CPB Netherlands Bureau for Economic Policy Analysis

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Assessment of the technical assumptions on exchange rates, oil prices and interest rates

Jasper Lukkezen
Ona Ciocyte
Douwe Kingma
Cindy Biesenbeek
Yanqun Zhang

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Summary[1]

This Background Document presents an assessment of the technical assumptions on the projections (short: projections) of four variables: euro-dollar exchange rate, oil price, the long-term interest rate in the euro area and the short-term interest rate in the euro area. These variables are being used as exogenous inputs in projections of the world economy and of the Dutch economy.

First we present a short overview of the theory and the projection methods applied in the literature and used by international organizations. Then we compare the average forecast error of projection based on a random walk with the forecast error of projections based on futures or swaps. We conduct this analysis on historical data and calculate the forecast errors out-of-sample one to eight quarters ahead. We also examine whether it makes a difference whether we use the data from the last day before the projections are made, or the average over the past week, two weeks, month or quarter.

Finally we explain our future modelling choice, which we make based on three criteria: forecasting accuracy, internal consistency and tractability, and compatibility with the literature and international common practice. Table 1 lists the choices we have made.

Table 1 Projection procedure

Instrument	Variable	Previously	Becomes
Exchange rate	euro-dollar	Random walk	Random walk
Oil price	Brent North Sea oil	Random walk	Futures
Long-term interest rate euro area	10Y Bunds	Term structure	Random walk
Short-term interest rate euro area	3m Euribor	Futures	Futures
For all instruments		Average last month	Average last week

This Background Document accompanies the *Centraal Economisch Plan 2015*.

[1] A Dutch translation of this Background document is available as well. It is titled: *Beoordeling van technische veronderstellingen over wisselkoersen, olieprijzen en rentes* and can be found here [link].

1 Relevance and criteria

An important task of the CPB is to provide short-term projections of the Dutch economy. These projections include unemployment, gross domestic product, consumption, government debt and many more economic variables. Policy makers use these projections for decision-making, so forecast errors, or the distance between predicted and realized values, should be as small as possible.

The CPB uses the macro-econometric models NiGEM, Saffier, Mimosi and others to make these projections. These models require inputs on the economy and on policy. The inputs on the economy consist of historical data and projections of exogenous time series. Historical data is mostly retrieved from other institutions such as the Netherlands Central Bureau of Statistics (CBS) or Eurostat. The primary examples of exogenous data are future values of interest rates, energy prices and exchange rates. As a change in the predicted value of these variables affects the projections for both the international and the Dutch economy, having reliable projections for these exogenous variables matters.

CPB (2010) shows the impact of a change in interest rates and oil prices on the key macroeconomic variables of the Dutch economy.[2] The effect of the exchange rate works indirectly through changes in import and export prices. As these effects are sizable, it is worthwhile to assess current practice and to see whether improvements in the accuracy of these projections can be achieved.

When comparing current practice and alternative methods, apart from considering forecasting accuracy, we also take into account internal consistency and tractability and compatibility with the literature and international common practice. Internal consistency and tractability mandate that we would like to have the same procedure for all quarters ahead of the same variable and that the projection procedure should be operable within the CPB framework. Taking account of the literature and international common practice enhances the acceptability / authority of the CPB's projections.

2 Theory on predictions

On the commodities, money, capital and foreign exchange markets trade volumes are large. Traders spend a significant amount of time and energy analyzing and forecasting market trends, as being right about future price movements enables them to make a substantial profit. Traders can basically use three types of information: public information on trends and liquidity in the market (technical analysis), public information on factors driving the market (fundamental analysis) and private information. Technical analysis consists of forecasting future values from past market behavior and fundamental analysis is about forecasting market supply and demand.

[2] Also, CPB (2015) looks in light of the recent drop in oil prices at the effect of oil prices.

Unfortunately, the market cannot be beaten systematically by trading strategies based on technical and fundamental analysis. An explanation for this is provided by the efficient market hypothesis, which states that all publicly available information about an asset is reflected in its current price and that any new information about the asset will change its price immediately when it comes available, see among others Fama (1970). The mechanism behind this works as follows: when information becomes available that increases the expected future asset price, any investor would want to buy this security. Demand goes up and so does the price.

