Dániel Horváth, Péter Kálmán, Zalán Kocsis and Imre Ligeti: What factors influence the yield curve?*, [1]

The role of expectations and the term premium in the evolution of the yield curve

The shape and dynamics of the yield curve provide useful information in the analysis of current economic and financial developments, and market expectations. This article describes the key theoretical factors affecting the yield curve and examines their role in the developments in advanced and emerging markets seen in recent years. Our findings show that the common component of term premia and interest rate expectations of emerging countries co-move with corresponding factors observed in the United States. Of these two components, the term premium appears to be affected by global risk shocks. Concerns related to the Fed's tapering of its QE3 programme were reflected markedly in the term premia of emerging markets and, to some extent, even had an upward impact on rate expectations. In the Hungarian context, in addition to analysing co-movement with international factors, we focus on the potential of the yield curve in the monitoring of domestic base rate expectations.

INTRODUCTION

From a central bank and economic policy point of view, money market yields – as indicators of market expectations, risk perception and monetary conditions – are important sources of information. Accurate evaluation of the information extracted from the level, shape and dynamics of the yield curve broadens the information base of the economic policy maker, thereby contributing to sound decision-making.

According to the theoretical framework underlying this article, the market yield level comprises two factors: the expected baseline scenario and the term premium. In markets linked directly or indirectly to the central bank base rate, the expected yield level is usually closely tied to the reference rate. Thus, this component reflects the actual expectations about the central bank's interest rate policy. The term premium component of yields is composed of multiple factors, and experience shows that it increases with the length of maturity. In general, central bank measures only directly affect short-term yields, but since the 2007–2008 crisis a more effective shaping of longer sections on the yield curve has also become important for the central banks of certain developed countries. That, in turn, has put further emphasis on the need to analyse the factors affecting the yield curve. To be able to choose the tools most suitable for influencing yield levels, decision makers need to identify the factors bearing relevance under the given circumstances. The most important techniques used for this purpose by central banks in developed countries have included asset purchase programmes (*quantitative easing, QE*) and so-called forward looking messages (*forward guidance).* While quantitative easing can help bring down the term premium, forward guidance is more suitable for putting downward pressure on the expectation component.

The article first reviews the most important theoretical issues related to the yield curve and the role of the term premium, along with the relevant literature. This is followed by an analysis of trends observed in the United States, with particular attention to the impacts of recent measures taken by the Fed. Then, developments in emerging markets are assessed through an analysis of common drivers of emerging markets' yield components. These drivers are interpreted in relation with events in developed markets. The final section of our article provides a discussion of trends and developments in Hungary. On the one hand, we investigate the relationship between the country's term premium and the factors of both developed and emerging markets. On the other hand, we study how available

* The views expressed in this article are those of the author(s) and do not necessarily reflect the offical view ot the Magyar Nemzeti Bank.

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domestic sources of information can be used to infer base rate expectations.

THEORETICAL CONSIDERATIONS

In general, government securities and interbank market instruments represent investment opportunities over different maturities. Yields vary by the length of the term of the investment, and thus the yield curve (i.e. the rate of return in relation to maturity) is seldom horizontal.

One reason for this is that, on short-term investments, current yields typically differ from expected future yields, which, in turn, also causes current short and long-term yields to depart from each other. The expected yields on future short-term investments affect the yields on long-term investments, since – instead of a single long-term investment – market participants may also opt to continuously reinvest their funds in short-term instruments. If market participants expect short-term yields to increase in the future, the current longer-term yields will also be higher than the current short-term yield (in other words, the yield curve will rise).

If the shape of the yield curve is determined only by expectations – this is called 'expectations hypothesis' – forward rates calculated from the yield curve will correspond to the actually expected future yields. In this case, for instance, the forward rates calculated from government bond and interbank yield curves would directly indicate the future trajectory of the central bank base rate as expected by market participants.

Yield expectations can be affected by a variety of factors. Short-term yields are predominantly driven by the interest rate policy adopted by the central bank. Therefore, the relevant expectations are formed based on expected future trends in macroeconomic variables considered by the central bank (expected future inflation, expected changes in real economic variables) and the measures taken in response (central bank reaction function). For emerging currencies, exchange rate risk may be another important determinant of short-term yields, along with the sovereign default risk, which is factored into the prices of instruments denominated in the given country's currency.

However, besides future yield expectations, the shape of the yield curve may also be affected by a number of other factors, collectively referred to as the term premium. Where there is a term premium, forward rates do not match market expectations concerning the future central bank base rate. Most empirical research in recent decades has found positive term premia – i.e. market yield curves were above those derived from real yield expectations – and the rate of the premium varied across maturities and in time (Kane, 1981; Campbell and Schiller, 1991; Fama-Bliss, 1987; for a summary of the relevant body of literature, see Gürkaynak and Wright, 2012; for Hungarian data, see for example Gábriel and Pintér, 2006).

The term premium may comprise a number of factors. For the purposes of this article, **and taking into account the aspects of the analysis that is to follow, the term premium is broken down into two groups of factors (Chart 1). One represents the component linked to the uncertainty of yield expectations, which is separated from liquidity and structural factors.**

