanPerformance.

the U.S. trajectory with a one- to two-year lag (though with a shortage of participants seeking to take long positions, property derivative markets can be fairly illiquid, failing fully to reflect market views). In other over-extended markets (see Box 3.1 in the April 2008 WEO), industry analysts are also forecasting declines in home prices (Figure 1.4). In addition, in the United Kingdom a sizable share of mortgage loans face interest rates that will reset to higher levels this year, just at a time when lenders are tightening standards, adding another source of stress.[11] Nevertheless, underlying collateral performance remains strong in Europe. As a result, recent prime delinquencies are trending in line or lower relative to prior vintages, and loss rates remain low. More conservative mortgage financing arrangements in European countries suggest effects of house price declines will likely be more muted than those in the United States.

If growth slows in Europe, as predicted in the latest WEO, repossessions and write-offs will rise. Some analysts foresee a near doubling of repossessions in the United Kingdom, for example, pushing writedowns to 1.4 percent of total mortgages outstanding or around $32 billion, driven mainly by nonprime and high loan-to-value loans.[12] Delinquency rates on UK nonconforming loans would therefore rise (Figure 1.5).

Spillovers have emerged in the U.S. commercial real estate sector, which is unlikely to remain insulated from a cyclical deterioration and tightening in financing conditions.

The $3.3 trillion commercial real estate market, like the residential market, has experienced rising property prices, rapid origination growth, and increasing securitization, and has also begun to show signs of strain (Figure 1.6). Property price appreciation has already slowed

[11]Many UK borrowers coming off fixed rates will face rate increases of 100 to 200 basis points.

[12]As mentioned in the October 2007 GFSR, UK nonconforming loans have some features in common with U.S. nonprime loans (IMF, 2007a). Lending criteria for UK nonconforming loans were tightened in late 2007 and early 2008.

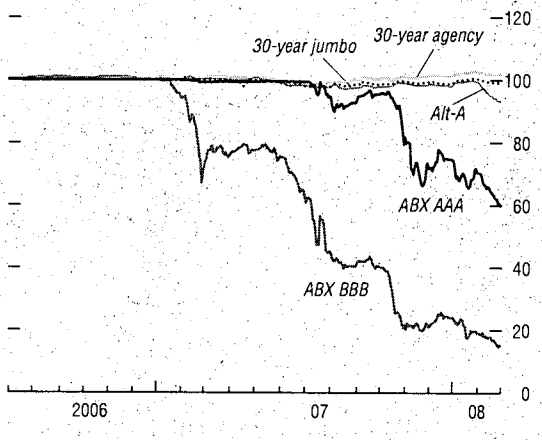
and securitization has stalled so far this year. Although product innovation and risk layering techniques have been less widespread, loan-to-value ratios have risen, debt service coverage ratios have dropped, and an increasing share of loans have been originated under looser standards.[13] So far, delinquency and loss rates have remained low as rents have stayed high and vacancy rates low. However, the weaker U.S. economic outlook, combined with tighter lending standards, is likely to lead to increasing losses, particularly on recently originated loans. Commercial mortgage-backed security (CMBS) spreads have widened to near-record levels, even on the highest-rated tranches, implying market expectations for default and loss rates worse than any yet experienced in the U.S. commercial property market (Figure 1.7).[14]

There are notable differences, though, that may prevent the risks to the commercial real estate sector from intensifying to the same extent as in the residential mortgage sector. First, only about one-quarter of the commercial real estate sector is securitized, substantially lower than the 80 to 90 percent securitization rates observed in the subprime residential market at its peak, and there is less repackaging into structured products. This should increase the "skin in the game" for the sector as a whole. Second, commercial mortgage borrowers are less likely to face payment shocks associated with resetting mortgage rates, since most commercial mortgages are standard, 7- to 10-year fixed-rate loans. Third, borrowers in the commercial sec-

[13]For instance, an increasing proportion of new loans were full-term, interest-only loans. Such loans do not amortize until the final payment, and thus offer less amortization over the life of the loan than other types of mortgages. In addition, subordination levels in securitized products declined, typical of the countercyclical pattern observed in rating cycles. Only in early 2007 did the major rating agencies begin to require higher subordination levels on new deals, leading to some improvement in credit quality later in the year.

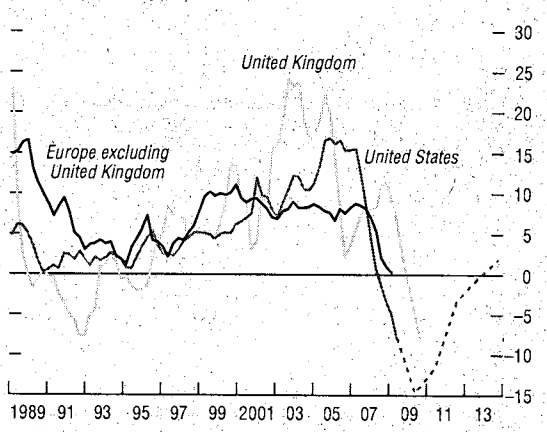
[14]Technical factors may have played a role in the spread widening, as speculative and hedging activity shifted from the ABX to the CMBX, indices of credit default swaps linked to a subset of underlying subprime and commercial mortgage-backed securities, respectively.

Figure 1.3. U.S. Mortgage-Related Securities Prices



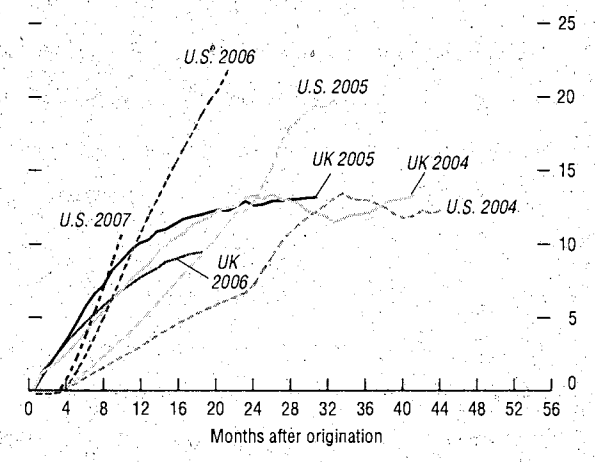
Sources: JPMorgan Chase & Co.; and Lehman Brothers.
Note: ABX = an index of credit default swaps on mortgage-related asset-backed securities.

Figure 1.4. U.S. and European House Price Changes
(Percent year-on-year)



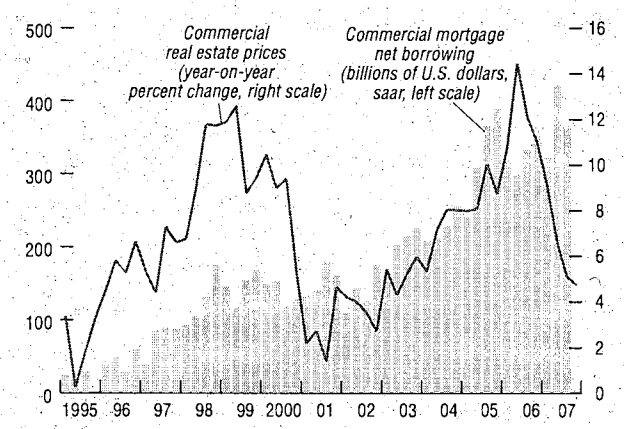
Sources: Standard & Poor's/Case Shiller; national authorities; and IMF staff estimates.
Note: Europe excluding the United Kingdom: unweighted average of Spain, Germany, Italy, Netherlands, Greece (from 1995), and Ireland (from 1997). Estimates are based on futures prices. Dashed lines are futures implied.

Figure 1.5. U.S. and UK Nonconforming Delinquencies by Mortgage Vintage Year
(In percent of balance)



Sources: Fitch Ratings; LoanPerformance; Merrill Lynch; and IMF estimates.
Note: UK delinquencies for 90+ days; U.S. delinquencies for 60+ days.

Figure 1.6. Commercial Mortgage Borrowing and Real Estate Prices



Sources: Federal Reserve; and Standard and Poor's.
Note: saar = seasonally-adjusted annual rate.

tor typically have audited financial statements, which should help keep the incidence of fraud well below that observed in the residential subprime sector.

Concerns about the economic outlook and tighter lending conditions are also starting to weigh on U.S. consumer credit markets.

Despite the weakening in mortgage markets, credit quality in the $2.5 trillion U.S. consumer debt market has remained fairly strong, suggesting that some borrowers have made it a priority to stay current on credit card and auto debts.[15] Delinquency and charge-off rates have picked up slightly since late 2005 across the various consumer credit markets, but remain low relative to levels observed during the last U.S. economic downturn in 2001 (Figure 1.8).[16] This may reflect the fact that consumer loans have not grown at the same pace as mortgages over the last few years and that declaring bankruptcy to avoid paying consumer debt has become a less attractive option for some borrowers following bankruptcy reforms in 2005.[17,18] However, consumer credit performance is expected to weaken as the rate of personal bankruptcies rebounds and unemployment increases. Econometric work used to estimate consumer loan losses indicates that rising unemployment rates have made the most significant contribution to increases in consumer loan charge-offs.

[15]As of 2007, U.S. households held $2.5 trillion in consumer debt in the form of revolving ($900 billion), primarily credit card debt, and nonrevolving debt ($1.6 trillion), most of which is auto loans. The securitized market represents roughly $780 billion, spanning a wide range of assets, including credit cards ($343 billion), auto leases ($199 billion), student loans ($236 billion), and other miscellaneous securitized loans.

[16]A charge-off occurs when payments are no longer collectible, due either to bankruptcy or default.

[17]Consumer debt grew at an average annual rate of 5 percent during 2002–06 compared with the 12 percent growth rate of secured mortgage debt, which included home equity loans.

[18]Consumer charge-off rates dropped significantly after a spate of accelerated personal bankruptcies in late 2005 before the implementation of a stricter bankruptcy law.

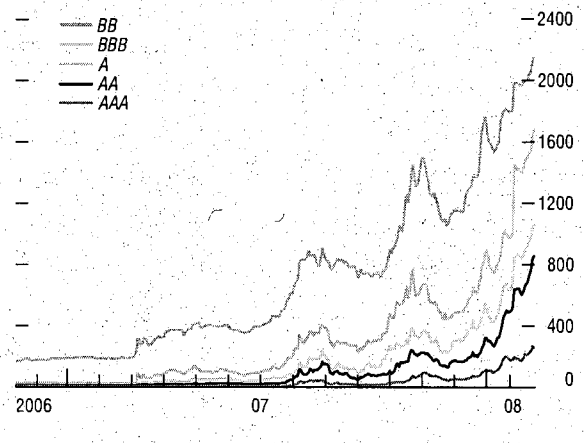
Reflecting concerns about the deteriorating outlook, spreads on consumer-related asset-backed securities (ABS) have widened to record levels. However, a simple comparison of credit card charge-off rates to discounts on consumer credit ABS suggests that spreads are implying an extreme high in charge-off rates relative to the historical trend (Figure 1.9).[19] As in some other credit markets, the repricing in risk premia appears to be more reflective of the broader credit market stress than of the underlying collateral quality.

The corporate debt market appears vulnerable as default rates are set to rise, owing to both macroeconomic and structural factors.

Financial innovation and low policy rates have helped keep corporate default rates at historically low levels long after they had been forecast to rise. The October 2007 GFSR warned that highly leveraged firms were vulnerable to business and economic shocks (IMF, 2007a). Experience is already bearing out this view. U.S. corporate defaults on high-yield debt in January 2008 alone roughly equaled defaults for the whole of 2007, and January's leveraged loan defaults were twice those seen in all of 2007. Meanwhile, the ratio of downgrades to upgrades on U.S. debt has already risen back to the level of May 2005, when General Motors and Ford were downgraded to subinvestment grade. Downgrades occurred across a range of assets, not just structured finance, and rating agencies appear to be ready to change ratings more promptly than in the past. At the same time, supply factors continue to weigh on the market. The pipeline of leveraged loans and related high-yield bonds has shrunk only modestly, as banks have preferred to take loans onto their balance sheets rather than sell them at deep discounts. Nevertheless, loan prices have fallen (Figure 1.10) in secondary markets and some

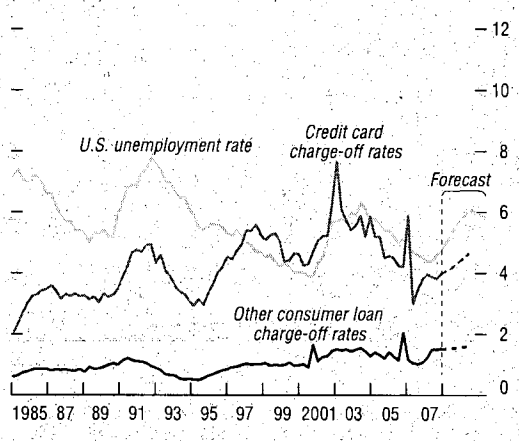
[19]An alternative explanation could be that markets are anticipating a deeper downturn and retrenchment of credit card debt, which would increase the correlation among the underlying individual risks, and would have an impact on valuation and capital requirements.

Figure 1.7. CMBX Spreads
(In basis points)



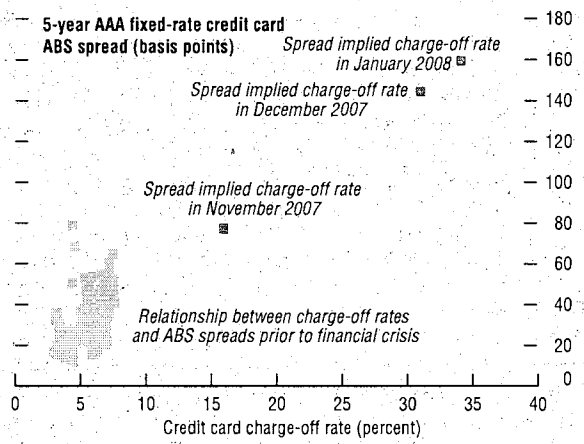
Source: JPMorgan Chase & Co.
Note: CMBX = an index of 25 credit default swaps on commercial mortgages.

Figure 1.8. Charge-Off Rates for U.S. Consumer Loans
(In percent)



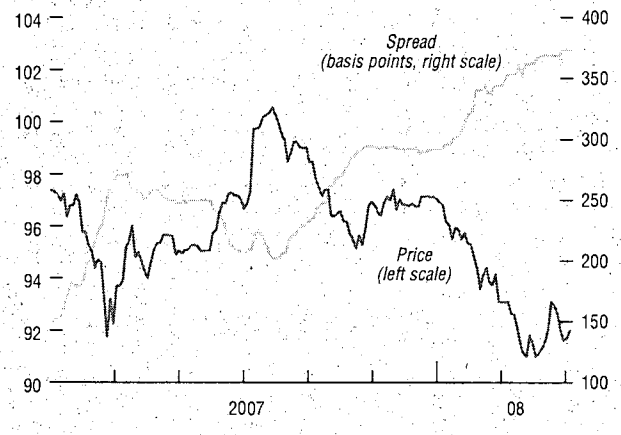
Sources: Federal Reserve; and IMF staff estimates.

Figure 1.9. Credit Card Charge-Off Rates versus Credit Card Asset-Backed Spreads on Securities



Sources: Federal Reserve; JPMorgan Chase & Co.; Standard & Poor's; and IMF staff estimates.
Note: Data are based on monthly observations. ABS = asset-backed security.

Figure 1.10. LCDX Prices and Spreads



Source: JPMorgan Chase & Co.
Note: LCDX = an index comprised of 100 credit default swaps referencing first-lien loans.

collateralized loan obligations (CLOs) used to repackage leveraged loans are unwinding, forcing banks to take loans back onto their balance sheets.

Looking ahead, high-yield default rates may rise to 4 to 12 percent if the economy goes into recession (see Box 1.1). The higher side of that range would be comparable to the last recession in 2001 and come close to the peak in defaults during the 1990–91 recession. The unprecedented issuance of low-tier corporate debt over 2003–07, combined with the increase in leverage, may exacerbate corporate distress during the credit downturn (Figure 1.11).[20,21] Refinancing risk could further pressure defaults in the near term as $650 billion of leveraged loans are set to mature starting in 2008 over the next three years.[22]

Systemic Risks Have Risen Sharply

The previous section detailed the deepening and the broadening of the crisis to other market segments. This section attempts to quantify the potential losses that can be expected from the crisis, while tracing the potential systemic effects.

Broader credit deterioration, a weakening economy, and falling credit prices combine into a substantial hit to the capital of systemically important financial institutions.

We estimate aggregate potential writedowns and losses to be approximately $945 billion as

[20]Over the last five years, low-tier bonds accounted for an average of 21 percent of total high-yield debt issuance (peaking at 37 percent in 2007), compared with an average of 15 percent in 1998, which preceded escalating defaults over 1999–2002. Typically, 60 percent of CCC-rated bonds default before they mature, and 36 percent default within three years of issuance.

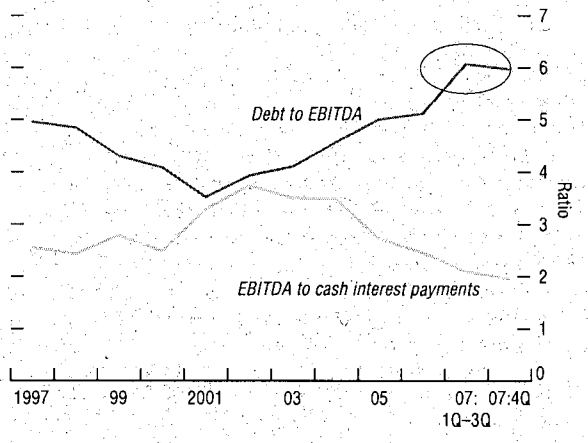
[21]Leverage was needed to boost returns over the last few years, owing to a lack of distressed debt. This led to 7 times (and sometimes as much as 10 times) leverage on U.S. leveraged buyouts. In Europe, debt multiples also were stretched, with leverage of 5.5 times in 2007, versus 4.7 times in 1998.

[22]The increase in "covenant-lite" loans may hinder early intervention by lenders, possibly delaying some defaults until later in the cycle, but potentially increasing the probability of default.

of March 2008 (see Table 1.1 and Annex 1.2 for details on the methodology).[23,24] Aggregate losses are on the order of $565 billion for U.S. residential loans (nonprime and prime) and securities and $240 billion on commercial real estate securities. Corporate loans (including leveraged loans and CLOs) are expected to account for $120 billion of losses, while consumer loan losses are likely to add an additional $20 billion. Most of the nonprime losses are in securities rather than unsecuritized loans. At present, pricing of mortgage-related derivative indices suggests higher losses than do calculations based on projected cash flows for the underlying loans.[25] Since the October 2007 GFSR, ABS prices have declined between 20 and 40 percent across tranches rated AAA to BBB–, and as much as 50 percent on ABS collateralized debt obligations (ABS CDOs) across all ratings categories, reflecting market expectations of future deterioration and illiquidity of the underlying securities. (See Boxes 2.2 to 2.4 in Chapter 2 for more details on the fragility of structured product ratings and their valuations.) Market prices continue to adjust on an almost daily basis, pressuring mark-to-market losses higher.

Potential credit losses would lower aggregate capital adequacy ratios at U.S. banks by

Figure 1.11. U.S. Leveraged Buyout Loans: Credit Quality Indicators



Sources: Standard & Poor's LCD; and IMF staff estimates.
Note: EBITDA = earnings before interest, tax, depreciation, amortization.

[23]Loss estimates vary considerably, given different assumptions about inputs and valuation methods, so IMF staff estimates should be regarded as merely an exercise to help gauge the indicative magnitude of risks to the financial system. We estimate losses in two parts as indicated in Table 1.1, which is a composite of market-implied accumulated losses in the securitized markets and potential loan losses associated with the slowdown in economic activity. The top panel estimates projected losses on unsecuritized loans, net of recoveries, on real estate, consumer, and corporate loans, based on projected shortfalls in cash flows in the near term. Underpinning cash flow estimates is an expected deterioration in the U.S. economy, consistent with increasing macroeconomic risks highlighted in the global financial stability map and detailed in the April 2008 WEO.

[24]Note the term "losses" used in this context refers to potential writedowns, as opposed to negative net profits.

[25]ABS prices are based on the ABX, an index of credit default swaps linked to 20 underlying subprime mortgages. ABS CDO prices are based on the TABX, an index that tranches synthetic CDOs based on the BBB– and BBB ABX indices.

Table 1.1. Estimates of Financial Sector Potential Losses as of March 2008
(In billions of U.S. dollars)

	Estimates of Losses on Unsecuritized U.S. Loans		Breakdown of Losses on Unsecuritized Loans				
	Outstanding	Estimated loss	Banks	Insurance	Pensions/ Savings	GSEs and government	Other (hedge funds, etc.)
Subprime	300	45	20–30	<5	<5	10–15	5–10
Alt-A	600	30	15–20	<5	<5	5–10	<5
Prime	3,800	40	15–20	<5	<5	15–20	<5
Commercial real estate	2,400	30	15–20	<5	<5	<5	<5
Consumer loans	1,400	20	10–15	<5	<5	—	<5
Corporate loans	3,700	50	25–30	<5	<5	—	15–20
Leveraged loans	170	10	5–10	<5	<5	—	<5
Total for loans	12,370	225	100–130	10–20	10–20	30–50	40–00
	Estimates of Mark-to-Market Losses on Related Securities		Breakdown of Losses on Securities				
	Outstanding	Estimated mark-to-market loss	Banks	Insurance	Pensions/ Savings	GSEs and government	Other (hedge funds, etc.)
ABS	1,100	210	85–100	20–35	35–45	20–35	15–20
ABS CDOs	400	240	145–160	35–50	15–25	0–25	20–45
Prime MBS	3,800	0	—	—	—	—	—
CMBS	940	210	85–95	20–35	30–45	20–35	20–45
Consumer ABS	650	0	—	—	—	—	—
High-grade corporate debt	3,000	0	—	—	—	—	—
High-yield corporate debt	600	30	10–15	<5	5–10	—	<5
CLOs	350	30	15–20	<5	<5	—	0–10
Total for securities	10,840	720	340–380	95–110	70–120	—	95–120
Total for loans and securities	23,210	945	440–510	105–130	90–160	40–140	110–200

Sources: Goldman Sachs; JPMorgan Chase & Co.; Lehman Brothers; Markit.com; Merrill Lynch; and IMF staff estimates.
Note: ABS = asset-backed security; CDO = collateralized debt obligation; CLO = collateralized loan obligation; CMBS = commercial mortgage-backed security; GSE = government-sponsored enterprise; MBS = mortgage-backed security.

about 250 basis points, and at European banks by about 150 basis points. Although aggregate ratios remain above regulatory norms, a bottom-up analysis of losses indicates that some banks and regions will suffer disproportionately. Put in historical perspective, this crisis is of similar dollar magnitude to the Japanese banking crisis of the 1990s (Figure 1.12).[26]

Uncertainty over the size and spread of losses further elevates systemic risks, even as markets price in losses for banks and insurance companies.

Global banks are likely to shoulder roughly half of aggregate potential losses, totaling from $440 billion to $510 billion, with insurance companies, pension funds, money market funds, hedge funds, and other institutional investors accounting for the balance.[27] Banks generally hold the most senior tranches of these products, but even these are now likely to incur substantial losses (see Boxes 2.3 and 2.4 in Chapter 2). European banks hold sizable amounts of complex structured products such as MBS and CDOs and have been exposed to losses related to structured investment vehicles (SIVs) (Figure 1.13).

By mid-March 2008, U.S. banks had reported most of their estimated losses, with European banks' disclosures catching up owing partly to the longer reporting lags of European banks

[26]It should be noted that the current scenario is not directly comparable to prior crises, since the subprime crisis reflects potential estimated losses to financial institutions, some of which have yet to occur.

[27]The exposure of market participants to losses is uncertain partly because placement data for various types of securities are imprecise.

(see Annex 1.2). In addition, nonbank financial institutions, including insurance companies, may yet also report sizable additional writedowns.

Bank equity and debt capital markets appear to have taken into account the effect of credit-market-related losses. The market capitalization of banks globally declined by some $720 billion through March 2008. Insurance companies have also experienced a decline in market value that appears to be commensurate with the top-down loss estimate of $105 billion to $130 billion.

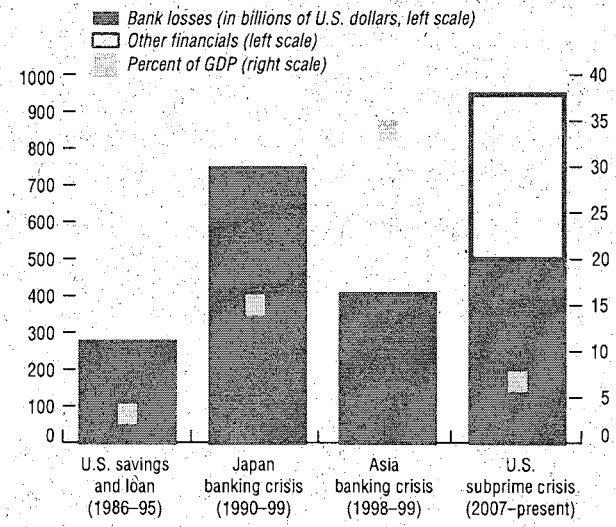
Strains are compounded by pressures on financial guarantors...

Additional bank losses may originate from the knock-on effects of rating downgrades on financial guarantors, as the ratings on insured bonds would decline and certain hedges would become less effective. IMF staff estimate the total losses to banks from potential downgrades of financial guarantors to be $60 billion to $90 billion, depending on whether the downgrade is one grade (from AAA to AA) or two (to A).[28,29] Since 1998, most financial guarantors (such as AMBAC, MBIA, and FGIC) have expanded their traditional business of insuring bonds issued by U.S. municipalities to include structured credit (i.e., ABS and ABS CDOs) and, to a lesser extent, corporate bonds. Losses on ABS protection have now eaten into the capital of a number of financial guarantors, threatening both their own credit ratings and those of

[28]These estimates are subject to considerable uncertainty given the limited information on individual banks' exposures, especially to credit default swap (CDS) contracts written by financial guarantors and used by banks to hedge CDOs.

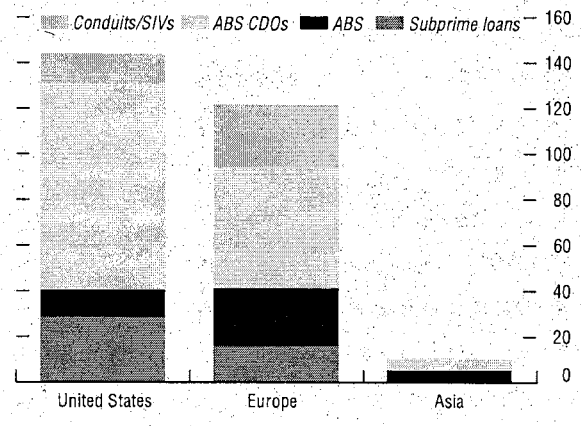
[29]Initiatives to resolve the problems affecting some financial guarantors are continuing. The New York state insurance regulator has been working with banks on plans to recapitalize and potentially restructure those companies most affected by losses on structured finance business. Some of the companies have now raised new capital, enabling them to retain AAA ratings for the time being. But it remains unclear whether there will be further ratings downgrades of financial guarantors in the future. The New York regulator has committed to a review of its regulatory approach to financial guaranty business.

Figure 1.12. Comparison of Financial Crises



Sources: World Bank; and IMF staff estimates.
Note: U.S. subprime costs represent staff estimates of losses on banks and other financial institutions from Table 1.1. All costs are in real 2007 dollars. Asia includes Indonesia, Korea, the Philippines, and Thailand.

Figure 1.13. Expected Bank Losses as of March 2008
(In billions of U.S. dollars)



Sources: Goldman Sachs; UBS; and IMF staff estimates.
Note: ABS = asset-backed security; CDO = collateralized debt obligation; SIV = structured investment vehicle.

Box 1.1. Outlook for U.S. High-Yield Corporate Debt Markets and Default Rates[1]

The corporate debt market is set to weaken and default rates are expected to rise from historic lows due to both macroeconomic and structural factors. Macroeconomic variables, credit and financial conditions, and market perception of risk are typically used to model and forecast default rates. All of these indicators and models have predicted rising corporate debt defaults since 2007. However, increased financing flexibility extended by lenders may have deferred realized defaults. As well, structural changes in the composition of the corporate debt market may add to market distress in a downturn.

Three empirical approaches discussed below all point to a rise in defaults in 2008, with macroeconomic and credit market conditions being the key drivers.