Apart from spot prices, whose projections are the subject of this Background Document, there is also trading in oil futures, currency exchanges and interest rate swaps. If the efficient market hypothesis holds, the prices of these oil futures, currency swaps and interest rate swaps are the best indicator of future oil prices, exchange rates and interest rates.

Unfortunately, the future market may be systematically different from the currently expected future market. This may arise from risk assessments or liquidity considerations from a part of market participants. Consider for example the current price of the three month interest rate one year from now from interest rate futures. If borrowers are more risk averse than lenders, they are willing to pay more now than the expected interest rate in a year to get a fixed price for their borrowing in a year. The one-year ahead short-term interest rate from futures is then lower than the expected short term interest rate in a year. As this is usually explained in terms of liquidity preference, this is referred to as the liquidity preference theory. Its origins trace back to Keynes. If such considerations hold true systematically, the market expectations of future prices may be worse predictors than the current price. A model that puts the projected future value of a commodity or derivative at its current value is called a random walk model.

In the rest of this Background Document the forecasting accuracy of random walk models is compared to the forecasting accuracy of future prices.

3 Methods in the literature

In this section, we summarize the academic literature on forecasting international price variables and explain which methods international institutions use in their projections.

Exchange rates

The fact that random walk models provide the best forecasts for exchange rates and cannot be outperformed consistently by more advanced forecasting models is widely supported in the literature and known as the Meese-Rogoff puzzle. Meese and Rogoff (1983) have tested whether univariate time series models, unconstrained vector autoregressive models, or structural models yield better forecasts of exchange rates than current exchange rates. They found that none of these models could forecast exchange rates better than the random walk model.

Generally, exchange rate forecasts based on future contracts do not do better (Frankel, 1983; Levich, 1985; Boothe and Longworth, 1986 and Kilian and Taylor, 2003). Also, several researchers tried to forecast exchange rates using fundamental models, but none of them found evidence that these models provide significantly better forecasts than the random walk model (Engel, 1993; Mark and Sul, 2001; Rapach and Wohar, 2001; Cheung et al., 2005). More recently, (Bayesian) vector autoregressive models have been used to forecast exchange rates. There is some evidence that these models provide slightly better forecasts than the random walk model (Preminger and Franck, 2007; Wright, 2008; Carriero et al., 2009).

Oil prices

Following the energy crisis in the 1970s, almost every expert forecasted oil prices incorrectly in the 1980s (Huntington, 1994). No doubt most experts have not forecast the boom-bust cycle of recent years. In retrospect, the oil price rise in the summer of 2008 can be explained by low price elasticity of demand, strong demand growth in China and some other countries, and the limited global production of oil. But the fact that these factors explain past oil prices well, does not imply they will also yield good forecasts for future oil prices.

Forecasts of energy prices generally assume that energy prices fluctuate around an increasing trend, due to changes in technology or exhaustion of natural resources. Therefore, most of the literature uses a random walk with drift model. Pindyck (1999) and Hamilton (2008), however, show that fluctuations in oil prices are persistent and that oil prices are difficult to predict. This would argue against a random walk assumption and in favour of futures, who can take the drift into account. Nevertheless, forecasts based on futures mostly provide similar results to those of random walk models, for exceptions see Coimbra and Esteves (2004), Lemmen (2006) and Alquist et al. (2011). Furthermore, Manescu and Van Robays (2014) show that forecast combinations of several models perform best.

Interest rates

The short-term interest rate is closely linked to the policy rate of the European Central Bank. The main questions is then whether Euribor futures are good predictors of future moves in the policy rate. According to Bernoth and Von Hagen (2003) all the information about future interest rate expectations is captured in the future prices; so structural models cannot improve on interest rate forecasts from future prices. Others claim however that the random walk model is the best forecast of future interest rates (Reichenstein, 2006), as the price of futures includes a risk premium. Risk-averse investors are willing to pay slightly more for Euribor futures than their expected value (Ivanova and Puigvert Gutiérrez, 2014). Forecasts of long-term interest rates are usually based on implicit forward swaps or the term structure (Kalev and Inder, 2006), yet they tend to be outperformed by random walk methods (Brooks and Gray, 2004).

