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Forecasting long-term interest rates

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Summary

The long-term interest rate in the Euro area is an important exogenous input in CPB macro-econometric models to project the world economy and the Dutch economy, so it is important to have a reliable projection for it. However, there were concerns about the CPB practice of forecasting the long-term interest rate, especially over the inconsistency of long-term interest rate projections in the short and medium term. Therefore, this document compares the old CPB practice with several alternative forecasting methods for long-term interest rates, and evaluates these methods on the basis of three criteria: (1) forecasting accuracy, (2) internal consistency between short term and medium term, and (3) internal consistency between forecasting short and long-term interest rates. Alternative forecasting methodologies include: the random walk, the term structure, the forward interest swap rates, and two univariate methods (AR(1) and AR(2)). Additionally, we also construct forecasts based on different combinations of the afore-mentioned methods.

Our empirical analyses show that the random walk always performs the best in terms of forecasting accuracy, whereas the forward swap rates have the highest forecasting accuracy except for statistical models (random walk and both AR models). The results are robust in the post-break period and in the presence of the forecast combination. However, we don't choose the random walk to project long-term interest rates, because random walk projection tends to lead to an inverted yield curve without any economic background. For the old CPB practice, it does not satisfy evaluation criteria (2) and (3), and it provides lower forecasting accuracy than the forward swap rates.

The forward swap rate is a good predictor that meets all criteria. Compared to the other methods this method has several advantages: first, it is consistent for short term and medium term periods; second, both the short-term and long-term forecasts are based on market information; third, it provides higher forecast accuracy than the old CPB practice; finally, the choice of the swap rate is consistent with the current practice of the European Commission to project the long-term rate. Therefore, starting in CEP 2018 we adopt the forward swap rate to project long-term interest rates.

1 Introduction

CPB uses long-term interest rate in the Euro area as an important exogenous input in macro-econometric models to project the world economy and the Dutch economy. Therefore, it is critical to have reliable projections of the long-term interest rate.

Recently, the CPB practice projected the long-term interest rate for the short term (one and two years ahead) as a random walk, and for the medium term (three to five years ahead) as the sum of the projected short-term rate¹ and a predeterminded spread. This practice has two problems: first, the projection is not internally consistent between the short and medium term. In the transition from two to three years ahead, the predicted long-term rate will experience a jump, which is purely due to technical construction instead of the real economic events. This becomes more problematic, as the CPB updates the medium term forecast annually at the request of the government. Second, the forecasting performance of the CPB practice was not better than the projections based on market information.

To improve the current forecasting practice, this document compares the old CPB practice with alternative methods to forecast the German 10-year government bond yield from one to five years ahead, and examines which method is preferable. Similar analyses have been conducted in Lukkezen et al. (2015), but we have several updates: first, Lukkezen et al. (2015) evaluate the forecasting methods based on a random walk, the term structure and forward swap rates², and we compare them with two more forecasting methods: the old CPB practice of the medium-term forecast and autoregressive models; second, Lukkezen et al. (2015) only compare their forecasting performance for one and two years ahead, while the forecasting horizon in our document is from one year to five years ahead; third, the data in our document is extended to 30 Nov 2017.

We evaluate the projection methods based on three criteria: 1) good forecasting performance; 2) internal consistency between short term and medium term; 3) internal consistency between forecasting short and long-term interest rates. Our empirical analyses show that the forecasting method based on forward swap rates strikes a good balance between all the criteria.

This background document is arranged as follows: section 2 provides an overview of the international common practices, section 3 describes different forecasting methods, section 4 presents the data, section 5 presents results from the baseline empirical analyses and robustness checks, section 6 evaluates forecasting methods on

¹ The short term rate for the short term and the medium term was based on Euribor futures.

² An interest swap is a contract where a variable interest rate is exchanged for a fixed rate. The swap rate is the fixed interest rate in this agreement.

different criteria and describes our choice, section 7 applies some forecasting methods in our study to the CEP2018 projection for the period 2018-2022, and section 8 concludes.