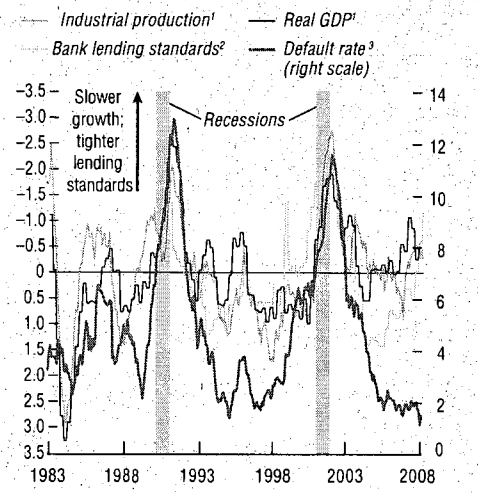
Macroeconomic and credit conditions. Historically, default rates are inversely related to the level of economic activity (see first figure). Both GDP and industrial production closely track the contemporaneous level of default rates. Bank lending standards tend to lead a rise in default rates and are considered a reliable forecasting indicator. Both macroeconomic and credit variables have been signaling a pickup in the default rate over the last year, with expected defaults far exceeding actual defaults.

Financial and corporate indicators (see second figure). Another way to project default rates

Note: Sergei Antoshin prepared this box.

[1]While this box relates exclusively to U.S. credits, it is recognized that losses related to European-issued securities could be substantial. Indeed, European leveraged buyout deals saw a similar, albeit less pronounced, rise in leverage. In addition, the European high-yield market has also become riskier (as reflected by the higher share of low-tier debt issuance), although it still only represents 15 to 20 percent of the global high-yield debt market.

Macroeconomic Indicators and Default Rates



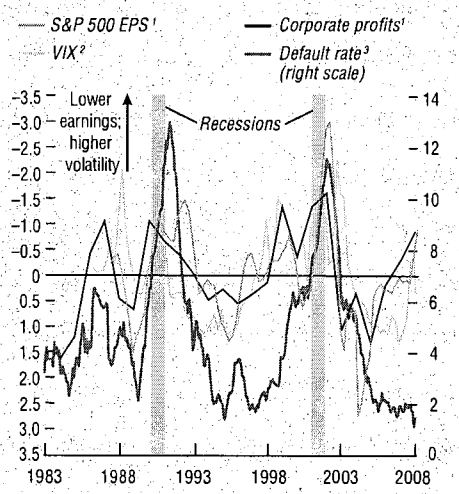
Sources: Bureau of Economic Analysis; Federal Reserve; JPMorgan Chase & Co.; Merrill Lynch; Moody's; National Bureau of Economic Research; and IMF staff estimates.

[1]Year-on-year changes; standardized over 1983–present; inverted scale.

[2]Net survey balances; standardized over 1990–present.

[3]Issuer-weighted.

Financial and Corporate Indicators and Default Rates



Sources: Bloomberg L.P.; Bureau of Economic Analysis; JPMorgan Chase & Co.; Merrill Lynch; Moody's; National Bureau of Economic Research; and IMF staff estimates.

[1]Year-on-year changes; standardized over the sample periods; inverted scale.

[2]Standardized over 1986–present.

[3]Issuer-weighted.

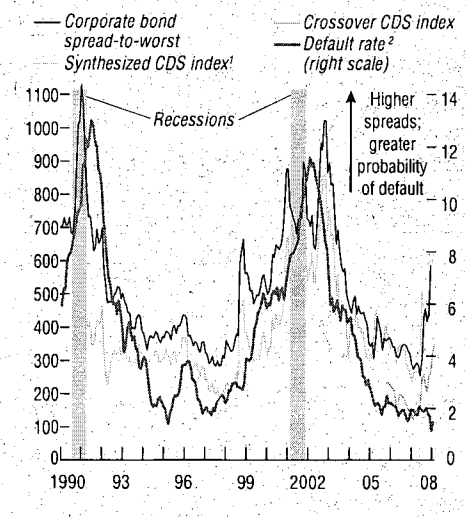
examines corporate profits (to proxy corporate debt market performance), the implied volatility of the S&P 500 (to capture uncertainty over the future earnings stream), and the debt-to-earnings ratio for high-yield companies (to capture the degree of debt burden relative to revenue). After posting strong growth during 2002–06, corporate profits contracted 1.9 percent year-on-year in 2007, and are expected by the market to remain flat in 2008. Implied equity volatility (VIX) rose from 11 percent in January 2007 to 25 percent as of February 2008, and futures markets expect volatility to remain elevated during 2008. The debt-to-earnings ratio for high-yield corporates has been growing since 2005, and is likely to increase further in 2008. In short, financial indicators also point in the direction of increasing default rates.

Extraction of default probabilities from credit risk transfer markets. Observed prices or yields on corporate bonds and credit default swaps can also be used to derive the implied probability of default. The corporate debt and credit default swap markets have already partly priced in a heightened probability of default (see third figure and Annex 1.2).

Weakening credit discipline may have both delayed and masked the rise in defaults. Loosening credit standards, especially in the leveraged buyout market, resulted in the growth of "covenant-lite" loans, whose holders are not obliged to meet quarterly maintenance criteria. This increased financing flexibility from the lender's side may help to explain the unusually low number of defaults in the last two years.

As the credit cycle turns, the rise in default rates may magnify stress in bond markets

Valuation of Financial Instruments Based on Implied Probability of Default



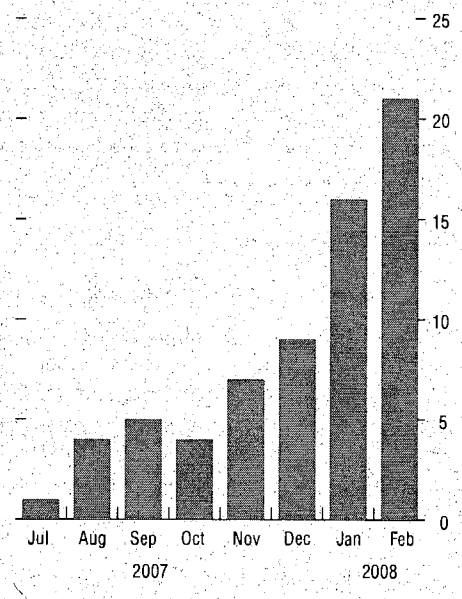
Sources: Bloomberg L.P.; Dow Jones; JPMorgan Chase & Co.; Merrill Lynch; Moody's; National Bureau of Economic Research; and IMF staff estimates.

[1]Index based on a blend of realized collateralized debt swaps (CDS) and high-yield bond indices.

[2]Issuer-weighted.

Share of "Stressed Debt"

(Percent of high-yield market trading 1000+ basis points above U.S. treasuries)



Source: Bloomberg L.P.

Box 1.1 *(concluded)*

Forecasts of U.S. High-Yield Default Rates in 2008

(In percent)

	Assumptions[1]		Forecasts[2] *(In percent of U.S. high-yield corporate debt)*	
	Industrial production	Lending standards	Structural delay[3]	No structural delay[4]
Best case scenario (No deterioration of economic conditions)	1.7	20	4.0	9.3
Baseline scenario (Moderate deterioration of economic conditions)	–2.0	30	4.7	10.4
Worst case scenario (Economic recession)	–5.5	50	5.8	12.3

Sources: Bureau of Economic Analysis; Federal Reserve; and IMF staff estimates.

[1]For industrial production, 2008:Q4 year-on-year growth in percent; for lending standards, 2008:Q4 net percentage of respondents reporting tightening lending standards for commercial and industrial loans to large and medium-size firms.

[2]The default rate is modeled as dependent on its lags, the current and past levels of industrial production growth, and lags of the lending standards indicator.

[3]Under the structural delay assumption, default rates depend on the economic and credit variables, but loosening financing standards continue to delay the full realization of default rates in 2008. The default rate for 2008 is forecast based on the 1990–2007 sample.

[4]Under the no-structural delay assumption, shadow default rates followed the fundamentals in 2007 and defaults are fully realized in 2008. The default rate for 2007 and 2008 is forecast based on the 1990–2006 sample.

owing to several factors. First, there was an unprecedented issuance of low-rated debt over 2003–07, which has raised the share of CCC-rated bonds in total high-yield debt above the end-2000 level. Second, increased leverage on corporate debt—amid deterioration in overall debt quality—may have aggravated vulnerability to external financial conditions, affecting asset quality and earnings streams. In addition, the increase in the share of secured corporate debt from 5 to 11 percent of total high-yield debt over the last seven years may lower recovery rates and prices of unsecured bonds. Third, the maturity profile of leveraged loans is fairly short, subjecting them to near-term refinancing risk as well as raising default risk.

When realized default rates diverge from fundamentals, some analysts rely on proxies for distressed debt, such as the share of "stressed debt" (trading 1000 basis points or more above U.S. treasuries). As the fourth figure illustrates, the pendulum has swung dramatically, presaging rising defaults, with the share of stressed debt rising from 9 percent in December 2007 to 21 percent in February 2008. Other measures of debt distress attempt to estimate the number of companies that are able to raise additional debt in the absence of cash to pay interest on existing debt. Liquidity ratings compiled by the major rating agencies suggest that liquidity positions of leveraged borrowers weakened dramatically during 2007.

The different scenarios for the default rate in 2008 are outlined using econometric modeling based on macroeconomic and credit variables and taking into account the possibility of a delay in a full realization of defaults (see table). If the loosening financing standards from lenders continue to delay realized default rates, the default rate is projected in the range of 4 to 6 percent, depending on the extent of the U.S. economic slowdown. If default rates are set to revert to the levels implied by economic fundamentals that were observed before 2007, defaults could rise more sharply, in the range of 9 to 12 percent, based on our estimates.[2]

[2]These forecast ranges are in line with the 2 to 10 percent array of forecasts produced by credit agencies and market analysts.

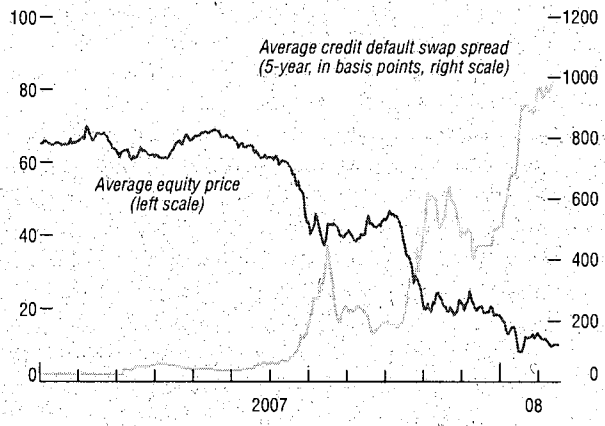
the debt they insure (Figure 1.14).[30] Additional downgrades of financial guarantors would cause the value of the $800 billion of structured credit they have insured to fall further, imposing additional losses on banks.

...raising concerns about counterparty risks and spillovers in the credit default swap market...

In view of the weakened capital position of financial guarantors—and because guarantors are not required to post maintenance margins on credit default swap (CDS) contracts that they have sold—many banks have begun to write down the value of the protection they have bought from financial guarantors. For the CDS market overall, losses incurred by protection sellers should equal the gains of protection buyers, but specific sectors may be heavily positioned one way, leading to an increase in counterparty credit risk in the event of a rise in corporate defaults. The concentration of counterparty risk in the CDS market could further compound the risk of multiple failures, for instance, if an individual protection seller is unable to fulfill its payment obligations.[31,32]

Weaknesses in infrastructural arrangements for CDS markets may further exacerbate risks. Despite earlier attempts to address back-office processing delays, recent slippage in the timeliness of confirmations and affirmations in over-the-counter markets—including corporate CDS—means that many market participants cannot assess in real time changes in their CDS exposures. Moreover, the absence of a central counterparty and multilateral netting of contracts leaves the system dependent on potentially

Figure 1.14. Financial Guarantors



Source: Bloomberg L.P.

[30]Several financial guarantors have already been downgraded.

[31]The requirement to post margins mitigates this risk. A protection seller posts an initial margin (2 to 3 percent) and from then on daily margin equal to changes in the market value of the underlying security. Therefore, unless defaults increase abruptly and are largely unanticipated, most market participants will not experience substantial margin calls over a short period.

[32]The 10 largest market makers account for close to 90 percent of the $45 trillion outstanding notional value of CDS.

long exposure chains that are vulnerable to a default at any one point. In addition, CDS contracts often require delivery of the underlying bond, and since the volume of contracts often exceeds the volume of underlying instruments, large-scale defaults could result in settlement problems. Since the corporate CDS market may be tested over the coming months, these potential problems need to be monitored closely by policymakers.

...and stability at the core of the global financial system...

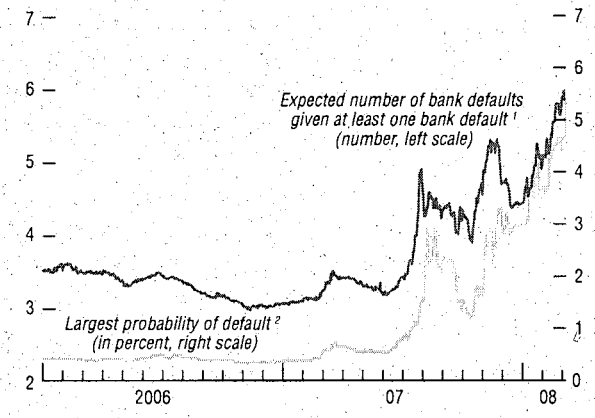
Measures of default risk for large complex financial institutions and the potential for contagion within the financial system derived from market prices point to heightened concern about system risk (Figure 1.15).[33] The highest likelihood of a single default and the likely number of defaults in the event of a single default in the group—a measure of contagion risk within the global banking system—have both risen significantly.

...despite sizable injections of bank capital from sovereign wealth funds and elsewhere.

Sovereign wealth funds have contributed about $41 billion of the $105 billion of capital injected into major financial institutions since November 2007. This compares with total reported losses among global banks of some $193 billion (see Box 1.2). Such injections are welcome and critical to restoring bank balance sheets. However, despite these injections, market indicators suggest that many investors believe that some banks still need to raise additional capital.

Bank funding strains are symptomatic of a broad deleveraging of the global financial system and systemic stress.

Figure 1.15. Systemic Bank Default Risk



Sources: Bloomberg L.P.; and IMF staff estimates.
[1] Among 15 selected large and complex financial institutions (LCFIs).
[2] Measures the largest probability of default among the sampled 15 LCFIs each day.

[33] This GFSR enhances the use of credit-derivatives-based credit risk indicators used in prior GFSRs to monitor the evolution of market perceptions of default risk in mature market financial systems. The mature market credit risk indicators measure the expected number of bank defaults given at least one bank default for 15 financial institutions, implied from the prices of CDS. See Box 1.5 for details.

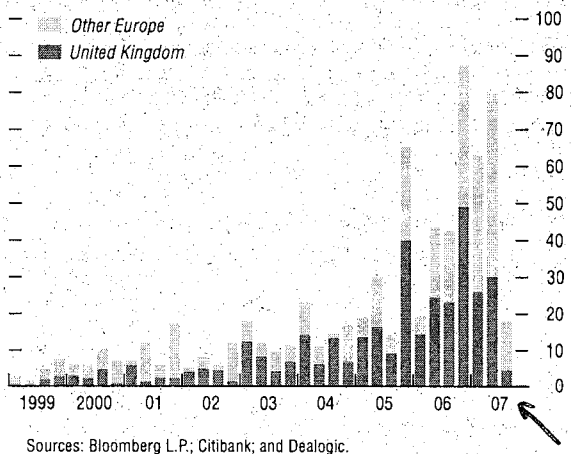
Some banks have rapidly expanded their balance sheets in recent years, largely by increasing their holdings of highly rated securities that carry low risk weightings for regulatory capital purposes (see Box 1.3 on page 31). Part of the increase in assets reflects banks' trading and investment activities. Investments grew as a share of total assets, and wholesale markets, including securitizations used to finance such assets, grew as a share of total funding (Figure 1.16). Banks that adopted this strategy aggressively became more vulnerable to illiquidity in the wholesale money markets, earnings volatility from marked-to-market assets, and illiquidity in structured finance markets. Equity markets appear to be penalizing those banks that adopted this strategy most aggressively (Figure 1.17).

The forced deleveraging has impacted other leveraged institutions, especially hedge funds.

Until recently, one of the remarkable features of the current crisis was how few large hedge funds had failed. Among the funds that have folded, most appear to have unwound their positions without undue difficulty, suggesting that collateral was liquidated at close to the pledge value. Even as they shrank their balance sheets elsewhere, large banks tried to maintain their prime brokerage lending to hedge funds, on the basis that it enhanced the bank's long-run franchise value. This situation is changing with the intensification of the crisis as margin locks roll off and pressure on bank balance sheets increases.[34] "Haircuts" and margins have increased, and fewer hedge funds are able to secure the leverage required to meet return targets on low-yielding assets. A forced deleveraging of the type outlined in the October 2007 GFSR may therefore be under way, further reducing demand for AAA-rated assets. The example illustrated in Table 1.3 in

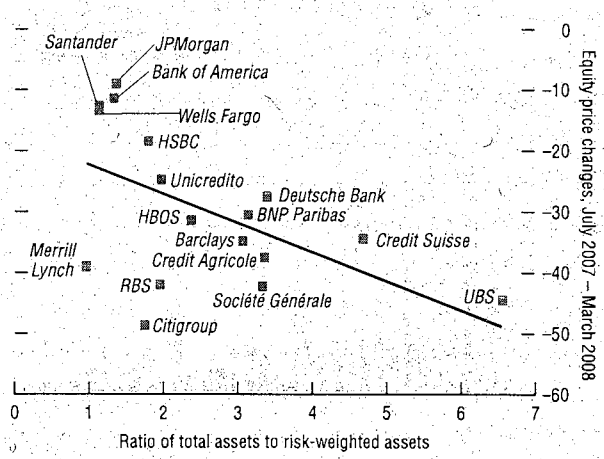
[34]Many hedge funds had negotiated "margin locks" that prevented their prime brokers from increasing the margins they pay when borrowing securities, or the "haircuts" they pay when pledging securities as collateral with their brokers for a fixed period of time.

Figure 1.16. Securitization Volume in the European Union (EU-15)
(In billions of euros)



Sources: Bloomberg L.P.; Citibank; and Dealogic.

Figure 1.17. Bank Equity Price Changes and Balance Sheet Leverage
(In percent)



Sources: Bloomberg L.P.; and IMF staff estimates.

Box 1.2. Do Sovereign Wealth Funds Have a Volatility-Absorbing Market Impact?

Between November 2007 and February 2008, sovereign wealth funds (SWFs) were frequently in the news, as major mature market financial institutions required additional capital. This box examines the impact that SWF-provided capital may have had in current volatile market conditions. It may be premature to draw strong conclusions in the absence of a broader set of data and the need for a better understanding of the diverse investment policies and risk management practices of the SWFs. However, given their typically long time horizon and limited liquidity needs, SWFs can have a shock-absorbing role, at least in terms of abating short-term market volatility.[1]

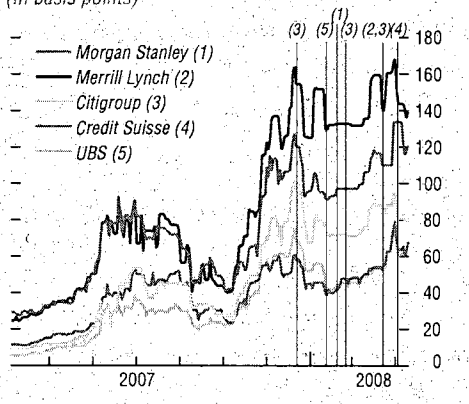
SWFs as investors. There are several factors that facilitate the ability of the SWFs to act as a countervailing force in times of market stress.

- Most SWFs have a long-term investment horizon and limited liquidity needs (with the notable exception of stabilization funds), as they are commonly established to meet long-term macroeconomic objectives;
- Many SWFs aim to meet long-term real return objectives, and accept short-term volatility in return for expected higher long-term returns and the diversification benefits from a less-constrained strategic asset allocation;
- Compared with other institutional investors, SWFs also have a stable funding base and no capital adequacy or prudential regulatory requirements;
- The below-average valuations of stocks in crisis-hit financial markets may have provided a window for SWFs to accumulate significant exposure in the global financial sector.

The table provides a summary of the transactions in which SWFs have injected capital into mature market financial institutions. Common features of these transactions are that they were (1) significant in size, while remaining minority stakes in companies; (2) privately negotiated rather than executed in public markets; and (3) often in convertible bonds, high-yielding bonds that are to be converted to equity stakes in the future. While many SWFs execute their strategic asset allocation decisions in public markets, historically, some of the major SWFs have also used privately negotiated transactions. Increasingly, some of the SWFs are broadening the set of eligible asset classes, including through private equity, in order to implement their long-term investment and strategic asset allocation decisions.[2]

Recent capital injections. The capital injections by SWFs have augmented the involved financial institutions' capital buffers and have been helpful in reducing their risk premium, at least

Credit Default Swap Spreads on Selected Financial Institutions
(In basis points)



Sources: Bloomberg L.P.; and IMF staff estimates.
Note: Vertical lines indicate capital injections to each institution on that date.

Note: Kristian Flyvholm, Heiko Hesse, and Tao Sun prepared this box.

[1]It is not the first time that SWFs have invested in financial firms. For instance, China recapitalized its banking sector in 2003 (via Central Huijin Investment Company Limited, which was later merged into the China Investment Corporation as a wholly-owned subsidiary), and Temasek owns stakes in banks in the United Kingdom and in Asia.

[2]For example, there are recent investments by the China Investment Corporation in Blackstone, and a prospective investment by the Government of Singapore Investment Corporation in the Texas Pacific Group.

Sovereign Wealth Fund (SWF) Capital Injections into Financial Institutions and Market Response

Date of Announcement	Financial Institutions	Writedown (of financial institution)	SWFs and Other Investor(s)		Amount (percent of total stakes) from SWFs and Other Investor(s)		Immediate Market Response (change after announcement compared to previous transaction day)	
			SWFs	Other investor(s)	SWFs	Other investor(s)	Stock price (%)	CDS (%)
Nov. 26, 2007	Citigroup	$6 billion in 2007:Q3	Abu Dhabi Investment Authority		$7.5 billion (4.9%)		–1.2	–6
Dec. 10, 2007	UBS	$18 billion in 2007	Government of Singapore Investment Corporation	Unknown Middle Eastern investor	$9.7 billion (10%)	$1.8 billion (2%)	1.4	–9
Dec. 19, 2007	Morgan Stanley	$9.4 billion in 2007:Q4	China Investment Corporation		$5 billion (9.9%)		4.2	0
Dec. 21, 2007	Merrill Lynch	$8.4 billion in 2007:Q3	Temasek Holdings	Davis Selected Advisors, L.P.	$4.4 billion (9.4%)	$1.2 billion (2.6%)	1.9	0
Jan. 15, 2008	Citigroup	$18.1 billion in 2007:Q4	Government of Singapore Investment Corporation, Kuwait Investment Authority	Sanford Weill, Saudi Prince Alwaleed bin Talal, Capital Research Global Investors, Capital World Investors, New Jersey Investment Division	$6.8 billion from Government of Singapore Investment Corporation (3.7%) and $3 billion from Kuwait Investment Authority (1.6%)	$2.7 billion (1.5%)	–7.3	–5
Jan. 15, 2008	Merrill Lynch	$14.1 billion in 2007:Q4	Korea Investment Corporation, Kuwait Investment Authority	Mizuho Financial Group Inc.	$2 billion (3.2%) from Korea Investment Corporation and Kuwait Investment Authority, respectively	$2.6 billion (4.1%)	–5.3	–12
Feb. 18, 2008	Credit Suisse	$2.85 billion	Qatar Investment Authority		Approximately $500 million (1% to 2%); the purchase was on the open market		3.2	2

Sources: Bloomberg L.P.; Citigroup; and IMF staff estimates.

Note: The stock price of Citigroup rose 6.5 percent on November 28, 2007, the third day after the announcement of the first capital injection. The stock price declines of Citigroup and Merrill Lynch on January 15, 2008 were confounded owing to the simultaneous announcement of huge writedowns and dilution of the claims of existing shareholders.

in the short term, as the injection curtailed the need to reduce bank assets to preserve capital. The figure and table suggest that the announcements of capital injections from SWFs have assisted in stabilizing share prices and the elevated CDS spreads, at least over the short run.

In most cases, after the announcement of new capital injections, the initial share price reactions to the SWF investments were positive, since announcements of asset writedown

Box 1.2 *(concluded)*

went hand-in-hand with a solution based on the capital injection from investor groups in which the SWF had a significant role (see table). Also, share price volatility declined somewhat following the capital injections, which supports the view that SWFs could have a volatility-reducing impact on markets. However, the long-term impact and the potentially stabilizing role of SWFs as major institutional investors will require a broader set of data and assessment.

Next steps. The IMF is currently working across a broad range of issues relating to SWFs. Recognizing the growing importance and relevance for its surveillance activities, the Finance Committee has encouraged the IMF to analyze SWF issues and engage in a dialogue with SWFs to identify best practices. The IMF Executive Board has endorsed the call and asked the staff to prepare a set of commonly agreed best practices for SWFs, which will be a voluntary framework developed in close partnership with SWFs during 2008.

the October 2007 GFSR shows that, even with no change in value or redemptions by investors, an increase in margin to 10 percent, from an initial 3 percent, would force a fund to sell nearly 70 percent of its holdings (IMF, 2007a). Table 1.2 shows that such increases in margins have been far from unprecedented. Some hedge fund indices already suggest cumulative hedge fund returns have been zero for the last 12 months, even before taking account of the survivorship and reporting biases that tend to overstate returns. It would therefore be unsurprising if there were more hedge fund failures in coming months.

Central banks have worked to contain the crisis, giving direct support to term funding markets...

Central banks have adopted a novel and pivotal role in interbank funding markets, different from previous periods of market stress. As private banks retrenched from interbank markets and nonbanks backed away from term funding markets, major central banks became key counterparties in those markets (Figures 1.18 and 1.19).[35] They accepted collateral—including some structured products—that many private banks would not. For example, the European Central Bank has accepted as collateral highly rated ABS and MBS, allowing banks to continue to securitize some high-quality assets to use as collateral (see Chapter 3 for more detail).

...but while liquidity strains have eased, bank counterparty credit risks remain elevated, making a central bank exit difficult.

Central bank operations had relieved some of the liquidity strains, especially during the turn of the year, but term interbank rates picked up again, possibly reflecting a significant counterparty credit risk component (Figure 1.20).[36] Thus, it is difficult for central bank operations to target liquidity concerns in term funding markets without distorting (lowering artificially) the market pricing of credit risk. This makes other private and official measures to restore counterparty confidence and reduce risks in the financial system vital to diminish the need for central banks to interpose themselves as counterparties in term funding markets.

[35]In the United States, Federal Home Loan Banks have also stepped in to re-intermediate the credit market.

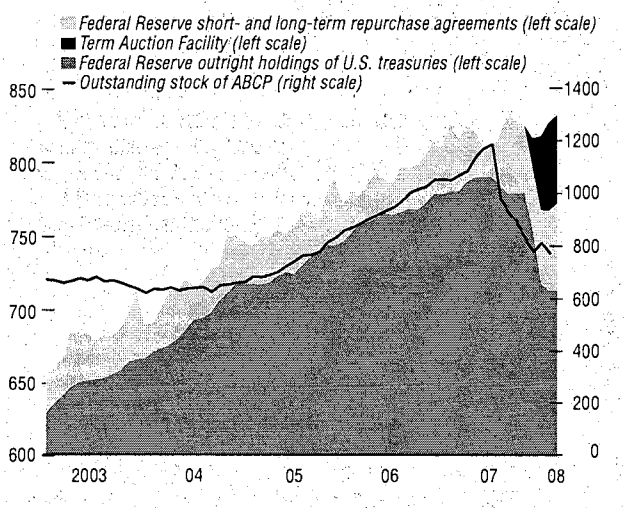
[36]Figure 1.20 subtracts the average CDS spread referencing U.S. banks from the 1-year LIBOR overnight index swap spread to give an indicative decomposition into a credit and other component, the residual of which likely represents liquidity. See Bank of England (2007, pp. 499–500) for more detail.

Table 1.2. Typical "Haircut" or Initial Margin
(In percent)

	January–May 2007	April 2008
U.S. treasuries	0.25	3
Investment-grade bonds	0–3	8–12
High-yield bonds	10–15	25–40
Equities	15	20
Investment grade CDS	1	5
Synthetic super senior	1	2
Senior leveraged loans	10–12	15–20
2nd lien leveraged loans	15–20	25–35
Mezzanine level loans	18–25	35+
ABS CDOs:		
AAA	2–4	15
AA	4–7	20
A	8–15	30–50
BBB	10–20	40–70
Equity	50	100
AAA CLO	4	10–20
AAA RMBS	2–4	10–20
Alt-a MBS	3–5	20–50

Sources: Citigroup; and IMF staff estimates.
Note: ABS = Asset-backed security; CDO = collateralized debt obligation; CDS = credit default swap; CLO = collateralized loan obligation; RMBS = residential mortgage-backed security.