4 Methods used by international institutions and current practice

Table 2 summarizes the modelling approaches of the Organisation for Economic Cooperation and Development (OECD), the International Monetary Fund (IMF), the European Central Bank (ECB), the European Commission (EC), and the current practice at the CPB.

Exchange rates

All projection methods need a whole range of bilateral exchange rates as inputs. Not all bilateral exchange rates future markets are sufficiently developed, whereas spot rates are available for all series. For reasons of consistency alone, all institutions use a random walk to project the future exchange rate. The CPB projection of the future euro-dollar exchange rate is currently the average value over the month preceding the day on which the projections are made. The time period over which is averaged to get the current value, varies across institutions (OECD (2014); IMF (2014), ECB (2014) and EC (2015)). The ECB for example projects exchange rates as the average of the last two weeks, the IMF uses the past four weeks, while the OECD uses the last day and the EC the last ten working days.

Oil prices

There is not one worldwide oil price, but there are prices depending on the quality of oil and the market where it is traded. We focus on Brent North Sea oil, which is most relevant for the Netherlands. The CPB currently uses a random walk model to project the oil price, averaged over the month preceding the projection. The OECD uses a random walk with drift model to project energy prices. It assumes that the price of crude oil increases with a constant (OECD, 2014). The European Commission, the ECB and the IMF use futures to make projections for the oil price (EC (2015), ECB (2014) and IMF 2014).

Interest rates

The CPB currently uses three months Euribor futures to make projections for the short-term interest rates and the term structure of German government bonds to make projections for the long-term interest rates in the euro area. The Dutch long-term interest rate projection then is the German rate plus the current risk premium, which is assumed to be constant. For short-term interest rates, the EC and the ECB use three months Euribor futures as well, whereas the OECD and the IMF use a policy model. For long-term interest rates, the EC and the ECB use implicit forward swap rates and the OECD builds them from the short-term interest rates by adding a term premium and a risk premium.

Table 2 Projection methods used by international institutions and current practice

	Exchange rates (a)(b)	Oil price (a)(b)	Long-term interest rates (b)	Short-term interest rates (b)
IMF	RW (4 weeks)	Futures		Policy model
OECD	RW (last day)	RW with drift	Short-term interest rate + term premium + risk premium	Policy model
EC	RW (last 10 days)	Futures (last 10 days)	Implicit forward swap rates	Euro area: Euribor futures Other countries: implicit forward swaps
ECB	RW (two weeks)	Futures (two weeks)	Implicit forward swap rates	Euribor futures
CPB	RW (month)	RW (month)	Term structure (month)	Euribor Futures (month)

(a) RW means random walk
(b) In parenthesis the time period over which the current value is averaged

5 Data used

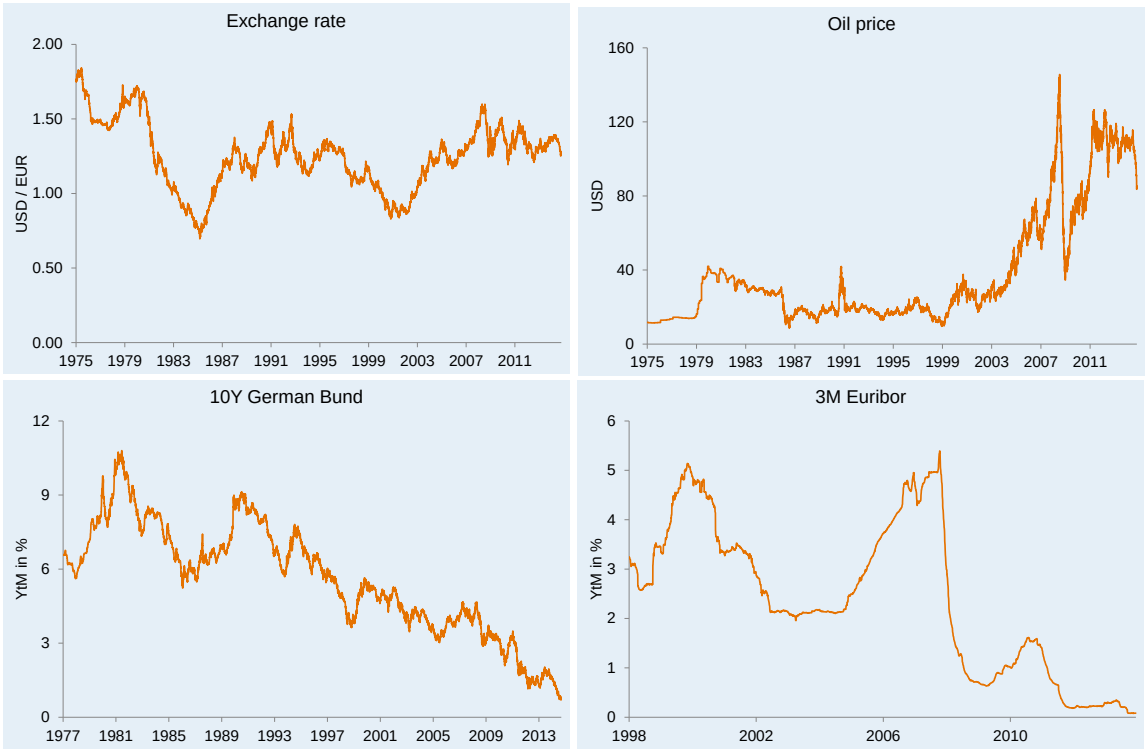
In the next section, we will test the forecasting performance of a random walk vis-á-vis a futures based methods. Here we describe the data.

