Understanding the term structure of swap spreads

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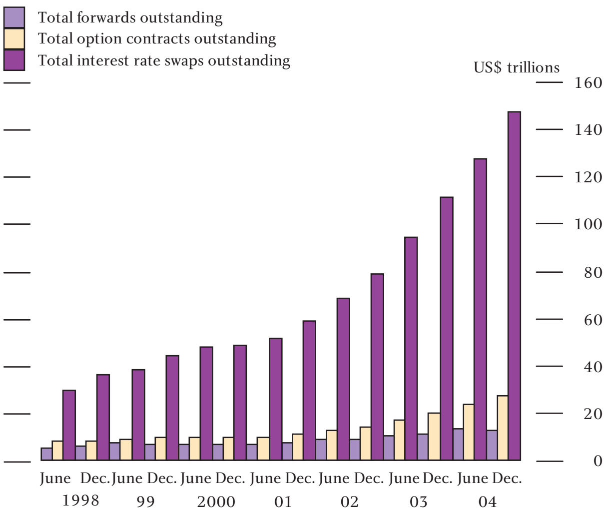
Market expectations about the future path of interest rates can be derived from both government bond and swap yield curves. But at times these curves may provide imprecise signals about interest rate expectations. Understanding what factors can affect the term structure of swap spreads — the difference between government bond rates and swap rates at different maturities — may therefore be helpful to policymakers when interpreting market views of future interest rate developments.

This article reviews past developments in dollar, euro, sterling and yen government bond and swap markets and considers the potential influences on the term structure of swap spreads. Using statistical analysis, it finds that some influences seem to be common across international markets, but others, such as liquidity or preferred habitat issues, tend to be specific to certain markets.

Introduction

A swap is an agreement between two parties to exchange cash flows in the future. The most common type of swap is a 'fixed-for-floating' interest rate swap where one party receives floating (variable) interest rate payments over a given period and is willing to pay the other party a fixed (swap) rate to receive those floating payments. The volume of interest rate swap transactions has grown rapidly in recent years, led by increasing demand from hedging and speculative sources(1) (Chart 1). Swaps are the largest type of traded interest rate derivative in the OTC (over-the-counter)(2) market, accounting for over 75% of the total amount traded of these contracts. The increase in the size and liquidity of the swap market has led the swap curve to become a benchmark curve widely used by market participants when pricing financial assets.

Chart 1
OTC interest rate contracts by instrument in all currencies



Source: Bank for International Settlements.

Differences between swap rates and government bond yields of the same maturity are referred to as swap spreads. A number of empirical studies have examined the possible determinants of swap spreads at specific benchmark maturities such as five and ten years.(3) For example, Cortes (2003) found that swap rates may contain a time-varying default premium over government bond yields to compensate investors for the possible risk of a systemic failure of the banking sector. At the same time, swap spreads may be affected by market factors such as shifts in supply and demand in both the swap and the government bond markets at particular maturities.

(1) Swaps were initially developed as a means of allowing institutions to manage interest rate exposures on their asset and liability portfolios more efficiently. More recent demand has come from hedging and speculative sources. See Cortes (2003) for further detail.
(2) Over-the-counter means an asset that is not traded on an exchange but traded as a result of direct negotiation between counterparties.
(3) Benchmark maturities refer to maturities of bonds that are widely viewed as high quality, liquid investment vehicles and that are actively used for hedging and trading purposes.

However, there are few studies that have considered the determinants of the term structure of swap spreads — that is, the factors that influence swap spreads at different maturities. Understanding what affects the term structure of swap spreads may be helpful to policymakers when interpreting market perceptions of future interest rate developments. Specifically, market expectations about the future path of interest rates can be derived from both nominal government bond and swap yield curves. Indeed, the Bank of England provides estimates for both of these sorts of curves.(1) But at times these curves may provide different signals about market expectations of the path of future interest rates. For example, changes in investors' perceptions of the likelihood of bank defaults may influence swap rates although government bond rates should be unaffected. Similarly, market inefficiencies, associated for example with liquidity conditions in particular financial markets or imbalances in supply and demand for securities of particular maturities, can affect government bond and swap curves in different ways. Identifying when these factors may be important and how they impact on the term structure of the swap spreads might therefore help in assessing expectations of future interest rates derived from estimated yield curves.

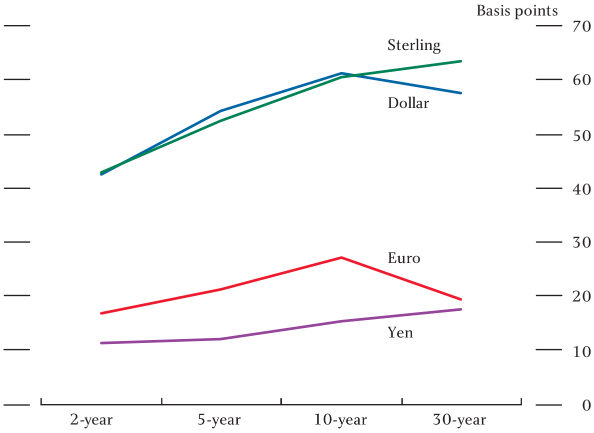
This article reviews developments in the term structure of swap spreads over the past few years for the major currencies and considers a series of explanations for the observed movements. More specifically, using statistical analysis and drawing on discussions with market participants, the article tries to evaluate the possible influences on the term structure of international swap spreads. Among the candidate explanations, this article reviews the possibility that some of the factors suggested in Cortes (2003), such as the default premium embedded in interbank lending rates in the London market (ie London interbank offered rate — Libor) and demand and supply imbalances in the swap and the government bond markets, vary across maturities; and as a result are associated with changes in the term structure of international swap spreads.