Figure 1.18. U.S. Funding Market Liquidity
(In billions of U.S. dollars)



Source: Federal Reserve.
Note: ABCP = asset-backed commercial paper.

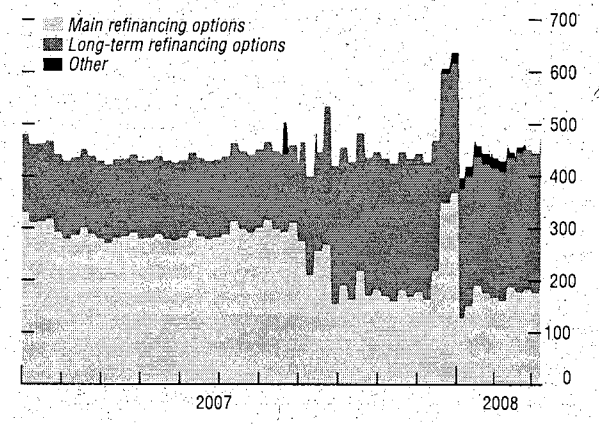
Will Emerging Markets Remain Resilient?

Emerging markets have so far proved broadly resilient to the financial turmoil. Improved fundamentals, abundant reserves, and strong growth have all helped to sustain flows into emerging market assets. However, as noted in the October 2007 GFSR, there are macroeconomic vulnerabilities in a number of countries that make them susceptible to deterioration in the external environment (Table 1.3). Eastern Europe, in particular, has a cluster of countries with current account deficits financed by private debt or portfolio flows, where domestic credit has grown rapidly. A global slowdown, or a sharp drop in capital flows to emerging markets, could force painful adjustment.

There are several distinct risks to emerging markets arising from the current turmoil.

First, mature market banks may pare back funding to their local subsidiaries, particularly in circumstances where external imbalances are large.

Figure 1.19. Euro Area Funding Market Liquidity
(In billions of euros)



Source: European Central Bank.

Table 1.3. Macro and Financial Indicators in Selected Emerging Market Countries
(Estimates for 2007)

	Current Account (percent of GDP)	Growth in Private Credit (percent year-on-year)	Change in Private Credit as Share of GDP (percentage points)	External Position vis-à-vis BIS Reporting Banks (percent of GDP)
Europe, the Middle East, and Africa				
Bulgaria	−21.4	62.5	19.7	−11.9
Croatia	−8.8	17.8	3.4	−50.8
Estonia	−16.0	41.8	15.1	−68.7
Hungary	−5.6	16.8	1.6	−42.5
Kazakhstan	−6.7	55.2	12.5	−9.5
Latvia	−22.9	45.0	10.7	−53.9
Lithuania	−13.3	45.3	10.9	−34.7
Poland	−3.7	39.6	8.0	−12.7
Romania	−14.5	60.4	10.7	−25.7
Russia	5.9	51.0	7.1	8.3
Serbia	−16.5	40.1	6.0	−7.6
South Africa	−7.4	22.0	5.4	9.6
Turkey	−7.6	26.5	4.1	−13.9
Asia				
China	11.1	19.5	2.1	0.8
India	−1.4	21.7	2.6	−3.0
Indonesia	2.3	22.4	2.0	−7.9
Korea	0.6	13.5	8.7	−13.9
Malaysia	13.7	11.8	3.4	0.5
Philippines	4.4	3.3	−1.5	−0.4
Thailand	5.6	3.9	−1.4	5.1
Latin America				
Argentina	0.7	37.0	1.4	−7.1
Brazil	0.3	28.5	5.1	−7.8
Chile	4.7	20.8	5.9	−8.0
Colombia	−3.8	23.5	4.7	−7.3
Mexico	−0.8	19.0	2.2	−5.8
Peru	1.6	22.3	6.2	−0.5
Venezuela	9.2	72.5	4.9	2.9

Sources: Bank for International Settlements (BIS); European Central Bank; IMF, *International Financial Statistics* and *World Economic Outlook*; and IMF staff estimates (preliminary data as of March 3, 2008).

Note: The gray boxes of the table point to areas of potential concern. Cutoff values are as follows: current account balance below −5 percent of GDP; private sector credit growth greater than 20 percent year-on-year; growth in the ratio of private sector credit to GDP of more than 10 percent year-on-year; and net external position to BIS banks less than −10 percent of GDP.

Second, balance sheet contraction by global financial institutions may reduce funding for investments by hedge funds and other institutions, raising their dollar funding costs, and inducing financial stress within some emerging markets.

Third, emerging market corporate credit risks may continue to increase. Emerging market corporate debt spreads have already moved out about as much as those of similarly rated credits in mature markets.

Fourth, emerging market financial institutions may yet prove vulnerable to financial contagion through exposure to subprime or other structured credit products.

Fifth, a spike in exchange rate volatility could slow or reverse flows into emerging market fixed-income assets, leading to higher funding costs. Negative terms-of-trade shocks could raise difficulties for emerging markets in Latin America and elsewhere that have benefited from the commodity price boom. More broadly, a global slowdown could affect flows into emerging market assets.

For some emerging markets there remains a risk of overheating. Countries whose monetary

policy is tied to the U.S. dollar may experience a buildup of domestic liquidity.

Potential funding pressures on foreign banks active in emerging Europe pose risks to a soft landing.

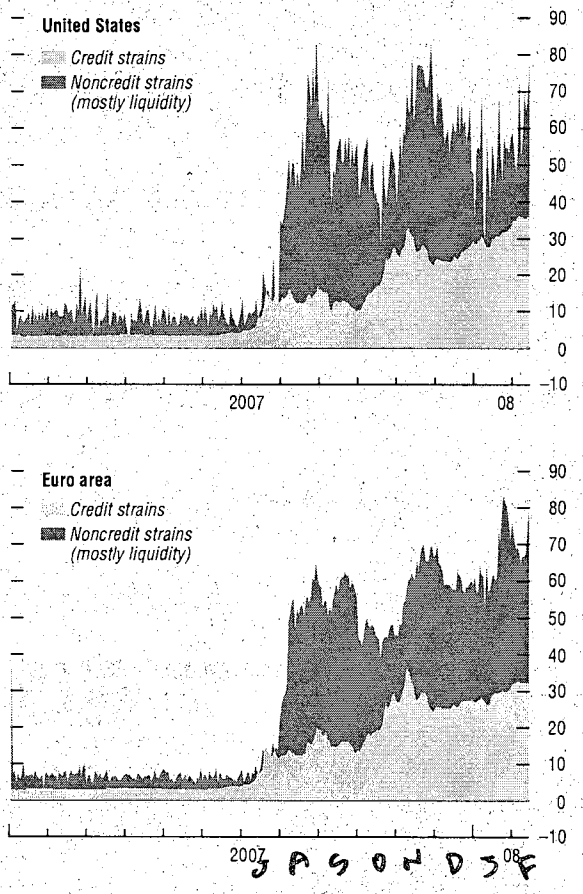
Domestic banks in Eastern Europe have built up large negative net foreign positions vis-à-vis parent banks and international lenders, as credit growth has far outpaced growth in domestic deposits (Figure 1.21). Most European parent banks have plans to sustain cross-border financing of their subsidiaries in the Baltics and southeastern Europe, while gradually slowing credit to cool the economies. Swedish, Austrian, and Italian banks take a long-term view of the growth opportunities in the Baltics and southeastern Europe, and seek to protect their franchise values.

The main parent banks are vulnerable to continued financial turbulence because they obtain a substantial part of their funding on international wholesale markets, as do many mid-sized European banks (Figure 1.22). A soft landing in the Baltics and southeastern Europe could be jeopardized if external financing conditions force parent banks to contract credit to the region. For example, with about half of their funding denominated in foreign currencies, Swedish banks—the main suppliers of external financing to the Baltics—could come under pressure.[37]

Locally owned banks make up one-third of the banking sector in Latvia. These banks are under substantial external funding pressure, which could force them to curtail lending. As with other banks that rely heavily on external bond markets, liquidity for these banks has all but dried up, and spreads have widened 500 basis points. In response, local banks are seeking alternative sources of financing and have worked to increase local deposits.

In Bulgaria and Romania, tighter credit risk controls by parent banks have not been effec-

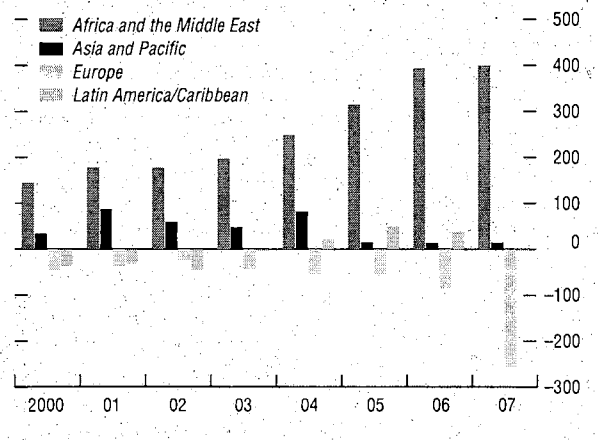
Figure 1.20. Decomposing Interbank Spreads
(In basis points)



Sources: Bloomberg L.P.; and IMF staff estimates.
Note: Credit strains are derived by averaging the one-year credit default swap spreads of the banks that determine dollar LIBOR and euro LIBOR rates. These results are then subtracted from the spread between LIBOR and overnight index swaps (OIS) to determine noncredit strains, which are likely to be liquidity related.

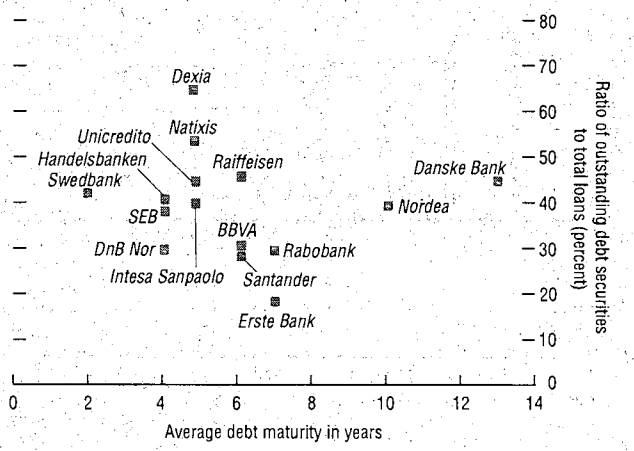
[37]So far, Swedish banks have been able to access euro funding through private placements with European investors, and the Swedish covered bond market has continued to function even when the European market has shut down.

Figure 1.21. External Position of Emerging Markets by Region vis-à-vis BIS Reporting Banks
(In billions of U.S. dollars)



Source: Bank for International Settlements (BIS).

Figure 1.22. Selected European Banks: Dependence on Wholesale Financing as of March 2008



Sources: Bloomberg L.P.; Thomson Worldscope; and IMF staff estimates.

tive in slowing aggregate credit growth, as new entrants, notably Greek and Portuguese banks, have sought to expand market share. Since Bulgaria and Romania only recently joined the European Union, they are still seen by many banks as offering attractive growth opportunities. However, there is a danger that local banks may underestimate the deterioration in the quality of loan portfolios that often accompanies rapid credit growth.

A credit crunch could create pressures for asset quality deterioration in many of the central and southeast European countries.

Banks active in the region also face risks on the asset side of the balance sheet. House prices have soared in tandem with domestic credit growth, and the credit portfolios of banks in emerging Europe have increasingly become exposed to the real estate sector (Figures 1.23 and 1.24). In Estonia and Latvia, house prices have now started to fall, which has led banks to curtail lending to many construction projects, while more developers have resorted to pre-selling apartments in order to receive financing for them. Banks have not experienced a significant increase in loan losses so far, but they have centralized and strengthened risk management in a manner similar to mature market banks. Internal risk controls could force a sharp reduction in credit to protect bank capital, if asset quality deteriorates sharply.

Perceptions of higher risks are reflected in bank stocks exposed to the region, in CDS, and in the Romanian leu (Figure 1.25).[38] The stocks of Swedish banks exposed to the Baltics have underperformed other Nordic bank shares partly owing to significant short-selling. CDS spreads on sovereign debt have surged since August 2007, as investor demand for credit protection has pushed up prices.

[38]The Romanian leu is the only floating currency with a liquid forward market among the group of eastern European countries with large external imbalances. It has depreciated substantially since July 2007, as some investors have expressed negative views on the region as a whole.

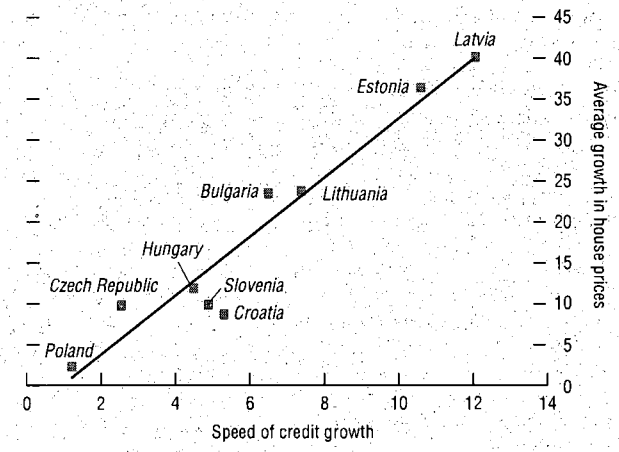
Reduced access to international funding is having an impact across regions, with some risks to domestic credit markets.

External funding difficulties have arisen in a number of emerging markets and have been particularly acute among some emerging market economies. In Kazakhstan, banks that relied heavily on bond and syndicated loan markets, and where investors are now more concerned about credit risks and weak disclosure practices, have run into funding difficulties, as evidenced by the recent sharp widening in bank CDS spreads. Some private Russian banks have encountered similar problems. In Hungary, tightening credit conditions have pushed up swap and interbank rates, prompting some leveraged investors funding at the swap rate to sell off holdings of government bonds. While pressures on Turkish banks are not as strong, there has been a shift in funding sources away from external bond markets and back toward syndicated loan markets. At the same time, spreads in the cross-currency swap market—used to transform currency exposure and maturities—have moved against domestic Turkish banks.

Despite generally strong external positions, some concerns about dollar funding have arisen in Asia, particularly in Korea, Taiwan Province of China, and, to an extent, in India. Korea's large stock of external dollar-denominated banking debt—about $95 billion as of September 2007—presents some potential rollover risk, although much of it reflects currency hedging by exporters (notably shipbuilders) enjoying record order flows. In India, some corporations have borrowed dollars and swapped the resulting debt into yen, increasing the difference between borrowing and lending rates, but leaving a large open exposure.[39] Nevertheless, the risk to the

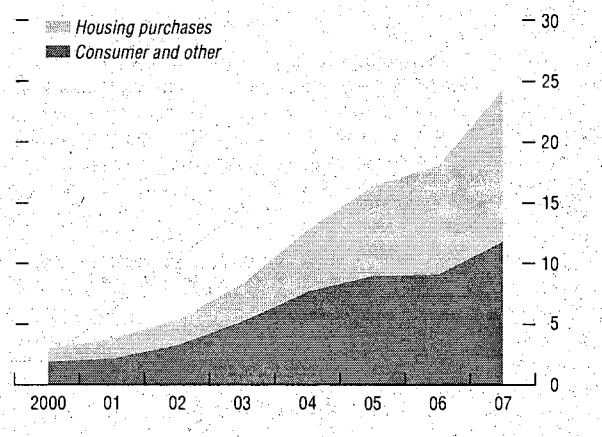
[39]Indian corporations had net cross-border obligations of $31 billion as of September 2007, while Indian banks had very limited net exposure as of January 2008, according to the Bank for International Settlements. The October 2007 GFSR cited estimates that up to one-half of Indian firms' short dollar positions had been swapped into yen (IMF, 2007a). Market sources suggest that the ratio of yen borrowing has likely diminished since then.

Figure 1.23. Central and Eastern Europe: Growth in Private Credit and House Prices, 2002–06
(In percent)



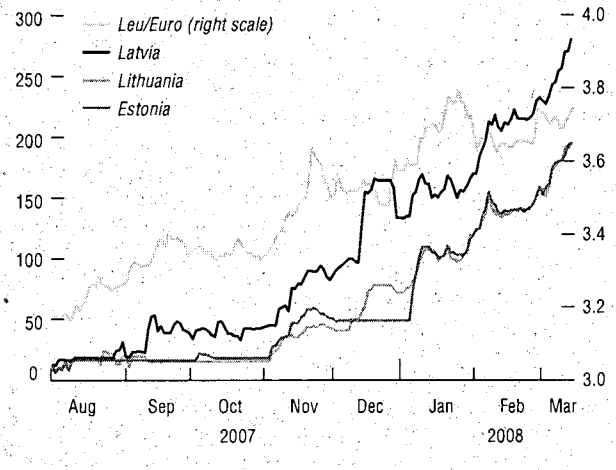
Sources: Égert and Mihaljek (2007); and IMF staff estimates.
Note: The speed of credit growth is defined as the annual percentage point increase in the private credit-to-GDP ratio, averaged over 2002–06.

Figure 1.24. Baltic States, Bulgaria, and Romania: Credit to Households by Type
(In percent of GDP)



Sources: European Central Bank; and IMF staff estimates.
Note: The figure aggregates credit and GDP across countries. The ratio of household credit to GDP is considerably higher in Estonia and Latvia (above 40 percent in 2007), and lower in Romania (18 percent in 2007).

Figure 1.25. Baltic States' 5-Year Credit Default Swap Spreads and Romanian Leu
(In basis points, left scale, unless indicated)



Sources: Bloomberg L.P.; and Datastream.

Indian financial sector arising from these transactions currently appears manageable.

External funding pressures in Latin America remain modest by the standards of past episodes of financial turmoil, due in part to a decline in regional dependence on foreign capital flows. In many countries in the region, much of the financing for domestic credit growth in recent years has come from an expanding domestic deposit base. In Brazil, the development of this credit channel is evident in domestic currency interbank spreads that have remained stable despite the global turmoil. Nevertheless, dollar spreads in Brazil have widened somewhat, particularly at longer maturities. Elsewhere in the region, external funding costs, as indicated by corporate global bond spreads, have also risen.

The widening in corporate spreads could point to future funding issues.

Emerging market corporate spreads have widened substantially since the beginning of the turmoil, signifying that the concerns about funding and credit risks in mature markets have spilled over to emerging market credit. Corporate credit has been more highly correlated with similarly rated mature market credit than it has with other types of emerging market assets, particularly sovereign bonds. In contrast to corporate spreads, the widening in sovereign bond spreads has so far been quite moderate by the standards of previous financial crises, due in part to debt repurchases that have reduced outstanding supply.

With the expansion of emerging market corporate debt as an asset class and the development of CDS and index-based contracts that facilitate the trading of that debt, investors have drawn fewer distinctions between mature and emerging corporate bonds. That perspective, while positive for the asset class, has opened a new potential channel of contagion. Should mature market credit spreads widen further, emerging market corporate funding costs would probably increase, pushing credit demand into domestic banking systems,

and increasing domestic funding pressures (Figure 1.26).

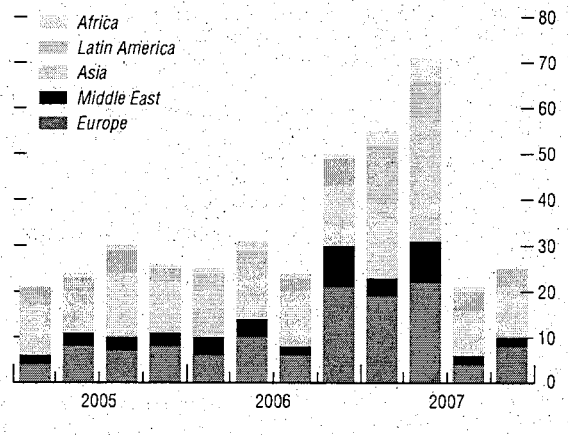
The degree of exposure to mortgage-related credit is not yet fully known.

Thus far, exposure to subprime instruments appears to be quite limited in most emerging markets. Some emerging Asian financial institutions have revealed subprime exposures, but writedowns have been less than $1 billion. There has also been rapid growth in Asian-originated structured credit products—most of which are not related to real estate—but the growth has been from a low base, and the total outstanding is likely still below $100 billion.[40] Purchases of subprime and structured credit products in Latin American markets appear to have been quite limited, as yield-seeking domestic investors have regarded high domestic nominal interest rates as an attractive alternative to offshore instruments, while tight banking regulations have helped limit exposure to riskier assets. In the emerging Europe region, banks have typically focused on expanding domestic lending, often at high expected real rates of return, rather than acquiring foreign assets. Nevertheless, experience in mature markets suggests that subprime exposure often turns out to be larger than initially indicated.

Exchange rate volatility could prompt outflows.

Cross-border carry trades into emerging market currencies that have flourished during the past half-decade may still be vulnerable to bouts of volatility (Figure 1.27).[41,42] Popular carry trade

Figure 1.26. Emerging Markets: Private Sector External Bond Issuance
(In billions of U.S. dollars)



Source: Dealogic.

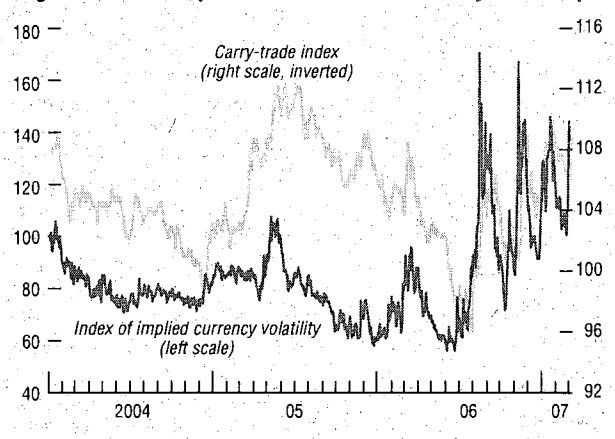
[40]In fact there have already been some writedowns. For example, one Korean bank has written down $440 million in mortgage-backed CDO exposure and $20 million in nonmortgage-backed CDO exposure.

[41]Currency volatilities have risen across the board, in both actual and implied terms, for mature and emerging market currencies.

[42]A cross-border carry trade is normally defined as the combination of a short position in a lower-yielding currency with a long position in a higher-yielding currency, with the aim of collecting the interest rate differential between the two. Such trades can be highly leveraged and entail exposure to currency risk.

destinations have included Brazil, Colombia, Iceland, Indonesia, New Zealand, Turkey, and South Africa, with funding most often from the Japanese yen or Swiss franc, as well as, now, the U.S. dollar. Since July 2007, risk repricing and yen appreciation have prompted the unwinding of a substantial proportion of yen carry trades, but cross-border interest rate differentials have persisted, and lower U.S. interest rates have increased the use of the dollar as a carry trade funding currency. The continued strength of a number of emerging market currencies—including the Brazilian *real* and the Indian rupee—suggests that some carry trades have persisted. This could present a channel of vulnerability in the event of future volatility spikes.

Figure 1.27. Carry-Trade Index and Currency Volatility



Sources: Bloomberg L.P.; and IMF staff estimates.
Note: Implied currency volatility obtained from 1-month U.S. dollar–Japanese yen options.

A generalized slowdown could still prompt a broad retreat from emerging market assets.

A global slowdown, in turn, could lead to a decline in most types of capital inflows to emerging markets. While there have been some signs of slowing, inflows to emerging equity markets have generally remained positive. Some supply-side factors continue to favor emerging markets, with institutional investors in Europe and North America still seeking portfolio diversification, retail investors in Japan continuing to look for higher returns abroad, and institutional or sovereign investors in the Middle East recycling oil-based surpluses. High commodities prices are also supportive. Nevertheless, the experience of previous bouts of global risk reduction in the midst of slowing growth suggests that the possibility of a reversal in equity flows remains considerable, particularly if other factors are unfavorable.

For certain emerging markets there may be a risk of overheating as investors shift away from mature market assets.

For countries with strong balance of payments positions and tight links to the dollar, the possibility of overheating remains.[43] A number

[43]See the April 2008 WEO for other sources of overheating, including high energy and food prices in some emerging market economies (IMF, 2008).

Box 1.3. The Rise in Balance Sheet Leverage of Global Banks

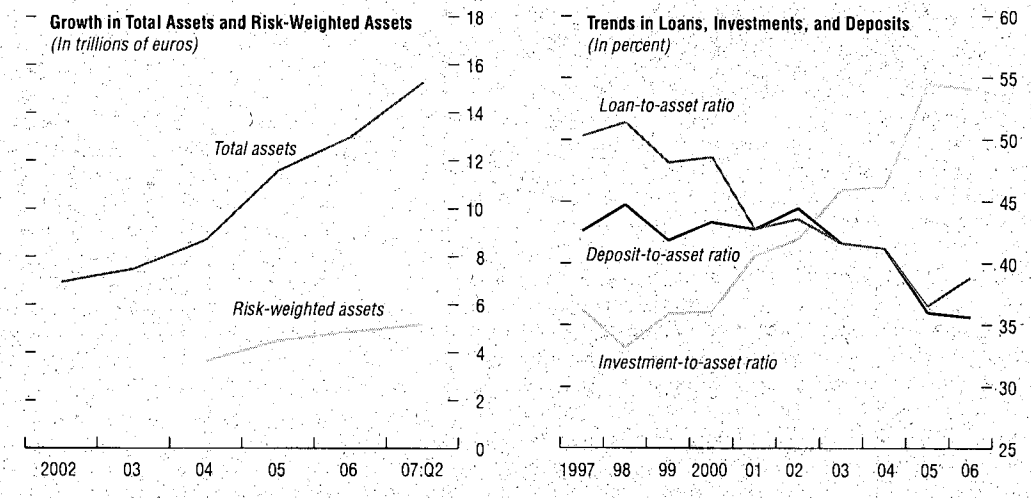
For the past decade, high levels of liquidity and low volatility supported significant asset growth among the largest banks, while asset growth that contributed to holdings of regulatory capital was more moderate. This trend is evident in the 10 largest publicly listed banks from Europe and the United States, which doubled in aggregate assets in the last five years to 15 trillion euros, while risk-weighted assets, which drive the capital requirement, grew more moderately to reach about 5 trillion euros (see figure). While considerable differences are present among individual institutions, the widening gap between risk-weighted assets and total assets reflects an expanding share of assets that for regulatory capital purposes carried a lower risk weighting. Two key factors are responsible for the difference.

- The adoption of international financial reporting standards (IFRS) in Europe caused the re-recognition on the balance sheet of substantial activity associated with the originate-to-distribute business model. Activities that were earlier transferred under national accounting standards to special-purpose vehicles (SPV) were brought onto bank balance sheets. Under Basel I, which used a different measure for risk transfer, the banks were able to record a lower or no risk weight for the associated assets (and for backup credit lines extended to SPV).
- The increase in trading and investment activities (e.g., asset-backed securities, and hedging). The associated risk weights on these instruments were substantially less than loans because they were generally highly rated, showed relatively stable prices, or were used for hedging.

Regulatory capital requirements did not constrain asset growth. The banks continued to meet the Basel I capital requirement with relative ease. The banks showed on average a Tier 1 capital-to-risk-weighted-asset ratio of between 7 and 9 percent—well above the 4 percent minimum. With the high capital ratios, many of the large banks were able to engage in stock repurchases through the third quarter of 2007.

Note: Michael Moore prepared this box.

Balance Sheet Profiles for 10 Large Publicly Listed Banks



Sources: Thomson Financial; and IMF staff estimates.

Box 1.3 *(concluded)*

The composition of bank balance sheets for large banks moved away from loans funded by deposits. Loans declined as a share of total assets, and investments (securities holdings and trading activities) grew (see figure). A companion to the loan decline was a falloff in the importance of retail deposits as a source of stable funding, which is most significant among the banks that grew the quickest.

Banks became more reliant on liquidity from money markets (i.e., interbank borrowing and other forms of short- and long-term debt, including securitized funding) or from the sale of marketable securities. These funding sources, however, entailed higher market-sensitive interest costs (compared to slower growing consumer deposits), which increased and became more difficult to obtain with the tightening of market liquidity starting in the third quarter of 2007. Moreover, the ability to sell marketable securities at close to book values proved increasingly more difficult, as fears of underlying credit quality tainted market valuations.

of Middle East oil exporters have currencies that are closely linked to the dollar, and many of these have already experienced strong inflationary pressures. In some Asian economies, steps taken to limit the pace of appreciation against the dollar may lead to monetary policy settings that are looser than would otherwise be optimal. Despite the financial turmoil, some "Asia play" flows into currencies such as the Chinese renminbi and Indian rupee have continued.[44] In contrast to the predominant view in prior crises, a few investors have even taken the position that emerging market assets could provide a form of safe haven from mature market upheavals. Under such circumstances, further downward pressure on the dollar, particularly if it emanates from subprime or similar shocks, could boost liquidity and lead to an intensification of inflationary pressures in some emerging markets.