Table 3 Data availability

Instrument	Variable (a)	Spot / future	Time
Exchange rate	Eur-USD	Spot price	75Q1-14Q3
		Forward Q1-Q6	06Q4-14Q3
Oil price	Brent Oil	Spot price	75Q1-14Q3
		Future Q1-Q5	94Q4-14Q3
		Future Q6-Q8	06Q4-14Q3
Long-term interest rates	10Y Bunds	YtM	77Q1-14Q3
		Term structure	97Q3-14Q3
		Implicit forward swaps	04Q1-14Q4
Short-term interest rates	3m Euribor	YtM	98Q4-14Q3
		Futures	98Q4-14Q3

(a) Data from Datastream

Figure 1 Graphs of spot prices and yields



The time series used are described in Table 3. The exchange rate, the oil price and the ten year German bund are available from the seventies onwards, whereas the Euribor is only available since the introduction of the euro. Most future, forward and swap prices are available only for much shorter time periods.

The spot prices and yields are plotted in Figure 1 and Table 4 provides summary statistics on daily data, Table 5 provides summary statistics on averaged quarterly data. In the oil price series, the oil crisis of the late seventies and early eighties is clearly visible, as is the boom-bust cycle in 2008-2009. In contrast, there is a lot of fluctuation in the euro-dollar exchange rate, but for most of the past forty years it has fluctuated around 1.25 dollar per euro. The long-term interest rate is on a declining trend over this time period and has almost hit zero now. The short-term interest series is shorter and displays the ICT-boom-bust cycle around 2000 and the boom in the run-up to the great recession. For the past few years it has been close to zero.

Table 4 Summary statistics of the spot prices and yields (daily data)

		minimum	maximum	mean	standard deviation	number of observations
Exchange rate	Levels (a)	0.70	1.84	1.25	0.22	10384
	Changes (b)	-4.1	4.7	0.0	0.6	
Oil price	Levels (c)	9	146	38	31	10384
	Changes (b)	-36	38	0	2	
Long-term interest rates	Levels (b)	0.7	10.8	5.6	2.2	9821
	Changes (d)	-0.43	0.33	0.00	0.04	
Short-term interest rates	Levels (b)	0.1	5.4	2.4	1.5	4161
	Changes (d)	-0.36	0.39	0.00	0.02	
(a) In dollar per euro						
(b) In per cent						
(c) In US dollar / barrel						
(b) In percentage points						