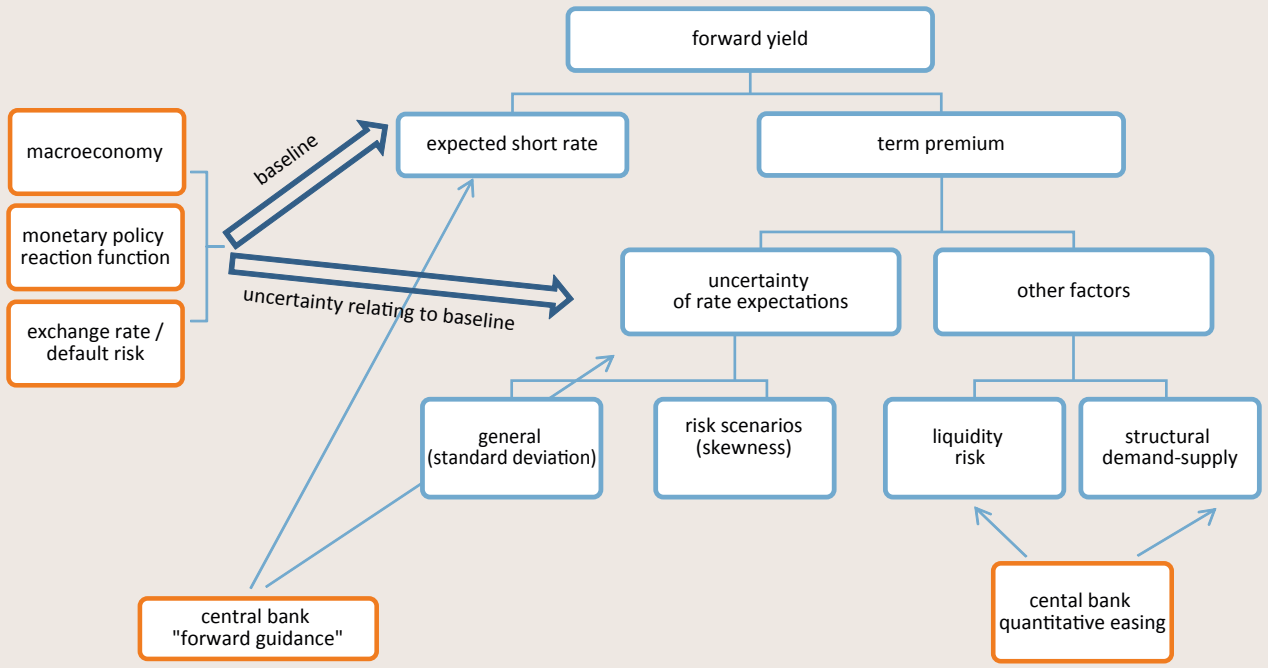
The uncertainty of yield expectations stems from the uncertainty of factors determining future yields. Accordingly, the term premium is affected by uncertainties relating to future trends in macroeconomic factors (such as inflation and real economic activity), uncertainties relating to the monetary policy reaction function and uncertainties relating to exchange rate and sovereign default risks. For example, Backus and Wright (2007) argue that the flattening of the yield curve (which Alan Greenspan called a 'conundrum') between 2004 and 2006 stemmed, for the most part, from an increasing predictability of the macroeconomic environment and monetary policy, through a decline in the term premium. Transparent communication and the increasingly popular forward guidance of central banks may, in addition to its direct influence on the expected yield, reduce the term premium by increasing the predictability of the central bank reaction function.

Besides the general uncertainty (standard deviation) of the expected yield path, another important driver of the term premium is the asymmetric impact of deviations from the expected value in terms of the utility of market participants. That is, a rise in yields may affect investor utility differently from the effects of a decrease in yield of equal magnitude. Such asymmetry in utility may, for instance, be a result of yield increases being related to incidence of a recession/crisis, when incurring a loss due to a yield increase comes at a particularly unfavourable time.

Clearly, in the case of interest rate swaps, for example, if it were not for this asymmetry, there would be no term premium stemming from the uncertainty of yields. In interest rate swaps – where participants take up symmetrical interest rate positions – short and long counterparties, respectively, would require equal compensation on account of upside and downside risks associated with the yields. Since these would necessitate a positive and a negative term premium at the same time, the actual forward yield would not deviate from the expected value.

If, however, in the case of an increase in yields, the relative increase in utility on the profitable (long) position would

Chart 1
A schematic illustration of the components of the forward rate



exceed the relative loss of utility in the case of a decrease in the yield, and then there would be a net utility advantage of the long position. For this expected utility advantage investors in long positions would pay compensation to the short counterparty in the form of a higher-than-expected fixed swap yield. Therefore, the correlation between yields and the incidence of crisis/recession will cause the term premium to be positive, with its rate rising parallel to the increase in yield uncertainty.

However, the term premium may also be a product of two other factors in addition to the uncertainties of yield expectations (Chart 1, other factors).

– One such factor is **liquidity risk**. Investors require liquidity premia on their long-term investments (liquidity preference theory), because they may happen to need cash during the maturity period and quickly selling their longer-term investments is bound to entail certain expenses. This may be the case when, as a consequence of a systemic shock, many investors find themselves in need of cash at the same time. For instance, the funding liquidity shortage witnessed during the 2007–2008 financial crisis caused such a systemic supply shock with regard to bonds of longer maturities in emerging markets.

– The term premium may also be affected by **structural factors of supply and demand.** If arbitrage is not or is only partly functioning across different maturities (for example because market participants have a preferred investment horizon from which they only depart under a strong price stimulus – preferred habitat theory), market supply and demand in the longer maturity segments may deflect yields from the expectations.

One of the most interesting such structural factor currently is the impact on yields of the asset purchase programmes of advanced central banks, for which estimates have been calculated by a number of authors (Gagnon et al., 2010; Krishnamurthy et al., 2011; Jarrow and Li, 2012). Quantitative easing on the part of central banks, however, may also impact other factors affecting yields. The liquidity effect is evident for instance in the case of the Fed, as the US central bank entered the market to create additional demand in the case of negative systemic shocks, which mitigated risks stemming from market illiquidity. The effectiveness of quantitative easing, however, depends on central bank credibility as well. In the absence of credibility, such a programme can drive expected inflation higher, along with expected yields, while also sending other components of the term premium on an upward course through the uncertainty of the macro path/central bank reaction function.