Credit Squeeze or Credit Crunch?

What began as a fairly contained deterioration in portions of the U.S. subprime market has metastasized into severe dislocations in broader credit and funding markets that now pose risks to the macroeconomic outlook in the United States and globally. This is best illustrated by Figure 1.28, which documents how the deterioration that first emerged in nonprime mortgage markets spread to leveraged finance and mortgage-related structured credit markets, global money markets, and then moved up the credit spectrum from low- to high-grade corporate credit markets, and to prime residential and commercial mortgage markets, finally threatening to broaden to emerging market assets. Spreads have widened across the full range of credits—not only subprime but high-grade—and around the globe to Europe as well as the United States and to emerging as well as mature markets (Figure 1.29).

Off-balance-sheet structures and leveraged entities are being forced to unwind leverage, adding supply to the market from distressed debt sales and a downward spiral of credit prices.

Rising funding costs and low valuations are forcing off-balance-sheet credit vehicles, some hedge funds, and some investment funds to sell assets to raise liquidity and reduce leverage. SIVs are under rising pressure to sell assets as they struggle to roll over much of their medium-term financing. Falling prices on lever-

[44]The "Asia play" can be loosely defined as the purchase of Asian-currency-denominated assets on the view that the local currency will likely appreciate against the dollar, especially if authorities are expected to reduce the scope of interventions.

aged loans have triggered unwinds of some of the $300 billion of market-value CLOs, requiring their managers to sell the underlying loans onto the market, depressing prices further.[45] These sales added to the pressure from the estimated $230 billion overhang of debt sitting on bank balance sheets from buyout deals completed in 2007.[46] Financial guarantor concerns have spilled over to municipal markets and guaranteed bonds, as funding pressure is now being felt across markets wherever AAA-rated paper was issued to finance assets with lower ratings. Markets for other types of short-term securities have also come under pressure, suggesting some contagion effects.[47] Spreads on the municipal bonds backed by the financial guarantors have widened, and corporates are also finding it more expensive to issue.

Both engines of credit creation are sputtering.

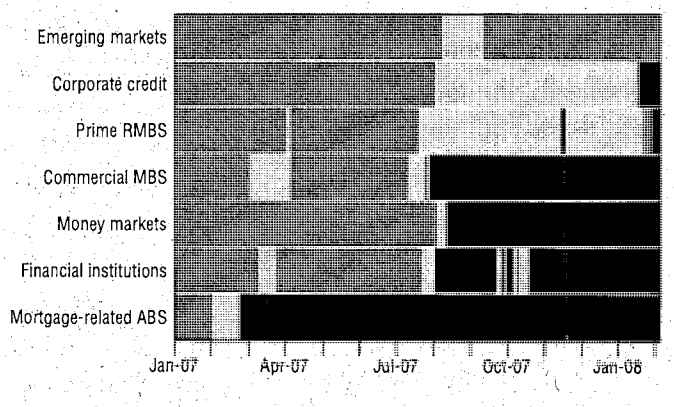
Against this backdrop, the environment for new issuance in some securities markets is more challenging. This year, private sector net debt issuance is expected to contract markedly. Investment-grade corporate issuance is thought likely to hold up relatively well, and highly rated firms should still be able to borrow on reason-

[45]CLOs are securitized packages of leveraged loans. A market-value CLO is one in which the manager has latitude to trade assets within the portfolio. Payments to investors come from both cash flows from the underlying assets and sales of some assets. Payments to tranches are not contingent on the adequacy of the underlying assets' cash flows (as in a "cash-flow CLO"), but rather on whether the market value of the CLO exceeds certain thresholds. If those thresholds are breached, an automatic unwind of the structure is triggered to protect the position of the senior creditors.

[46]The $175 billion or so of leveraged loans include the $17 billion issued by Bell Canada Enterprises, $15 billion by Clear Channel Communications, $10.5 billion by Alltel, $6 billion by Harrah's Entertainment, and $8.8 billion by the Texas Utility Corporation. The remainder is high-yield bonds.

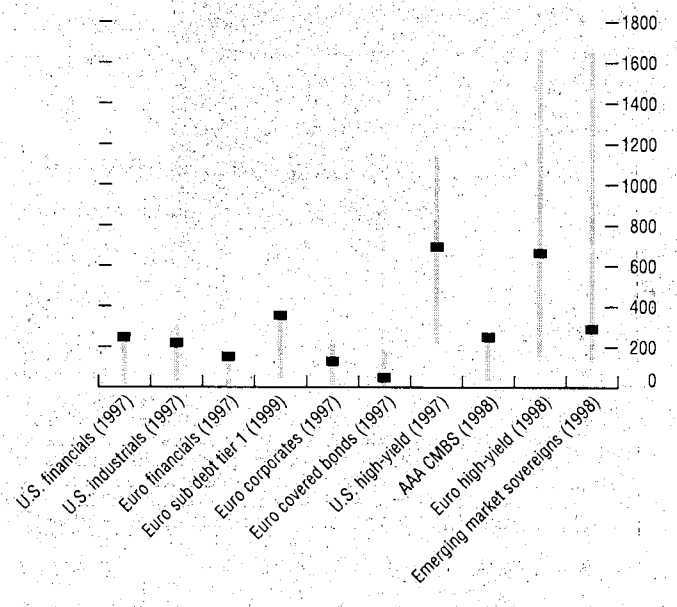
[47]For example, demand for auction rate securities issued by student loan lenders and some U.S. municipalities have fallen dramatically. Similar dislocations are observed in the tender option bond (TOB) sector, primarily reflecting concerns that a downgrade of a financial guarantor will lead to a downgrade of the municipal bonds that serve as collateral for TOB products.

Figure 1.28. Heat Map: Developments in Systemic Asset Classes



Source: IMF staff estimates.
Note: The heat map measures both the level and 1-month volatility of the spreads, prices, and total returns of each asset class in terms of deviation relative to the average during 2004–06 (i.e., wider spreads, lower prices and total returns, and higher volatility). That deviation is expressed in terms of standard deviations. Green signifies a standard deviation under 1, yellow signifies 1 to 4 standard deviations, and black signifies greater than 4 standard deviations. ABS = asset-backed security; MBS = mortgage-backed security; RMBS = residential mortgage-backed security.

Figure 1.29. Spreads Across Credit: Historical Highs, Lows, and Current Levels
(In basis points)



Sources: JPMorgan Chase & Co.; Merrill Lynch; and IMF staff estimates.
Note: Yellow lines indicate period ranges. Black squares are as of March 2008. Data inception in parentheses. CMBS = commercial mortgage-backed security.

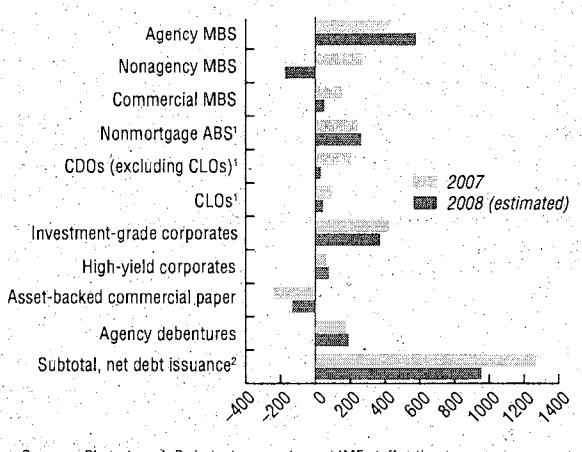
able terms, but mortgage issuance and high-yield corporate loan issuance are likely to fall sharply (Figure 1.30). Many of the structures created over recent years are struggling, as the traditional buyer base of the high-rated securities has shifted to more liquid and less risky assets. Confidence in the architecture, ratings, and process of structured finance will require reform and time to be restored.

Bank balance sheet adjustment could crimp or bind credit.

The possible immediate credit impact of the aggregate loss estimates on banks is that credit growth could be substantially squeezed. Estimating the impact on credit to the private sector is difficult. One gauge is to assume that banks will cut back lending to offset part, but not all, of the worsening of their key ratios that would result from the losses they will incur and involuntary balance sheet expansion. Using this approach, and spreading the credit withdrawal over three quarters, the pace of credit growth in a squeeze would be reduced to a little over 4 percent of the outstanding private sector debt stock in the United States. It is worth noting that credit had grown on average by nearly 9 percent in the United States in the post-war period. A credit squeeze might therefore feel roughly like the normal constriction of credit seen at the bottom of the business cycle in mature markets.

A supply shock to credit would result in a more painful credit crunch. In a negative scenario, funding markets remain restricted, forcing banks to de-lever and hold more capital in support of their balance sheets, banks' profits fall and fee-earning sources shrink, and raising fresh capital is more difficult. Banks may not only limit exposure to lower-quality loans, but curtail credit across the board—central bank surveys show a remarkably consistent picture of tightening of credit standards, including across categories of lending (Figure 1.31). In this case, credit growth could be reduced to 1 percent of the outstanding private sector debt in the United States. The resulting slowing of credit growth would be similar to that experienced

Figure 1.30. U.S. Private Sector Net Debt Issuance by Sector
(In billions of U.S. dollars)



Sources: Bloomberg L.P.; industry reports; and IMF staff estimates.
Note: ABS = asset-backed security; CDO = collateralized debt obligation; CLO = collateralized loan obligation; MBS = mortgage-backed security.
¹Only gross debt issuance data are available.
²Subtotal is based on data for which net figures are available.

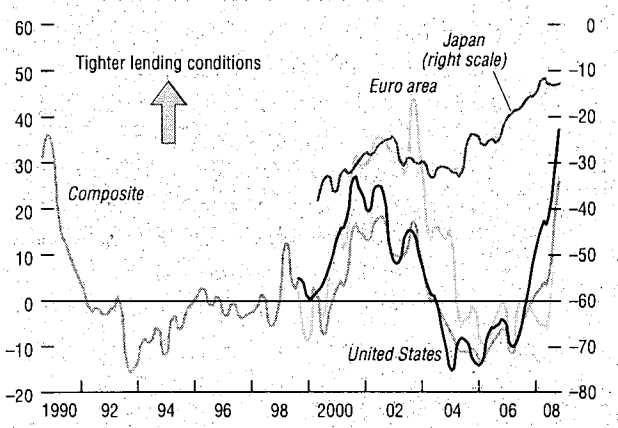
during the 1990–91 recession, and worse than those in previous recessions (Figure 1.32).[48]

Simulations suggest that a supply shock to credit is likely to have a significant impact on economic growth.

We develop a simple vector autoregression model to get some feel for how credit growth and other economic variables affect one another. The model includes real GDP growth, inflation, private sector borrowing, and the prime loan rate on quarterly data for the United States between the first quarter of 1952 and the third quarter of 2007.[49] Private sector borrowing is measured as a percentage of the outstanding stock of private sector debt.[50]

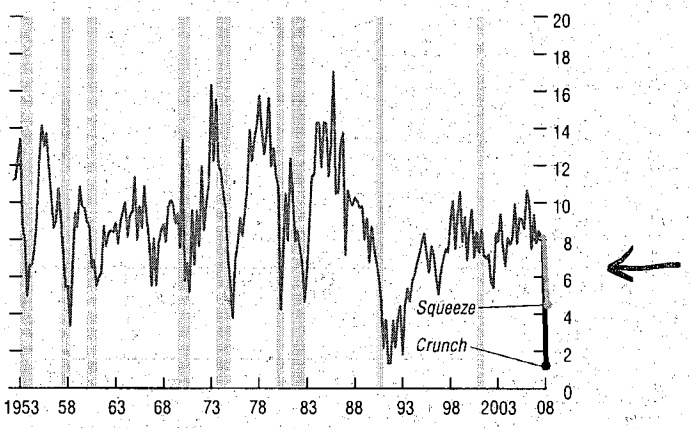
The model detects a statistically significant impact of a negative shock to credit growth on GDP growth.[51] A credit squeeze and a credit crunch spread evenly over three quarters will reduce GDP growth about 0.8 and 1.4 percentage points year-on-year, respectively, assuming no other shocks to the system (Figure 1.33). This suggests that the adjustment process is likely to

Figure 1.31. G-3 Bank Lending Conditions
(Net percentage of domestic respondents reporting tightening standards for loans)



Sources: Bank of Japan; European Central Bank; Federal Reserve; and IMF staff estimates.
Note: Monthly interpolated GDP-weighted average. Euro area 1999:Q1 to 2002:Q4 based on values implied by credit growth.

Figure 1.32. U.S. Private Sector Borrowing
(Borrowing by households and nonfinancial corporations as a percent of debt outstanding)



Sources: Federal Reserve; National Bureau of Economic Research; and IMF staff estimates.
Note: Yellow bars represent recession periods.

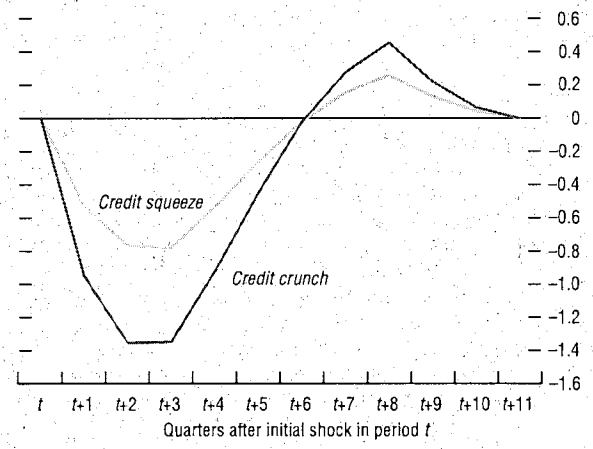
[48]The shock will be mitigated to the extent banks can raise fresh capital, either from existing shareholders or from new ones (see Box 1.2). Other important factors include the rate at which losses are recognized, the amount of profits insulated from the credit crunch, and the extent to which some banks (and rating agencies) tolerate a temporary dip in capital ratios.

[49]The model includes two lags, which is what the Schwarz information criterion prescribes for this particular sample. Parameters are stable according to Quandt-Andrews tests.

[50]The data on borrowing and debt are from the Federal Reserve's Flow of Funds Accounts. Borrowing is defined as the increase in credit market liabilities for households and nonfarm, nonfinancial corporations. It includes mortgages, consumer credit, bank loans, and issuance of commercial paper and corporate bonds. Over the sample period, private sector borrowing has averaged 8.8 percent of outstanding private sector debt, quarterly annualized, with a standard deviation of 2.9 percent.

[51]The impulse response function is based on Cholesky decomposition, with the variables ordered as above. One caveat is that this simple model cannot distinguish between demand and supply shocks to credit. Figure 1.33 introduces three sequential shocks to borrowing, which bring borrowing growth down to 4 and 1 percent in a credit squeeze and a credit crunch, respectively. The simulation takes into account the model's endogenous path for borrowing, as well as the dynamic effects of previous shocks.

Figure 1.33. Impulse Response of U.S. GDP to Credit Shocks
(In percent, year-on-year)



Source: IMF staff estimates.
Note: Credit withdrawal spread over three quarters.

be long lasting, and would continue to dampen growth well into 2009.

A great deal of uncertainty surrounds such an exercise. The model does not account for the unusually aggressive monetary policy easing being undertaken by the Federal Reserve, which is likely to mitigate some of the predicted impact on growth. At the same time, however, the effect on GDP could get substantially larger if market dislocations were to affect the issuance of nonfinancial corporate debt more significantly. Furthermore, the fact that this credit shock is taking place in the heart of the banking system, where securitization and structured credit products have been used to shift credit risks to other holders, not simply in smaller banks where such risks were retained, means that the impact could be more profound than suggested by historical patterns in the data. Finally, although not modeled here, the slowing of credit growth in Europe would be substantial, and the greater role of banks in credit intermediation in many European economies than in the United States means that the impact on European economies could be significant.

Immediate Policy Challenges

Against a backdrop of continuing weakness in global credit markets, threats to systemic stability have intensified. Despite some reductions in policy rates in the United States, United Kingdom, Canada, and a few other economies, as well as a sizable U.S. fiscal package, global growth is likely to slow significantly in 2008. The risks of a credit crunch are heightened by spreading dislocations in securities markets, significant bank balance sheet adjustment, and growing concerns about counterparty credit risks. This more negative scenario, however, is not a forgone conclusion. Banks are seeking capital injections and private participants, including banks, financial guarantors, and credit rating agencies are taking steps to rebuild market confidence and stem systemic risks.[52] Nevertheless, a range of finan-

[52]In response to the crisis of confidence, market participants have already begun to strengthen their due

cial policies—in addition to macroeconomic policies—will be needed to mitigate downside risks. These policies aim to foster counterparty confidence, and set the stage for more medium-term reforms discussed in Chapters 2 and 3.

Restoring counterparty confidence is an immediate priority to reduce systemic threats and spillovers.

Lack of reliable information about exposures and risks has led to misunderstandings and misperceptions that have amplified systemic risks. More rapid and informative disclosure by financial institutions is needed, including how complex structured credit securities are valued and the extent of losses. However, some financial institutions may lack incentives to do this, and addressing such shortcomings will take time and require international agreements. More immediately, national authorities should seek to remove misperceptions about the vulnerabilities of national financial institutions and markets. One approach would be to issue special financial stability reports drawing information from supervisory authorities that assesses risks, provides information and analysis relevant to financial stability, and highlights plans to restore financial soundness as needed. Such reports would complement other policy measures aimed at containing systemic risks.

Systemically important financial institutions need to continue to raise capital and funding to support balance sheets.

To strengthen confidence and avoid capital reductions that could constrain lending, banks with weak capital positions should be strongly encouraged to raise capital. In some instances, supervisors may need to direct banks to strengthen capital ratios and fortify funding positions, even in the more costly current environment. To improve confidence in reported information in Europe, consideration could be given to making nonconfidential information from supervisory prudential reports public, as is the practice in a few other countries. Financial guarantors along with others will need to continue to explore avenues for shoring up capital to back up commitments to structured credit products and protect or restore ratings, while reinforcing risk management and governance. Regulators will need to develop a capital adequacy framework for financial guarantors that is less dependent on rating agency ratings and models.

A strengthening of supervisory oversight should reduce the incidence of unsuspected risk exposure and contribute to the rebuilding of counterparty confidence.

Repeatedly during the crisis, banks have revealed unexpectedly large risk exposures. This risk came through many channels—purchases of securities based on loans that had initially been sold on by banks, implicit guarantees provided to off-balance-sheet vehicles, and large lines of credit extended to hedge funds and other high-risk clients, among others. At the same time, the degree of leverage undertaken by hedge funds and other market participants has often turned out to be much higher than expected. The revelation of such high and previously unsuspected levels of systemic risk underlines the important role that supervisory oversight should play in ensuring that institutions' risks are well managed. Confidence in financial institutions can be enhanced through supervisory oversight that examines more broadly the risks banks are taking, with closer coordination among supervisors when they are international. There is an urgent need to review the regulatory framework and effectiveness of supervision. In particular:

- Banks must be able to show sufficient capital to absorb shocks from the reduction in mark-to-market valuations or losses on asset sales. They need to demonstrate that they have sufficient capital and liquidity resources to reassure counterparties that good access to funding and

diligence. With less support from rating agencies, financial guarantors, and traditional prepayment and cash flow models, though, credit analysis is now more operationally intensive. For instance, in the mortgage sector, each loan in a pool must be analyzed to determine equity build-up, prepayment history, triggers, and other credit attributes to forecast borrower behavior. Typically, each pool has 7,000 loans, with 70 different credit attributes across each pool that must be analyzed against several different home price scenarios.

money market liquidity, including during periods of severe turbulence, can be maintained. Pillar 2 of Basel II—supervisory review—can be used to ensure that banks hold additional capital beyond the minimum requirement identified by risk weights or by internal models under Pillar 1, when the supervisors identify deficiencies (see Chapter 2).

- Bank supervisors need to take more account of balance sheet leverage as they assess capital adequacy. The risks (particularly market and liquidity risks) that have accompanied balance sheet growth need to be properly considered for capital adequacy purposes. While banks continue to meet the minimum regulatory capital requirements, the low absolute capital levels for many large banks at present and the prospect of further losses are adding to concerns about whether capital is sufficient. Banks that must be particularly vigilant are those that hold high levels of assets subject to mark-to-market valuations, that are highly reliant on wholesale funding markets, and that employ high leverage.
- Banks need to improve their management of liquidity risk. This may include improvements in measurement, evaluation of the backup contingency lines, severe stress tests, and contingency plans for long periods when wholesale markets are unavailable. Supervisors need to be more proactive in countering signs that banks have inadequately protected against liquidity risks (see Chapter 3).
- Stricter rules are needed on the use of off-balance-sheet entities by banks, and disclosure should be improved so that investors can assess the sponsor's risk to the entity. Supervisors may need to strengthen guidelines regarding the circumstances under which risk transfers to off-balance-sheet entities warrant capital relief (see Chapter 2).

Public measures can help alleviate some stress in the U.S. mortgage markets, but longer-term policy repercussions need to be considered carefully.

Public measures to alleviate mortgage-related stress should help cushion some of the fallout from the crisis. In addition to a sharp easing in monetary policy and broader tax relief, measures adopted in the United States include a moratorium on interest rate resets for subprime borrowers; an increase in the limit on the size of loans that conform to packaging requirements at the GSEs; a removal of the cap on the GSEs' retained portfolios; and an expansion in the Federal Housing Administration lending program. These steps, though helpful, are not a panacea. The planned moratorium, for example, seeks to limit foreclosures, but may also redistribute the cost from borrowers to lenders, servicers, and investors. Other measures will need to be weighed carefully to ensure that a balance is struck between (legitimate) issues of consumer protection and protection of legal contracts that underpin modern finance, as some of these measures may undermine existing contracts.

If systemic risks significantly increase, remedial measures may be warranted.

Public policy should seek to safeguard financial stability and market functioning. However, care should be taken to avoid creating adverse incentives or moral hazard that undermines discipline imposed on private players by such events. At the same time, the public resources should be kept as small as possible. Supervisors need to ensure prompt recognition of mark-to-market losses but should recognize that prices in illiquid markets can overshoot their new equilibrium (see Chapter 2). In a case of depleted capital, the preferred approach would be to take remedial measures and resolve the institution if it is no longer viable. Shareholders should bear the brunt of the adjustment, and the resources raised by the liquidation of the institution should be shared with creditors. When the failure of the institution poses a systemic threat, the case for public assistance may need to be considered, but only after shareholders have borne the full brunt, with clear mechanisms in place to ensure that operations continue on a commercial basis, and with an unambiguous plan for exit by the public sector.

Resolution should avoid adding to pressures of distressed debt sales. Under extreme sce-

narios, sales of structured finance assets from off-balance-sheet entities and banks under resolution could place further pressure on credit and may force other banks to become undercapitalized, leading to potentially disruptive and costly strains on insured depository institutions. Accordingly, disposition of assets should be managed in an orderly fashion.

Resolving institutions should go hand-in-hand with reforms to strengthen the financial system.

An important lesson from the crisis has been the role that underlying vulnerabilities and weakness in the financial system architecture has played in amplifying problems and raising costs to both private and public parties. Although a rush to regulate should be avoided, supervisors need to be able to respond proactively to address misaligned incentive structures—such as in the "originate-to-distribute" model—that together with an overall resolution strategy should reduce future risks. For example, some German Landesbanken were particularly exposed to subprime instruments, and IMF missions have called for a restructuring of these state-sponsored banks—a process that may gain new impetus. In the United Kingdom, a review of financial stability arrangements is under way—following the events at Northern Rock. This anticipates the establishment of a stronger system for the detection of banking sector problems, and associated with this a special resolution regime. An addition reform of the payment system oversight arrangements is being considered. In the United States, the experience of the financial guarantors argues for reforms to U.S. insurance regulation. Responsibility currently resides with the states, which has impeded coordination of regulatory efforts across states and with federal bank and securities regulators where spillovers are now evident. A new strategy for regulation of the financial guarantor sector needs to be implemented, including a coherent approach to capital adequacy and new limits on financial guarantors' activities.

Restoring counterparty confidence in funding markets should support an exit by central banks as conditions stabilize.

Central bank operations in the term funding markets pose challenges for monetary operations in the presence of counterparty credit concerns. Term premiums reflect, in part, market perceptions and pricing of credit risk. Therefore, determining the size, tenor, and vigor of such operations needs to balance the desire to stabilize market conditions without unduly distorting the market pricing of credit risk. Importantly, central banks will find exiting the role of term funding support difficult without the implementation of the above policy measures, because central bank operations can address liquidity but not credit problems. Once counterparty confidence is restored and banks have strengthened their liquidity and funding positions, central banks should seek to gradually exit from significant support to term funding markets.

Emerging markets need to strengthen their resilience to global turmoil.

Policy improvements have contributed to the resilience of many emerging markets in the face of the global turmoil. In many countries, macroeconomic stabilization programs have helped to eliminate distortions and reduce external imbalances, making domestic markets less vulnerable to external shocks. Countries vulnerable to external financing shocks and higher inflation need to adjust to the new tighter external financing conditions and adopt policies to reduce domestic repercussions of sustained financial turmoil. These policies may include a tightening of limits on external borrowing by banks and other financial institutions. In addition, to prepare for the possibility of a deeper global liquidity shock, policymakers should map out contingency plans with potential responses to short-term funding problems. The importance of transparency in bolstering investor confidence has also become more apparent. The limited exposure to subprime and other impaired instruments in emerging

markets should not lead to complacency, as the same benign conditions have underpinned higher risk-taking in some countries. As well, the lessons from the turmoil underscore the need to make further progress on fine-tuning the design and strengthening the implementation of accounting and disclosure standards for financial institutions.

The IMF is developing new methods to examine various types of risk and is seeking to strengthen its assessments of macro-financial linkages (see Box 1.4). These efforts will be intensifying given the now more urgent task of limiting the knock-on effects of the current crisis to the IMF's broader membership.

Annex 1.1. Global Financial Stability Map: Construction and Methodology[53]

This annex outlines our choice of indicators for each of the broad risks and conditions in the stability map. To complete the map, these indicators are supplemented by market intelligence and judgment that cannot be adequately represented with available indicators.

To begin construction of the stability map, we determine the percentile rank of the current level of each indicator relative to its history to guide the assessment of current conditions, relative both to the October 2007 GFSR and over a longer horizon. Where possible, we have therefore favored indicators with a reasonable time series history. However, the final choice of positioning on the map is not mechanical and represents the best judgment of IMF staff. Table 1.4 shows how each indicator has changed since the October 2007 GFSR and the overall assessment of the movement in each risk and condition.

Monetary and Financial Conditions

The availability and cost of funding linked to global monetary and financial conditions (Figure 1.34). To capture movements in general monetary conditions in mature markets, we begin by examining the cost of short-term liquidity, measured as the average level of real short rates across the G-7. From there, we take

[53]The main author of this annex is Ken Miyajima.

Table 1.4. Changes in Risks and Conditions Since the October 2007 *Global Financial Stability Report*

Conditions and Risks	Change since October 2007 GFSR
Monetary and Financial Conditions	↓
G-7 real short rates	↑
G-3 excess liquidity	↓
Financial conditions index	↔
Growth in official reserves	↓
G-3 lending conditions	↓
Risk Appetite	↓↓
Investor survey of risk appetite	↔
Investor confidence index	↓
Emerging market fund flows	↓
Risk aversion index	↓
Macroeconomic Risks	↑↑↑
World Economic Outlook global growth risks	↑
G-3 confidence indices	↑
Economic surprise index	↑
OECD leading indicator	↑
Implied global trade growth	↑
Emerging Market Risks	↑↑
Fundamentals EMBIG spread	↑
Sovereign credit quality	↑
Credit growth	↑
Median inflation volatility	↑
Corporate spreads	↑
Credit Risks	↑↑↑
Global corporate bond index spread	↑
Credit quality composition of high-yield corporate bond index	↑
Speculative-grade corporate default rate forecast	↑
Banking stability index	↑
G-3 loan delinquencies	↑
Market Risks	↑
Hedge fund estimated leverage	↑
Speculative positions in futures markets	↓
Common component of asset returns	↓
World implied equity risk premia	↓
Composite volatility measure	↑
Financial market liquidity index	↑

Source: IMF staff estimates.

Note: Changes are defined for each risk/condition such that ↑ signifies more risk or easier conditions and ↓ signifies the converse; ↔ indicates no appreciable change. The number of arrows for the six overall conditions and risks corresponds to moves on the global financial stability map.

Box 1.4. Quantitative Financial Stability Modeling

In the wake of the U.S. subprime crisis, the IMF has expanded its research agenda in quantitative financial stability modeling to strengthen the analysis of macro-financial linkages.

The IMF is developing new applications for stress tests and other risk assessment models to help identify and address financial system vulnerabilities in member countries. This work aims at enhancing the quality of quantitative analyses performed in the context of the Financial Sector Assessment Program, supporting technical cooperation on risk-based supervision and Basel II implementation, and facilitating offsite surveillance of national and global financial systems, and hence IMF surveillance more broadly.