Table 5 Summary statistics of the spot prices and yields (quarterly data)

		minimum	maximum	mean	standard deviation	number of observations
Exchange rate	Levels (a)	0.74	1.81	1.25	0.22	159
	Changes (b)	-12.2	9.2	-0.1	4.5	
Oil price	Levels (c)	11	122	38	31	159
	Changes (b)	-52	59	2	14	
Long term interest rate	Levels (b)	0.8	10.6	5.6	2.2	151
	Changes (d)	-0.84	1.06	-0.04	0.36	
Short-term interest rate	Levels (b)	0.1%	5.0	2.4	1.5	65
	Changes (d)	-2.18	0.73	-0.05	0.41	
(a) In dollar per euro						
(b) In per cent						
(c) In US dollar / barrel						
(b) In percentage points						

6 Empirical analysis

We calculate the root mean square prediction error of projections based on a random walk and on futures over the time period that both time series are available for one to eight quarters ahead. We vary the time period preceding the projection period over which the daily observations are averaged, and use the last day, the last week, the last two weeks, the last month and the last quarter.

We use a random walk based on the last day before the projections are made as the benchmark and we test whether the improvement in forecasting accuracy is significant using a Diebold-Mariano test (Diebold and Mariano, 1995). As it turns out, projections based on futures are better in some instances, but never significantly so. The same goes for variations in the period over which the observations are averaged. Therefore, we refrain from displaying the Diebold-Mariano test results in this Background Document.

Exchange rates

Table 6 displays the root mean square prediction error of the euro-dollar exchange rate projections with the random walk and based on futures up to five quarters ahead over the 2006Q4-2014Q3 period. It turns out that the forecasting performance of the benchmark (random walk, last day) is comparable to the forecasting performance of futures over the entire projection horizon. The one-quarter-ahead projection based on the last day is a bit better than the projections based on averages over longer time periods. For more periods ahead there is no difference.

Table 6 Euro-dollar exchange rate 2006Q4-2014Q3, Root mean square prediction error in USD/EUR

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	0.039	0.083	0.109	0.119	0.120	0.115	0.119	0.134
Walk	week	0.042	0.085	0.109	0.118	0.118	0.116	0.121	0.135
	2 weeks	0.042	0.085	0.108	0.117	0.116	0.114	0.119	0.133
	month	0.043	0.087	0.112	0.120	0.116	0.110	0.116	0.131
	quarter	0.058	0.095	0.114	0.119	0.113	0.111	0.121	0.133
Futures	day	0.038	0.080	0.103	0.110	0.110			
	week	0.041	0.081	0.103	0.110	0.108			
	2 weeks	0.041	0.081	0.102	0.108	0.106			
	month	0.041	0.084	0.106	0.112	0.107			
	quarter	0.055	0.090	0.107	0.110	0.102			

Oil Prices

Table 7 displays the root mean square prediction error of oil price projections based on the random walk and futures up to five quarters ahead over the 1994Q4-2014Q3 period. It turns out that the benchmark (random walk, last day) does slightly better in the first three quarters and slightly worse in the fourth and fifth quarter than projections based on future contracts. The one-quarter-ahead projection based on the last day is a bit better than the projections based on averages over longer time periods. For more periods ahead there is no difference.

Table 7 Oil prices 1994Q4-2014Q3, Root mean square prediction error in USD / barrel

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	7.1	14.0	17.3	18.6	19.8	20.4	21.1	22.0
Walk	week	7.6	14.1	17.4	18.6	19.9	20.5	21.2	22.0
	2 weeks	7.4	13.8	17.2	18.4	19.7	20.3	21.0	21.9
	month	7.5	13.9	17.2	18.5	19.7	20.2	20.8	21.8
	quarter	9.3	14.6	17.1	18.4	19.4	20.0	20.4	21.5
Futures	day	7.8	14.6	17.5	18.4	19.0			
	week	7.9	14.6	17.6	18.4	19.1			
	2 weeks	7.8	14.4	17.4	18.3	19.0			
	month	7.9	14.4	17.4	18.3	19.0			
	quarter	9.7	15.0	17.2	18.1	18.6			

Table 8 displays the root mean square prediction error of oil price projections based on the random walk and futures up to eight quarters ahead over the 2006Q4-2014Q3 period. It turns out that the benchmark (random walk, last day) is slightly better in the first two

quarters and slightly worse from the third quarter onwards. The one-quarter-ahead projection based on the last day is a bit better than the projections based on averages over longer time periods. For more periods ahead there is again no difference.