The article begins by seeking to establish some stylised facts about the term structures of international swap spreads. It then goes on to employ formal statistical analysis to evaluate possible explanations for these empirical regularities, with a particular focus on the US market where most data are available. An appendix gives further details of the modelling approach employed.

Some stylised facts

Chart 2 plots average swap spreads(2) for dollar, euro, sterling and yen for different maturities over the January 1997–July 2005 period. For maturities up to ten years, the average term structure of swap spreads has been upward sloping in all four markets. In other words, the spread of swap rates over government bond yields has tended to be greater at ten-year than at two-year maturities. But euro and dollar swap spreads have been lower on average at thirty-year than at ten-year maturities: the term structure of swap spreads in these markets has been inverted at the long end.

Chart 2
Average term structure of swap spreads(a) (January 1997–July 2005)



Source: JPMorgan Chase and Co.

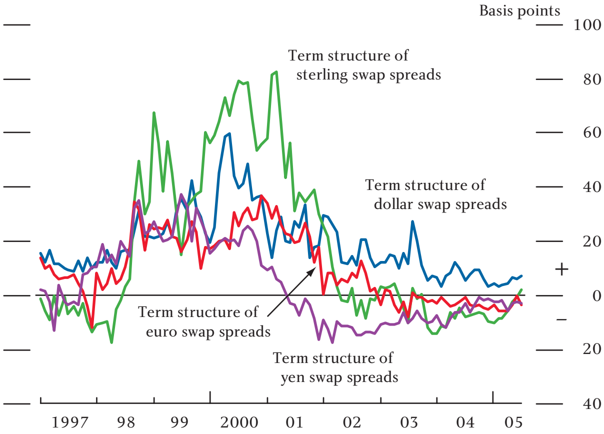
(a) Since Japanese 30-year government bonds were not issued until 1999, this article uses yen swap spreads of 20-year instead of 30-year maturity. Before 1999, deutschmark swap spreads are used to proxy for the euro area.

The averages mask considerable variation over time in swap spreads. The shape of the term structure has moved frequently and with significant shifts over the review period. Some of these shifts appear to have been largely temporary and were quickly unwound. But there were other changes that appear to have been of a more persistent nature (Charts 3 and 4).

Much of the change in the term structures has occurred internationally. Table A shows bivariate correlation coefficient statistics for the two-to-ten year and ten-to-thirty year parts of the term structure in the dollar, euro, sterling and yen markets. The higher the

(1) Nominal government bond yield curves have been estimated in the Bank of England for more than 35 years. The Bank also estimates bank liability curves that are derived from swap rates.
(2) This article uses monthly maturity-matched swap spreads from JPMorgan Chase and Co.

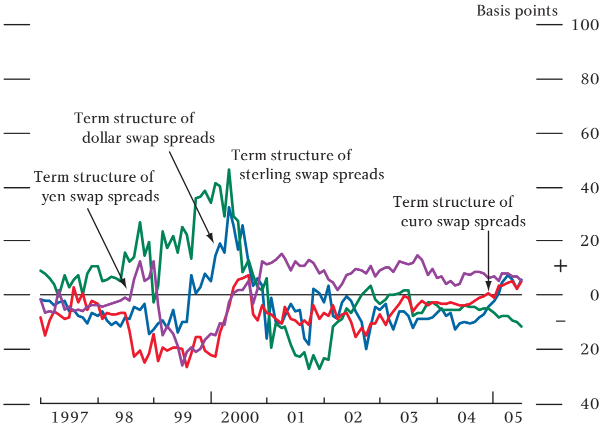
Chart 3
The term structure of swap spreads between two and ten-year maturities[(a)]



Source: JPMorgan Chase and Co.

(a) Constructed as the ten-year (maturity-matched) swap spread less the two-year (maturity-matched) swap spread.

Chart 4
The term structure of swap spreads between ten and thirty-year maturities[(a)]



Source: JPMorgan Chase and Co.

(a) Constructed as the thirty-year (maturity-matched) swap spread less the ten-year (maturity-matched) swap spread.

correlation coefficient, the closer the co-movement of international swap spreads.

As Table A shows, movements in the term structure of swap spreads out to ten-year maturities appear highly positively correlated across all four markets. In other words, out to ten years, swap spreads across all four markets tend to move up or down together. In contrast, there is less evidence of co-movement between ten and thirty-year maturities. This may suggest that domestic influences are more important at the very long end of the term structure. For example, there has been increasing (but differentiated) international focus on regulation on the pension funds and life insurance industry over recent years. This may have had

Table A
Bivariate correlations of the term structure of swap spreads between two and ten-year and between ten and thirty-year maturities

Two-to-ten swap spreads[(a)]

	Dollar	Euro	Sterling	Yen
Dollar		0.73***	0.78***	0.58***
Euro			0.86***	0.64***
Sterling				0.59***
Yen				

Ten-to-thirty swap spreads[(b)]

	Dollar	Euro	Sterling	Yen
Dollar		0.21	0.41***	-0.22
Euro			-0.41***	0.46***
Sterling				-0.72***
Yen				

(a) Ten-year swap spread less two-year swap spread.
(b) Thirty-year swap spread less ten-year swap spread.
*** Correlation coefficient different from zero at the 1% significance level.

significant effects on government bond markets at long maturities, giving rise to changes in the term structure of swap spreads.