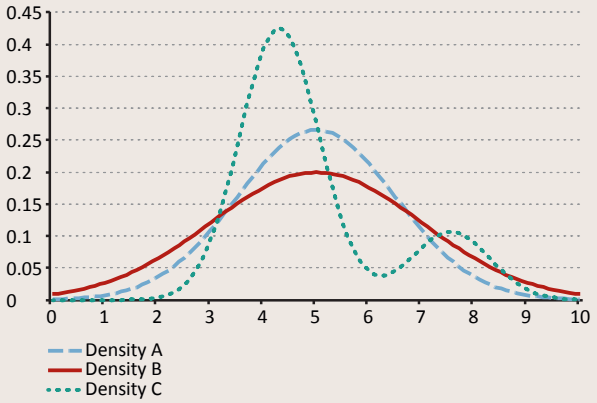
Box 1
Types of uncertainty: the standard deviation and asymmetry of the expected yield distribution

Uncertainty relating to yield expectations can come in a variety of forms. It may take the form of a period of higher volatility, during which future yields are generally less predictable. On the other hand, uncertainty may stem from the pricing of low-probability alternative risk scenarios (e.g. a return of the crisis). Such theoretical concepts are illustrated in Chart 2. For each of the three distributions featured, the hypothetical expected value equals 5 per cent, i.e. whichever distribution reflects the expectations of market participants, the expected yield will remain at 5 per cent. The standard deviation of distribution 'B' however, exceeds that of distribution 'A', which can be interpreted as an increase in general uncertainty regarding the expected yield. Risk averse investors would claim higher premia in the case of distribution 'B' than in that of distribution 'A'.

By contrast, while matching the standard deviation of distribution 'A', distribution 'C' is asymmetric: the expected yield distribution it illustrates is the sum of a probability distribution of mean 4.25 per cent (according to the baseline scenario) and another distribution with mean of 7.5 per cent (reflecting a risk scenario). The market may factor in a premium in this hypothetical case as well, owing to the existence of the risk scenario.

A brief mention should also be made of analysts' surveys as well, where analysts – in order to best predict eventually realised yields most of the time – may be assumed to report the most likely values of the expected distributions (their mode in the baseline scenario), which, for market expectations similar to distribution 'C', does not match the expected value. The forward rate priced in the case of 'C' in the above example would thus be higher than the 5 per cent average yield expected by the market (this is the term premium) and the difference would be even more substantial in comparison with the 4.5 per cent consensus of analyst forecasts.

Chart 2
Hypothetical density functions associated with different yield expectations



Methods for estimating the term premium

Over the past decades, financial economic research has elaborated a number of methods for separating forward rate components (expected yields and the term premium). This study draws on three main methodological approaches.

– **Arbitrage-free yield curve models.** This method assumes a factor model for changes in the yield curve over time, the parameters of which are estimated by using time series and cross section data (yield curve points) of the yields. It has the advantage that the yield curve is well fitted by just a few factors, but it has the drawback that short-term yield forecasts estimated based on a short time sample usually change very little through the forecast horizon (i.e. the model provides forecasts very similar to the current short-term yield, whether on a one- or ten-year horizon), which often contradicts analysts' estimates and economic considerations. For longer time samples, however, the performance of such models deteriorates due to the possibility of structural breaks and potential specification errors (see for example Kim and Orphanides, 2005; Wright, 2011).

– **Direct comparison of forward rates to realised yields.** Comparing forward rates to subsequent actual yields is a simpler method which may reveal systemic errors in the forecasts of forward rates, which may be interpreted directly as the term premium. While this method is model-free, it also has the disadvantage that the choice of the sample has a significant impact on the outcome: an overly short sample may lead to a less reliable estimate owing to small sample bias, while an overly long sample may do so on account of structural breaks. Another drawback of this method is that it is more backward-looking in nature, and is therefore less

suitable for analysing current developments or producing forecasts. Further implicit assumptions of the method are rational expectations and constant premia relating to each tenor.

– **Use of analysts' surveys.** Expected future yields may be approximated by analysts' forecasts, in which case the term premium equals the difference between the forward rate and the forecasts. The advantages of this method include that it provides a more robust model-free estimate for expected short-term yields and that it is free of the majority of the problems of sample selection. The use of analysts' surveys also has its disadvantages: surveys may include measurement errors; also of relevance may be the different information sets based on which analysts produce their forecasts (different analysts produce their forecasts at different points in time). The difference between the mode and expected value of the distribution of the yield expectation may be an important factor in some cases, when the expectational distribution is asymmetric (see also Box).

EXPERIENCES OF DEVELOPED MARKETS

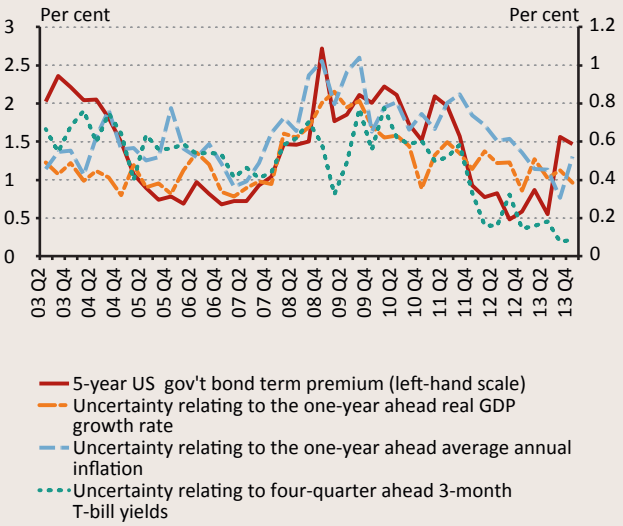
The following section shows proxies for term premium components identified in the theoretical framework, based on examples from the US government securities market. This is the most frequently studied market in the literature on term premia and it also offers the advantage of having a strong structural supply and demand element in the yield curve (as a consequence of the central bank's asset purchase programme).

