# Czech Government Bond yields under FX pressure

Simerský, Mojmír

May 2018

# Czech Government Bond yields under FX pressure

Mojmír Simerský*

May 2018

**Abstract**

This paper presents some results of the yield curve (YC) estimation method proposed in [5]. We focus on the Czech Government Bond market in the period 2014–2017, when the Czech National Bank (CNB) weakened the CZK exchange rate by long–term currency interventions.

The input data is the Czech daily fixing published online by MTS [3]. These quotations suffer, however, from a large bid–ask or YTM spreads, a fact that reflects itself in the YC estimation errors. Some 700 YCs were computed and the histograms of yield estimation errors and of YC smoothness are given. Of interest is the comparison of the Czech benchmark zero–coupon yields at 1, 5, and 10 years with the ECB AAA yields [2].

Selected YCs in 2017 show that the outstanding depression of the short–term bond yields occurred in mid–January, some two months before the CNB announced the end of interventions (April 6). The termination itself influenced the Czech bond yields only moderately.

**Keywords:** yield curve estimation, zero–coupon yields, Czech bond market, Czech National Bank, ECB
JEL: C51, E43, G12

## 1 Introduction

The Czech Government bond secondary market offers an opportunity to put into practice the YC estimation procedure we proposed in [5]. Most importantly, there is a price source [3] covering regularly and fully this market. The number of bonds and the range of maturities are sufficient. As a prerequisite, we are technically acquainted with the Czech bond market conventions and rules.

In the last years the policy of central banks led to a new phenomenon – negative nominal interest rates, in the Czech case accentuated by the CNB interventions with the aim to fix the exchange rate of CZK at 27 CZK/EUR. As a result, yield curves have acquired

*Contact: simersky@gmail.com, Location: Prague, Czech Republic

new and more complicated shapes, not quite tractable by standard parametric estimation. A viable nonparametric approach, which we propose, can therefore prove useful.

We start with an evaluation of the quality of input data, i.e., price quotations. The YC estimation works with the mid prices and the level of bid–ask spreads relates to the YC estimation errors. Because we optimize the sum of squared yield errors rather than price errors, the YTM spreads are of importance and were evaluated as well. Seen from either side, the quality of the Czech daily fixing price quotations is poor.

We processed some 700 YCs in the period 2014–2017. The key estimation parameter, the RMSE of estimated yields, depends on the degree of smoothing in the opposite way as does the smoothness of the spot curve. To find a compromise, we took, as a proxy of the smoothness, the number of inflexion points on the spot curve. The histograms of the yield RMS errors and those of the inflexion point numbers are plotted and deemed to corroborate our choice of the smoothing parameter.

Next, the computed zero–coupon Czech yields at benchmark maturities are compared with the corresponding Eurozone AAA zero–coupon yields, as published by the ECB [2]. Because the rating of the Czech Republic is more than one grade lower, it is to be expected that the credit spreads would be permanently positive. For the 1Y maturity, it is certainly not the case.

Several YCs were chosen from our library of the Czech YCs (www.zyc.cz) to document a substantial deepening of the short–term bond yields in January 2017, some two months before the CNB reverted its policy of weakening the currency.

In the following sections, we present and comment the graphs illustrating the points mentioned above. Our view will be strictly descriptive; we endeavor to eschew any economic speculations, let alone divinations.

## 2 Input data

The Czech daily fixing data are issued on every Czech working day at about 11:30 a.m. [3]. Apart from bid and ask clean prices, there are: mid price, mid YTM, and bond duration. The list of responsible contributors can be found in [4].

In the period 2014–2017 we gathered price data of 695 days, up to 22 December 2017, first fortnightly or weekly, from November 2015 daily. The data of the 2017 last week had to be discarded due to their very poor quality.

In total, some 12 750 price quotations were processed. To evaluate price and yield spreads, the quotations were divided into four duration brackets: 0.3 – 1 year, 1 – 3 years, 3 – 10 years, and 10 – 30 years. The YTM spread was calculated from the fixing data as

$$YTM\_SPREAD = \frac{ASK\_PRICE - BID\_PRICE}{MID\_PRICE} * \frac{1 + MID\_YTM}{DURATION}$$

in words, the relative price change divided by the modified duration.