2 An overview of international common practice

Forecasts of the long-term interest rates from international institutes, like OECD, IMF, ECB and the European Commission, are based on different methodologies.³ The OECD, in its most recent twice yearly Economic Outlook (OECD, 2017), provides a flat forecast of the long-term rate for the euro area until mid-2018 and a slight increase thereafter. The forecast is based on the assumption that 'the ECB will gradually taper asset purchases in 2018'. In earlier versions of the Outlook the OECD used different methodologies for different countries. For example, in their May 2014 Outlook (OECD, 2014), the long-term interest rate for the United States and for Germany are assumed to converge slowly toward a reference rate (reached only well after the end of the projection period), determined by future projected short-term interest rates, a term premium and an additional fiscal premium.⁴ For other countries in the euro area an assumption is made about the spread vis-à-vis Germany.

The ECB uses current market data (the par yield curve) to make a forecast for longterm rates. The ECB euro area 10-year nominal bond yield is a weighted average of countries' 10-year yields, weighted by annual GDP figures. The forward path of the long-term rate is derived from the ECB's euro area all-bonds 10-year par yield (ECB, 2008, 2017), with the initial discrepancy between the two series kept constant over the projection horizon. In the same way, country specific rates can be derived from the euro area average.

The European Commission, in its twice yearly European Economic Forecast, also provides interest rate forecasts based on market information. According to European Economic Forecast (Autumn 2017), their assumptions for interest rates reflect market expectations at the time of the forecast. Long-term rates for the euro area are calculated using forward swap rates. These forward rates are corrected for the current spread between the yield of a 10-year government bond and the swap rate. To shield the assumptions from possible volatility during any given trading day,

³ In the World Economic Outlook of the IMF (IMF, 2017), IMF publishes a long term rate in its Outlook (the 'World Real Long-Term Interest Rate') based upon the rates for Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, without revealing details of forecasting methods.

⁴ The fiscal premium is assumed to be 2 basis points for each percentage point of the gross government debt-to-GDP ratio in excess of 75% and an additional two basis points (four basis points in total) for each percentage point of the debt ratio in excess of 125%.

averages from a 10-day reference period are used to calculate assumptions for shortterm and long-term interest rates.

3 Methodology

This section presents five forecasting methods used in this document, and describes how we evaluate the forecasting performances of these methods.

3.1 The old CPB practice

Currently CPB forecasts the long-term rate for three to five years ahead as the sum of the short-term rate and a predetermined spread. The short-term rate is derived from EURIBOR futures. The spread 5 years ahead of year t (t+5) is the 15-year average of the spread between long-term and short-term rates before t.⁵ The spread at t+2 is calculated as the difference between the random walk forecast of the long-term rate and the short-term rate based on Euribor futures. Then the spreads in years t+3 and t+4 is a smooth path towards the level of the spread in t+5.

We use MEV 2018 as an illustration. In MEV 2018, the short-term rate for the whole period (2017Q1-2021Q4) is derived from EURIBOR futures (2022Q1-2023Q4 is by assumption equal to 2021Q4, see above). For 2017Q3-2018Q4 the long term rate is based on the random walk assumption. For this period the spread is the difference between the two. For the period 2019Q1-2021Q4 the spread is given by the assumption about its level in 2021Q1 (the average of spread between 2002 to 2015) and a smooth path towards this 2021Q1 level from the level in 2018Q4 (2022Q1-2023Q4 is by assumption equal to 2021Q1). The long-term rate is the sum of the short-term rate and the spread.

3.2 The random walk

The simple random walk model is specified as:

$$R_{t+f} = R_t + \varepsilon$$

Where R_{t+f} represents the interest rate at the month t+f, where f stands for the forecast period. R_t is the interest rate at the month t and ε is the disturbance term. The expected value of R at the time t+f is equal to R_t :

$$E(R_{t+f}) = R_t$$

⁵ In this document we use 5 years instead of 15 years average of the spread between long-term and short-term rates to obtain more observations to compare.

3.3 Univariate forecast (AR (1), AR(2))

As first alternative to the benchmark model, we select AR(1) and AR(2) models. For example, Fauvel et al. (1999) find that ARIMA models are satisfactory and useful for interest rate forecasting. Stock & Watson (2004) also find that univariate forecast typically outperforms the forecasts using predicators.

The AR(1) model is specified as:

 $R_t = \varphi_1 R_{t-x} + c + \varepsilon_t$

And the AR(2) model is specified as:

 $R_t = \varphi_1 R_{t-x} + \varphi_2 R_{t-x-1} + c + \varepsilon_t$

where x represents the forecast horizon.