Decomposing the term premia would go beyond the scope of this study; therefore, only the main trends are discussed here with a focus on the period following the peak of the financial crisis. The main objective of the large-scale asset purchase programme launched by the Fed during this period was to reduce longer-term fixed income market yields mostly through the decline in term premia elements. Since term premia accrue most notably over longer terms, the impacts of term premium drivers are illustrated on the five-year maturity. The term premium variable used in the following analysis is based on an arbitrage-free yield curve model.[2]

The uncertainty of the macroeconomic and the monetary policy environment also affects the general uncertainty of yield expectations. For compensation, investors typically require extra yields on their longer-term investments. A widely applied approach for proxying forward-looking macroeconomic uncertainty is the use of survey information (Chun, 2011; Dick et al., 2013; Wright, 2011). Most of the studies have found a significant relationship between term premia and survey-based uncertainty factors.

The above mentioned uncertainty proxies are constructed as the standard deviation of individual expectations on annual inflation and real GDP growth rates expected over the next year, and as the standard deviation of individual expectations on the 3-month Treasury bill yield 4 quarters ahead. Source of survey data is the Survey of Professional Forecasters.[3] **Chart 3 demonstrates that the uncertainty relating to the expected developments in the real economic and monetary policy environment correlates with the five-year term premia in the US government securities market.** This co-movement is even more apparent in the period following the collapse of Lehman Brothers. This can be explained by the term premia and real economic variables monitored by the central bank becoming even more synchronised, due to large-scale asset purchase programmes. This co-movement was further strengthened by state-dependent forward guidance. **When news is published on the real economy which makes estimation of future fundamentals more difficult, this entails an increase in the term premium. A similar impact is noticeable when the central bank's likely responses to**

Chart 3
Forward-looking uncertainty in the US macro environment and developments in the 5-year term premia



Source: Survey of Professional Forecasters, authors' calculations.

[2] The model used is based on Adrian et al. (2013).
[3] In the SPF survey (Survey of Professional Forecaster) managed by the Federal Reserve Bank of Philadelphia, analysts provide estimates for a wide range of US macro and financial variables on a quarterly frequency.

information on the economy become more difficult to predict. Forward guidance – by affecting the baseline scenario – is aimed at improving this predictability. For this reason, communication relating to both the policy rate and the asset purchase programme plays a substantial role in influencing the term premium.

The asset purchase programmes (QE1, QE2, QE3) initiated by the Fed at various times belong to the structural supply and demand category of term premium components. Numerous empirical studies have investigated the impact of quantitative easing on term premia[4]. Event study-type analyses have examined price changes in US Treasuries during a short time window around important statements and news concerning the QE programmes. The weakness of this approach is the choice of the window-length: it should be long enough to include all the information relevant for pricing, but it should be short enough to exclude noise. The advantage of model-based methods is that these grasp the full information process. In this case, the main difficulty is the choice of the appropriate explanatory variables.

Depending on the method used, studies have shown that the first programme (QE1) reduced the yield on the 10-year Treasury by between 40 and 110 basis points, while the QE2 programme had an estimated effect of 15-45 basis points.

Comprehensive studies on the impact of the third round of quantitative easing have not emerged yet, but the increase in yields on long-term Treasury securities experienced in May 2013 attracted the attention of market analysts. Official communication on the possibility of reducing quantitative easing resulted in an increase in term premia and the expected interest rate path which contributed to the rise of US yields. As regards the US government bond market, liquidity risk is difficult to interpret since, given the role of US government bonds as safe haven assets (*flight to quality*), the liquidity of these instruments is less prone to being impaired by the increase in the general stress in financial markets.[5] Apart from the most turbulent periods of the crisis in 2008, the liquidity risk factor is not usually among the relevant term premium elements.

EXPERIENCES OF EMERGING MARKETS

In contrast to the large number of empirical analyses of US data, there is practically no literature on emerging market experiences. This is probably a result of the lack of suitably long and homogeneous time series which would be required for yield curve models. In our case, the problem can be bypassed with model-free and sample-independent analyst surveys and with principal component analysis, thereby analysing the relation between emerging market yields and trends in developed and the domestic market. Median values of analysts' forecasts are regarded below as the expected short-term yield, while the points making up the forward rate curve grasp the sum of the yield expectations and the term premium. Given the limitations of the analysts' forecast horizon, however, this method only allows for analyses of the short-term segments of the yield curve.

To interpret the trends in emerging market yield expectations, developments in monthly data for 15 countries[6] were analysed for the period between 2009 and 2013. Owing to differences in the data available for various countries, the term premium levels calculated for various countries are not directly comparable.[7] Nevertheless, the co-movement of term premium indicators can still be interpreted, since the general rise of the term premium in emerging countries is likely to drive the indicators (whether for swap or government securities markets calculated for the three, one-month yields or the base rate) similarly upwards, even if at different rates.