As an illustration, in the United Kingdom, the Minimum Funding Requirement (MFR), applied under the Pensions Act 1995, increased UK pension funds' demand for long-term conventional gilts. The MFR allowed the liabilities of pension funds defined in nominal terms to be discounted using long-term gilts. This gave UK funds an incentive to hold gilts to limit the risk of not matching their liabilities.[(1)] Also, the decline in long-term gilt yields put pressure on UK insurance companies' solvency levels, prompting them to buy more long-term gilts in an attempt to improve their solvency. This is turn led to a widening of sterling swap spreads, particularly at the longest maturities.

However, expectations of a reform of the MFR began to emerge in the first half of 2000 as market participants anticipated regulatory changes. This caused a gradual increase in gilt yields at long maturities, and this in turn led to a flattening of the term structure of sterling swap spreads at long maturities. These regulatory changes were confirmed by the Myners report into institutional investment on 8 November 2000 and the announcement of the abolition of the MFR by the Chancellor on 7 March 2001.

In summary, the main features of the term structure over recent years are:

- across the major markets, the term structures of swap spreads out to ten years have been on average upward sloping;

(1) See the 'Markets and operations' section of the *Bank of England Quarterly Bulletin*, November 2000, page 334.

- there has been considerable variation over time in the term structure of swap spreads, especially at maturities up to ten years; and
- some of this variation appears to have occurred internationally, particularly at maturities up to ten years. But the term structures also appear to have moved independently in each market, suggesting market-specific features may also have been important.

Empirical analysis

Common factors

In order to investigate further the underlying influences on the term structure of swap spreads, this article employs formal statistical analysis, concentrating on the two-to-ten year part of the term structure of swap spreads.

The previous section found that there appears to be a relatively high correlation in the term structure of international swap spreads at maturities up to ten years. To examine the co-movement further, a statistical technique called principal component analysis (PCA) can be employed to uncover the common variables that might be driving the term structure of international swap spreads.(1) Once the common factors have been isolated, the article will also consider the possible idiosyncratic or country-specific influences on the term structure of swap spreads.

Using PCA, there appears to be one significant principal component, or common factor, that captures over three quarters of the total variance of the two-to-ten year part of the dollar, euro, sterling and yen term structure of swap spreads. There is less co-movement across countries in the term structures between ten and thirty-year maturities than for the two-to-ten year part of the term structure.

In order to help interpret the principal component of the two-to-ten year part of the term structure, it is helpful to consider candidate variables for the underlying sources of the co-movement in the term structure of swap spreads internationally. Two possible influences in particular stand out: a default term premium and global expectations of government bond issuance.

If the swap and government bond markets are priced efficiently, the swap curve should represent the path of expected future interest rates plus a term premium. This term premium will not only reflect uncertainty about future interest rates, but will also include compensation for uncertainty about the risk of systemic failure of the banking sector in the future. Since investors are likely to be more uncertain about the risk of a systemic failure of the banking sector at longer horizons, the term or uncertainty premium might be expected to increase with the maturity of swap contracts. Therefore, the term structure of swap spreads could be affected by a default term premium, which might lead to an upward sloping term structure. To the extent that a default term premium exists, it also seems likely that it will be similar across the dollar, euro, sterling and yen markets. This is because the same international banks tend to feature in the panel of institutions whose lending rates are used to form the Libor benchmark rates in the four markets.(2)

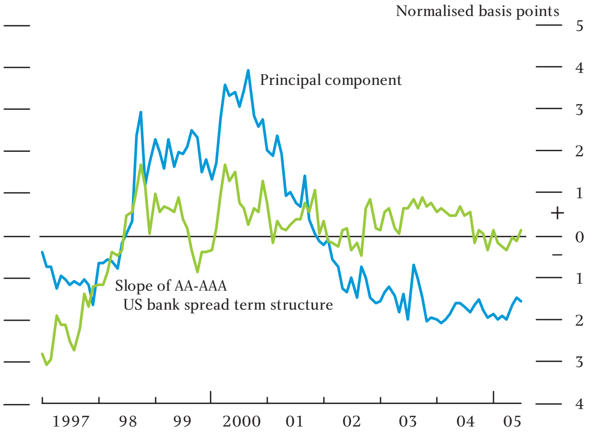
Information about the default term premium of the international Libor panel may be inferred from the term structure of the corporate spread of the Merrill Lynch AA-AAA rated US banking sector index.(3) The term structure of a highly rated corporate bond is usually upward sloping — the probability of the corporate defaulting on its debt is typically negligible in the short run, but there is always uncertainty about the possibility of the corporate defaulting on its debt at long maturities.(4)

Chart 5 plots the principal component of international swap spreads and the term structure of the spread of the AA-AAA rated US banking sector.(5) They tend to move broadly together, although arguably the degree of association appears to be stronger in the earlier part of the sample. Confirming this, Table B shows the results of a simple regression of first differences of the principal