Among the specific areas in which the IMF has been active are the further development of credit risk modeling; analysis of the "second-round effects" of shocks—both interactions within the financial sector and feedback between the financial sector and the real economy; and expansion of existing approaches to liquidity risk modeling.

Credit Risk Modeling

Work in this area revolves around three methodologies. One application models portfolio credit risk based on CreditRisk+, a tool used by financial institutions and supervisors to compute credit portfolio loss distributions (Avesani and others, 2006). This application can be useful for scenario stress testing when complemented with models of the probability of default and loss given default. Other recent work includes macro stress testing in the presence of data constraints, an approach that seeks to quantify the impact of macroeconomic shocks on banks' economic capital in the presence of short time series of default probabilities (Segoviano Basurto, 2006). It simultaneously accounts for changes in the correlation among banks' assets through the economic cycle. The contingent claims approach (CCA)—a method that combines balance sheet and market information with widely used finance techniques to construct risk-adjusted balance sheets—is also being used to conduct scenario analysis and can be applied to financial institutions that issue securities in sufficiently deep markets (Gray, Merton, and Bodie, 2007).

Measurement of Second-Round Effects

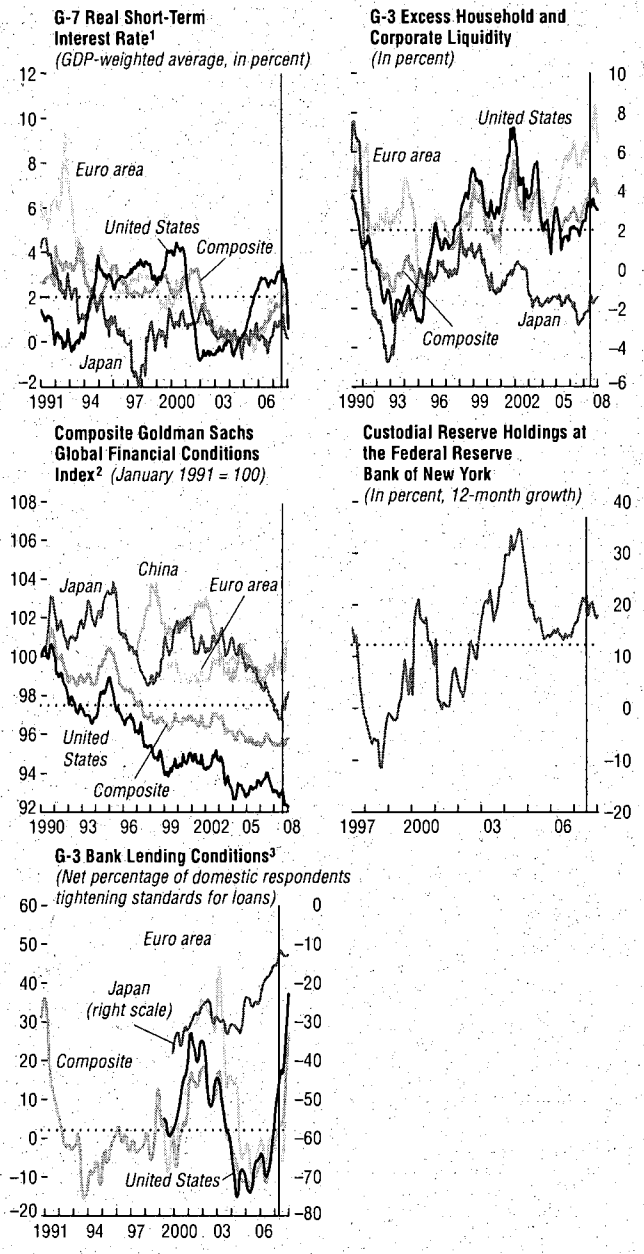
This includes a measure of financial fragility at the system level—a banking stability index—based on banks' joint probability of default (see Box 1.5). This approach can also be applied at the global level by looking at joint probabilities of default (or other measures of stability) for key large complex financial institutions. Another approach to modeling contagion uses the extreme value theory framework to capture the possibility that large, extreme shocks are transmitted across financial systems differently than small shocks (Chan-Lau, Mitra, and Ong, 2007). A third approach is to develop a CCA-based framework that provides risk indictors and can be linked to macroeconomic models of varying degrees of complexity.

Liquidity Risk Modeling

Work is under way to enhance the range of tools and methods available to stress test exposures to liquidity risk—a risk area that the current turmoil has made more apparent. The three main directions of work in this area are (1) building on existing methodologies to identify funding liquidity risk (including non-traditional sources, such as securitization) and expanding them to incorporate market liquidity risk (including the effects of asset fire sales and crowded trades); (2) capturing off-balance-sheet concentration risk—for example, excessive committed and uncommitted credit lines to a single counterparty; and (3) extending the CCA-based framework using information from equity option prices to capture the effects of increased uncertainty of asset values, market illiquidity, potential for fire sales, and funding liquidity risk.

Note: The main author of this box is Marina Moretti.

Figure 1.34. Global Financial Stability Map: Monetary and Financial Conditions



Sources: Bloomberg L.P.; Goldman Sachs; OECD; lending surveys by Bank of Japan, European Central Bank, and Federal Reserve Board for households and corporates; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

[1]Only G-3 subindicators are shown.

[2]A GDP-weighted average of China, euro area, Japan, and the United States. Each country index represents a weighted average of variables, including interest rates, credit spreads, exchange rates, and financial wealth.

[3]Monthly interpolated GDP-weighted average. Euro area 1999:Q1 to 2002:Q4 based on values implied by credit growth.

a broad measure of excess liquidity, defined as the difference between broad money growth and estimates for money demand. Realizing that the channels through which the setting of monetary policy is transmitted to financial markets are complex, some researchers have found that including capital market measures more fully captures the effect of financial prices and wealth on the economy. We therefore also use a financial conditions index that incorporates movements in real exchange rates, real short- and long-term interest rates, credit spreads, equity returns, and market capitalization. Rapid increases in official reserves held by the central bank create central bank liquidity in the domestic currency and in global markets. To measure this, we look at the growth of official international reserves held at the Federal Reserve. While the above measures capture the price effects of monetary and financial conditions, to examine the quantity effects, we incorporate changes in lending conditions based on senior loan officer surveys in mature markets.

Risk Appetite

The willingness of investors to take on additional risk by increasing exposure to riskier asset classes, and the consequent potential for increased losses (Figure 1.35). We aim to measure the extent to which investors are actively taking on more risk. A direct approach to this exploits survey data. The Merrill Lynch Fund Manager Survey asks about 200 fund managers what level of risk they are currently taking relative to their benchmark. We then track the net percentage of investors reporting higher-than-benchmark risk-taking. An alternative approach is to examine institutional holdings and flows into risky assets. The State Street Investor Confidence Index uses changes in equity holdings by institutional investors relative to domestic investors to measure relative risk tolerance.[54] The index extracts relative

[54]The estimated changes in relative risk tolerance of institutional investors from Froot and O'Connell (2003) are aggregated using a slow, exponentially weighted moving average in order to account for slow-moving secular

risk tolerance by netting out wealth effects and assuming that changes in fundamentals symmetrically affect all kinds of investors. We also take account of flows into emerging market equity and bond funds as these represent another risky asset class. Risk appetite may also be inferred indirectly by examining price or return data. As an example of this approach, the Goldman-Sachs Risk Aversion Index measures investors' willingness to invest in risky assets as opposed to risk-free securities, building on the premises of the capital asset pricing model.[55] By comparing returns between government bills and equities, the model allows the level of risk aversion to move over time. Taken together, these measures provide a broad indicator of risk appetite.

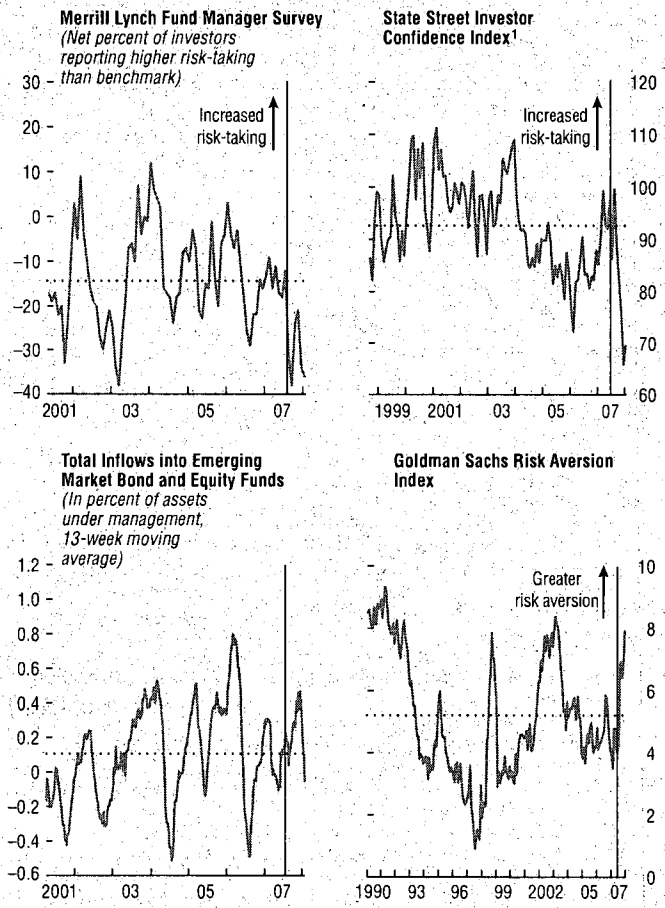
Macroeconomic Risks

Macroeconomic shocks with the potential to trigger a sharp market correction, given existing conditions in capital markets (Figure 1.36). Our principal assessment of the macroeconomic risks is based on the analysis contained in the WEO and is consistent with the overall conclusion reached in that report on the outlook and risks for global growth (see, in particular, Figure 1.12 of the April 2008 WEO). We complement that analysis by examining various economic confidence measures. The first of these is a GDP-weighted sum of confidence indices across the major mature markets to determine whether businesses and consumers are optimistic or pessimistic about the economic outlook. A second component is a "surprise" index that shows whether data releases are consistently surprising financial markets on the upside or downside. The aim is to capture the extent to which informed participants are likely to have to revise their outlook for economic growth. Third, recognizing the importance of turning points between expansions and slowdowns of

changes in the data. The index is scaled and rebased so that 100 corresponds to the year 2000.

[55]The index represents the value of the coefficient of risk aversion, constrained to values between 0 and 10.

Figure 1.35. Global Financial Stability Map: Risk Appetite Conditions

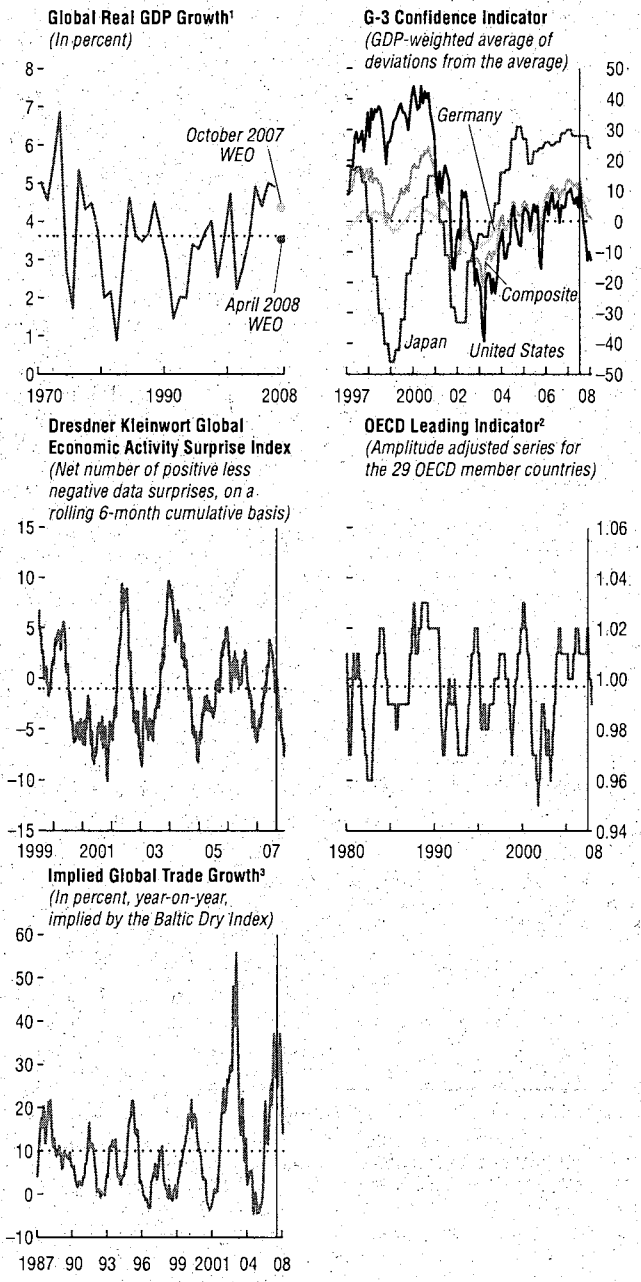


Sources: Emerging Portfolio Fund Research, Inc.; Goldman Sachs; Merrill Lynch; State Street Global Markets; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

[1]The estimated changes in relative risk tolerance of institutional investors from Froot and O'Connell (2003) are integrated to a level, scaled, and rebased so that 100 corresponds to the average level of the index in the year 2000.

Figure 1.36. Global Financial Stability Map: Macroeconomic Risks



Sources: IMF, *World Economic Outlook*; Bloomberg L.P.; Dresdner Kleinwort; OECD; The Baltic Exchange; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

[1]The 2008 revised datapoint accounts for skewness in the distribution of risks to the baseline forecast.

[2]Amplitude adjustment is carried out by adjusting mean to unity and the amplitude of the raw index to agree with that of the reference series by means of a scaling factor.

[3]The Baltic Dry Index is a shipping and trade index measuring changes in the cost of transporting raw materials such as metals, grains, and fuels by sea.

economic activity, we incorporate changes in the Organization for Economic Cooperation and Development's composite leading indicator. Finally, to gauge inflection points in global trade, we include global trade growth estimates implied by the Baltic Dry Index, a high-frequency indicator based on the freight rates of bulk raw materials that is commonly used as a leading indicator for global trade.

Emerging Market Risks

Underlying fundamentals in emerging markets and vulnerabilities to external risks (Figure 1.37). These risks are conceptually separate from, though closely linked to, macroeconomic risks insofar as they focus only on emerging markets. Using an econometric model of emerging market sovereign spreads, we identify the movement in Emerging Market Bond Index Global (EMBIG) spreads accounted for by changes in fundamentals, as opposed to the movement in spreads attributable to other factors. Included in the fundamental factors are changes in economic, political, and financial risks within the country.[56] This is complemented with a measure of the trend in actions by sovereign rating agencies, such as Moody's and Standard & Poor's, to gauge changes in the macroeconomic environment and progress in reducing vulnerabilities arising from external financing needs. We also measure fundamental conditions in emerging market countries that are separate from those related to sovereign debt, particularly given the reduced need for such

[56]The model uses three fundamental variables to fit EMBIG spreads: economic, financial, and political risk ratings. The economic risk rating is the sum of risk points for annual inflation, real GDP growth, the government budget balance as a percentage of GDP, the current account as a percentage of GDP, and GDP per capita as a percentage of the world average GDP per capita. The financial risk rating includes foreign debt as a percentage of GDP, debt service as a percentage of GDP, net international reserves as months of import cover, exports of goods and services as a percentage of GDP, and exchange rate depreciation over the last year. The political risk rating is calculated accounting for 12 indicators representing government stability and social conditions.

financing in many emerging market countries, by including an indicator of growth in private sector credit. Other components of the subindex include a measure of the volatility of inflation rates, and a measure of corporate credit spreads relative to sovereign counterparts.

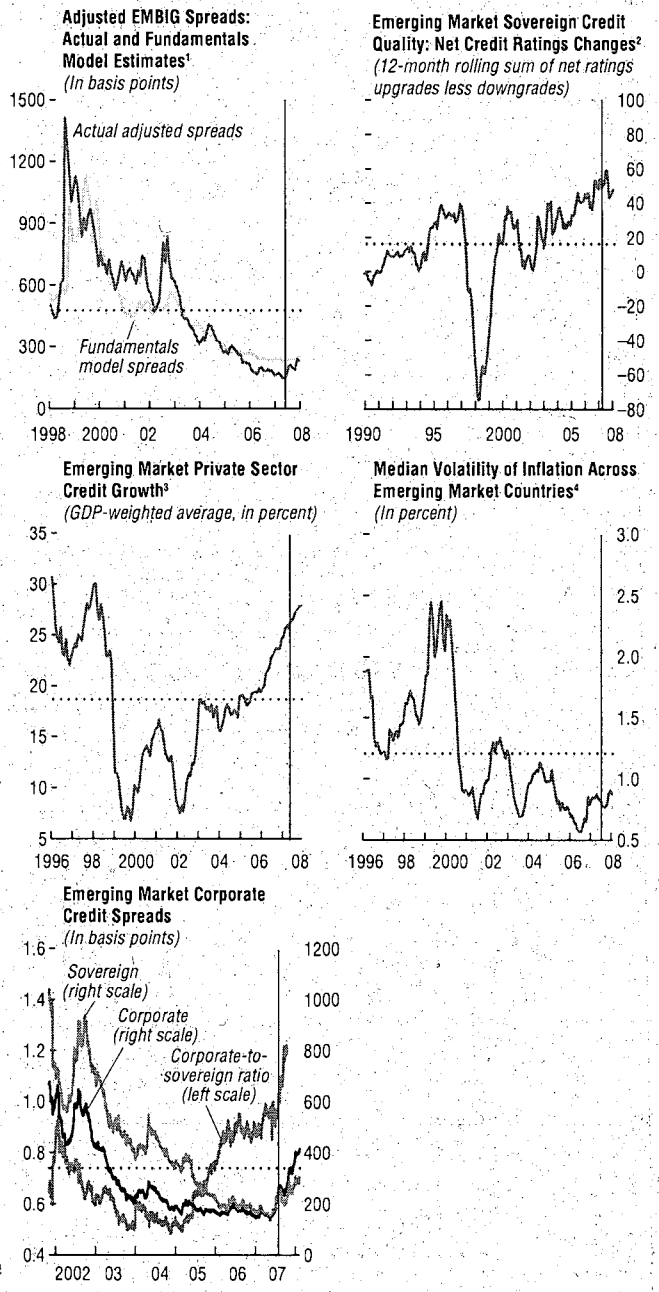
Credit Risks

Changes in and perceptions of credit quality that have the potential for creating losses resulting in stress to systemically important financial institutions (Figure 1.38). Spreads on a global corporate bond index provide a market-price-based measure of investors' assessment of corporate credit risk. We also examine the credit-quality composition of the high-yield index to identify whether it is increasingly made up of higher- or lower-quality issues, calculating the percentage of the index comprised of CCC or lower-rated issues. We also incorporate forecasts of the global speculative default rate produced by Moody's. Another important component of the subindex is a Banking Stability Index (see Box 1.5), which represents the expected number of defaults among large complex financial institutions (LCFIs), given that at least one LCFI defaults. This index is intended to highlight market perceptions of systemic default risk in the financial sector. Finally, to capture broader credit risks, we include delinquency rates on a wide range of noncorporate credit, including residential and commercial mortgages and credit card loans.

Market and Liquidity Risks

The potential for instability in pricing risks that could result in broader spillovers and/or mark-to-market losses (Figure 1.39). An indicator attempting to capture the extent of market sensitivity of hedge fund returns provides an indirect measure of institutional susceptibility to price changes. The subindex also includes a speculative positions index, constructed from the noncommercial average absolute net positions relative to open interest of a range of

Figure 1.37. Global Financial Stability Map: Emerging Market Risks



Sources: Bloomberg L.P.; JPMorgan Chase & Co.; The PRS Group; IMF, *International Financial Statistics*; Credit Suisse; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

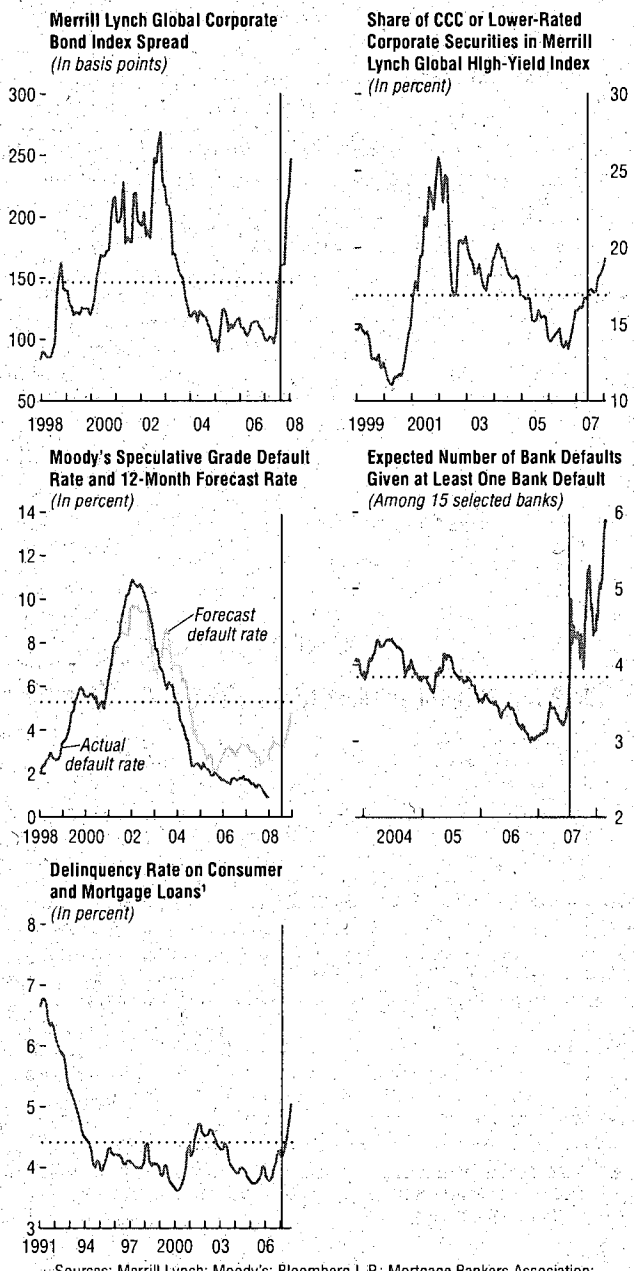
[1]EMBIG = Emerging Market Bond Index Global. The model excludes Argentina because of breaks in the data series related to debt restructuring. Owing to the short data series, the model also excludes Indonesia and several smaller countries. The analysis thus includes 32 countries.

[2]Net actions of upgrades (+1 for each notch), downgrades (–1 for each notch), changes in outlooks (+/– 0.25), reviews and creditwatches (+/–0.5).

[3]44 countries.

[4]Average of 12-month rolling standard deviations of consumer price changes in 25 emerging markets.

Figure 1.38. Global Financial Stability Map: Credit Risks



Sources: Merrill Lynch; Moody's; Bloomberg L.P.; Mortgage Bankers Association; Federal Reserve; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

[1]30-, 60-, and 90-day delinquencies for residential and commercial mortgages, and credit card loans in the United States.

futures contracts as reported to the Commodity Futures Trading Commission. These typically rise when speculators are taking relatively large positional bets on futures markets, relative to commercial traders. Also included is an estimation of the proportion of return variance across a range of asset classes that can be explained by a common factor. The higher the correlations across asset classes, the greater the risk of a disorderly correction in the face of a shock. An additional indicator is an estimate of equity risk premia in mature markets using a three-stage dividend discount model. Low ex ante equity risk premia may suggest that investors are underestimating the risk attached to equity holdings and so increasing potential market risks. There is also a measure of implied volatility across a range of assets. Finally, to capture perceptions of funding, secondary market trading, and counterparty risks, we incorporate the spread between major mature market government securities yields and interbank rates, the spread between interbank rates and expected overnight interest rates, bid-ask spreads on major mature market currencies, and daily return-to-volume ratios of equity markets.

Annex 1.2. Methodology for Calculating Global Losses and Bank Exposures[57]

This annex describes the methodology for estimating losses on holdings of U.S. residential and commercial mortgages, consumer credit, and corporate debt.

Loss estimates vary widely depending on the methodology employed. Our estimates are based on potential loan losses that have occurred since the subprime crisis began and over the next two years, consistent with the period of expected slowing of the U.S. economy and mark-to-market losses on related securities over the course of the past year reflecting the credit deterioration that has occurred and is anticipated to occur. The objective of the analysis is to identify the scale of losses that market participants have already

[57]The main author of this annex is Mustafa Saiyid.

recognized and could potentially recognize in the period ahead. Losses on loans are based on projections of cash flow shortfalls, while losses on securities are based on changes in the market pricing of cash and derivative indices.

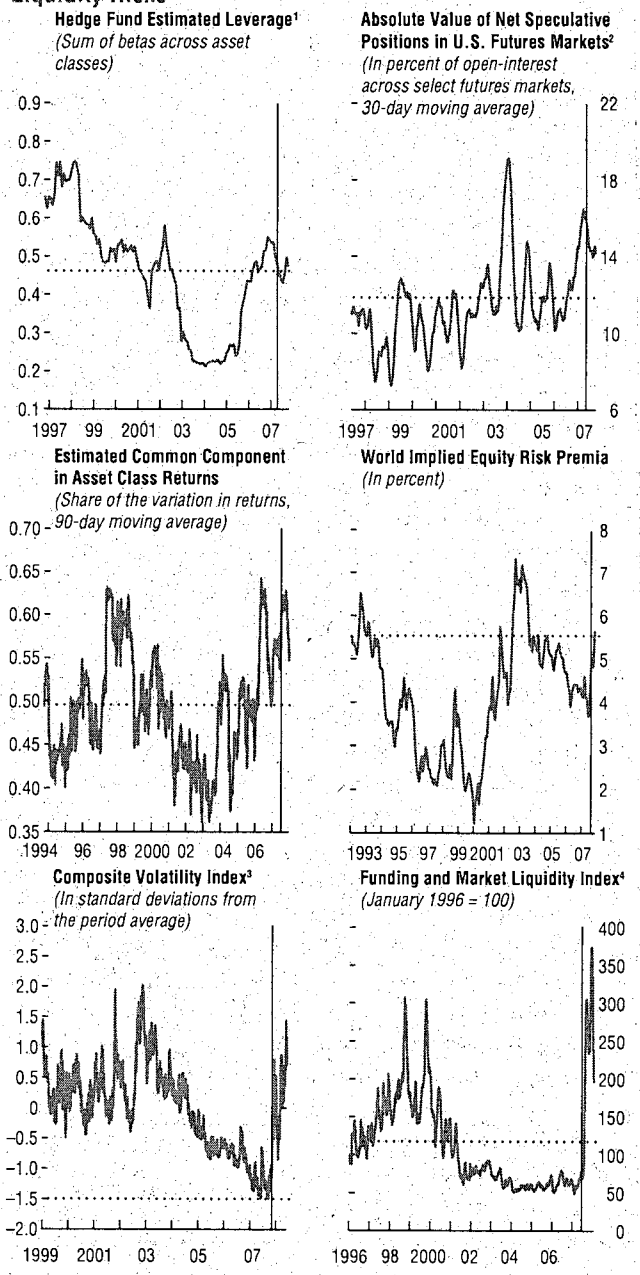
The loans captured in the exercise include subprime, alt-A, prime residential and commercial real estate mortgages, consumer, corporate, and leveraged loans. Securities include ABS and ABS CDOs based on subprime and alt-A residential mortgage loans, prime MBS, CMBS, auto loan and credit card ABS, CLOs, and high-yield and investment-grade corporate debt.

Losses on different types of loans were estimated from regression analysis using various relevant factors, such as changes in unemployment, lending standards, and housing and commercial real estate pricing, as relevant. In each case, the outstanding stock of the type of loan was multiplied with the change in the forecasted loss (charge-off) rate. The underlying historical data on loan loss rates and changes in lending standards were obtained from the Federal Reserve. Although the loan loss data are for banks only, it was assumed that loans held by other lenders would exhibit similar performance.

Losses on residential and commercial mortgages were also estimated by a second procedure. This one involved a three-step process. We first estimated the percentage of loans that would become delinquent, then the percentage of delinquent loans that would default, and finally losses on defaulted loans after completion of the foreclosure or recovery process. Each of these steps is detailed below.