Table 8 Oil prices 2006Q4-2014Q3, Root mean square prediction error in USD / barrel

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	10.8	21.3	26.2	27.8	28.9	29.2	29.8	30.8
Walk	week	11.5	21.5	26.3	27.9	29.0	29.3	29.8	30.8
	2 weeks	11.2	21.1	25.9	27.5	28.7	29.0	29.4	30.5
	month	11.3	21.1	26.0	27.5	28.5	28.8	29.1	30.4
	quarter	14.1	22.1	25.6	27.2	27.9	28.2	28.4	29.7
Futures	day	11.6	21.9	25.6	26.1	25.8	27.2	25.5	24.7
	week	11.8	21.8	25.7	26.2	26.0	27.5	25.7	25.0
	2 weeks	11.7	21.5	25.5	25.9	25.9	27.2	25.3	24.7
	month	11.8	21.5	25.5	25.8	25.6	26.9	25.1	24.6
	quarter	14.6	22.4	24.9	25.1	24.7	26.1	24.3	23.8

Interest rates

Table 9 displays the root mean square prediction error of the ten year German government bond rate projections based on the random walk and future prices from the term structure up to eight quarters ahead over the 1997Q3-2014Q3 period. It turns out that the benchmark (random walk, last day) is better than the projection derived from the term structure over the entire horizon. The one-quarter-ahead projection based on the last day and the last week are a bit better than the projections based on averages over longer time periods. For more periods ahead there is no difference.

Table 9 Long-term interest rates 1997Q3-2014Q3, Root mean square prediction error in percentage points

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	0.228	0.448	0.581	0.676	0.761	0.824	0.881	0.947
Walk	week	0.227	0.446	0.576	0.672	0.758	0.823	0.882	0.946
	2 weeks	0.240	0.452	0.577	0.674	0.761	0.828	0.886	0.950
	month	0.249	0.459	0.583	0.679	0.763	0.829	0.882	0.942
	quarter	0.303	0.487	0.597	0.690	0.769	0.832	0.888	0.948
Term	day	0.265	0.544	0.750	0.922	1.040	1.132	1.214	1.302
Structure	week	0.266	0.544	0.748	0.920	1.039	1.135	1.220	1.307
	2 weeks	0.276	0.547	0.744	0.917	1.036	1.133	1.217	1.304
	month	0.285	0.553	0.749	0.922	1.038	1.135	1.214	1.296
	quarter	0.343	0.593	0.778	0.951	1.064	1.160	1.238	1.316

Table 10 displays the root mean square prediction error of the ten year German government bond rate projections based on the random walk and based on future prices from implicit forward rates up to 8 quarters ahead over the 2004Q1-2014Q3 period. It turns out that the benchmark (random walk, last day) is better than the projections from the implicit forward swap rates over the entire horizon. The one-quarter-ahead projection based on the last day and the last week are a bit better than the projections based on averages over longer time periods. For more periods ahead there is no difference.

Table 10 **Long-term interest rates 2004Q1-2014Q3, Root mean square prediction error in percentage points**

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	0.247	0.469	0.576	0.620	0.672	0.728	0.806	0.889
Walk	week	0.247	0.468	0.574	0.619	0.674	0.732	0.809	0.891
	2 weeks	0.256	0.468	0.569	0.616	0.672	0.733	0.809	0.892
	month	0.259	0.465	0.566	0.618	0.675	0.738	0.808	0.883
	quarter	0.297	0.467	0.545	0.605	0.675	0.747	0.822	0.890
Implicit	day	0.301	0.515	0.671	0.773	0.869	0.970	1.061	1.177
forward	week	0.307	0.516	0.674	0.780	0.880	0.981	1.073	1.185
rates	2 weeks	0.318	0.521	0.673	0.779	0.882	0.981	1.074	1.187
	month	0.318	0.518	0.670	0.777	0.882	0.979	1.069	1.175
	quarter	0.365	0.526	0.660	0.771	0.886	0.989	1.090	1.192

The fact that the expected future yields from the term structure and expected yields from implicit forward swap rates are worse than the random walk, can be explained by the fact that on average the expected future yields have been slightly higher than the current yield, whereas the actual future yield was slightly lower than the current yield. Given those characteristics, the current yield is a better forecast for the future yield than the (slightly upward sloping) expected future yield.