(1) PCA is a statistical technique that can be used to simplify correlation matrices so that only the most important sources of information are retained. For an introduction to PCA, see Jackson (1991).
(2) Of the 16 banks in Libor panels, the same eleven were part of the dollar, euro, sterling and yen panels in 2004. These were Bank of America, Barclays, Deutsche, HSBC, JPMorgan Chase, Lloyds TSB, Rabobank, Tokyo-Mitsubishi, Royal Bank of Scotland, UBS and Westdeutsche Landesbank.
(3) This assumes that there is a relatively high correlation between credit spreads of US banks and non-US banks. Hawkesby, Marsh and Stevens (2005) found evidence of a high degree of commonality in credit spread movements of large complex financial institutions, although there was also evidence of some regional differences.
(4) See Litterman and Iben (1991), Gehr and Martell (1992), Adedeji and McCosh (1995) and Bedendo, Cathcart and El-Jahel (2004).
(5) The series are normalised, by subtracting the sample means and dividing each data point by the corresponding sample standard deviation. Otherwise the principal component would be dominated by the country (market) specific variable with the greatest volatility.

component on the proxy for the default term premium. The sign of the coefficient of the regression suggests that an increase in the default term premium appears to be associated with a steeper term structure of swap spreads, as expected. The coefficient is statistically significant at the 5% level for the January 1997–July 2005 period, though not for the more recent January 2001–July 2005 period, perhaps indicating a weakening influence from any default term premium on swap spreads.

Chart 5
The term structure of highly rated US banks[(a)] and the principal component of the term structure of international swap spreads between two and ten-year maturities



Sources: JPMorgan Chase and Co, Merrill Lynch and Bank calculations.

(a) The term structure of corporate spreads is estimated as the option-adjusted spread of the five-to-ten year Merrill Lynch AA-AAA rated banking sector index minus the one-to-five year index.

Table B
OLS regression of first differences of the principal component on the default term premium[(a)]

Variable	Coefficient	Period
D(default term premium)	0.24**	Jan. 1997–July 2005
	0.16	Jan. 2001–July 2005

Note: *D* represents the change in the variable, such that $D(X) = X_t - X_{t-1}$.
** indicates significance at the 5% level.

(a) The default term premium is estimated as the term structure of the spread of the AA-AAA rated US banking sector.

Despite the statistical association, anecdotal evidence suggests that some market contacts seem unconvinced that investors in swaps demand a term premium to compensate for potentially greater uncertainty about the systemic failure of the banking sector at longer relative to shorter horizons. Instead, they suggest that other factors may account for the term premia in swap spreads. In particular, demand and supply imbalances in the government bond and swap markets at different maturities may drive a wedge between government bond yields, swap rates and market expectations of future interest rates.[(1)]

Cortes (2003) found that government bond prices could fall in response to extra prospective supply, prompting government bond yields to rise and swap spreads to narrow. Expectations of government bond issuance may also have an effect on the term structure of swap spreads. There is evidence of a positive relationship between the slope of government bond yield curves and the amount of government bond net borrowing — the higher net borrowing, the steeper the yield curve.[(2)] And if there are similar trends in expectations of government issuance internationally, the term structure of swap spreads may, in the absence of any other factors, therefore become flatter internationally as government net borrowing increases.

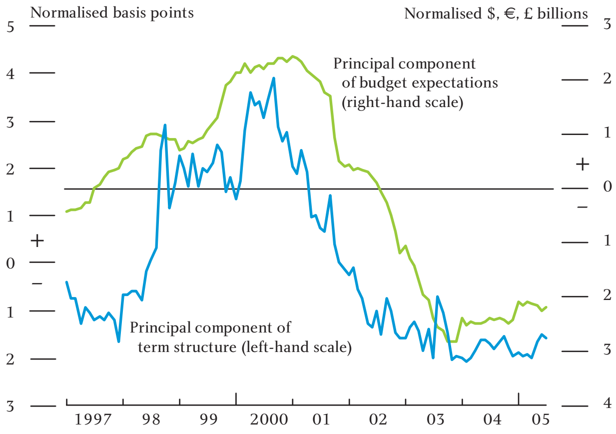
Consensus Economics provides a monthly average estimate of budget balance expectations across different countries for the current and subsequent year.[(3)] Simple correlation analysis suggests that there seems to be a particularly high association between expectations of government budget balance in the United States, Germany (used as a proxy for the euro swap market) and United Kingdom over recent years.[(4)] And PCA suggests that there appears to be one significant principal component that accounts for over 95% of the total variance of government budget balance expectations in the United States, Germany and the United Kingdom. These results indicate that expectations of fiscal positions tend to move together across countries, perhaps reflecting similarities in cyclical positions.

In terms of explaining the co-movement in the term structure of swap spreads, Chart 6 shows that there seems to be some association between the principal component of the term structure of swap spreads and the principal component identified for budget balance expectations in the United States, Germany and the United Kingdom. To examine this relationship

(1) See Peacock (2004) for further detail on the existence of a risk premium that can lead to forward rates being a biased measure of expected future interest rates.
(2) Brooke, Clare and Lekkos (2000) found a positive relationship between net borrowing and the steepness of the yield curve in the United Kingdom, United States and Germany during the 1990s.
(3) See Cortes (2003).
(4) The correlation coefficients between US, German and UK budget balance expectations were all above 0.9 over the period from January 1997 to July 2005.

further, Table C shows the results of the regression of the first difference of the principal component of the term structure of swap spreads on the first difference of the principal component of budget balance expectations.

Chart 6
Principal component of the term structure of international swap spreads between two and ten-year maturities and principal component of budget balance expectations in the United States, Germany and the United Kingdom



Sources: Consensus Economics, JPMorgan Chase and Co and Bank calculations.

Table C
OLS regression of the first differences of the principal component of the term structure of swap spreads between two and ten-year maturities on first differences of the principal component of budget balance expectations in the United States, Germany and the United Kingdom[(a)]

Variable	Coefficient	Period
D(PC of budget balance expectations)	0.38	Jan. 1997–July 2005
	0.63**	Jan. 2001–July 2005

(a) *D* represents the change in the variable, such that $D(X) = X_t - X_{t-1}$.
** indicates significance at the 5% level.