In the first step, we projected delinquencies on residential and commercial loans over a multi-year period using historical patterns and the current trajectory of recent vintage loans. An average delinquency for each loan type (prime, alt-A, subprime, and commercial) was computed by weighting the maximum projected delinquency on loans issued each year by the size of issuance. In the second step, 70 percent of prime, alt-A, and commercial real estate

Figure 1.39. Global Financial Stability Map: Market and Liquidity Risks



Sources: Credit Suisse Tremont Index LLC; Bloomberg L.P.; JPMorgan Chase & Co; IBES; Morgan Stanley Capital International; and IMF staff estimates.

Note: Dashed lines are period averages. Vertical lines represent data as of the October 2007 GFSR.

[1]36-month rolling regressions of hedge fund performance versus real asset returns. [2]Data represent the absolute value of the net position taken by noncommercial traders in 17 select U.S. futures markets. High values are indicative of heavy speculative positioning across markets, either net-long or net-short. [3]Represents an average *z*-score of the implied volatility derived from options from stock market indices, interest, and exchange rates. A value of 0 indicates the average implied volatility across asset classes is in line with the period average (from 12/31/98 where data are available). Values of +/–1 indicate average implied volatility is one standard deviation above or below the period average. [4]Based on the spread between yields on government securities and interbank rates, term and overnight interbank rates, currency bid-ask spreads, and daily return-to-volume ratios of equity markets. A higher value indicates tighter market liquidity conditions.

Box 1.5. Banking Stability Index

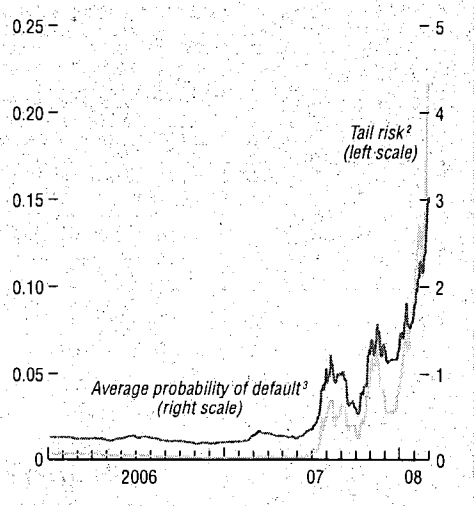
Simultaneous large losses in several banks can affect a banking system's financial stability, and so the likelihood of such an event needs to be monitored and measured. This box describes the banking stability index and additional indicators.

The proper estimation of default dependence among banks is vital for financial stability surveillance because banks are usually linked—either directly, through the interbank deposit market, or indirectly, through lending to common sectors. This default dependence varies across the economic cycle, rising in times of distress so that the fortunes of banks decline concurrently. Thus, simultaneous large losses in several banks could affect stability in the overall banking system. Supervisors should assess both the risk of large losses and possible default of a specific bank, and the impact that this would have on other banks in the system.

To model the stability of the banking system, we follow Goodhart and Segoviano (forthcoming) in treating the banking system as a portfolio of banks. Then, using market-based probabilities of default (PoDs) of individual banks, and employing a novel nonparametric copula approach, we derive the joint probability of default (JPoD) of the banking system.[1] The JPoD represents the probability of all the banks in the portfolio going into default, that is, the tail risk of the system. In periods of financial distress, the banking system's JPoD may experience larger and nonlinear increases than those experienced by the PoDs of individual banks. Based on the JPoD, we estimate a Banking Stability Index (BSI), which reflects the expected number of bank defaults given that at least one bank defaults. A higher number signifies greater instability. This framework allows for the estimation of additional measures of stability, including the probability that each bank in the system will default, given that another bank in the system defaults. Such pair-wise conditional probabilities provide insights into the likelihood of contagion and can be presented in a default contagion matrix (DCo).

To examine the effects of the current credit turmoil on the banking system, the average PoD for a portfolio of 15 systemically important large and complex financial institutions (LCFIs) is compared with changes in the system's JPoD.[2] As stress grew from mid-2007 to the present, the JPoD increased more than 10 times than the

Tail Risk and Average Probability of Default[1]
(In percent)



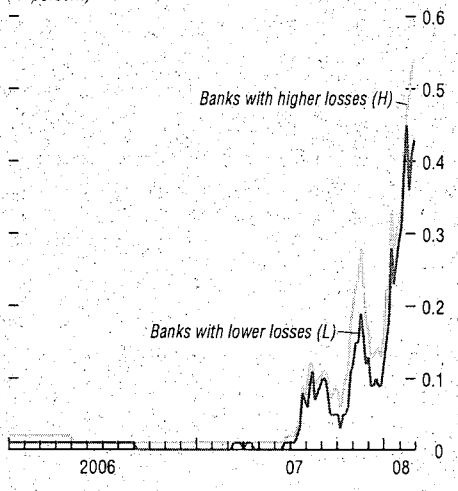
Sources: Bloomberg L.P.; and IMF staff estimates.
[1]From January 1, 2007 to March 10, 2008, the average probability of default increased by a factor of 14.8, while the JPoD, measure of tail risk, increased by a factor of 203.6.
[2]Joint probability of 15 simultaneous defaults.
[3]Unweighted average of individual banks' probabilities of default.

Note: The main author of this box is Miguel Segoviano.

[1]The structure of linear and nonlinear dependencies among banks in a system can be represented by copula functions. Our approach infers copulas from the joint movement of individual banks' PoDs. This is in comparison with traditional approaches, in which parametric copulas have to be chosen and calibrated explicitly—usually a difficult task, especially under data constraints.

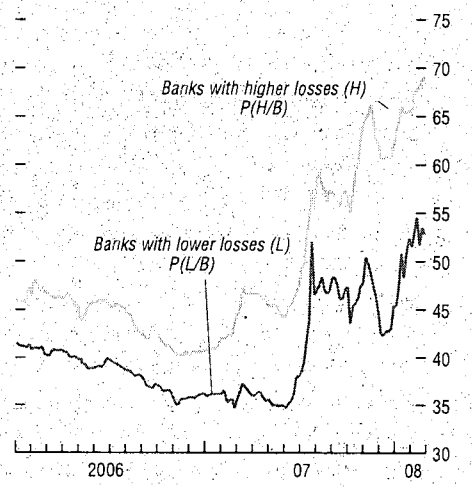
[2]ABN Amro, Bank of America, Bear Stearns, BNP, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JPMorgan, Lehman Brothers, Merrill Lynch, Morgan Stanley, UBS, and Société Générale.

Joint Probability of Default (JPoD) for Banks with Higher and Lower Losses[1]
(In percent)



Sources: Bloomberg L.P.; and IMF staff estimates.
[1]On March 5, 2008, the JPoD for *H* banks was higher than that for *L* banks by a factor of 1.3.

Mean Default Contagion (DCo) for Banks with Higher and Lower Losses[1]
(In percent)



Source: IMF staff estimates.
[1]Unweighted average of pair-wise conditional probabilities of default, which indicate that *H* banks or *L* banks default given that any other bank *(B)* defaults. In order to keep the confidentiality of the analyzed institutions, we report the mean-DCo, rather than the institution-specific DCo. From January 1, 2007 to March 5, 2008, the mean-DCo rose by a factor of 1.5 among *L* banks, and by a factor of 1.7 among *H* banks.

average PoD. The difference is mainly explained by an increased default dependence among the banks in the system, which has significantly augmented the tail risk in the system (see first figure) and sharply increased the BSI.[3] This increased instability was driven by banks under greater stress, which can be seen when grouping the 15 LCFIs into two categories; that is, lesser-stressed banks (*L*) and higher- stressed banks (*H*).[4] As the credit woes worsened, the JPoD for each group increased significantly, though more severely for *H* banks, indicating that tail risk within the *H* banks increased more sharply (see second figure). Also, contagion among the *H* banks is higher, as indicated by the mean-DCo (see third figure). These estimations provide evidence that a bank's resilience to shocks is affected by the overall resilience of the other banks within the financial system. Thus, unless banks' default dependence is taken into account, supervisors may not accurately estimate the banking system's stability.

[3]The BSI is used to construct the credit risk component of the global financial stability map.
[4]This classification was based on the expected size of banks' losses due to subprime mortgage exposures relative to Tier 1 capital. The methodology used for this classification is further explained in Annex 1.2.

loans were assumed to convert from late stage (60-day) delinquency into default. One hundred percent of 60-day delinquent subprime loans were assumed to default. These figures are broadly consistent with market estimates.

For the final step, the recovery rate of principal from the foreclosure process was assumed to be 60 percent for prime and commercial real estate loans, and 50 percent for both alt-A and subprime loans. The loss on

each category of residential and commercial loans was computed as the vintage-weighted delinquency times the conversion-to-default rate multiplied by the loss given default (or one minus the recovery rate). Average projected cash flow losses were estimated to be 15 percent of principal for subprime, 5 percent for alt-A, 1 percent for prime, and 1 percent for commercial loans.

Losses for securities were next estimated by multiplying the outstanding stock of each type of security by the change in the market price of the relevant index over the course of a year. The average price change was obtained by weighting price changes for constituent indices comprised of different vintages and ratings by the issuance in each of these categories.

Beginning with the residential mortgage market, subprime-related ABS and CDO securities were priced using ABX and TABX derivative indices, respectively. Average losses on securities were estimated as 30 percent of principal for ABS and 60 percent for ABS CDOs since last year. The corresponding dollar loss estimates for subprime and alt-A securities were adjusted for any overlap of losses on ABS with those on CDOs. For prime-mortgage-related securities, conforming and nonconforming issues were treated separately and weighted appropriately. The prices of on-the-run agency pass-through securities were used as reference for conforming securities, while quotes on pools of jumbo loans were used to represent the pricing of nonconforming securities. Spreads on agency pass-throughs have widened versus U.S. Treasury securities, as have spreads on pools of jumbo loans versus agency securities. However, the absolute change in market prices of these prime securities has been positive over the course of the past year because of falling yields on U.S. treasuries. No losses were therefore estimated on holdings of prime securities.

Appropriately weighted indices were also used for other types of securities: CMBS, consumer ABS, and corporate debt. The CMBX derivative indices were used to estimate losses on CMBS, while cash indices were used for consumer ABS (autos and credit cards), investment-grade corporate debt, high-yield debt, and for the LCDX for CLOs. No losses were estimated for holdings of consumer ABS or investment-grade U.S. corporate debt, as corresponding indices have been positive over the last year.

The loss estimates are subject to the following caveats and uncertainties:

- The fall in market prices may be overshooting potential declines in cash flows over the lifetime of underlying loans.
- Projected delinquency patterns may not fully account for recent structural changes in markets, including a rise in the proportion of adjustable-rate mortgages likely to experience rate resets in the near term.
- Falling U.S. house prices and further deterioration in the macroeconomic environment could increase rates of delinquency, default, and loss. Conversely, fiscal stimulus, monetary easing, and loan modification measures could lower these rates.

Based on this approach, we estimate total losses from broad credit market deterioration of $945 billion globally, $565 billion of which is due to losses on residential mortgage debt, $240 billion on commercial real estate debt, $120 billion on corporate debt, and $20 billion on consumer credit debt.[58] Securitized debt (rather than whole loans) accounts for the bulk of losses (Table 1.5).

Banks globally are expected to shoulder roughly half of the subprime mortgage-related losses, based on bottom-up analysis using publicly disclosed exposures. Specifically, banks are estimated to have $740 billion of net subprime exposure, mostly held by U.S. banks (53 percent), with the remainder held by European (41 percent), Asian (5 percent), and Canadian

[58]Losses on the residential mortgage market were estimated as the sum of losses on subprime, alt-A, and prime loans, as well as on ABS, ABS CDOs, and prime mortgage securities. Losses on corporate debt were estimated as the sum of losses on corporate and leveraged loans, as well as on related securities, including investment-grade debt, high-yield debt, and CLOs.

Table 1.5. Losses by Asset Class as of March 2008
(In billions of U.S. dollars)

	Base Case Estimates of Losses on Unsecuritized U.S. Loans		
	Outstanding	Estimated loss October 2007 GFSR	Estimated loss March 2008
Subprime	300	30	45
Alt-A	600	10	30
Prime	3,800	Not estimated	40
Commercial real estate	2,400	Not estimated	30
Consumer loans	1,400	Not estimated	20
Corporate loans	3,700	Not estimated	50
Leveraged loans	170	Not estimated	10
Total for loans	12,370	40	225
	Base Case Estimates of Mark-to-Market Losses on Related Securities		
	Outstanding	Estimated mark-to-market loss October 2007 GFSR	Estimated mark-to-market loss March 2008
ABS	1,100	70	240
ABS CDOs	400	130	240
Prime MBS	3,800	Not estimated	0
CMBS	940	Not estimated	210
Consumer ABS	650	Not estimated	0
High-grade corporate debt	3,000	Not estimated	0
High-yield corporate debt	600	Not estimated	30
CLOs	350	Not estimated	30
Total for securities	10,840	200	720
Total for loans and securities	23,210	240	945

Sources: Goldman Sachs; JPMorgan Chase & Co.; Lehman Brothers; Markit.com; Merrill Lynch; and IMF staff estimates.

Note: ABS = asset-backed security; CDO = collateralized debt obligation; CLO = collateralized loan obligation; CMBS = commercial mortgage-backed security; MBS = mortgage-backed security.

(1 percent) banks. In terms of composition, U.S. banks (together with government-sponsored enterprises) hold a greater proportion of overall exposure to the subprime market through unsecuritized subprime loans and ABS CDOs compared with European banks. On the other hand, European banks hold a greater proportion of their exposure to the subprime market via ABS. Banks are assumed to hold the most senior tranches.

Based on average loss estimates of 15 percent for unsecuritized mortgage loans, 30 percent on ABS, and 60 percent on ABS CDOs as described above, potential losses of U.S. banks ($144 billion) are likely to be similar to those borne by European banks ($121 billion). Losses of Asian banks are likely to be less than one-tenth of losses in Europe. More than half of the aggregate subprime-related loss would likely come from exposure to CDOs, while the remainder is expected to come from ABS, unsecuritized subprime loans, and losses on off-balance-sheet liquidity lines. In particular, potential losses on off-balance-sheet conduit and SIV liquidity lines could result in $40 billion of losses globally ($27 billion for European banks and $13 billion of losses for U.S. banks). These estimates are based on the assumption of an average loss of 5 percent on liquidity lines to off-balance-sheet conduits and SIVs. The 5 percent loss assumption is based on losses on a typical asset composition for conduits and SIVs. Losses on conduit assets are assumed to pass directly to the liquidity line, but losses on SIV assets are assumed to be mostly absorbed by the junior notes, given their funding structures (see Box 2.5 in Chapter 2). Conduits and SIVs are weighted by their market proportions—90 percent and 10 percent of the total, respectively—and it is assumed that all liquidity lines eventually get called.

Through mid-March 2008, banks had reported $190 billion in losses on U.S. mort-

Table 1.6. Global Bank Losses as of March 2008
(In billions of U.S. dollars)

Country/Region	Total Reported Losses	Estimated Losses on U.S. Subprime/Alt-A Loans	Estimated Losses on ABS	Estimated Losses on CDOs	Estimated Losses on Conduits/SIVs	Total Estimated Subprime-Related Losses	Remaining Subprime-Related Losses Expected
Europe	80	16	27	53	27	123	43
Of which:							
United Kingdom	19	16	1	12	11	40	22
Switzerland	23	0	7	15	1	23	0
Scandinavia	0	0	0	0	1	1	1
Euro area	33	0	10	20	15	45	12
Unallocated	5	0	9	6	0	14	9
United States	95	29	12	90	13	144	49
Asia excluding Japan	1	0	3	0	0	4	3
Of which: China	1	0	3	0	0	3	2
Japan	10	0	5	5	0	10	0
Asia	11	0	9	5	0	13	3
Canada	7	0	2	5	0	7	0
Gulf Cooperation Council	1	0	1	1	0	1	0
Total	193	44	50	153	40	288	95

Sources: Goldman Sachs; UBS; and IMF staff estimates.

Note: Bank allocation to asset-backed securities (ABS) in Table 1.1 includes estimated losses on ABS and conduits/SIVs. CDO = collateralized debt obligation; SIV = structured investment vehicles.

1/3 to go

gage market exposure. Much of that, however, represents mark-to-market losses, and some could yet be recoverable going forward. Most of subprime-related losses appear to have been reported already. U.S. banks and government-sponsored enterprises could report a further $49 billion in additional writedowns, while European banks could report as much as $43 billion in additional writedowns (Table 1.6). These loss estimates should be regarded with caution for the following reasons:

- Loss estimates ultimately depend on the quality of disclosure about holdings. Where data have not been available, we have used estimates of exposure to subprime loans, ABS, and CDOs.
- Because the loss ratio on CDOs differs from that on unsecuritized loans, the aggregate loss estimate is highly sensitive to the estimated proportions of bank exposure accounted for by unsecuritized loans, ABS, and CDOs.
- The timing of loss recognition is uncertain. UK banks, in particular, appear to have significant exposure to unsecuritized loans, for which it may take some time to recognize losses relative to holdings of securities. There are also differences in methodology across countries regarding recognition of losses.
- Estimates are also sensitive to the breakdown of exposure to different tranches of securities, as there is substantial variation in the pricing on which the mark-to-market estimates are based. For instance, a recent vintage AAA-rated ABX is quoted at 75 cents on the dollar, while a subordinated A-rated tranche of a different vintage is quoted at 16 cents. Lack of information appears to be an even bigger problem in Asia, including in Japan, where the breakdown of bank holdings of ABS and CDOs is largely unavailable.
- Estimates of bank exposure to ABS and CDOs rely upon market indices, which may not represent the secondary market prices of actual bank holdings, as individual ABS and CDO tranches held by banks could have significantly different collateral and cash flow characteristics.
- Implementation of remedial measures, including modification of mortgage loan terms, could lower loss estimates.

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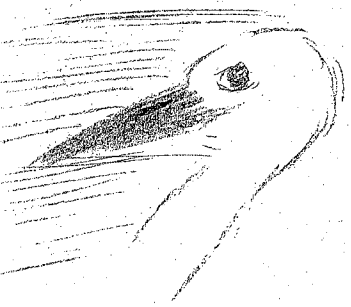
where do the resources go?
If I ↓, then C ↑ at full employment.



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Agency Costs, Net Worth, and Business Fluctuations

By BEN BERNANKE AND MARK GERTLER*

This paper develops a simple neoclassical model of the business cycle in which the condition of borrowers' balance sheets is a source of output dynamics. The mechanism is that higher borrower net worth reduces the agency costs of financing real capital investments. Business upturns improve net worth, lower agency costs, and increase investment, which amplifies the upturn; vice versa, for downturns. Shocks that affect net worth (as in a debt-deflation) can initiate fluctuations.

Many students of the business cycle have suggested that the condition of firm and household balance sheets (equivalently, the state of borrower "solvency" or "creditworthiness") is an important determinant of macroeconomic activity. For example, Frederic Mishkin (1978) and Ben Bernanke (1983) argued that the weakness of borrowers' balance sheets contributed to the severity of the Great Depression, while Otto Eckstein and Allen Sinai (1986) put firm balance sheet variables at the center of their analysis of cyclical dynamics. Numerous studies have connected balance sheet conditions with household and firm spending decisions.

In this paper we present a formal analysis of the role of borrowers' balance sheets in the business cycle. Our vehicle is a modified "real business cycle" model, in which a characteristic of the investment technology is an asymmetry of information between the entrepreneurs who organize and manage physical investment and the savers from whom they borrow. Specifically, we assume a "costly state verification" problem, as in Robert Townsend (1979, 1988). This informational asymmetry makes the Modigliani-Miller theorem inapplicable, opening up the possibility of an interesting interaction between real and "financial" (i.e., balance sheet) factors.

Several aspects of balance sheets are potentially of interest to macroeconomists: The particular balance sheet variable upon which we focus is borrower net worth.[1] Net worth is important, we believe, for the following reason: Whenever there is an asymmetry of information between borrowers and lenders, optimal financial arrangements will typically entail deadweight losses (agency costs), relative to the first-best perfect-information equilibrium; these costs manifest themselves as a higher cost of "external," as compared to "internal," funds. For the particular model used here, and for most standard principal-agent models, it is true that the greater the level of net worth of the potential borrower, the less will be the expected agency costs implied by the optimal financial contract.[2] Thus periods of financial "distress" (when borrower net worth is low) are also times of relatively high agency costs in investment.

At the macroeconomic level, the proposition that borrower net worth and the agency costs of investment are inversely correlated has at least two significant implications.

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[1] More specifically, the focus is on "collateralizable" net worth, as opposed to, for example, human capital. For simplicity of modeling, we do not distinguish in this paper among assets that are more or less easy to sell or borrow against. The issues raised by varying balance sheet liquidity are deserving of further research.

[2] This proposition is quite general. For example, in his analysis of the perhaps more familiar Bengt Holmstrom, 1979, principal-agent setup, in which agents' unobserved actions affect project returns, David Sappington, 1983, demonstrated a similar inverse relationship between the agent's wealth and the agency costs of the principal-agent relationship. See Bernanke and Mark Gertler, 1987, for another example and for references. For a model in which this result need not hold, see Joseph Stiglitz and Andrew Weiss, 1987.

First, since borrower net worth is likely to be procyclical (borrowers are more solvent during good times), there will be a decline in agency costs in booms and a rise in recessions. We will show that this is sufficient to introduce investment fluctuations and cyclical persistence into an environment which is rigged to exhibit neither of these features when agency costs are not present; a kind of accelerator effect emerges. Second, shocks to borrower net worth which occur independently of aggregate output will be an initiating source of real fluctuations. A possible example of this is the "debt-deflation," first analyzed by Irving Fisher (1933): During a debt-deflation, because of an unanticipated fall in the price level (or, alternatively, a fall in the relative price of borrowers' collateral, for example, farmland), there is a decline in borrower net worth. This has the effect of making those individuals in the economy with the most direct access to investment projects suddenly un-creditworthy (i.e., the agency costs associated with lending to them are high). The resulting fall in investment has negative effects on both aggregate demand and aggregate supply. We perform a preliminary analysis of the macro effects of a shock to borrower net worth using the model developed below.

We have tried to conduct our analysis solely from first principles. In particular, we derive the form of all financial arrangements endogenously, and we do not rule out randomizing strategies and lotteries. The model is thus necessarily simple, and our analysis should be viewed as an attempt to obtain qualitative insights, rather than to provide an empirically realistic description of real-financial interactions. Other papers in this area which proceed in a general manner similar to ours include those of Roger Farmer (1984), Bruce Greenwald and Joseph Stiglitz (1986), and Stephen Williamson (1987).

The plan of this paper is as follows: Section I lays out the assumptions of the model. Section II analyzes the benchmark-perfect information case. The equilibrium in this case is rigged to involve no business cycle dynamics (investment is constant and output fluctuations are serially independent). Section III introduces asymmetric information and agency costs. Section III, Parts A, B consider optimal lending contracts and the entrepreneurial investment decision for this case. Implications for macroeconomic equilibrium dynamics are investigated in Section III, Parts C, D; we show that, in contrast to the perfect-information case, the economy with agency costs exhibits persistent fluctuations in investment and output, and that redistributions between borrowers and lenders (as in a debt-deflation) have real aggregate effects. Section IV concludes. Additional results on the nature of the optimal contract under "costly state verification" are presented in the Appendix.

I. The Model

Our starting point is a generic "real business cycle model," that is, a stochastic neoclassical growth model. This framework allows us to illustrate starkly the role of financial factors, since in the standard version of the real business cycle model (for example, Edward Prescott, 1986), the assumption of perfect markets implies that financial structure is irrelevant. Specifically, we study an overlapping generations (OG) model, in the general form used by Peter Diamond (1965). The OG approach has the advantage of providing a tractable framework for dynamic general equilibrium analysis, into which heterogeneity among borrowers and lenders is easily incorporated. The OG setup also allows us to abstract (for the present paper) from long-term financial relationships.[3] The "generations" in our model should be thought of as representing the entry and exit of firms from credit markets, rather than as literal generations; a "period" in our model should therefore be interpreted as the length of a typical financial contract (for example, a bank loan).

As in Diamond (1965) we will assume that each generation of individuals lives for two periods; and that individuals are able to earn labor income only in the first period of life,

[3]For equilibrium analyses of the implications of long-term relationships in agency settings, see Edward Green, 1987, and Gertler 1988.

so that they must save to finance second-period consumption. In Diamond's paper it is assumed that saving can be done either by investing in physical capital or by purchasing government bonds: For an expositional reason that will be explained, we make consumption-good inventories, rather than government bonds, the alternative mode of savings to capital investment. Our model also differs from Diamond's original (which was non-stochastic) in that, in the spirit of the real business cycle literature, we allow for shocks to the aggregate production function.

The modifications to Diamond's model just described are minor and have no particularly surprising implications. The significant distinction between our model and Diamond's is that we replace his simple capital production technology (in which output is transformed into capital one-for-one) with a technology that involves asymmetric information. Specifically, we assume that only the entrepreneurs who direct physical investment can costlessly observe the returns to their individual projects; outside lenders must jointly incur a fixed cost to observe those returns. This "costly state verification" model was first analyzed by Townsend (1979, 1988);[4] he showed that the optimal financial arrangements in this setting will involve (most likely randomized) auditing strategies by lenders, which introduce dissipative agency costs into the process. A main goal of this paper is to draw a connection between the condition of borrower balance sheets and these agency costs, and to demonstrate how this connection may play a role in the business cycle.

The detailed assumptions of the model are now stated.

Time. Time is infinite in the forward direction and is divided into discrete periods indexed by t.

Agents. There are overlapping generations of two-period lived agents (and an initial "old" generation in period zero). It will be convenient to assume that there are a countable infinity of agents in each generation. (An implication of this assumption is that we will generally have to deal in per capita, rather than aggregate, quantities.)

There are two classes of agents. An exogenous fraction η of individuals in each generation are called "entrepreneurs." The rest of the population will be called "lenders." Entrepreneurs and lenders differ in endowments and preferences; much more importantly, they differ in that only entrepreneurs have direct access to the investment technology (see below).

The class of entrepreneurs is itself not homogeneous: We will assume that individual entrepreneurs are indexed by a parameter ω, which in the population of entrepreneurs is uniformly distributed on $[0,1]$. Low-ω entrepreneurs will have a lower cost of investment, and thus may be thought of as more "efficient." (Again, see below.)

Goods. There are two goods, a capital good and an output good. Output produced in a given period t may be consumed by agents during t, or it may be invested in the production of the capital good (which becomes available for use in $t+1$). We also allow output to be stored directly as an inventory. The gross rate of return on storage is r, $r \geq 1$; that is, a unit of output stored in t yields r units in $t+1$.

Capital cannot be consumed but can be used in the production of output. Capital is assumed to depreciate fully in one period (this is expositional reasons only).

Production Technologies. There are separate production technologies for output and for capital. The output good is produced by a constant returns technology using capital and labor. We will assume below that labor supplies are fixed;[5] we may therefore write the production function in per capita[6] terms. For any period t, the production function for per capita output y_t is assumed to be

$$y_t = \tilde{\theta}_t f(k_t), \tag{1}$$

[4] See also Douglas Gale and Martin Hellwig, 1985.

[5] We focus here on explaining investment fluctuations rather than employment fluctuations. Extensions of the results to the case with variable employment is straightforward in principle.

[6] Throughout "per capita" means "per member of a given generation."

where k_t is the amount of capital per head, and $\tilde{\theta}_t$ is a random aggregate productivity shock. We assume that some production can take place without capital, that is, $f(0) > 0$. We take the random variable $\tilde{\theta}$ to be i.i.d. over time, to be distributed continuously over a finite positive support, and to have a mean equal to θ.

Output in period t can be transformed into period-$(t+1)$ capital (without the use of labor) by means of an investment technology. This investment technology comes in discrete, nondivisible units, called "projects." Each entrepreneur is endowed with one of these projects (and we assume that it is too costly to trade or transfer a project away from the original owner). A project belonging to an entrepreneur of type ω takes as input exactly $x(\omega)$ units of the output good y, where $x(.)$ is increasing in ω. With less than $x(\omega)$ units of y, nothing is produced, and the marginal product of increments of y to a project that already has its requisite quantity of input is zero.

Any project that is undertaken in t produces a quantity of capital, which is available for use in $t+1$. The amount of capital produced by a given project is a discrete random variable with possible outcomes κ_i, $i = 1, 2, \ldots, n$, with $\kappa_j \geq \kappa_k$ for $j > k$. (In the main text we will focus on the case $n = 2$.) The probability of outcome κ_i is π_i, and the expected outcome is κ. Note that project outcomes do not depend on the entrepreneur's type ω, although the quantity of inputs does (high-ω entrepreneurs require higher inputs); this is a simple way of motivating an upward-sloping supply curve of capital goods. The distribution of outcomes is identical *ex ante* across projects and is not affected by any action or effort of the individual entrepreneur.