The pseudo out-of-sample forecast is performed with AR models. In particular, the entire sample is divided into two sub-periods: the period 18/04/1977 to 02/01/2004 is used for estimating the parameters, and the rest of the sample (02/01/2004 to 12/10/2017) is used for evaluation (i.e. for comparing the forecasting values with the true values). To see whether the parameters in the AR models are stable in our sample period, we also conduct Andrews test (1993) to detect any possible structural breaks in the series.

3.4 The term structure

The term structure of German government bonds are used to make projections for the long-term interest rates in the euro area.

$$R_{10,t+f}^{e} = \sqrt[10]{\frac{(R_{10+f,t}+1)^{10+f}}{(R_{f,t}+1)^{f}}} - 1$$

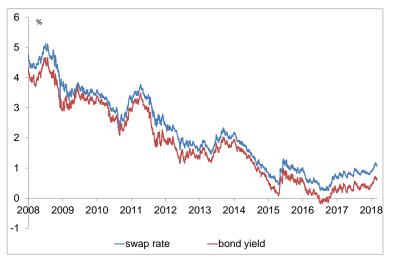
Where $R_{10,t+f}^e$ represents the Germany government bond with residual 10 years to maturity, forecasted *f* years ahead at time *t*. f (=1, 2, 3, 4, 5) refers to the forecasting horizon in years.

3.5 The forward swap rates

In an *interest swap*, two parties agree to exchange one stream of future interest payments for another, based on some principal amount. Usually, one of the streams is based on a floating interest rate (e.g. the LIBOR) and the other interest rate is fixed (the *swap rate*, to be negotiated). For the party that ends with the fixed interest rate, the swap is an insurance against future interest rate moves. The other party increases its exposure to fluctuations of the interest rate.

It is possible to delay the starting point of the swap for a number of months or years. This is called a *forward swap*. E.g. it is possible to swap interest payments for 10 years, starting 5 years from now. The *forward swap rate* in such a contract is a market forecast of what the 10-year interest rate would be 5 years from now.





The 10-year swap rate and the 10-year government bond yield are closely related (figure 3.1). In normal circumstances, the yield on government bonds (red line) is below the swap rate (blue line), reflecting the lower risks associated with government debt. The difference between the two is called the *swap spread*:

swap spread_t = 10-year swap rate $- R_{10,t}$

where $R_{10,t}$ is the yield of German government bonds with 10 residual years to maturity at time *t*.

The forward swap rates can be used to forecast future yields of government bonds. To project the yield on government bonds, we need to adjust the forward swap rates for the swap spread. We do so by subtracting the current swap spread from the forward swap rate (the European Commission applies the same method):

 $R_{10,t+f}^e = f$ -year forward swap rate – swap spread_t Where $R_{10,t+f}^e$ represents the yields of the Germans government bonds with residual 10 years to maturity, forecasted f years ahead at time t. f (=1, 2, 3, 4, 5) refers to the forecasting horizon in years. To smooth the volatility of the spread, we take a 5-day average of the current swap spread.

3.6 Evaluation

We calculate the mean absolute error for each forecasting method:

$$MAE = 1/n \sum_{t=1}^{t=n} |\widehat{y_t} - y_t|$$

We also evaluate the performance of a candidate forecasting method using its out-ofsample RMSFE:

$$RMSFE = \sqrt{\frac{\sum_{1}^{n} (\hat{y_t} - y_t)^2}{n}}$$

We test whether the improvement in forecasting accuracy is significant using Diebold-Mariano test (Diebold and Mariano, 1995).

4 Data

Table 4.1 Data

			-
Forecasting Methods	Data series	Time	Source
Forward swap rates	1 year to 5 years forward rate of the 10y EUR swap rate	2004:M1-2017:M10	Datastream
Term structure	structure Term structure of interest rates on listed Federal securities (method by Svensson) / daily data)		Bundesbank
Random walk	10Y German bonds rate	1977:M4-2017:M10	Datastream
AR(1), AR(2)			
Old CPB practice	10Y German bonds rate		
	3-month Euribor rates	1998:M1-2017:M10	Datastream
	Money market rates reported by Frankfurt banks / Three-month funds / Monthly average	1962 – 1998	Bundesbank
	Long term interest rates, total, % per annum	1962 – 1998	OECD

The evaluation period in our current comparison is from 02/01/2004 to 30/11/2017. This is consistent with the evaluation period for the AR models.⁶ The starting point is chosen due to the constraint of the swap rates, and the way of constructing the spread between long-term and short-term rates. To take into account the potential structural breaks, we also choose shorter evaluation periods for robustness checks. The choice of the evaluation period is discussed in more detail later.