The principal components of the time series were taken into account to analyse common factors in the emerging countries. Thus, the first principal component of the analysts' short-term yield forecasts and the first principal component of the term premia were extracted from respective datasets. Using principal components is also consistent with viewing available country indicators as noisy observations of the global – or general emerging market – factors. The first principal components explain 30–50 per cent of the total variance, showing that there was material correlation between the indicators. However, the country-specific factors were also significant – partly on account of different yield drivers, partly

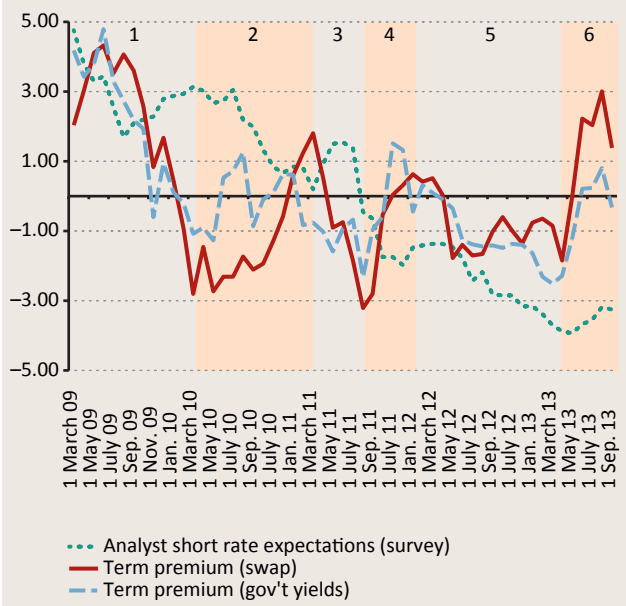
[4] Gagnon et al. (2011); Hamilton and Wu (2012); Krishnamurthy et al. (2011); Li and Wei (2012); Meaning and Zhu (2011); Wright (2012).

[5] In the literature, the liquidity premium in the case of US government securities is typically captured as the difference between the yields on currently issued *(on the run)* and earlier issued *(off the run)* bonds. The spread has been a few basis points on the 10-year term in the past 10 years.

[6] Hungary, Poland, the Czech Republic, Turkey, Israel, South Africa, the Philippines, Singapore, Thailand, India, Indonesia, Mexico, Columbia, South Korea and Russia.

[7] In general, 1-month swap and 3-month government bond yields in one year's time were used. In the absence of these, yields on different maturities, forward interest rate agreements or one-day indexed swap yields were used. Analysts' forecasts were also available for different short-term yields, forward rates for various horizons and for different money market instruments.

Chart 4
Principal components of analysts' yield expectations and swap and government securities market term premia in emerging countries
(2009–2013)



Note: Developments and main turning points of emerging market yield expectations and term premium time series: Period 1: easing of the first phase of the financial crisis; Period 2: first escalation of European debt concerns; Period 3: easing of the debt crisis and launch of the Fed's QE2 programme; Period 4: European debt crisis in focus again, USA loses its "AAA" status, closure of QE2 programme; Period 5: general consolidation and correction of risk pricing due to ECB's commitment; Period 6: Bernanke's address on the possible reduction in the pace of the Fed's QE3 asset purchases.
Source: Bloomberg, Thomson Reuters, authors' calculations.

as a consequence of the differences between the indicators used, and partly as a result of the characteristics of the analysts' forecasts. A number of clearly separable periods can be distinguished in the observed time horizon, associated mainly with market-moving events.

Major events of global importance significantly affected yields in emerging countries between 2009 and 2013. It was primarily the term premium components of those yields (in both the government securities and the inter-bank market) which reacted significantly to these events. The markets primarily focused on the waves of the euro-area debt crisis, the Federal Reserve's quantitative easing programmes and its commitment to a steadily low base rate, the downgrading of the US debt rating and a key announcement of the ECB governor (on potential bond market intervention).

Bernanke's speech in May 2013 on the possible tapering of US central bank's asset purchase programme triggered a massive increase in emerging market yields, risk aversion and capital outflows from the emerging markets. The term premium component responded markedly again (to an extent comparable to that observed during the euro-area debt crisis), while analysts' rate expectations increased less sharply in comparison to their historical developments. In general, it could also be said that the **principal component of analyst expectations was characterised by a gradual downward trend and that it responded less spectacularly to global risk shocks.**

Relationship with US yield components

The co-movement between the above-mentioned emerging market yield components and their US counterparts[8] is illustrated in Chart 5.

The yield components of emerging countries (interest rate expectations and term premium) showed a marked correlation with the respective US yield components. The rise in US term premium coincided, in general, with a rise in term premia in emerging markets as well, though in many cases with a certain delay, and the US indicator was clearly more noisy than the emerging market indicator. This is partly a consequence of the applied method, since the principal component eliminates country-specific noise from the emerging market time series. A close correlation was also found between the developments of interest rate expectations in emerging markets and in the US. The correlation was weaker in recent years due to the fact that the US base rate has reached the zero-lower bound. Consequently, the forward looking US three-month LIBOR expectations were also stuck below 0.5 per cent, while the downward trend continued in the emerging regions up to May 2013, which was followed by a slight increase.