The sign of the coefficient of the regression suggests that an increase in government budget balance expectations (ie lower expected government bond issuance) is associated with a steeper term structure of swap spreads internationally, as expected. The coefficient is not statistically significant at the 10% level during the January 1997–July 2005 period. But, in contrast to the default term premium, the coefficient is statistically significant — and at the 5% level — during the later part of the sample (January 2001–July 2005 period).

Idiosyncratic factors

The term structure of swap spreads may also be affected by forces that are idiosyncratic to each market. Some of these influences may be related to movements in the term structure over the whole period. But other influences may be related to movements in the term structure at specific points in time. These idiosyncratic drivers might usefully be categorised into three different groups:

a. *Different liquidity preferences of investors in government bonds relative to swaps.* In particular, there may be a time-varying liquidity term premium, whereby investors demand an extra premium for receiving fixed interest payments via swaps rather than holding 'on-the-run' (ie the most recently issued)[(1)] government bonds at longer maturities during certain periods.[(2)]

b. *Preferred habitat influences on the government bond curve.* The preferred habitat theory states that in addition to interest rate expectations, market participants have different investment horizons and require a premium to buy assets with maturities outside their 'preferred' maturity or habitat. These influences may be associated with regulatory changes that affect specific maturities of the government bond curve. They may also be related to demand for government bonds of specific maturities such as the recent purchases of short and medium-run US Treasuries by foreign central banks.

c. *Preferred habitat influences on the swap curve.* These are often related to demand for specific maturities in the swap curve associated with hedging activities, such as mortgage convexity hedging, swapped corporate issuance and banks' hedging of the market risk of their bond portfolios.

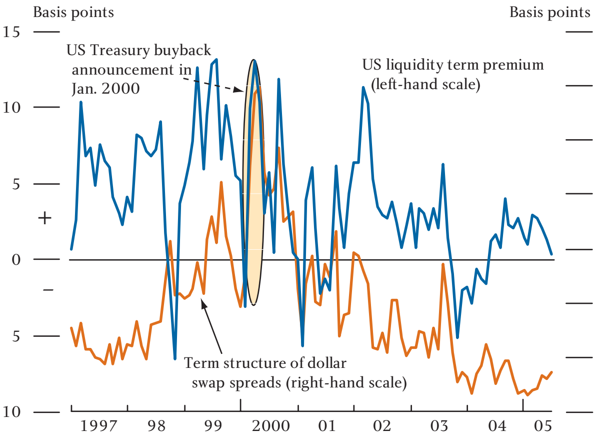
To examine the empirical importance of these sorts of idiosyncratic influences on the term structure of swap spreads, this section concentrates its analysis on the term structure of dollar swap spreads. Ideally, other government bond and swap markets would be included in order to evaluate how these factors differ across countries. Unfortunately, a lack of reliable indicator variables for euro, sterling and yen markets prevents such an analysis.

(1) Previously issued securities of similar maturity are known as 'off-the-run'.
(2) Liu, Longstaff and Mandell (2004) argue that US Treasury yields can represent downwardly biased estimates of the true cost of risk-free borrowing. They find that there is a liquidity premium between the 'true' risk-free rate and US Treasury yields that increases — on average — with maturity and that varies across maturities over time.

US liquidity term premium

The term structure of the spread between the on-the-run benchmark Treasury note and a basket[1] of off-the-run Treasury notes might serve as proxy of the US liquidity term premium in swap spreads since the only difference between these bonds is the lower liquidity of the off-the-run Treasury notes. Chart 7 plots the term structure of this spread between two and ten-year maturities against the term structure of dollar swap spreads between the same maturities. Both the term structure of dollar swap spreads and the term structure of the on-the-run/off-the-run spread steepened significantly following the US Treasury announcement of buybacks in January 2000, suggesting the possible influence of liquidity effects on swap spreads.[2]

Chart 7
The term structure of international swap spreads between two and ten-year maturities and the term structure of the on-the-run/off-the-run spread on a basket of US Treasury notes



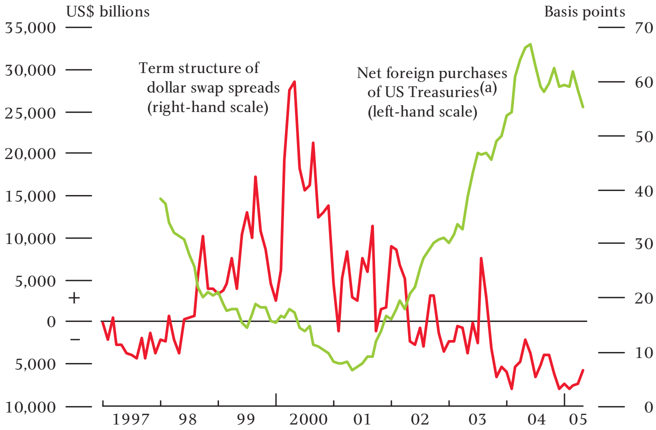
Sources: JPMorgan Chase and Co and Bank calculations.