⁶ As discussed above, for AR models, the entire sample is divided into two sub-periods: the period 18/04/1977 to 02/01/2004 is used for estimating the parameters, and the rest of the sample (02/01/2004 to 12/10/2017) is used for evaluation (i.e. for comparing the forecasted values with the true values).

5 Empirical analysis

5.1 Baseline

Tables 5.1 and 5.2 summarize the RMSFE's and MAE's from different methods, and Table 5.3 presents the statistics of the Diebold-Mariano test for the comparison of different forecasting errors 1 to 4 years ahead. The results indicate that: 1) the predictions from the random walk always perform the best; 2) no predictions based on market information (the swap rates and the term structure) or the old CPB practice can beat random walk and AR models; 3) the swap rates have higher prediction power than the term structure and the old CPB practice. While the old CPB practice has smaller RMSFE and MAE than the term structure, the D-M test shows no clear evidence that the old CPB practice significantly outperforms the term structure.

	1Y	2Y	3Y	4Y	5Y
RW	0,65	0,93	1,19	1,45	1,69
Term Structure	0,95	1,5	1,99	2,35	2,65
SWAPS	0,81	1,28	1,76	2,2	2,66
СРВ	0,65	0,93	2,08	2,66	N.A.
AR(1)	0,66	0,93	1,21	1,52	1,82
AR(2)	0,67	0,97	1,29	1,63	1,95

Table 5.1 Root mean square prediction error in percentage points (02/01/2004 - 30/11/2017)

Note: RW=random walk; SWAPS= the forward swap rates; CPB= the old CPB practice. The terms apply to all the other tables &figures.

Table 5.2 Mean absolute error in percentage points (02/01/2004 -30/11/2017)

	1Y	2Y	3Y	4Y	5Y
RW	0,52	0,78	1,04	1,24	1,44
Term Structure	0,77	1,34	1,8	2,16	2,45
SWAPS	0,64	1,11	1,58	2,04	2,52
СРВ	0,52	0,78	1,93	2,53	3,11
AR(1)	0,54	0,79	1,03	1,29	1,57
AR(2)	0,54	0,82	1,12	1,42	1,72

Table 5.3Diebold-Mariano	test
--------------------------	------

	TS	1 year ahe CPB	ead SWAP	AR(1)	AR(2)
	10	CFD	SWAF	AR(I)	AR(2)
СРВ					
SWAP	-1,9299				
AR(1)	-1,9779		-1,7218		
AR(2)	-1,9995		-1,7393	1,3121	
RW	-2,0351		-1,9357	-0,6146	-1,2541
	2,0001		.,	0,0110	.,_0
		2 years ah	ead		
CPB					
SWAP	-1,4088				
AR(1)	-1,5764		-1,3761		
AR(2)	-1,5694		-1,367	1,6326	
RW	-1,6172		-1,4442	-0,1401	-0,9311
		3 years ah	ead		
CPB	1,0049				
SWAP	-1,1961	-1,0115			
AR(1)	-1,33	-1,0107	-1,1795		
AR(2)	-1,3125	-1,0107	-1,1694	1,5239	
RW	-1,3921	-1,0107	-1,2204	-0,221	-1,0274
		4 years ah	ead		
СРВ	1,0112				
SWAP	-1,0694	-1,013			
AR(1)	-1,188	-1,0118	-1,1073		
AR(2)	-1,1578	-1,0118	-1,0924	1,4182	
RW	-1,2665	-1,0118	-1,1315	-0,6441	-1,2174
		5 years ah	ead		
СРВ					
SWAP	-1,0241				
AR(1)	-1,1698		-1,1129		
AR(2)	-1,1455		-1,1178	1,2873	
RW	-1,2352		-1,1063	-1,0623	-1,2715

Following common practice, to shield the assumptions from possible volatility during any given trading day, we also make projections with all the forecasting methods above with a moving average of 5-day and 10-day long-term interest rate, respectively. Their RMSFE's, MAE's and D-M test statistics are highly consistent with those in tables 5.1 and 5.2.⁷

⁷ The results are not included in the main text, but are available upon request.