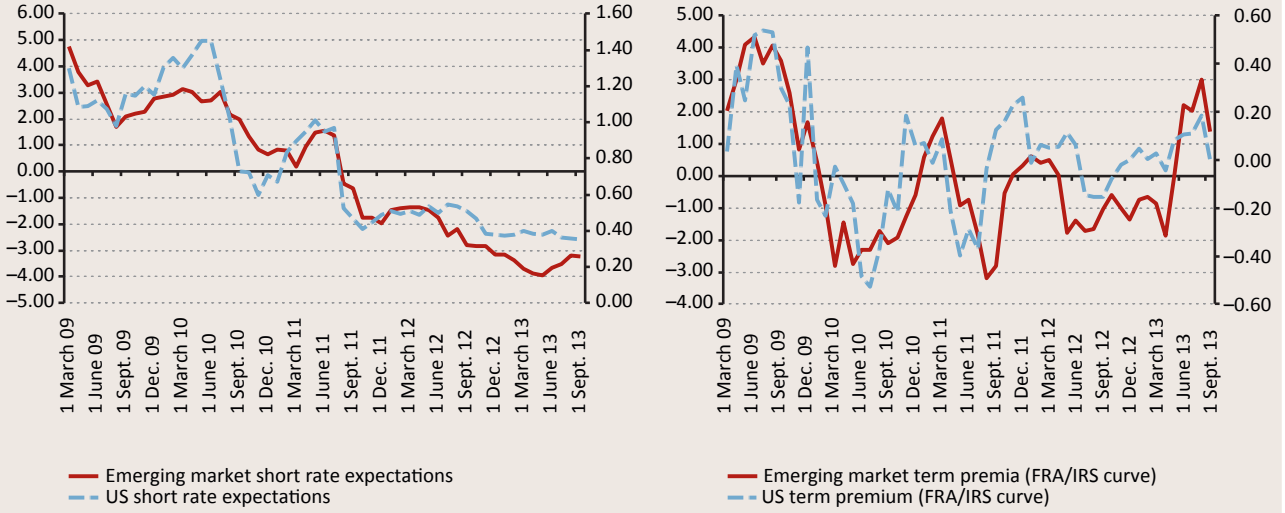
EXPERIENCES IN HUNGARY

Relationship between the domestic risk premium and international factors

Domestic financial and economic trends may be understood more thoroughly using estimates on the extent to which domestic yields were affected by rate expectations and by the term premium. A comparison of the developments observed in the domestic market to those in the international emerging markets also provides important information for economic policy decision makers, with which they can separate country-specific and international shocks.

[8] The US yield components were calculated based on 3-month USD LIBOR forecasts for the 1-year horizon and the corresponding interbank forward rates.

Chart 5
Trends in US and emerging market yield components, 2009–2013

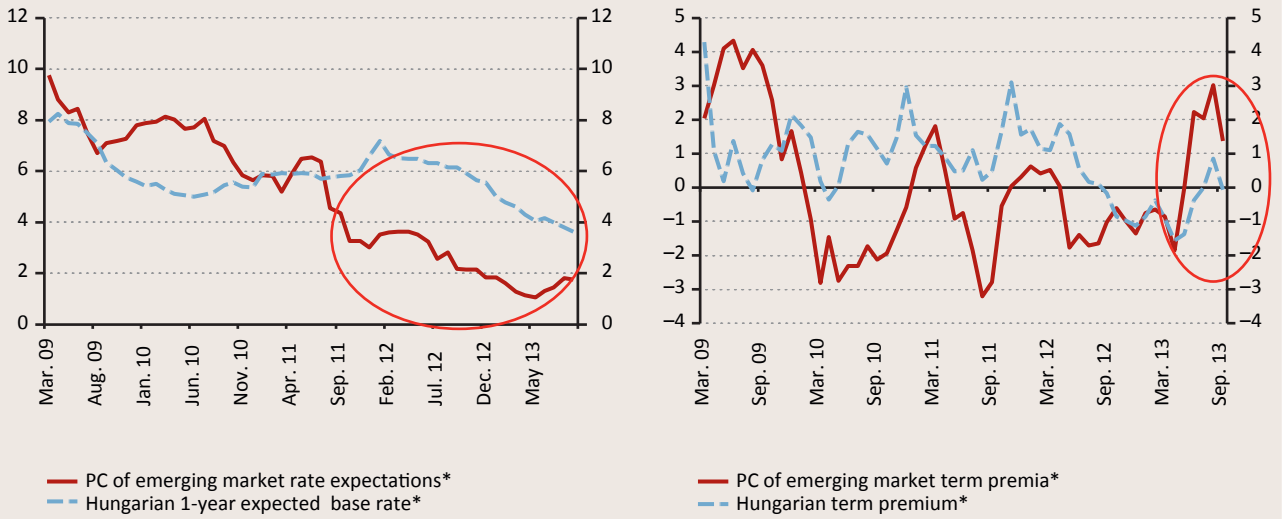


Note: The emerging market term premium is the first principal component of the emerging market one-year term premium series calculated from their inter-bank yields. This may be regarded as the basic trend of the term premia of the emerging region. The emerging market rate expectations time series is the first principal component of analysts' interest rate expectations, which reflects the general shifts in emerging market rate expectations. The sample average and the sample variance of the emerging market time series was normalised to the respective US time series.
Source: Bloomberg, Thomson Reuters, authors' calculations.

If one sees a strong link between the risk premium component of domestic yields and international factors, then developments are not likely to be driven by country-specific risk events, and thus domestic decision makers may only have limited ability to affect yields. In the opposite case, it may be worth identifying the factors that explain deviations from international trends. Regarding interest rate expectations, the relationship between international and domestic trends can be similarly analysed. It should also be noted that correlation does not necessarily reflect a causal relationship, and therefore the underlying money market drivers always need to be identified when analysing particular events.

Regarding Hungarian experiences (Chart 6) in general, we can say that yield components in the Hungarian market co-moved relatively closely in certain periods with the corresponding

Chart 6
One-year interest rate expectations and term premium in emerging markets and Hungary



**The common factor (principal component) is a quantity without a unit of measurement. To enable comparability to domestic indicators and for illustration purposes the values are adjusted to a common scale. Consequently, it is the dynamics that are comparable and not the levels of indicators. The domestic yield components were separated on the basis of Reuters analyst surveys.*
Source: Bloomberg, Thomson Reuters, authors' calculations.

international factors, while at other times the correlation was not so large. With respect to rate expectations, in 2010 and 2011 the expected level of interest rates seems to have been affected primarily by country-specific factors. Since March 2012 interest rate expectations have been more in line with the general emerging market trend, though domestic factors may also have played a role.

Some co-movement – albeit of varying intensity – can be identified since 2011 between domestic and international term premia. Chart 6 shows that the relationship was particularly strong after the spring of 2013 when Fed decision makers first mentioned the possibility of gradually phasing out asset purchases. At that point **an intensive increase in yields started along with a general outflow of capital from emerging markets. As indicated on the right and left panels of the chart, this yield increase in the emerging markets was related to an increase in interest rate expectations and in the term premium as well. Yields in Hungary appear to have been affected mostly through a rise in the term premium.**

Monitoring interest rate expectations in Hungary

For central banks, analysis of the short segment of the yield curve and the assessment of the size of the term premium are important primarily for inferring interest rate expectations from market pricing. In this section, we analyse how market participants' expectations can be assessed based on available domestic sources of information.