Central bank purchases of US Treasuries

Net foreign purchases of US Treasuries might reflect preferred habitat influences on the US Treasury curve. In recent years, the large share of US Treasuries among central banks' foreign exchange reserve holdings has made them important players in the US Treasury market. Demand from central banks for US Treasuries at short maturities can prompt US Treasury yields to fall at short relative to long maturities. This could lead to a widening of dollar swap spreads at short-term maturities relative to long-term maturities. There is evidence that a majority of foreign exchange reserve asset purchases have been US dollar denominated in the past two years.[3] This implies that demand from central banks for US Treasuries may have had an effect on the term structure of dollar swap spreads due to the relatively large size of these purchases.

Chart 8 plots the term structure of dollar swap spreads and the twelve-month moving average of net foreign purchases of US Treasuries over the January 1997–May 2005 period. Over the whole period, the two series are not highly correlated. But over the past two years, the large size of net foreign purchases of US Treasuries, driven by central banks, may have contributed to the flattening of the term structure of dollar swap spreads.

Chart 8
The term structure of international swap spreads between two and ten-year maturities and net foreign purchases of US Treasuries(a)



Sources: JPMorgan Chase and Co, US Treasury and Bank calculations.

(a) Twelve-month moving average.

US mortgage-related hedging

For almost all home mortgages in the United States, borrowers are able to prepay their mortgage loans at any time without penalty. As a result of this prepayment option, investors in mortgages and mortgage-backed securities (MBS) face the risk that they will experience a return of principal earlier than anticipated and be left to invest that principal at potentially lower yields.

(1) This basket is calculated using the average yield of the last three previously issued Treasury notes of similar maturity. The term structure of the on-the-run/off-the-run spread is then estimated as the differential between the yield of this basket and the yield of the on-the-run Treasury note at the ten-year maturity minus the same spread at the two-year maturity.
(2) The reduced prospective supply of Treasuries, following the US Treasury announcement of debt buybacks in January 2000, pushed down on-the-run Treasury yields, and widened dollar ten-year swap spreads by over 50 basis points in the following four months. See Cortes (2003).
(3) Higgins and Klitgaard (2004) find that 88% of all global reserve asset purchases were US dollar denominated in 2003.

Because prepayments on mortgages and MBS tend to accelerate when interest rates drop, the increased prepayment risk also causes the duration of the mortgage to shorten, thereby changing the interest rate exposure of the investor's portfolio going forward.(1)

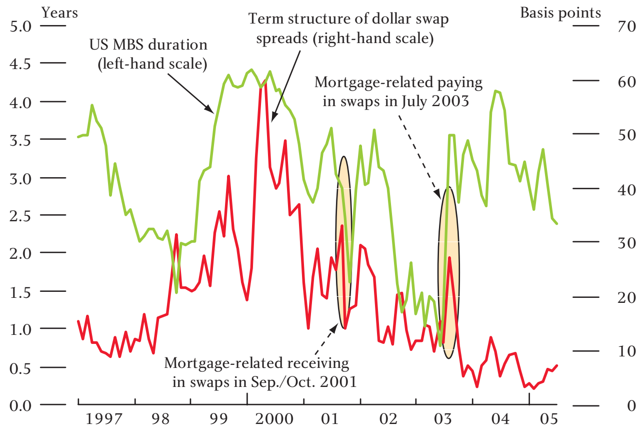
Mortgage holders will typically attempt to offset any changes in duration ie to reduce the sensitivity of their assets and liabilities to future interest rate movements. A key hedging instrument for many investors are swaps — investors generally seek to increase their 'receive-fix' swap positions when interest rates decline and their 'pay-fix' swap positions when rates increase. Cortes (2003) reported evidence that such mortgage-related hedging activity has been associated with changes in the level of swap spreads. Since US mortgage holders usually pay (receive) using five and ten-year dollar swaps(2) in order to reduce (extend) the duration of their assets, this mortgage-related hedging activity can also potentially affect the term structure of dollar swap spreads. In this way, US mortgage-related hedging may be an example of preferred habitat effects on the dollar swap curve.

In the past, periods in which significant US mortgage-related hedging occurred seem to have been associated with sharp movements in the slope of the term structure of dollar swap spreads (Chart 9). For example:

- between mid-September and mid-October 2001, the duration of MBS holdings fell sharply as the US Fed eased interest rates from 3.5% to 2.5% and US mortgage holder refinancing activity increased. This prompted a wave of mortgage-related hedging by investors with 'receiving fixed' concentrated on five and ten-year swaps. In turn, this was associated with the flattening of the slope of the dollar swap spread term structure, as spreads narrowed more at intermediate and long maturities than at shorter maturities; and

- in July 2003, in contrast, there was a sharp rise in long-term interest rate expectations (reflected in long-term Treasury yields) that led to a sharp fall in mortgage refinancing activity. This increased the duration of portfolios of mortgage-backed securities, triggering mortgage-related hedging flows with investors 'paying fixed' in five and ten-year swaps. This demand was associated with a steepening of the term structure of dollar swap spreads over the month.

Chart 9
The term structure of international swap spreads between two and ten-year maturities and the effective duration of US mortgage-backed securities



Sources: JPMorgan Chase and Co, Merrill Lynch and Bank calculations.

Combining the common and idiosyncratic factors — US market example

To capture the potential influence of common and idiosyncratic factors on the persistent changes (medium-run trends) of the term structure of swap spreads, we use an error correction model (ECM). This allows us to identify an 'equilibrium' relationship of the term structure of swap spreads over our sample period (January 1997–July 2005), indicating the direction in which the term structure of dollar swap spreads needs to move following short-run shocks in order to re-establish the medium-run trends in the data. More formally, the ECM can be represented by the regression equation:

D(term structure of dollar swap spreads) =
β_1 * D(principal component)
α_1 * D(US liquidity term premium) +
α_2 * D(net foreign purchases of US Treasuries) +
α_3 * D(effective duration of MBS) –
λ* MREC(-1)

Note: D represents the change in the variable, such that $D(X) = X_t - X_{t-1}$.