5.2 Robustness checks

5.2.1 Potential structural breaks

The baseline empirical analyses are conducted from January 2004 to November 2017. However, this period witnessed the Great Financial Crisis, the Sovereign Debt Crisis, and subsequently many unconventional monetary policies by European Central Bank, so structural breaks may also occur in the long-term rate series. We would like to see whether the forecasting performances from different methods are stable in the presence of structural breaks.

Andrews test (1993) shows that potential structural breaks may occur at 77% of the long-term rate series.⁸ The potential break makes economic sense, as it is very close to the collapse of Lehman Brothers on 15 September, 2008, which initiated the Great Financial Crisis in the U.S., and then spread to the other regions in the world. Following most forecasting literature, we choose the post break period (the remaining 23% of the series) for estimation and evaluation. In particular, for the AR models, the estimation window is the 80% of the sample period 27/08/2008 to 30/11/2017, and the evaluation period is the remaining 20% of the sample (which is also the evaluation period for the other methods).

Tables 5.4 and .55 present RMSFE's and MAE's from different forecasting methods in the post-break evaluation period. Generally all the methods have smaller forecasting errors. This is because a shorter evaluation period entails less forecasting uncertainty. Except for this, the forecasting performances from different methods are highly consistent with the baseline: random walk still performs the best, and all the statistical models fit the series better than the other methods. Besides, the forward swap rates have higher prediction accuracy than term structure and the old CPB practice.

	1Y	2Y	3Y	4Y	5Y
RW	0,48	0,85	1,33	1,37	2,05
Term Structure	0,59	1,4	2,37	2,76	3,46
SWAPS	0,56	1,26	2,11	2,32	2,94
СРВ	0,48	0,85	2,23	2,7	
AR(1)	0,54	1,09	1,56	1,76	2,33
AR(2)	0,57	1,18	1,66	1,89	2,41

Table 5.4 Root mean square prediction error in percentage points (18/01/2016 - 30/11/2017)

⁸ The Andrews test also indicates another potential structural break at 90% of the series, but since it is too close to the end of the series, and the statistic does not reach the 10% significance critical value, we simply ignore it.

	1Y	2Y	3Y	4Y	5Y
RW	0,39	0,68	1,24	1,35	1,89
Term Structure	0,45	1,2	2,3	2,75	3,4
SWAPS	0,42	1,08	2,03	2,31	2,84
СРВ	0,39	0,68	2,19	2,68	3,52
AR(1)	0,42	0,93	1,52	1,74	2,26
AR(2)	0,45	1,04	1,62	1,87	2,35

Table 5.5 Mean absolute error in percentage points (18/01/2016 - 30/11/2017)

While a majority of literature uses only the post-break sample to estimate the parameters and make the forecasts, some literature argues that the pre-break sample may also contain some relevant information. Using the pre-break sample may sacrifice a bit consistency, but gain efficiency. So there is a consistency-efficiency trade-off in the window selection. There are at least two ways to deal with this trade-off: one is to average the forecast across different windows. By appropriately choosing the weight, we can make an explicit trade-off between consistency and efficiency; the second way is to select the optimal window by minimizing the MSFE which is a function of window.

It is beyond the scope of this document to analyse different methodologies of choosing the estimation and evaluation window in the presence of structural breaks. Nevertheless, some recent literature suggests that the breaks do not matter for forecasting. Boot and Pick (2017) propose a testing procedure to examine whether the break matters in forecasting. By applying this procedure to various datasets, they find that in most cases, the break does not matter for forecasting. Their finding suggests that we can simply ignore the breaks and use the whole sample to estimate and forecast.

5.2.2 Forecast combination

Initiated by Stock and Watson (2004), the current forecasting literature shows that combining forecasts obtained from different methods has the advantage of smaller and more stable MSFE's. Therefore, forecast combination has been applied to the forecasts of many important indicators, including the long-term rate. Butter and Jansen (2013) forecast the long-term interest rates for 5 OCED countries (United States, Germany, United Kingdom, the Netherlands and Japan) with four categories of models: time series models, structural models, forecasts that are based on expert knowledge, and a combination of structural models and experts forecast. They find that for the 3-month horizon, the random walk performs the best; while in the 12-month horizon, a combination of structural models and experts forecast beats the random walk. In more volatile periods, their combined model performs better as well.