In Hungary, there are three main sources of information from which conclusions can be drawn concerning interest rate expectations: yields of government securities, interbank yields (forward rate agreements [FRA] and interest rate swaps [IRS]) and analysts' surveys. We have seen that the forward rates of government securities and interbank market yields may contain a term premium component in addition to actual interest rate expectations. As mentioned, this premium can be identified using a variety of methods. For our purposes, here, we chose the most direct method: the forward rates are compared to the interest rates that actually materialised later on. If a systematic bias of the forward rates' prediction can be identified, this forecast error may be interpreted as an estimate of the term premium.

The 10-year period between January 2004 and December 2013 was chosen as the sample, since reliable data on interbank FRA rates have been available since 2004.

Chart 7 shows that the **term premium was positive on average and it was increasing with maturity both in the case of the government securities and the FRA market.** However, it should be noted that the calculated premium varied in a wide range (illustrated by the 1 standard deviation bands), i.e. the values calculated based on different periods may differ significantly from one another. It is also worth noting that **in the case of FRA yields the average premium was only half as large and at shorter maturities it was close to zero.** Our results are in line with the conclusions of Gábriel and Pintér (2006), which found similar (somewhat larger) systematic bias in the case of the government securities yield curve (FRA yields were analysed) based on an earlier period (2001–2006).

In assessing the predictive power of the three alternative methods (government bond forward rates, FRA yields,

Chart 7
Average term premium in the government securities market (left panel) and in the FRA market (right panel)

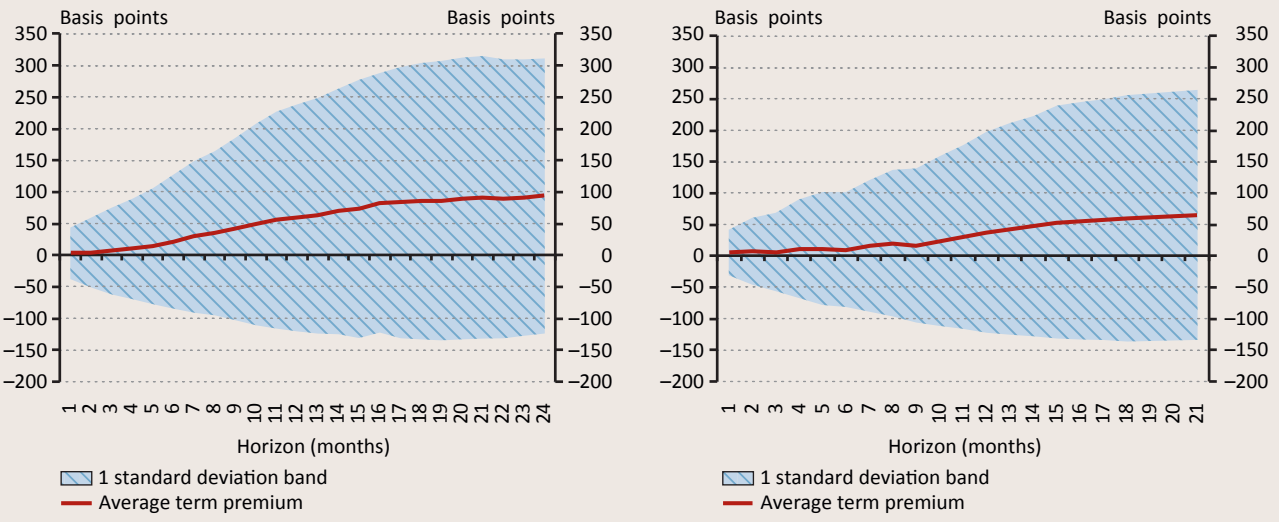


Table 1
Results of the Diebold–Mariano forecasting test in the different maturity segments

1-6 months	Random walk	FRA	Gov't
Survey	–3.49*	0.53	–1.86*
Gov't	–7.15*	1.28	
FRA	–9.47*		
7–12 months	**Random walk**	**FRA**	**Gov't**
Survey	–2.75*	1.07	–2.34*
Gov't	–0.91	3.03*	
FRA	–2.63*		
13–18 months	**Random walk**	**FRA**	**Gov't**
Survey	–1.96*	–0.47	–1.94*
Gov't	–2.25*	2.19*	
FRA	–2.52*		
19–24 months	**Random walk**	**FRA**	**Gov't**
Survey	–3.54*	–0.48	–1.56
Gov't	0.34	4.35*	
FRA	–1.82*		

**The values indicate results significant at a 5 per cent significance level. Negative values indicate a greater predictive power of the method in the row heading, while positive values indicate a greater predictive power of the method in the column heading.*

analysts' survey) we used the Diebold–Mariano test (DM) introduced by Diebold and Mariano (1995).[9] This test aims at examining whether either one of a pair of forecasting methods is significantly more accurate than the other. The two-year forecasting horizon under review was divided into four six-month sub-horizons and the methods were tested in these segments.

As a first step, each of the three methods was tested against the *random walk* assumption. This way we could assess whether the given method had a significant forecasting ability at all. Our results show that the interest rate paths estimated based on analysts' surveys and FRAs had significant predictive power for all maturity segments. In the case of government bond yields, the forecasting ability was significant only in the six-month and the 18-month segments out of the four horizons.