MREC is the medium-run adjustment (error correction) variable that accounts for the persistent deviations in swap spreads.

(1) More formally, mortgages and MBS have what is referred to as 'negative convexity'. This means that, unlike most bonds, the value of these assets/securities tend to fall as interest rates fall.
(2) See the 'Markets and operations' section of the *Bank of England Quarterly Bulletin*, Spring 2001, page 10.

Given the description of the factors already discussed, Table D indicates the expected signs of the model coefficients.

Table D
Expected relationship between the term structure of dollar swap spreads and explanatory variables

Variable	Influence[a]	Coeff. sign	Initial movement	Impact on the term structure
Default term premium	Common	+	Increase	Steepening
PC of budget balance expectations	Common	+	Increase	Steepening
US liquidity term premium	Idiosyncr.	+	Increase	Steepening
Effective duration of mortgage-backed securities (MBS)	Idiosyncr.	+	Increase	Steepening
Net foreign purchases	Idiosyncr.	–	Increase	Flattening

(a) Common influences are factors related to the term structure of international swap spreads while idiosyncratic influences are US (dollar) specific.

Some of the candidate factors are likely to be associated with both short-run movements and medium-run trends in the term structure of swap spreads. For example, both the default term premium and potential demand/supply imbalances might have a persistent effect on the term structure of swap spreads. Others might be only related to short-run developments such as sudden increases in the liquidity term premium, net foreign purchases of US Treasuries and mortgage hedging related demand to pay/receive in swaps.

Table E shows the regression results. Regression 1 uses the principal component from the PCA analysis to capture the common (ie international) influences on the US term structure of swap spreads. Changes in the principal component of the term structure of international swap spreads and the US liquidity term premium are significant at the 1% level. The medium-run adjustment variable is also significant at the 1% level, suggesting that the principal component has a statistically significant association with persistent deviations in the term structure of swap spreads. All the coefficients have the expected sign.

It is also possible to evaluate via the same regression framework the impact on the term structure of US dollar swap spreads of the two candidate factors for observed international co-movement in the term structure of swap spreads — a default term premium and global expectations of government bond issuance — together with the three candidate idiosyncratic variables. Regression 2 in Table E details the regression results where the proxy variables for the default term premium and demand/supply imbalances are used instead of the principal component. The results indicate that both variables have statistically significant short-run and long-run effects on the term structure of international swap spreads. The US liquidity term premium is also significant and has the expected sign.

Table E
OLS regression of the term structure of dollar swap spreads between two and ten-year maturities (January 1997–May 2005)[a]

Variable	Regression 1 Coefficient (T-stat)	Regression 2 Coefficient[b] (T-stat)
D(principal component)	0.59***	
D(default term premium)		0.36***
D(PC of budget balance expectations)		0.50*
D(US liquidity term premium)	0.13***	0.24***
D(effective duration of MBS)	0.11	0.09
D(net foreign purchases)	-0.04	-0.06
MREC(-1)	-0.23***	-0.28***
R-squared	0.62	0.44

(a) Net foreign purchases of US Treasuries data only available until May 2005 at the time of this analysis.
Regression 1: MREC(-1) = $S_{it-1} - 0.37C_{t-1} - 0.01$ where C is the principal component.
Regression 2: MREC(-1) = $S_{it-1} - 0.51DTP_{t-1} - 0.29PCBE_{t-1} + 0.002$ where DTP is the default term premium and $PCBE$ is the principal component of budget balance expectations.
*** and * indicates significance at the 1% and 10% levels, respectively.
(b) The medium-run 'equilibrium' relationship was restricted to include only the default term premia and budget balance expectations. Alternative representations which allowed other variables to influence the medium-run level for the term structure of swap spreads were permitted by the data but this was the preferred specification.

The R-squared of the regressions in Table E suggests that the explanatory variables can account for a sizable part — between around 40% and 60% — of the variation in the term structure of dollar swap spreads. However, there could be other factors that have a significant effect on the term structure of dollar swap spreads. These factors are often difficult to quantify and may have only a temporary effect. For example, the swapping of corporate issuance at particular maturities may be associated with temporary changes in the term structure of swap spreads. Corporations often 'receive fixed' in swaps when hedging their fixed-rate issuance. An illustration of this is when higher-than-expected demand to 'receive fixed' from international telecoms companies contributed to the flattening of the term structure of dollar swap spreads in 2000 (Chart 10). Fixed-rate bond issuance in dollars by telecoms companies amounted to over $20 billion in the second and third quarter of 2000.[1] Many of these telecoms firms issued fixed-rate dollar bonds at long maturities to pay for licences for the Universal Mobile Telecommunication Systems (UMTS) in Europe. The market had reportedly anticipated such activity, but a greater-than-expected amount was then swapped into floating-rate liabilities in the dollar swap market.

(1) See the 'Markets and operations' section of the *Bank of England Quarterly Bulletin*, November 2000, page 324.