In our analysis, we also combine forecasts from the above-mentioned methods and assess their performances. All the forecasts are combined with equal weights, as Stock e.a. found that the combination method with equal weights has the lowest

MSFE. Table 5.6 reports the RMSFE's and MAE's from two different combinations: *comb1* combines forecasts from random walk, term structure, and swap rates; *comb2* combines forecasts from all the five forecasting methods (i.e. random walk, term structure, swap rate, AR (1) and the old CPB practice). Compared with table 5.1 and 5.2 respectively, the combined forecasts still cannot beat statistical models, outperform those from the term structure and the CPB practice. The performance of the combined forecasts is at par with that based on the swap rate.

RMSFE in percentage points							
	1Y	2Y	3Y	4Y	5Y		
Comb1	0,8	1,23	1,67	2,09	2,52		
Comb2	0,78	1,2	1,65	2,08			
	MAE in perc	centage points					
Comb1	0,64	1,07	1,49	1,9	2,36		
Comb2	0,63	1,04	1,49	1,91			
Note: comb1 combines between forecasts from random walk, term structure, and swap; comb2 combines between							

Table 5.6 Prediction performance of forecast combinations (02/01/2004 - 30/11/2017)

forecasts from all the 5 forecasting methods (i.e. random walk, term structure, swap, AR (1) and the CPB practice).

We also combine the forecasts after the potential structural break, and evaluate the forecast performance in the period 18/01/2016 to 30/11/2017. The results are shown in table 5.7. In 1 year horizon, although the forecast from *comb1* cannot beat the random walk, it performs slightly better than AR models. In contrast, *comb2* performs the worst. From 2 to 4 years ahead, *comb1* and *comb2* cannot beat statistical models, but outperform models based on market information.

Table 5.7 Prediction performance of forecast combinations (18/01/2016 - 30/11/2017)

RMSFE in percentage points							
	1Y	2Y	3Y	4Y	5Y		
Comb1	0,54	1,17	1,93	2,15			
Comb2	0,59	1,21	1,98	2,19			
	MAE in perc	entage points					
Comb1	0,41	0,98	1,86	2,14			
Comb2	0,46	1,08	1,93	2,18			

The internal consistency 6

So far the empirical results have shown that the random walk performs the best, and except for statistical forecasting models (random walk and AR models), the forward swap rate provides the highest forecasting accuracy. But high forecasting accuracy alone does not justify the choice of the random walk as our forecasting method for the long-term interest rate. In addition to the forecasting accuracy, we still need to check the other two criteria: the internal consistency of the forecasting methods between the long-term interest rate and the short-term rate, and the internal consistency between short term and medium term.

Long-term interest rate projected with random walk is not internally consistent with the projected short-term interest rate based on market information. Currently, CPB projects the short-term interest rate with the Euribor futures price.⁹ In combination with a constant random walk projection of long-term rates, the short-term rate can possibly rise above the long-term rate. Although in practice, we cannot rule out the possibility of an inverted yield curve in the most depressed period (as shown in figure 6.1), it arises in this case without economic meaning, but purely out of technical reasons.

The issue with random walk is illustrated in figure 6.2 and 6.3, which display different projected spreads one year and four years ahead, respectively. In each figure, we compare the actual spread (= realized long-term interest rates minus short-term interest rates) and the projected spreads (projected long-term interest rates minus short-term interest rates). The projected long-term rates are obtained from random walk, forward swap rates, and old CPB practice.¹⁰ In 1 year ahead, three projected spreads share similar trends and level. However, in 4 years ahead, the spreads obtained from the random walk have lower spreads close to zero or negative in most of the evaluation period, while the spreads obtained from the forward swap rates and the old CPB practice are much closer to the actual spread.

⁹ The choice of this projection method for the short-term rate in the short run is described in Lukkezen et al. (2015). The document concludes that "In view of the literature and the practice of international institutes, there is a clear preference (...) for projections based on futures for (...) the short-term interest rate, while there is no clear preference for the long-term interest rate." ¹⁰ In one year ahead, the old CPB practice uses random walk projection, so there is no separate line for the CPB

practice.