After testing the three alternative forecasting methods against each other, no statistically significant difference was found between the forecasting accuracy of FRA yields and analysts' estimates at any time horizons. By contrast, interest rate expectations derived from yields on government securities proved to be less reliable forecasts than the other two alternatives, in three out of the four forecasting horizons.

In theory, the weaker performance of government yields may primarily be a consequence of higher liquidity risk in this market. Interbank transactions (FRAs, IRSs) have significantly lower liquidity requirements since, in the case of such transactions, the principal amount is not transferred between the parties. Moreover, government securities markets are less exposed to short selling, and therefore nearly all investors bear interest rate risks of the same direction (in that a yield increase results in losses) which may more easily lead to a systemic liquidity shock. In the case of the above-mentioned interbank transactions, however, positions are symmetric. Thus, when market yields change some market participants suffer a loss, but others obtain a profit. As a consequence, at a systemic level, the liquidity need does not change as dramatically. Accordingly, the government securities market has experienced more turbulences in recent years than the interbank market, and yields on government securities have been more volatile than interbank yields even during calmer periods. Chart 7 shows that the term premium varied in a higher and wider range than in the interbank market. A more detailed analysis also demonstrates that the 2008–2009 crisis and the partial dry-up of the government securities market also contributed to the poorer forecasting potential of government bond yields.

It can be concluded that, in view of experience accumulated over the past ten years, **FRA yields and the interest rate expectations identified by the Reuters survey have significant forecasting ability regarding the central bank base rate**. By contrast, the forecasting ability of **government bond yields is more uncertain** and it was found to be typically weaker

[9] The Diebold–Mariano test compares forecasting errors of two different methods. It tests the average of the difference between the forecasting errors, taking the overlap between the forecasting periods (errors are autocorrelated) into account.

Box 2
Identification of interest rate expectations in practice

Although the predictive power of analysts' surveys does not materially differ from that of FRA yields, it is worth discussing the special individual characteristics of the two different forecasts in order to be able to exactly map interest rate expectations. FRA yields are, theoretically, comprised of two elements: the expected average interest rate path and the term premium. If therefore there is an estimated term premium, subtracting it from the FRA yields provides the true average interest rate expectations. On the other hand, it is difficult to work out a dynamic estimate of the term premium and thus in practice this is usually not a feasible approach. Since the average term premium is lower at shorter maturities, unadjusted FRA yields may also prove to be a suitable tool in forecasting short-term yields, as has been confirmed by the results of the forecast tests. However, it is important to note, that in certain cases term premium can distort short yields considerably.

There are two additional factors that should be taken into account when gauging short-term interest rate expectations from FRA yields. Only expectations concerning the three-month interbank rate (BUBOR) are reflected directly by FRA yields. However, in recent years the BUBOR has been closely connected to the base rate – or it deviated by a nearly constant value. Therefore, it is possible to infer the expected change in the interest rate from the difference between FRA and BUBOR rates (rather than from the difference between FRA rates and the base rate). **Based on empirical experience the short-term interest rate expectations derived from FRA yields should be adjusted by the nearly constant difference between the BUBOR and the base rate.** It should also be noted that interest rate expectations are calculated on the basis of three-month yields, which should be converted to the – two-week – maturity of the base rate to produce a more accurate estimate. We did not make these two adjustments in our analysis, although experience shows that taking this into account adds to the forecasting ability of forward rate agreements.

On the other hand, instead of the expected average, it is the most likely interest rate outcome (the mode of the expected probability distribution) that appears in analysts' surveys (for more details, see Gábriel–Pintér, 2006). Therefore, in the case of asymmetric expectations (when the mode departs from the expected value) analysts' surveys are, on average, biased. This typically occurs when the probability of alternative scenarios increases in some direction around the expected baseline scenario. Examples may include an increase in the risks of exchange rate appreciation or depreciation, or the possibility of a higher- or lower-than-expected inflation path. The difference between FRA yields and analysts' estimates may therefore increase for two – interrelated – reasons: owing to an increase in the asymmetry of the expectational distribution or owing to an increase in the term premium. Therefore, when the methods outline different interest rate paths, this also informs about expectational asymmetries and the degree of risks.

than the other two alternative methods, **partly due to higher liquidity risk and partly due to anomalies observed during crisis periods.**

SUMMARY

From a central bank and economic policy perspective, financial market yields are important sources of information. The observed yield level is comprised of two factors: the component resulting from baseline expectations of future yields and a term premium component. The latter may be made up of a variety of factors, including the uncertainty of future expected yields, as well as structural and liquidity factors.

Based on the US government securities market, empirical studies have typically found a significant relationship between the term premium and the uncertainty of the macro environment and – consequently – yield expectations. Moreover, effects of structural factors can also be identified in relation to the quantitative easing programmes of the central bank. Such relationships are confirmed by the co-movement between the variables monitored in this study.

Emerging market experiences have not been extensively analysed so far, partly as a result of the absence of the data required for usual techniques. In this article, we have identified common rate expectation and term premium factors of emerging market yields via principal component analysis. Our findings show that the emerging market term premium component responded more strongly to global risk shocks than the interest rate expectation component. The general yield increase observed in emerging markets in mid-2013 was also more closely related to the increase in the term premium. Furthermore, a close co-movement was found between respective emerging market and US yield components.

Interest rate expectations and the term premium in Hungary co-moved with the respective yield components of emerging markets in some periods, while in others there was no such

correlation. The Fed's announcement in May 2013 concerning the tapering of its quantitative easing programme appears to have affected yields in Hungary primarily via the increase in the term premium.

Our results show, that the Hungarian term premium was positive on average and was increasing with maturity, in accordance with the relevant theory. Based on experience accumulated during the past ten years, interbank (FRA) yields and the interest rate expectations in analysts' surveys have significant forecasting ability regarding the central bank base rate. By contrast, yields in the market of government securities did not provide such a reliable tool for prediction.

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