To introduce issues of asymmetric information into the model, we assume that the realized outcome of any particular investment project is costlessly observable only by the entrepreneur who operates (was endowed with) that project. Other agents in the economy can learn the realized returns of a given project only by employing an auditing technology. This technology absorbs γ units of the capital good when operated, but reveals the outcome of the audited project to everyone in the economy and without error.[7] An entrepreneur who underreports the return to his project and is not audited can enjoy extra consumption equal to the marginal product of his extra capital. We assume that it is not possible, without auditing, to infer the outcome of a particular entrepreneur's project, for example, it is not possible for others to observe the entrepreneur's second-period holdings of capital or his realized consumption. We will assume that random auditing is feasible; that is, lenders can pre-commit to auditing with some probability (which may depend on the announced outcome). Finally, it makes things a bit simpler to assume that project outcomes are realized, announcements are made, and auditing takes place before the current value of $\tilde{\theta}$ is known; thus, incentive constraints relevant to decisions in t need depend only on expected values of functions of $\tilde{\theta}_{t+1}$.

Investment projects undertaken in a given period have mutually independent outcomes, so that there is no aggregate (per capita) uncertainty about the quantity of capital produced, that is, expected and actual capital per head are the same. Let i_t be the number of investment projects undertaken in t per capita, and let h_t be the fraction of projects initiated in t that are audited. (Both i_t and h_t will be endogenous in general equilibrium.) For any period t, then, next-period capital stock per head, k_{t+1}, is given by

$$k_{t+1} = (\kappa - h_t\gamma)i_t. \tag{2}$$

We also assume

$$\theta f'(0)\kappa > rx(0) + \gamma, \tag{3}$$

$$\theta f'(\kappa\eta) < rx(1). \tag{4}$$

[7]Alternatively, we could have assumed that auditing results are private information to the auditor. Then a role would arise for zero-profit intermediaries between lenders and entrepreneurs. These intermediaries would internalize all auditing costs and, by holding perfectly diversified portfolios, could eliminate the need to be monitored by depositors (see Douglas Diamond, 1984, and Stephen Williamson, 1987).

(3) and (4) will be sufficient to guarantee that it is always profitable for some but not all entrepreneurs to operate.

Endowments. Every individual has a fixed-labor endowment, which must be used during the first period of life. The labor endowment of an entrepreneur is L^e, the endowment of a lender is L. As a normalization, we assume that the economywide per capita labor endowment, $\eta L^e + (1-\eta)L$, is equal to one; this way we avoid carrying around the distinction between per capita and per labor-input variables.

Preferences. Individual preferences are defined over lifetime consumption (there is no disutility of labor). We assume that entrepreneurs care about only expected consumption when old, that is, they are risk-neutral and do not consume when young. Lenders consume in both periods; lenders born in t have identical utility functions of the form

$$U(z_t^y) + \beta E_t(z_{t+1}^o), \tag{5}$$

where z_t^y and z_{t+1}^o are the consumption of the representative period-t lender when young and old, respectively, $U(.)$ is of the usual concave form, and β is a discount factor.

The key restriction imposed by our specification of preferences is that both borrowers and lenders in t are risk-neutral with respect to period-$(t+1)$ consumption; as in Sappington (1983), the assumption of risk-neutrality permits us to concentrate on the role of the agent's wealth in mitigating agency costs, rather than on issues of risk-sharing. The assumptions that entrepreneurs and lenders have different utility functions and, in particular, that entrepreneurs do not consume when young are inessential.

We will focus on the behavior of this model economy in a competitive market environment. In such an environment, our agents' labor supply and consumption/saving behavior are easy to describe. Labor is supplied inelastically, so that, if the market wage per unit of labor endowment is w_t, entrepreneurs have per capita incomes of $w_t L^e$ and lenders have per capita incomes of $w_t L$. (By our normalization assumption, overall per capita income of the young generation is w_t.) Entrepreneurs do not consume when young, so average entrepreneurial saving, S_t^e, is given simply by

$$S_t^e = w_t L^e. \tag{6}$$

Entrepreneurial saving will be an important variable in the subsequent analysis.

Lenders do consume in the first period, so that their saving depends on the interest rate as well as the wage. We will make assumptions to guarantee that saving always exceeds capital formation ((see (9) below), so there is always storage of inventories in equilibrium. Thus the marginal rate of return is fixed at r, the rate of return to storage. Maximization of (5) implies that there is an optimal consumption for lenders when young, denoted $z_y^*(r)$. Average savings by lenders, S_t, is thus

$$S_t = w_t L - z_y^*(r). \tag{7}$$

The main import of (6) and (7) is the establishment of a direct link between wages (marginal productivities) and saving. This link, not empirically unreasonable in itself, is supposed to proxy for the more general idea that savings (and wealth) are greater when the economy is doing well.

We turn now to characterizing the rest of the competitive equilibrium for our model economy.

II. Equilibrium with Perfect Information

As a benchmark, we first consider the competitive equilibrium of our model when auditing is free ($\gamma = 0$), so that information is perfect. We begin by solving for equilibrium in period t, given the inherited capital stock per head, k_t; we then turn to the (trivial) dynamics.

Let $\hat{q}_{t+1}$ be the expected (as of t) relative price of capital in $t+1$; then $\hat{q}_{t+1}\kappa$ is the expected gross return from each investment project. The opportunity cost of investing for a type-ω entrepreneur is $rx(\omega)$. Assuming that entrepreneurs invest when they can earn nonnegative profits, the efficiency level $\bar{\omega}$ of the entrepreneur who is just indifferent

between investing and storing satisfies

$$\hat{q}_{t+1}\kappa - rx(\bar{\omega}) = 0. \tag{8}$$

The projects of entrepreneurs with efficiency levels ω of $\bar{\omega}$ or better (i.e., $\omega \leq \bar{\omega}$) produce an expected surplus, relative to storage. (Note that $\bar{\omega}$ is a function of $\hat{q}_{t+1}$.)

We assume, as noted in the previous section, that economywide savings always exceed the amount required by profitable projects

$$\eta S^e + (1-\eta)S > \int_0^{\bar{\omega}} x(\omega)\, d\omega, \tag{9}$$

for any $\bar{\omega}$, for any realization of θ, and for any inherited level of k_t. (For this to be plausible, the entrepreneurial sector needs to be a relatively small part of the economy.) Thus some saving always funds inventory accumulation in equilibrium and the marginal rate of return is always r.

The interesting issue is the joint determination, in period t, of $\hat{q}_{t+1}$ and the next-period capital stock per head, k_{t+1}. Let i_t be the number of projects undertaken (per capita) in t. Then we have

$$i_t = \bar{\omega}\eta, \tag{10}$$

$$k_{t+1} = \kappa i_t. \tag{11}$$

(10) follows from the observation that any entrepreneur of efficiency level $\bar{\omega}$ or better (which, since ω is uniform, is a fraction $\bar{\omega}$ of all entrepreneurs) will find it profitable to invest when the cost of funds is r. Thus (10) states that investment per capita equals the fraction of entrepreneurs who invest times the fraction of the population who are entrepreneurs. (11) says that the per capita future capital stock will be the average productivity of an investment project (which, by the law of large numbers, is non-stochastic) times the per capita number of projects.

Combining (8), (10), and (11) yields a "capital supply curve" for the perfect information case (call it the SS curve):

$$\hat{q}_{t+1} = rx(k_{t+1}/\kappa\eta)/\kappa \quad [\text{SS}] \tag{12}$$

The SS curve is upward-sloping (see Figure 1). A higher expected value of $\hat{q}_{t+1}$ raises the number of entrepreneurs who can profitably invest, so that a larger share of savings is devoted to capital formation instead of to consumption good inventories.

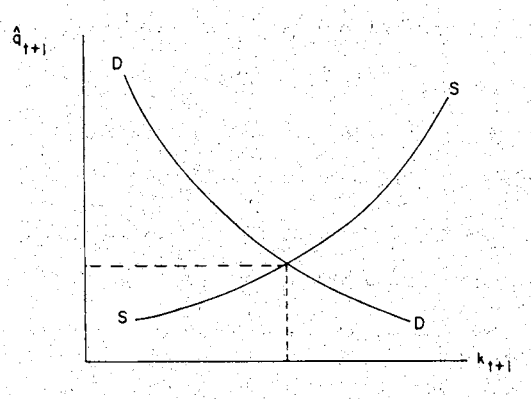

FIGURE 1

The "capital demand curve" for the perfect information case, DD, is just the condition that the expected price of capital equals its expected marginal product

$$\hat{q}_{t+1} = \theta f'(k_{t+1}) \quad [\text{DD}], \tag{13}$$

where, recall, θ is the mean of $\tilde{\theta}_{t+1}$ and f' denotes the derivative. The DD curve is downward-sloping (see Figure 1); the marginal product of capital is higher when the capital stock (per head) is smaller. In each period t, $\hat{q}_{t+1}$ and k_{t+1} are determined as the solution of (12) and (13), that is, as the intersection of the capital supply and demand curves in Figure 1.[8]

The dynamics in the perfect information case are extremely simple: Since (12) and (13) are independent of period-t state variables, $\hat{q}$ and k are constant over time. Investment is fixed and the quantity of production of the output good fluctuates in proportion to the (serially uncorrelated) productivity shock. The amount of consumption is positively serially correlated, since in high-productivity periods there is both more consumption and more inventory accumulation.

[8]The solution exists and is unique. Existence is guaranteed by (3) and (4), uniqueness by the fact that DD always slopes downward and SS always slopes upward.

We have thus developed a benchmark case in which investment is constant. This was the motivation for introducing inventories which pay a fixed-gross yield: The presence of this fixed-return mode of saving has the effect of making the supply of investment funds perfectly elastic with respect to the interest rate, while investment demand (which, in the absence of information problems, depends only on the expected marginal productivity of capital and the marginal cost of producing new capital) is fixed over time. In contrast, when information asymmetries are present, investment demand will vary and be history-dependent.

III. Equilibrium with Asymmetric Information

A. *The Optimal Financial Contract*

We now re-introduce imperfect information ($\gamma > 0$) and begin the process of deriving the dynamic macroeconomic equilibrium for this case. This is done in stages: We begin by considering the situation of an entrepreneur who with certainty intends to undertake his project,[9] but for whom the required project input exceeds his personal savings ($x(\omega) > S^e$). In this case, the entrepreneur must borrow in order to invest. Our task is to determine the optimal arrangements under which this borrowing can take place.

The entrepreneur is assumed to be borrowing from a lender (or consortium of lenders) who have an opportunity cost of funds r. At this point our analysis is partial equilibrium, in that we assume that the entrepreneur's own savings (S^e), the expected relative price in the next period of the produced capital good ($\hat{q}$), and the safe rate of return (r) are taken as exogenous.

The optimal contract is found by application of the revelation principle. Formally, the entrepreneur's problem is to maximize his expected next-period consumption, subject to the constraints that (*i*) the lender(s) receive an expected rate of return of no less than r, (*ii*) the entrepreneur has no incentive to lie about realized project outcomes, and (*iii*) the state-contingent consumptions and auditing probabilities[10] are feasible. The control variables are outcome-dependent auditing probabilities and the entrepreneur's realized consumption levels, which may be contingent both on the project outcome and on whether an audit has occurred.

The Appendix formally states the problem and gives a number of results for the n-state case. For the main text, we choose to specialize to the case $n = 2$. This is for the sake of concreteness; for $n = 2$, it is possible to write out the optimal contract explicitly, while for a larger number of states we have only been able to obtain indirect characterizations. It is worth stressing, however, that the n-state optimal contract does have the "net worth property," that expected agency costs are decreasing in the amount of entrepreneurial savings contributed to the project. Therefore, we can safely claim that allowing for an arbitrary number of possible project outcomes in our macroeconomic analysis would not affect the qualitative nature of our results.

With $n = 2$, there are two possible project outcomes: In state 1 (which occurs with probability π_1), the project produces κ_1 units of the capital good; in state 2 (probability π_2) it produces κ_2 units. State 1 is the "bad" state ($\kappa_1 < \kappa_2$). For an entrepreneur of type ω, the amount borrowed is $x(\omega) - S^e$, and the lenders' required expected return is $r(x(\omega) - S^e)$.

The Appendix shows that, under the optimal contract no auditing occurs when the best possible state (here, state 2) is an-

[9] We ignore for the moment his option of putting his savings into consumption-good inventories.

[10] We are allowing general random auditing strategies, which (as Townsend, 1979, first pointed out) may be significantly more efficient than nonrandom strategies. An implication of permitting random auditing is that the optimal contract will not be in the form of a debt contract, as it is when auditing is nonrandom (Dilip Mookherjee and Ivan Png, 1987; Townsend, 1988). Importantly, our macro results are essentially the same whether stochastic auditing is permitted or not. Thus, we do not have to rely on financial contracts taking a particular debt or equity form. For our purposes, the important distinction is between internal and external finance, not between debt and equity per se.

nounced. Thus, for $n = 2$, lenders audit only when the entrepreneur declares the bad state (state 1). Let p be the probability of an audit in the bad state, let c_i be the entrepreneur's consumption payoff when he announces state i $(i = 1,2)$ and is not audited, and let c^a be his consumption payoff when he announces the bad state and is audited.[11] Then the optimal contract is found by choosing the vector $\{p, c_1, c_2, c^a\}$ to solve[12]

$$(14) \quad \max \pi_1(pc^a + (1-p)c_1) + \pi_2 c_2$$

subject to

$$(15) \quad \pi_1[\hat{q}\kappa_1 - p(c^a + \hat{q}\gamma) - (1-p)c_1] + \pi_2[\hat{q}\kappa_2 - c_2] \geq r(x - S^e),$$

$$(16) \quad c_2 \geq (1-p)(\hat{q}(\kappa_2 - \kappa_1) + c_1),$$

$$(17) \quad c_1 \geq 0,$$

$$(18) \quad c^a \geq 0,$$

$$(19) \quad 0 \leq p \leq 1,$$

where $\hat{q}$ is the expected (next-period) relative price of capital.

Constraint (15) (which specializes the appendix inequality (A2)) requires that lenders receive an expected return of r; this constraint can be shown always to bind. Constraint (16) (which corresponds to the appendix inequality (A3)) is the truth-telling constraint on the entrepreneur; it requires that the contract be structured so that the entrepreneur has no incentive to misreport the good state as the bad state. (16) binds if $p > 0$. Constraints (17) and (18) require that the entrepreneur's consumption in the bad state be nonnegative.[13] These "limited liability" constraints restrict the entrepreneur's ability to pay lenders if the project's outcome is bad; as we shall see, the presence of these constraints is the basic reason that the entrepreneur's net worth is important. (19) is a feasibility constraint on p.

The optimal contract for $n = 2$ (the solution to (14)–(19)) is relatively simple. There are two regimes: In the first regime, the entrepreneur's net worth is sufficiently large that he is able to pay lenders their required return even in the worst state.[14] That is,

$$(20) \quad \hat{q}\kappa_1 \geq r(x(\omega) - S^e).$$

There is no agency problem in this case, since the entrepreneur can always pay off. Optimal auditing probabilities are always zero, and the lender's payoff is independent of the project's outcome. This might be called the "full-collateralization" case, since the entrepreneur's contribution is so large relative to the input requirement that the lenders face no idiosyncratic risk.[15] The entrepreneur's expected consumption in the full-collateralization case, $\hat{c}_{fc}$, is the expected project output less the required return to lenders:

$$(21) \quad \hat{c}_{fc} = \hat{q}\kappa - r(x(\omega) - S^e),$$

where, recall, $\kappa = \pi_1\kappa_1 + \pi_2\kappa_2$ is the mean project output.

If entrepreneurial savings S^e are insufficient, so that (20) fails, we are in the "incomplete collateralization" case, and there will be positive agency costs. In this case the incentive constraint (16) and the "limited liability" constraints (17) and (18) are binding,[16] as well as the outside return constraint

[11] More precisely, c^a is the payoff if the entrepreneur is audited and found to be telling the truth. The optimal payoff if the entrepreneur is audited and found to be lying is easily shown to be zero.

[12] The dependence of the control variables and of x on ω is suppressed in (14)–(19).

[13] A separate restriction for c_2 is unnecessary, since (16) and (19) imply $c_2 \geq 0$.

[14] Recall that we are assuming that project outcomes are realized and announcements made before θ_{t+1} (and thus q_{t+1}) is known. Thus, this ability to repay needs to hold only for the expected value of q, not for the realized value. The alternative assumption complicates the analysis slightly, because incentive constraints would depend on the realized value of q_{t+1}; but qualitative results are unchanged.

[15] If $\kappa_1 = 0$, then "full collateralization" requires $S^e \geq x(\omega)$.

[16] (17) and (18) bind because it is optimal to concentrate the entrepreneur's payoff in the good state, thereby minimizing his incentive to misreport.

(15) (which always binds). The optimal auditing probability p, conditional on the entrepreneur's announcement of state 1, is now given by

$$(22) \qquad p = \frac{r(x(\omega) - S^e) - \hat{q}\kappa_1}{\pi_2\hat{q}(\kappa_2 - \kappa_1) - \pi_1\hat{q}\gamma}.$$

The equation (22) is obtained from (15) through (18), which all hold with equality in this case.

The optimal auditing probability p is just sufficient to guarantee that the entrepreneur will report honestly when the good state occurs. Under the assumption that $\pi_2(\kappa_2 - \kappa_1) - \pi_1\gamma > 0$, which we will maintain, p is always positive when there is incomplete collateralization ((20) fails). (It can also be shown that, whenever expected entrepreneurial consumption is positive, $p < 1$.) The optimal auditing probability, and thus expected agency costs (which we identify with expected auditing costs, equal to $\pi_1 p\hat{q}\gamma$), is decreasing in the entrepreneur's contribution to the project, S^e. The intuition for the inverse relation of S^e and expected auditing costs is as follows: When S^e is low, lenders require a large total return, which reduces the entrepreneur's consumption in the good state. (The entrepreneur's consumption in the bad state is always optimally zero.) With a low c_2, the entrepreneur has less at risk if he falsely claims the bad outcome when the good state has occurred; thus he must be audited more frequently.

Expected entrepreneurial consumption when there is incomplete collateralization, $\hat{c}_{ic}$, is given by

$$(23) \qquad \hat{c}_{ic} = \alpha\{\hat{q}\kappa - r(x(\omega) - S^e) - \pi_1\hat{q}\gamma\},$$

where $\alpha \equiv [\pi_2\hat{q}(\kappa_2 - \kappa_1)]/[\pi_2\hat{q}(\kappa_2 - \kappa_1) - \pi_1\hat{q}\gamma] > 1$. Note that $\partial\hat{c}_{ic}/\partial S^e = \alpha r > r$; when collateralization is incomplete, the return to "inside" funds exceeds the return to "outside" funds. This is because additional inside funds not only replace outside funds but also reduce expected agency costs. Hence the average "cost of capital" in this model depends upon the mixture of internal and external finance.

B. *The Entrepreneurial Investment Decision*

The derivation of the optimal financial contract assumed that the entrepreneur is committed both to undertaking his investment and to contributing all of his personal savings to the project. As the next step toward constructing a market equilibrium, we now consider the effects of relaxing these provisional assumptions.

In the perfect information case, we distinguished two types of entrepreneurs, those that could profitably invest and those that could not. In the imperfect information case, it turns out, we must allow for three types of entrepreneurs. For any given period t, let $\underline{\omega}$ and $\bar{\omega}$ be the levels of entrepreneurial ability that satisfy

$$(24) \qquad \hat{q}\kappa - rx(\underline{\omega}) - \hat{q}\pi_1\gamma = 0,$$

$$(25) \qquad \hat{q}\kappa - rx(\bar{\omega}) = 0.$$

Entrepreneurs with efficiency levels less than $\underline{\omega}$ have projects whose expected net return[17] is positive, *even if announcements that the bad state has occurred precipitate auditing with probability one* ($p = 1$). Call entrepreneurs with $\omega \leq \underline{\omega}$ "good" entrepreneurs. Entrepreneurs with efficiency levels $\omega \leq \bar{\omega}$, on the other hand, are guaranteed to have positive expected net returns only if there is no auditing ($p = 0$), that is, when there are no dissipative agency costs; designate entrepreneurs in this range but who are not "good" (i.e., $\underline{\omega} < \omega \leq \bar{\omega}$) as "fair" entrepreneurs.[18] Finally, "poor" entrepreneurs ($\omega > \bar{\omega}$) have projects that have negative expected net returns even if agency costs are zero.

Note again that, as in Section II, both $\underline{\omega}$ and $\bar{\omega}$ are (increasing) functions of the expected relative price of capital, $\hat{q}$. Thus, our

[17]Defined as the expected value of output, less the opportunity cost of inputs and expected auditing costs.

[18]$\bar{\omega}$ is defined exactly as in the perfect information case; compare (8). Thus, for a given $\hat{q}$, both "good" and "fair" entrepreneurs would be "profitable" under perfect information. (Note, though, that the value of $\hat{q}$ in equilibrium is likely to differ in the two cases.)

classification of entrepreneurs is conditional on the value of $\hat{q}$.

Also, for any given ω, let us define the "full-collateralization" level of entrepreneurial saving, $S^*(\omega)$, to be the quantity that exactly satisfies (20). That is,

$$(26) \qquad S^*(\omega) = x(\omega) - (\hat{q}/r)\kappa_1.$$

An entrepreneur of type ω who contributes savings in amount greater than or equal to $S^*(\omega)$ to his project will be able to borrow and invest with zero probability of auditing (and thus with no expected agency costs). $S^*(\omega)$ is a (decreasing) function of $\hat{q}$.

We are now in a position to represent the opportunity sets of different types of entrepreneurs graphically (see Figure 2). For each class of entrepreneurs (good, fair, or poor), the solid line graphs expected entrepreneurial consumption (conditional on undertaking the project) as a function of the amount of savings contributed by the entrepreneur.[19] The dotted line, which in each graph is a ray from the origin with slope r, is the opportunity cost of saving, as determined by the alternative storage technology.

The optimal choices of each class of entrepreneur are easy to discover using Figure 2. Consider first the poor, or inefficient, entrepreneurs. For this group, the total return to storage exceeds the return to investment for any level of savings. Thus, poor entrepreneurs will put their savings into inventory (equivalently, become lenders) and will not undertake their projects.

Good entrepreneurs are in the opposite situation. As long as the quantity of savings that the entrepreneur contributes to his project is less than the full-collateralization level $S^*(\omega)$, the marginal (and average) return to investing in the project is greater than the return to holding inventories. Thus the good entrepreneur will put all of his savings into his own project,[20] up to the point where his contribution equals $S^*(\omega)$; beyond this point, he is indifferent between investing in his own project and either storing inventories or lending to others. If the good entreprenur's total savings are less than $S^*(\omega)$, his project will be audited with positive probability, so that agency costs are present. If $S^e \geq S^*(\omega)$, the project can be undertaken with zero-agency costs.

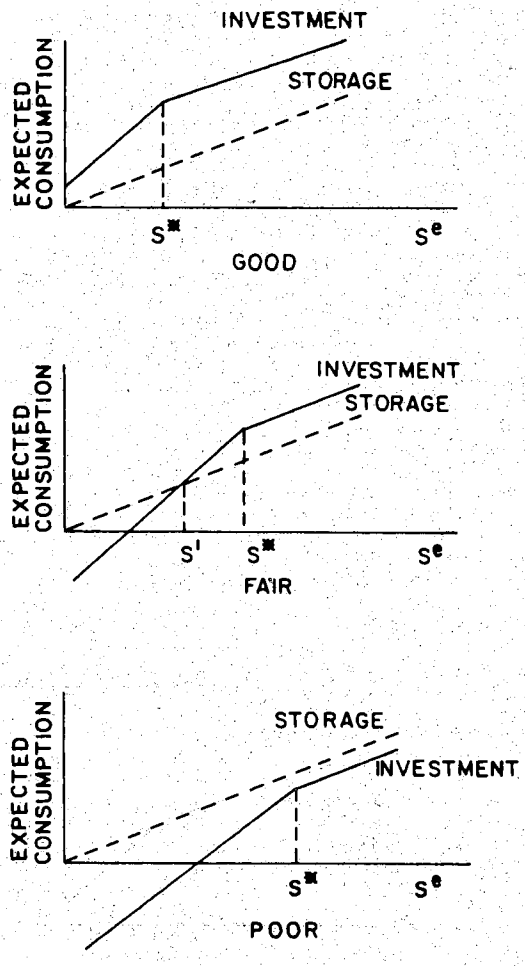

FIGURE 2

The fair entrepreneur's case is a bit more complicated. First, note that his opportunity set has three regions: If $S^e < S'(\omega)$ (where

[19] This line is defined by (23) for $S^e \leq S^*(\omega)$ and by (21) for $S^e > S^*(\omega)$, for a representative ω in each range. Figure 2 ignores the nonnegativity constraint on entrepreneurial consumption. This is harmless, since, as we shall see, entrepreneurs will not want to invest in the range where nonnegativity binds.

[20] Recall that we are assuming risk-neutrality, so that diversification is not an issue.

S' is defined, as in the diagram, as the level of savings at which the total returns to storage and investment are equal), the entrepreneur will store or lend rather than invest. If $S'(\omega) \leq S^e < S^*(\omega)$, then the entrepreneur will invest (contributing all his funds to the project), and will face a positive auditing probability. Finally, if $S^e \geq S^*(\omega)$, the entrepreneur will invest and will contribute enough to the project to ensure full collateralization. (He will be indifferent about the disposition of his savings in excess of $S^*(\omega)$.) Thus the fair entrepreneur's decision about whether to invest or store, as well as the auditing probability if he does invest, may depend on his level of savings.

We say "*may* depend" because of an interesting wrinkle that arises in this case. The upper envelope of the dashed and solid lines, which defines the fair entrepreneur's opportunity set, is *convex* between zero and $S^*(\omega)$. This means that the (risk-neutral) intermediate-quality entrepreneur in principle would be happy to enter a fair lottery. In particular, he would like to risk his savings in a lottery that pays $S^*(\omega)$ with probability $S^e/S^*(\omega)$, zero otherwise. An entrepreneur who wins this gamble would become fully collateralized and would be able to invest without agency costs; a loser gets zero consumption. *Ex ante*, this gamble improves the fair entrepreneur's expected utility.[21]

This incentive for extra risk-taking seems to arise generically in models in which agency costs are decreasing in the wealth of the agent (so that there may be increasing returns to wealth over a range).[22] It is a legitimate objection to our approach that lotteries of this sort are not seen in reality.[23] Presumably risk-aversion, which we exclude, is the major explanation. Any other factor which introduces concavity into the relationship between returns and wealth (for example, if agency cost savings diminish as wealth rises; see Bernanke-Mark Gertler, 1987) would also reduce the incentive for this sort of gambling.

For present purposes, in the spirit of maintaining internal consistency, we will assume that this "savings lottery" among the fair entrepreneurs (or equivalently, between the fair entrepreneurs and, say, lenders) does take place. (Our basic macro results are essentially the same whether we allow the lottery or rule it out arbitrarily.) Under this lottery, a fraction $g(\omega) = S^e/S^*(\omega)$ of entrepreneurs of type ω win their gamble and become fully collateralized investors; the rest get zero consumption and do not invest.

The outcomes of the good and fair entrepreneurs show two contrasting ways in which the quantity of borrower wealth affects investment efficiency. All investors with $\omega \leq \bar{\omega}$ would invest in a world without information problems,[24] since the net returns to their projects when there are no agency costs are positive. With asymmetric information, all "good" entrepreneurs still invest, but they do so with positive expected agency costs. These agency costs decrease in the level of entrepreneurial savings, S^e. Only a fraction of "fair" entrepreneurs invest;[25] those that do experience no agency costs. This occurs because, as a class, the fair entrepreneurs become essentially self-financing. (On net, the fair entrepreneurs are able to borrow from lenders only the difference between full collateralization and the input cost of their projects.) Thus, investment by the intermediate class of entrepreneurs is restricted essentially to the amount of "internal equity" they can generate. The result that entrepreneurs known to be more efficient can borrow externally (albeit with a higher cost

[21] This can be shown formally by modifying the problem (14)–(19) to allow the entrepreneur to enter any fair savings lottery. Only intermediate-quality entrepreneurs will actively desire to enter such a lottery, because of the shape of their payoff functions; good and poor entrepreneurs will be indifferent.

[22] See Bernanke–Gertler, 1987, for another example. Although he does not consider them, lotteries would also seem to ameliorate the principal-agent problem studied by Sappington.

[23] It does seem, though, that people who need a "stake," say to open a business, may exhibit risk-loving behavior.

[24] Poor entrepreneurs, with $\omega > \bar{\omega}$, do not invest in either case.

[25] If lotteries were ruled out, it would still be the case that only a fraction of fair entrepreneurs invest; agency costs would preclude the relatively less efficient ones from undertaking projects.

of funds externally than internally), but that more marginal projects must be largely self-financing, is at least suggestive of real-world arrangements.

C. *Within-Period Equilibrium*

We show now how the expected price and the quantity of new capital are determined within a period, given the inherited capital stock, and assuming $\gamma > 0$.