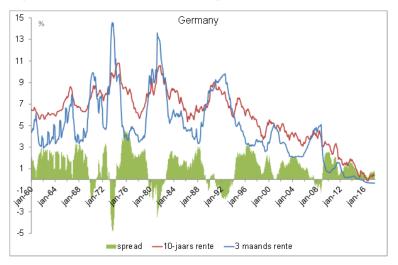
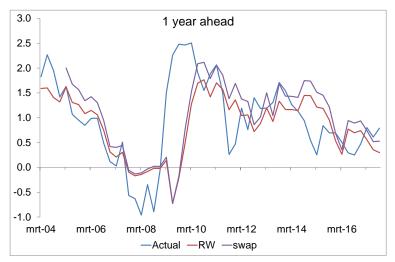
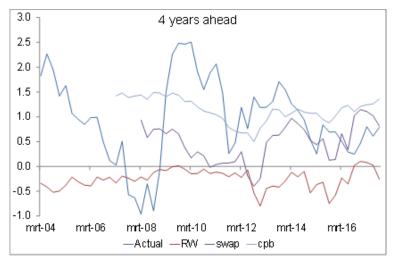


Figure 6.1 Historical series of long-term and short-term rates and their spreads









The discussions above indicate that the forward swap rates and the old CPB practice are preferable in the medium run. However, the old CPB practice is not internally consistent between the short term and the medium term. In the short term (within 2 years), long-term interest rates are projected based on a random walk, while in the medium term, the long-term rates are projected as the sum of short-term interest rate and a predetermined spread. As a result, the projected long-term rate experiences a jump during the transition from short term towards medium term. The jump occurs based on technical construction, but lacks economic background. Moreover, the old CPB practice provides lower forecasting accuracy than the forward swap rates. Therefore, we propose to use forward swap rates for long-term interest rate projection.

The table below exhibits the current projection methods and our proposal:

Table 6.1 Old and proposed methods to forecast long-term interest rate

	Short term	Medium term
Short-term rate		
Current method	Euribor futures	Euribor futures
Long-term rate		
Old method	Random walk	Short term rate + spread
Proposed method	Forward swap rate	Forward swap rate

7 Application to long-term rate projection: CEP2018 (2018-2022)

Based on three projection methods (i.e. random walk, forward swap rates, and the old CPB practice), long-term interest rates are shown for one to five years ahead based on the third week in 2018 (Jan 15th, 2018 to Jan 19th, 2018) in table 7.1 (Germany). For illustrative purposes we also show the results of the three forecasting methods for the United States interest rates (table 7.2). The projected short-term rates are also included in these tables. In all three cases, the forecast of the German short term rate is based on Eurodollar futures. The short term rate forecast for the United States is constant, while the other two prediction methods show increasing trends.

	2016	2017	2018	2019	2020	2021	2022
Long term (old CPB method)	0.10	0.36	0.50	0.51	0.88	1.44	1.83
Short term	-0.26	-0.33	-0.30	-0.07	0.32	0.67	0.93
Spread	0.36	0.69	0.80	0.58	0.56	0.77	0.90
Long term (forward swap rates)	0.10	0.36	0.59	0.83	1.02	1.18	1.31
Short-term	-0.26	-0.33	-0.30	-0.07	0.32	0.67	0.93
Spread	0.36	0.69	0.89	0.90	0.70	0.51	0.38
Long term (random walk)	0.10	0.36	0.50	0.51	0.51	0.51	0.51
Short term	-0.26	-0.33	-0.30	-0.07	0.32	0.67	0.93
Spread	0.36	0.69	0.80	0.58	0.19	-0.16	-0.43

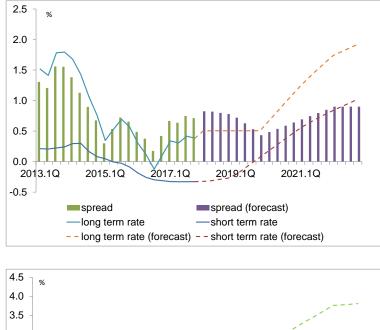
Table 7.1Comparing long term rate forecasts for Germany (CEP2018)

Table 7.2 Comparing long term rate forecasts for United States (CEP2018)