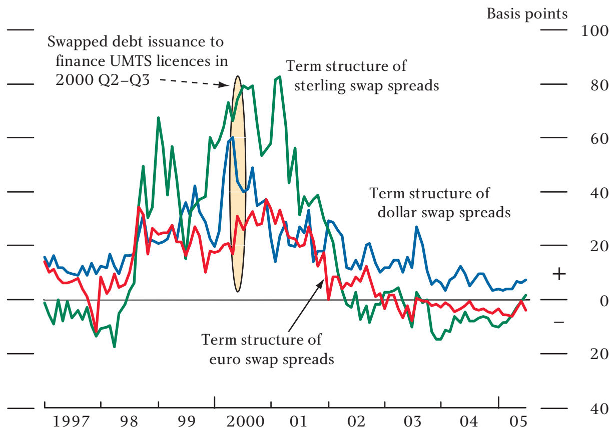
The same fixed-rate issuance by telecoms in the second and third quarters of 2000 had the opposite effect on the slope of both the euro and sterling term structure of swap spreads. The swapping of European telecom companies' dollar-denominated issues into euro and sterling led to an increase in the demand to 'pay fixed' in long-dated euro and sterling swaps in the second and third quarters of 2000. Since the increased demand was largely for long-maturity swaps, this in turn prompted the term structure of euro and sterling swap spreads to steepen (Chart 10).

Conclusion

There are few studies that have previously considered the possible determinants of the term structure of swap spreads. Understanding what affects the term structure of swap spreads may be helpful to policymakers in interpreting market perceptions of future interest rate developments, particularly during periods when market inefficiencies give rise to different signals about market expectations of the path of future interest rates extracted from both government bond and swap curves.

This article finds evidence of international co-movement in the two-to-ten year part of the term structure of swap spreads over the past decade. This co-movement could be associated with the existence of a default term premium that reflects changes in the perception of the risks of systemic failure of the banking sector embedded in the reference rates used to construct Libor. However, as well as compensation for the risk of default, the term premia in swap rates may reflect other influences

Chart 10
Term structure of dollar, euro and sterling swap spreads between two and ten-year maturities(a)



Source: JPMorgan Chase and Co.

(a) January 1997–July 2005 period.

associated with demand and supply for government bonds of different maturities which could be common for a number of international markets.

There may also be market-specific factors that influence the term structure of swap spreads. These may be related to market inefficiencies, associated perhaps with liquidity and preferred habitat issues that distort both the government bond and the swap curves. Concentrating on the US dollar market, this article finds evidence that both common and market-specific influences have had a significant statistical association with the term structure of dollar swap spreads over the past decade.

Annex
Statistical framework

Underlying model

The term structure of swap spreads is assumed to be characterised by a factor structure. That is, the term structure can be decomposed into two parts: a common part, driven by factors which are common to the four international markets, and an idiosyncratic part, which is country (market) specific. In turn, the idiosyncratic part can be decomposed into those market-specific effects that exert a systematic influence on the term structure and those effects that are temporary and discontinuous. More formally, the following static factor model is hypothesised:

$$S_{it} = \underbrace{\beta_i C_t}_{\substack{\text{Common} \\ \text{component}}} + \underbrace{\alpha_i IF_{it}}_{\substack{\text{Idiosyncratic} \\ \text{component}}} + \varepsilon_{it} \qquad \textbf{(1)}$$

where:

S_{it} refers to the term structure of swap spreads (which is approximated by the difference between the ten-year and two-year swap spreads); C_t is a set of r common influences on the term structure; IF_{it} are idiosyncratic factors that affect individual countries' swap and government bond curves which may be correlated both serially and across countries but are orthogonal to the common factors; and β_i and α_i are the sensitivity of the term structure of country i to the common and idiosyncratic influences respectively. ε_{it} are random influences that cannot be accounted for in the model.

Equation **(1)** can be thought of as capturing the persistent influences (medium-run trends) on the term structure of swap spreads. But it may take some time for the term structure to adjust to movements in the underlying drivers. To capture these dynamic effects, the following error-correction form is assumed:

$$D(S_{it}) = \beta_i D(C_t) + \alpha_i D(IF_{it}) - \lambda(S_{it-1} - \beta_i C_{t-1} - \alpha_i IF_{it-1}) + \zeta_{it} \qquad \textbf{(2)}$$

Equation **(2)** isolates the short-run and medium-run influences on the term structure of swap spreads. D represents change in the variable in the short term, such that $D(C_t) = C_t - C_{t-1}$. The λ parameter measures the speed at which the explanatory variables adjust to restore the 'equilibrium' relationship in the term structure of swap spreads over the sample period.

Estimation strategy

Instead of selecting candidate observable variables and undertaking some form of regression analysis for equations **(1)** and **(2)**, statistical data analysis was used first to determine the relative importance of common and idiosyncratic influences on the term structure. Specifically, principal component analysis (PCA) was used to extract the latent common factors for the series of two to ten-year term structures of swap spreads.

Once the common factors were derived, the influence of some candidate market-specific variables was explored by estimating equation **(2)** using regression analysis. Specifically, an error-correction model (ECM)(1) was estimated to help distinguish short-run from more persistent medium-run influences on the term structure of swap spreads. At this stage, it was also possible to examine the relative importance of the common and market-specific factors for the medium-run and short-run movements in the term structure of swap spreads.(2)

(1) See Fernandez-Corugedo, Price and Blake (2003) for an explanation and practical application of error-correction models.
(2) At least one cointegrating relationship was identified for the term structure of dollar swap spreads using Johansen's cointegration test. See Johansen (1995) for further details. Testing restrictions on the medium-run influences suggested the principal component as the key influence in the ECM. The medium-run influence of idiosyncratic factors was also tested but the results were less satisfactory.

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