In any period t, the inherited per capita capital stock k_t is predetermined. With labor supplied inelastically, output is determined by the production function and the random productivity shock θ (compare (1)). The wage and therefore lender and entrepreneurial saving in t are determined.

We would like to know the supply and demand curves for capital. Consider the determination of capital supply, for a given expected relative price of capital, $\hat{q}$.[26] For $\omega \leq \underline{\omega}$, define $p(\omega)$ to be the probability that an entrepreneur of type ω is audited (in the bad state). The function $p(\omega)$ is defined by

$$(27) \quad p(\omega) = \max\left(\frac{rx(\omega) - \hat{q}\kappa_1 - rS^e}{\hat{q}(\pi_2(\kappa_2 - \kappa_1) - \pi_1\gamma}, 0\right)$$

for $\omega \leq \underline{\omega}$ (compare (22)). $p(\omega)$ is decreasing in $\hat{q}$ and in S^e; $p(\omega) = 0$ for $S^e \geq S^*(\omega)$.

Fair entrepreneurs (with types between $\underline{\omega}$ and $\bar{\omega}$), because of the "collateralization lottery," do not face the agency cost of auditing when they invest; but only the fraction of fair entrepreneurs who win the lottery are able to invest. Let $g(\omega)$, defined for $\underline{\omega} < \omega \leq \bar{\omega}$, be the fraction of fair entrepreneurs of type ω who can invest (and $1 - g(\omega)$ be the fraction who are excluded). Using the fact that $g(\omega) = S^e/S^*(\omega)$, and substituting from (26), we have

$$(28) \quad g(\omega) = \min\left(\frac{rS^e}{rx(\omega) - \hat{q}\kappa_1}, 1\right)$$

for $\underline{\omega} < \omega \leq \bar{\omega}$. The quantity $g(\omega)$ increases in $\hat{q}$ and S^e, and for $S^e \geq S^*(\omega)$, we have $g(\omega) = 1$.

Again, entrepreneurs of type $\omega > \bar{\omega}$ do not invest.

Total capital formation (per head) in this case is given by

$$(29) \quad k_{t+1} = \left[\kappa\underline{\omega} - \pi_1\gamma\int_0^{\underline{\omega}} p(\omega)\,d\omega\right]\eta + \left[\kappa\int_{\underline{\omega}}^{\bar{\omega}} g(\omega)\,d\omega\right]\eta,$$

where the expression in the first set of brackets reflects capital formation (net of auditing costs) by good entrepreneurs, and the second expression in brackets is capital formation by fair entrepreneurs. (29) can be rewritten as

$$(30) \quad k_{t+1} = \left\{\kappa\bar{\omega} - \left[\int_0^{\underline{\omega}} \pi_1\gamma p(\omega)\,d\omega + \int_{\underline{\omega}}^{\bar{\omega}} \kappa(1 - g(\omega)\,d\omega\right]\right\}\eta \quad [\text{SS}].$$

(30) is the capital supply curve for the $\gamma > 0$ case. It is depicted in Figure 3 as the $S'S'$ curve, along with the perfect information capital supply curve (SS) (derived in Section II) for reference. Several points can be made about the $S'S'$ curve.

First, $S'S'$ lies to the left of SS, that is, capital supply is always less in the imperfect information case. ((From (9) and (10), $k_{t+1} = \kappa\bar{\omega}\eta$ when $\gamma = 0$; from (30), $k_{t+1} \leq \kappa\bar{\omega}\eta$ when $\gamma > 0$.) This is because imperfect collateralization when $\gamma > 0$ increases the agency costs for those projects undertaken and (perhaps more significantly) leads to a decline in the number of projects that can be profitably initiated.

Second, the $S'S'$ curve is upward-sloping in $(\hat{q}_{t+1}, k_{t+1})$ space. This can be verified by differentiating the expression for k_{t+1} in (30) with respect to $\hat{q}_{t+1}$, using (27), (28), and the definitions of $\underline{\omega}$ and $\bar{\omega}$ ((24) and (25)). (Note that the dependence of the cutoff efficiency levels $\underline{\omega}$ and $\bar{\omega}$ on $\hat{q}_{t+1}$ must be explicitly taken into account.) Since as $\hat{q}$ gets large enough the system approaches "full collateralization" ($p(\omega)$ and $1 - g(\omega)$ approach zero), the $S'S'$ and SS curves coincide at high values of $\hat{q}$.

[26] $\hat{q}$ means $\hat{q}_{t+1}$. We continue to drop the time subscript where there is no ambiguity.

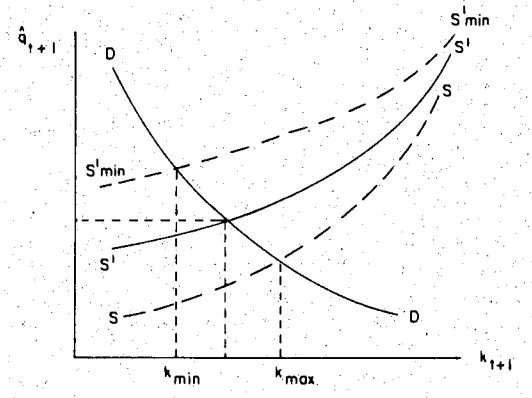

FIGURE 3

Third, unlike that of the SS curve, the position of the $S'S'$ curve depends on a period-t state variable, namely, entrepreneurial savings S^e (which enters into the expressions for $p(\omega)$ and $1-g(\omega)$). High values of S^e (which move the system closer to full collateralization) push the $S'S'$ curve down toward the SS curve; lower values of S^e move the $S'S'$ curve up and away from the SS curve. $S'S'$ reaches its farthest point from SS when S^e is at its minimum value.[27] The dashed line marked $S'S'_{(\min)}$ in Figure 3 describes this boundary.

The determination of the demand for capital is much simpler: Capital demand in the $\gamma > 0$ case is given by the identical DD curve as in the $\gamma = 0$ case (equation (13)). The intersection of $S'S'$ and DD (see Figure 3) determines capital formation in period t. Output which is saved in t but is not invested is stored, to be consumed in the subsequent period. This fully determines the within-period equilibrium.[28]

Two useful comparative statics results follow directly. First, consider the effect of a rise in current income, emanating from an increase in either the inherited capital stock k_t or the value of the productivity shock θ_t. In either case young entrepreneurs (as well as young lenders) will accumulate more savings. Higher entrepreneurial saving (S^e) lowers agency costs and therefore shifts the $S'S'$ curve down to the right, raising k_{t+1} and lowering $\hat{q}_{t+1}$. This effect is not present in the perfect information case. We see, therefore that the presence of agency costs induces a channel of dependence of investment on income as long as the incentive constraint binds for some entrepreneurs.

Second, imagine a redistribution of (labor) endowment from entrepreneurs to lenders, that is, raise L and lower L^e so that $\eta L^e + (1-\eta)L$ is still equal to one. The motivation for this exercise is to model an aspect of "debt-deflation," a situation in which a combination of unindexed debt contracts and unexpected deflation redistributes wealth from the debtor class to the creditor class.[29] A fall in L^e lowers S^e, shifting the $S'S'$ up to the left; $\hat{q}_{t+1}$ rises and k_{t+1} falls. Thus a redistribution from borrowers to lenders depresses capital spending. The intuition is that lower entrepreneurial wealth raises the agency costs associated with capital finance, reducing the net return to investment.[30]

D. *Dynamics*

We are now equipped to consider aggregate dynamics for the $\gamma > 0$ case.

As we have already seen, the (benchmark) perfect information ($\gamma = 0$) case has no interesting dynamics; the capital stock is fixed

[27]Given L^e, the minimum possible value of S^e occurs when wages are minimum, which in turn occurs when capital per head is zero and $\bar{\theta}$ is at its minimum possible value. Assumptions made above suffice to guarantee that this minimal wage is positive.

[28]Condition (3) guarantees that the $S'S'_{(\min)}$ curve intersects the vertical axis below the DD curve, so that investment is positive no matter how severe the agency problem. For an analysis of investment collapse induced by agency problems, see Bernanke-Gertler, 1987.

[29]The original discussion of debt-deflation is Fisher, 1933. See Bernanke, 1987, and James Hamilton, 1987, for some evidence that debt-deflation was an important feature of the Great Depression. Why debt contracts are in practice typically unindexed is a deep puzzle which we will not discuss here.

[30]If we had assumed diminishing rather than constant returns to the storage technology, the debt-deflation (by driving a larger share of savings into storage, the alternative asset) would also cause the safe rate of return to fall; this is the "flight to quality" phenomenon. Note though that, since $\hat{q}$ rises, debt-deflation cannot explain a stock market crash without introducing additional factors (such as aggregate demand externalities).

and production varies only with the productivity shock $\tilde{\theta}$. The $\gamma > 0$ case is different because of the dependence of the capital supply curve on entrepreneurial savings S^e. The $S'S'$ curve is shifted by variations in either the current capital stock k_t or the productivity shock $\tilde{\theta}_t$, either of which affects the value of the entrepreneurs' labor endowments and thus their savings. Thus future capital depends on both current capital and productivity, leading to a nontrivial dynamics.

Consider how a productivity shock is propagated over time when $\gamma > 0$. In the informationally constrained region, a (temporary) rise in $\tilde{\theta}$ stimulates investment by increasing entrepreneurial net worth (since incomes increase). The $S'S'$ curve shifts rightward. The expansion persists because the rise in the future capital stock makes investment in the subsequent period higher than it would otherwise be. Through the same mechanism, negative productivity shocks may induce a persistent investment downturn. This is our attempt to capture in a formal model the following sort of intuition: In good times, when profits are high and balance sheets are healthy, it is easier for firms to obtain outside funds. This stimulates investment and propagates the good times. Conversely, poor financial health in bad times reduces investment and reinforces the decline in output. Note again that this rationalizes a sort of accelerator effect of income on investment; note also that countercyclical agency costs are crucial to the story.

The dynamic effects of productivity disturbances may be asymmetric in this setup. (Sharp investment downturns are more likely than sharp upturns.) For example, suppose the initial level of capital equals the value the economy attains under perfect information; denote this value as k_{max}. Next, for the case $k_t = k_{max}$, let θ^* be the minimum value of $\tilde{\theta}$ which generates a level of S^e large enough to make all "good" and "fair" entrepreneurs fully collateralized.[31] Diagrammatically, θ^* is the minimum realization of $\tilde{\theta}$ which makes the capital supply curve ($S'S'$) exactly overlap the perfect information supply curve (SS), given $k_t = k_{max}$. In this case, a realization of $\tilde{\theta}$ above θ^* has no effect on investment. The $S'S'$ does not move outward since all the efficient entrepreneurs are already fully collateralized. In contrast, a realization of $\tilde{\theta}$ below θ^*, by pushing some entrepreneurs below full collateralization and moving the $S'S'$ curve left, induces an investment downturn.

An explicit characterization of the stochastic steady state of this model cannot be obtained without some additional assumptions (for example, about functional forms). We may note several points, however: First, as long as some part of the support of $\tilde{\theta}$ is below θ^*, then even if the economy begins at k_{max}, there is some probability that it will be in the informationally constrained region in the next period. Second, if the economy begins at the minimum possible equilibrium capital stock k_{min} (at the intersection of the DD and $S'S'_{min}$ curves), and assuming that $\tilde{\theta}$ is a nondegenerate and continuously distributed random variable, the capital stock will almost certainly rise over time. Third, independent of initial conditions, the equilibrium capital stock in each period (it is easy to show) will lie in the interval $[k_{min}, k_{max}]$. We conclude that for most plausible parameterizations the system will be in the interior of the informationally constrained region with some positive probability in any given period, even asymptotically.

A distributional shock, as described in Section III, Part C, will also initiate interesting dynamics. In particular, a redistribution from borrowers to lenders that does not affect total income will lower investment not only in the current period, but for a number of subsequent periods as well. Thus balance sheet considerations may initiate, as well as propagate, cyclical fluctuations.

IV. Conclusion

We have constructed a simple neoclassical model of intrinsic business cycle dynamics in which borrowers' balance sheet positions play an important role. The critical insight

[31] Given (6), (25), (26), and (13), θ^* is defined by $\theta^* = [x(\bar{\omega}) - (\hat{q}(k_{max})/r)\kappa_1]/[f(k_{max}) - f'(k_{max})k_{max}]$.

is that the agency costs of undertaking physical investments are inversely related to the entrepreneur's/borrower's net worth. As a result, accelerator effects on investment emerge: Strengthened borrower balance sheets resulting from good times expand investment demand, which in turn tends to amplify the upturn; weakened balance sheets in bad times do just the opposite. The aggregate effects of productivity shocks may be asymmetric (since the agency problem may only bind on the "down" side). Further, redistributions or other shocks that affect borrowers' balance sheets (as may occur in a debt-deflation) will have aggregate real effects.

We have investigated extensions of this approach in related work. Our 1987 paper studies the macroeconomic implications of agency costs in a richer model of the investment process. In that model, projects differ *ex ante* (not just *ex post*, as in the costly state verification model), borrowers are able to obtain private information about project quality by incurring an evaluation cost, and borrowers must decide whether to proceed with projects that they have evaluated. The analysis of that model shows that the concept of "agency costs" relevant to macroeconomic fluctuations is much broader than the monitoring costs of the present paper: "Agency costs" should include any deviation from first-best outcomes associated with the necessity of external finance (whether it be through debt or other instruments). This result is important for interpreting the model empirically. Our companion paper also verifies the robustness of this basic approach to variations in assumptions about endowments and the information structure, and to permitting coalitions among entrepreneurs.

We have not discussed policy implications in the present paper. While, as in most OG models, the competitive solution of our model economy is not guaranteed to be Pareto optimal, it is efficient in a limited, intra-generational sense.[32] Issues of efficiency and policy are taken up at greater length in our 1987 paper. In particular, that paper discusses whether a policy of "debtor bailouts" (redistributions from lenders to borrowers) may be desirable when borrower net worth is low. Also addressed there is the issue of whether agency costs typically lead to "under"- or "over" - investment on average.

Finally, it is important to find out whether the qualitative results of this paper go through when borrowers and lenders are able to make contacts that last many periods. This has been done by Gertler (1988). In an n-period setting, he shows that the concept of "borrower net worth" should be augmented to include not just current endowments (as in the present paper), but also the "most secure" portion of expected future profits; thus, agency costs depend not only on current wealth but also on expected future conditions. He demonstrates that this can induce additional interesting cyclical dynamics into the aggregate economy.

APPENDIX: OPTIMAL CONTRACTING WITH STOCHASTIC AUDITING

This appendix studies the optimal financial contract between risk-neutral[33] entrepreneurs and lenders when there is private information about project outcomes but lenders have access to a costly auditing technology, as described in the text. We allow explicitly for a randomized auditing strategy by the lenders. As in the main text, we are assuming that borrowing and investment occurs in a given period t, and that project realization, auditing, and "settling up" by entrepreneurs and lenders occurs in $t+1$. Settling up is done via transfers of the produced capital good, and takes place before the period-$(t+1)$ value of capital, in terms of the consumption good, is known. Time subscripts are omitted below for legibility.

There are n possible outcomes of the investment project. In state i, κ_i units of the capital good are produced. Assume $0 \leq \kappa_1 < \kappa_2 < \cdots < \kappa_n$ and denote the probability of the ith outcome by π_i, $\pi_i > 0$. After

[32] Our dynamic equilibrium replicates the solution to a planning problem in which there are restrictions on intergenerational trades and the planner is not allowed to manipulate the relative price of capital in order to relax incentive constraints.

[33] The assumption of risk-neutrality differentiates our analysis from that of Townsend, 1988, and Mookherjee and Png, 1987, who consider the risk-averse case. Interestingly, the risk-neutral case seems to avoid some apparent anomalies that can arise in the optimal contract with risk aversion.

privately observing the true state j, the entrepreneur announces a state, say k, to the lenders. The lenders can verify the true state only by incurring an auditing cost of γ units of capital. We assume that lies of the form $k < j$ are feasible; in this case, the entrepreneur can "hide" the extra capital $\kappa_j - \kappa_k$. The expected value of this hidden capital is $\hat{q}(\kappa_j - \kappa_k)$ units of consumption, where $\hat{q}$ is the expected relative price of capital. Lies of the form $k > j$ are assumed infeasible, that is, the entrepreneur cannot show the lenders produced capital that does not exist.

We look for the optimal incentive-compatible contract. Let c_i be the entrepreneur's contractual consumption when he announces outcome i and is not audited, and let c_i^a be his consumption when he announces i, is audited, and is found to be telling the truth. (It is straightforward to show that the entrepreneur's optimal consumption when he is audited and found to be lying is zero (see Mookherjee and Png, 1987); we impose this from the beginning.) We allow a general stochastic auditing strategy: The lenders can commit in advance to auditing an announcement of outcome i with probability p_i. The total input cost of the project is x (here we hold the entrepreneur's "efficiency," ω, fixed). The entrepreneur's contribution is his savings S^e, and the interest rate is r, so that the lenders' total required return is $r(x - S^e)$. The entrepreneur's (borrower's) formal problem is

$$\text{(A1)} \qquad \max_{\{c_i^a, c_i, p_i\}} \sum_{i=1}^{n} \pi_i \left(p_i c_i^a + (1 - p_i) c_i \right)$$

subject to

$$\text{(A2)} \qquad \sum_{i=1}^{n} \pi_i \left[\hat{q}\kappa_i - \left(p_i c_i^a + (1 - p_i) c_i \right) - \hat{q} p_i \gamma \right] \geq r(x - S^e) \qquad (\lambda_1)$$

$$\text{(A3)} \qquad p_i c_i^a + (1 - p_i) c_i \geq (1 - p_j)\left(c_j + \hat{q}(\kappa_i - \kappa_j) \right) \qquad i = 2, \ldots, n \quad j < i \qquad (\lambda_{2ij})$$

$$\text{(A4)} \qquad c_i \geq 0 \qquad i = 1, 2, \ldots, n \qquad (\lambda_{3i})$$

$$\text{(A5)} \qquad c_i^a \geq 0 \qquad i = 1, 2, \ldots, n \qquad (\lambda_{4i})$$

$$\text{(A6)} \qquad p_i \geq 0 \qquad i = 1, 2, \ldots, n \qquad (\lambda_{5i})$$

$$\text{(A7)} \qquad 1 \geq p_i \qquad i = 1, 2, \ldots, n \qquad (\lambda_{6i})$$

where the multipliers associated with each set of constraints are in the right margin in parentheses, and $\hat{q}$ is the expected value of q_{t+1}. The entrepreneur's objective, (A1), is to maximize expected consumption, subject to the constraint that lenders receive their required return (A2), the truth-telling constraint (A3), nonnegativity constraints on c_i and c_i^a, (A4) and (A5), and the restriction that auditing probabilities be between zero and one, (A6) and (A7). The first-order conditions for c_1^a, c_i^a $(i = 2, \ldots, n)$, c_1, c_i $(i = 2, \ldots, n-1)$, c_n, p_1, p_i $(i = 2, \ldots, n-1)$, and p_n are, respectively,

$$\text{(A8)} \qquad \pi_1 p_1 (1 - \lambda_1) + \lambda_{41} = 0$$

$$\text{(A9)} \qquad \pi_i p_i (1 - \lambda_1) + p_i \sum_{j=1}^{i-1} \lambda_{2ij} + \lambda_{4i} = 0 \qquad i = 2, \ldots, n$$

$$\text{(A10)} \qquad \pi_1 (1 - p_1)(1 - \lambda_1) - (1 - p_1) \sum_{k=2}^{n} \lambda_{2k1} + \lambda_{31} = 0$$

$$\text{(A11)} \qquad \pi_i (1 - p_i)(1 - \lambda_1) + (1 - p_i) \sum_{j=1}^{i-1} \lambda_{2ij} - (1 - p_i) \sum_{k=i+1}^{n} \lambda_{2ki} + \lambda_{3i} = 0 \qquad i = 2, \ldots, n-1$$

$$\text{(A12)} \qquad \pi_n (1 - p_n)(1 - \lambda_1) + (1 - p_n) \sum_{j=1}^{n-1} \lambda_{2nj} + \lambda_{3n} = 0$$

$$\text{(A13)} \qquad \pi_1 (c_1^a - c_1)(1 - \lambda_1) - \lambda_1 \pi_1 \hat{q} \gamma + \sum_{k=2}^{n} \left(c_1 + \hat{q}(\kappa_k - \kappa_1) \right) \lambda_{2k1} + \lambda_{51} - \lambda_{61} = 0$$

$$\text{(A14)} \qquad \pi_i (c_i^a - c_i)(1 - \lambda_1) - \lambda_1 \pi_i \hat{q} \gamma + (c_i^a - c_i) \sum_{j=1}^{i-1} \lambda_{2ij} + \sum_{k=i+1}^{n} \left(c_i + \hat{q}(\kappa_k - \kappa_i) \right) \lambda_{2ki} + \lambda_{5i} - \lambda_{6i} = 0 \qquad i = 2, \ldots, n-1,$$

$$\text{(A15)} \qquad \pi_n (c_n^a - c_n)(1 - \lambda_1) - \lambda_1 \pi_n \hat{q} \gamma + (c_n^a - c_n) \sum_{j=1}^{n-1} \lambda_{2nj} + \lambda_{5n} - \lambda_{6n} = 0.$$

From (A8) or (A9), it is immediate that $\lambda_1 \geq 1$, so that the lenders' return constraint (A2) always binds. Adding the difference between the LHS and RHS of

(A2) to the objective (A1) reveals that the problem is unchanged if we replace (A1) with

$$(A1)' \qquad \min_{\{c_i^a, c_i, p_i\}} \sum_{i=1}^{n} \pi_i \hat{q} p_i \gamma.$$

Thus we have

Result 1. The optimal contract minimizes expected auditing costs, subject to the constraints (A2)–(A7).

Result 1 and the fact that (A2) binds imply that expected auditing costs under the optimal contract are nondecreasing in the return required by lenders (the RHS of (A2)). For fixed r, this required return is decreasing in S^e, the collateral of the entrepreneurs. Thus we have

Result 2. Expected auditing costs under the optimal contract are nonincreasing in the quantity of the entrepreneur's collateral S^e (and they are strictly decreasing in S^e when expected auditing costs are positive at the initial point).

We have noted that $\lambda_1 \geq 1$. There are two interesting subcases, $\lambda_1 = 1$ and $\lambda_1 > 1$. If $\lambda_1 = 1$, then we are in the case of no auditing; that is, $p_i = 0$, all i. (Proof: If $\lambda_1 = 1$, then from (A9) we have $p_i \lambda_{2ij} = 0$ $(i = 2, \ldots, n; j < i)$. (A12) and the fact that $p_n \lambda_{2nj} = 0$ implies $\lambda_{2nj} = 0$, $j < n$. Using (A11) and working recursively backward from $i = n-1$, we conclude $\lambda_{2ij} = 0$ $(i = 2, \ldots, n; j < i)$. From (A13)–(A15), this implies $\lambda_{5i} > 0$, all i; that is, $p_i = 0$.) On the other hand, if $p_i > 0$ for any i, then $\lambda_1 > 1$. (Proof: If some $p_i > 0$, then $\lambda_{5i} = 0$. Suppose that $\lambda_1 = 1$. From (A13)–(A15), $\lambda_{5i} = 0$ implies that some λ_{2ij} or λ_{2ki} must be positive. But, as shown just above, this implies $\lambda_1 > 1$, a contradiction.)

Consider first the no-auditing case ($\lambda_1 = 1$). With no auditing there is no deadweight loss; the "first best" is attained. The next result characterizes when this is possible.

Result 3. The optimal contract involves no auditing if and only if the lender's required return is less than the value of the worst possible outcome of the project; that is, $p_i = 0$, all i, iff $r(x - S^e) \leq \hat{q}\kappa_1$.

PROOF:

Suppose $p_i = 0$, all i. From (A3), this implies $c_i \geq \hat{q}(\kappa_i - \kappa_1)$, $i = 2, \ldots, n$. Substituting this into (A2) yields $r(x - S^e) \leq \hat{q}\kappa_1$, which proves sufficiency. Now suppose $r(x - S^e) \leq \hat{q}\kappa_1$. Then the contract $\{c_i = \hat{q}\kappa_i - r(x - S^e),\ p_i = 0,\ c_i^a$ irrelevant$\}$ satisfies the constraints and involves no auditing. Since auditing costs are minimized, this contract is optimal, by Result 1.

When $r(x - S^e) > \hat{q}\kappa_1$, we are in the case $\lambda_1 > 1$, and the optimal contract involves some positive probability of auditing. We give a few results for this case ($\lambda_1 > 1$ is maintained).

Result 4. In any state in which there is a positive probability of auditing, the entrepreneur receives positive consumption only if he is audited; that is, $p_i > 0 \rightarrow c_i = 0$.

PROOF:

Our proof is for $i = 2, \ldots, n-1$; similar arguments apply for $i = 1$ and $i = n$. Assume $1 > p_i > 0$. (If $p_i = 1$, the value of c_i is irrelevant.) Comparing (A11) and (A9), note that the first two terms of (A11) are proportional to $-\lambda_{4i}$. If $\lambda_{4i} > 0$, then (A11) implies $\lambda_{3i} > 0$ and we are done. Suppose that $\lambda_{4i} = 0$. Then, in (A14), the first and third terms, which are proportional to λ_{4i}, disappear. Since $\lambda_{5i} = 0$, for (A14) to hold there must be some $k > i$ such that $\lambda_{2ki} > 0$. (A11) then again implies $\lambda_{3i} > 0$, so that $c_i = 0$.

Result 5. The entrepreneur receives no consumption in the worst state; $c_1^a = c_1 = 0$.

PROOF:

$\lambda_{41} > 0$ (if $p_1 > 0$) and $\lambda_{31} > 0$ (if $p_1 < 1$) follow immediately from (A8) and (A10).

Result 6. Let $\hat{c}_i = p_i c_i^a + (1 - p_i)c_i$ be the entrepreneur's expected consumption in state i. Then $\hat{c}_i$ is nondecreasing in i, that is, the entrepreneur does better in better states.

PROOF:

For some $\hat{c}_i$, we wish to show that $\hat{c}_k \geq \hat{c}_i$, any $k > i$. $\hat{c}_1 = 0$, so let $i > 1$. If $\lambda_{3i} > 0$ and $\lambda_{4i} > 0$, then $\hat{c}_i = 0$ and the result is immediate. Suppose instead then that either $\lambda_{3i} = 0$ or $\lambda_{4i} = 0$. Then from (A11) or (A9), there exists some $j < i$ such that $\lambda_{2ij} > 0$. This implies $\hat{c}_i = (1 - p_j)(c_j + \hat{q}(\kappa_i - \kappa_j))$. For any $k > i$, we know from (A3) that $c_k \geq (1 - p_j)(c_j + \hat{q}(\kappa_k - \kappa_j)) > (1 - p_j)(c_j + \hat{q}(\kappa_i - \kappa_j)) = \hat{c}_i$. Thus expected consumption is actually strictly increasing in the range where it is positive.

Result 7. There is never any auditing in the highest state; $p_n = 0$.

PROOF:

Suppose $p_n > 0$. Then $\lambda_{5n} = 0$ and, from Result 4, $c_n = 0$. Now if $c_n^a = 0$ also, (A15) can hold only if $\lambda_{5n} > 0$, and we have a contradiction. Suppose instead that $c_n^a > 0$. Then $\lambda_{4n} = 0$. Comparing (A15) with (A9), we see that the first and third terms of (A15), which are proportional to λ_{4n}, must be zero. But then once again (A15) can hold only if $\lambda_{5n} > 0$, a contradiction.

Result 8. The probability of auditing is nonincreasing in the announced state (p_i is nonincreasing in i).

PROOF:

For any p_i, $i = 2, \ldots, n-1$, we wish to show that $p_{i-1} \geq p_i$. If $p_i = 0$, this is trivial, so take $p_i > 0$. By Result 4, $c_i = 0$. Now there are two possibilities to consider, $c_i^a = 0$ and $c_i^a > 0$.

Suppose $c_i^a = 0$. Then for (A14) to hold, there must be some $k > i$ such that $\lambda_{2ki} > 0$. Thus $\hat{c}_k = (1 - p_i)(\hat{q}(\kappa_k - \kappa_i))$, where $\hat{c}_k$ is defined as in Result 6. We know that $\hat{c}_k \geq (1 - p_{i-1})(c_{i-1} + \hat{q}(\kappa_k - \kappa_{i-1}))$. Since $c_{i-1} + \hat{q}(\kappa_k - \kappa_{i-1}) > \hat{q}(\kappa_k - \kappa_i)$, it must be that $p_{i-1} \geq p_i$.

If $c_i^a > 0$, then $\lambda_{4i} = 0$, and the first and third terms of (A14), which together are proportional to λ_{4i}, equal zero. For (A14) to hold, there must again be some $k > i$ such that $\lambda_{2ki} > 0$, and the argument is the same as before.

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