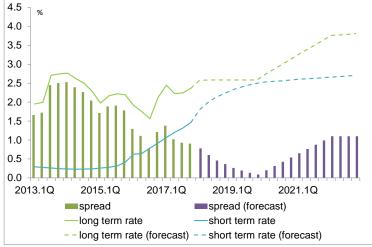
	2016	2017	2018	2019	2020	2021	2022
Long term (old CPB method)	1.84	2.32	2.58	2.59	2.93	3.44	3.78
Short term	0.74	1.26	2.03	2.42	2.56	2.62	2.68
Spread	1.10	1.06	0.55	0.17	0.37	0.82	1.10
Long term (forward swap rates)	1.84	2.32	2.60	2.69	2.72	2.75	2.78
Short-term	0.74	1.26	2.03	2.42	2.56	2.62	2.68
Spread	1.10	1.06	0.57	0.27	0.17	0.13	0.09
Long term (random walk)	1.84	2.32	2.58	2.59	2.59	2.59	2.59
Short term	0.74	1.26	2.03	2.42	2.56	2.62	2.68
Spread	1.10	1.06	0.55	0.17	0.03	-0.04	-0.10

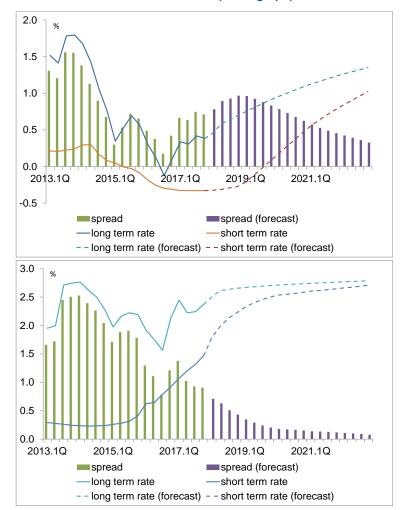
The first observation from these tables is that the difference in the projection for the long term interest rate is very small for 2017 and 2018, the years which has been published in previous projections. For 2019 the difference between the current and proposed method is more pronounced, where it is important to mention that the proposed method is more in line with the projections of the most recent medium term forecast of the CPB (2017).

The second observation is that the spread remains positive in the proposed method, but becomes negative with a random walk. The spread is the difference between the long term rate and the short term rate. Figure 7.3 shows that for the random walk forecast, the spread turns negative in the medium term. This is purely due to the technical construction, but has no economic meaning. This finding confirms that the random walk is not desirable in the medium horizon.

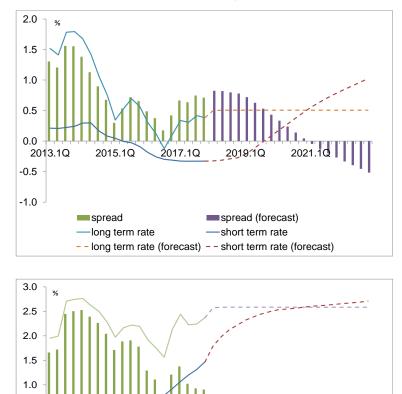












0.5 0.0

-0.5

2013.1Q

2015.1Q

spread
long term rate

2017.1Q

- - long term rate (forecast) - - short term rate (forecast)



1.1

2019.1Q

spread (forecast)

-short term rate

.

2021.1Q

8 Conclusion

This document compares different forecasting methods for long-term interest rates, and evaluates these methods on the basis of three criteria: 1) forecasting accuracy, 2) internal consistency between short term and medium term, and 3) internal consistency of forecasting long-term rates and short-term rates. Our empirical analyses show that the random walk always performs the best in terms of forecasting accuracy, whereas the forward swaps rate has the highest forecasting accuracy except for statistical models (random walk and AR models). The results are robust in the post-break period and in the presence of the forecast combination. However, we don't choose the random walk to project long-term interest rates, because random walk projection tends to lead to an inverted yield curve without any economic background. For the old CPB practice, it does not satisfy evaluation criteria (2) and (3), and it provides lower forecasting accuracy than the forward swap rates.

Therefore, starting in CEP 2018 we adopt the forward swap rate for long-term interest rates projection. This method has several advantages. First, it is consistent for short term and medium term periods; second, both the short-term and long-term forecast are based on market information; third, it provides higher forecast accuracy than the old CPB practice; finally, the choice of the swap rate is consistent with the current practice of the European Commission to project the long-term rate.

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