Table 11 displays the root mean square prediction error of the three month Euribor rate projections based on the random walk and projections derived from Euribor futures up to eight quarters ahead over the 1998Q4-2014Q3 period. It turns out that the benchmark (random walk, last day) is worse than the projections from Euribor futures over the first five quarters. The one-quarter-ahead projection based on the last day is a bit better than the projections based on averages over longer time periods. For more periods ahead there is no difference.

Table 11 **Short-term interest rates 1998Q4-2014Q3, Root mean square prediction error in percentage points**

	Average Last …	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Random	day	0.229	0.610	0.893	1.138	1.352	1.531	1.665	1.769
Walk	week	0.238	0.609	0.895	1.141	1.356	1.533	1.666	1.769
	2 weeks	0.247	0.612	0.898	1.143	1.358	1.535	1.668	1.770
	month	0.282	0.633	0.914	1.155	1.370	1.546	1.678	1.780
	quarter	0.412	0.733	0.996	1.221	1.420	1.581	1.704	1.801
Futures	day	0.161	0.449	0.736	0.978	1.239	1.464	1.670	1.846
	week	0.174	0.470	0.752	0.993	1.249	1.471	1.675	1.849
	2 weeks	0.183	0.488	0.771	1.008	1.261	1.481	1.682	1.854
	month	0.192	0.507	0.793	1.029	1.274	1.490	1.686	1.853
	quarter	0.245	0.559	0.824	1.069	1.312	1.534	1.727	1.895

7 Choices and concluding remarks

The columns under Forecasting Accuracy in Table 12 summarize the results from the previous section: empirically there is no significant difference between a projection based on

a random walk and a projection based on futures for the exchange rate, and while the difference is not significant, on short horizons projections based on a random walk and on longer horizons projections based on futures are preferred for the oil price, projections based on a random walk are preferred for the long-term interest rate and projections based on futures are preferred for the short-term interest rate. From the perspective of consistency and tractability there is a clear preference for using the random walk for the exchange rate, as there is a whole spectrum of exchange rates to account for. For the other variables, consistency and tractability implies that we should choose one of both, not a combination or different methods at different horizons. In view of the literature and the practice of international institutes, there is a clear preference for the random walk for the exchange rate, for projections based on futures for the oil price and the short-term interest rate, while there is no clear preference for the long-term interest rate.

Table 12 Overview of the evaluation

Variable (a)	Forecasting Accuracy				Consistency and tractability	Fit with the literature	Choice
	Time period	Q1	Q4	Q8			
Exchange rate	1994q4-2014q3	~	~		RW	RW	RW
Oil price	2006q4-2014q3	RW	F	F	~	F	F
Long-term interest rate	1997q3-2014Q3	RW	RW	RW	~	~	RW
Short-term interest rate	1998q4-2014q3	F	F	~	~	F	F

(a) RW means random walk is preferred, F means future is preferred, ~ indicates indifference.

For the exchange rate we choose to use a random walk, which is most pragmatic given the large amount of bilateral exchange rates and it matches both the literature and international practice. For the oil price we will use projections based on futures. Their predictive power is a little bit better on long horizons and it follows the methodology used by other institutions. For the long-term interest rate we choose to use a random walk. Empirically, this method was better over the past decade than a futures approach and there is no clear consensus emerging from the literature. And finally for the short-term interest rate, we use projections based on futures as this has –especially on the short horizon - better predictive power while it also follows the consensus in the literature.

Regarding the time period over which we average, there is theoretically a trade-off between forecasting accuracy and susceptibility to fluctuations from day-to-day market volatility. Forecasting accuracy is better, especially on short horizons, when averages are taken over short time periods, whereas susceptibility to market volatility is less when averaging over longer time periods. Empirically, we find that only for the one-quarter-ahead projection the last day observation is better than observations averaged over longer time periods for most variables. For longer projections horizons there is no difference. We choose to average over the last week.

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CPB Netherlands Bureau for Economic Policy Analysis
P.O. Box 80510 | 2508 GM The Hague
T +31 70 3383 380

info@cpb.nl | www.cpb.nl

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