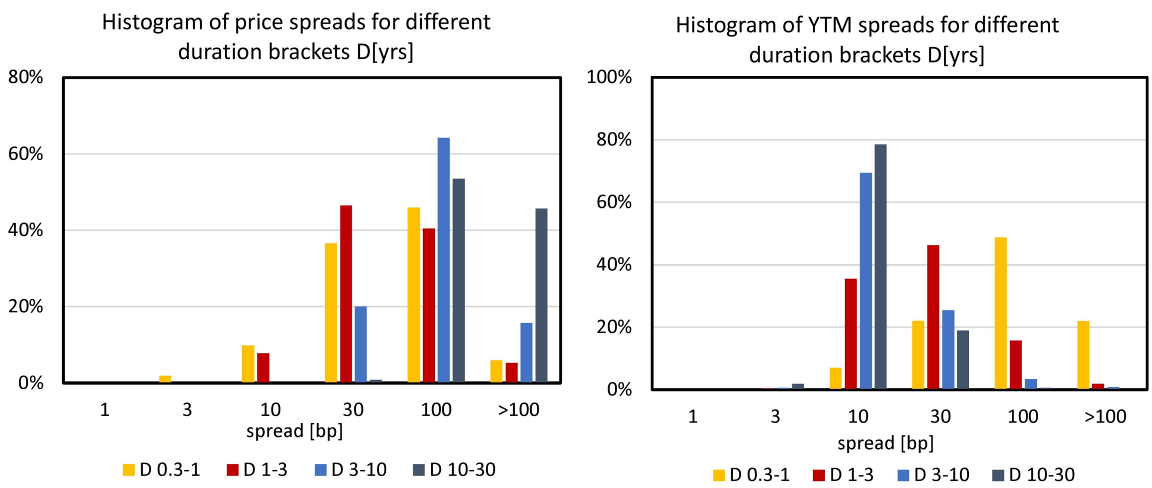


Fig. 1 presents the histogram of price quotation spreads (left part). Most of the data lie in the bracket 30 - 100 bps, except for the bonds with duration 1 – 3 years, where the maximum is between 10 and 30 bps. With the longest issues, the spreads above 100 bps occur in more than 40% of quotations. The yield spreads show that the shortest bonds are plagued with substantial imprecision of quotes. The peak is between 30 and 100 bps, but some 20% of prices suffer from even greater errors.

We note that if we were to insist on the condition stipulated by the ECB methodology: "Only actively traded central government bonds with a maximum bid-ask spread per quote of three basis points are selected" [2], we could have been able to use only 423 quotations out of 12 750, i.e., 3.3 percent.

# 3 Estimation errors

From each fixing, only fixed coupon bonds and zero-coupon bonds were selected. As in the ECB methodology, residual maturities from three months up to 30 years were considered. The number of selected bonds was most often between 18 and 20, the last maturity being in December 2036. Due to their number, we could not afford the luxury of outlier detection as in [2]. The only quality test used was the rejection of quotations with the YTM spread larger than 200 bps. The spot value at $t = 0$, required as an input parameter, was the average of PRIBOR and PRIBID 1 D rates [1].

The division of the time axis consisted of 40 knots, the $m$-th time knot being $t(m) = a+bm^2$, where $a$ and $b$ were the constants chosen so that $t(1) = 1/12$ (the shortest time knot, one month), $t(40) = 30$ (the last knot, 30 years).

The estimation was carried out for three values of the smoothing parameter $\lambda = -1, 0, 1$ ($\lambda$ is an exponent – see [5]). As a proxy of the curve smoothness, we chose the number of inflection points on the spot curve. The second derivative of the spot curve is discontinuous at the knots ([5]) and it can be demonstrated that the first derivative is always monotone between the knots. In the range 0.25 – 30 years we sought the knots where the first derivative was increasing on the time interval to the left and decreasing to the right, or vice versa. To suppress spurious inflexion points due to small derivative values etc., only the cases where the monotonicity lasted for at least two consecutive intervals were counted.

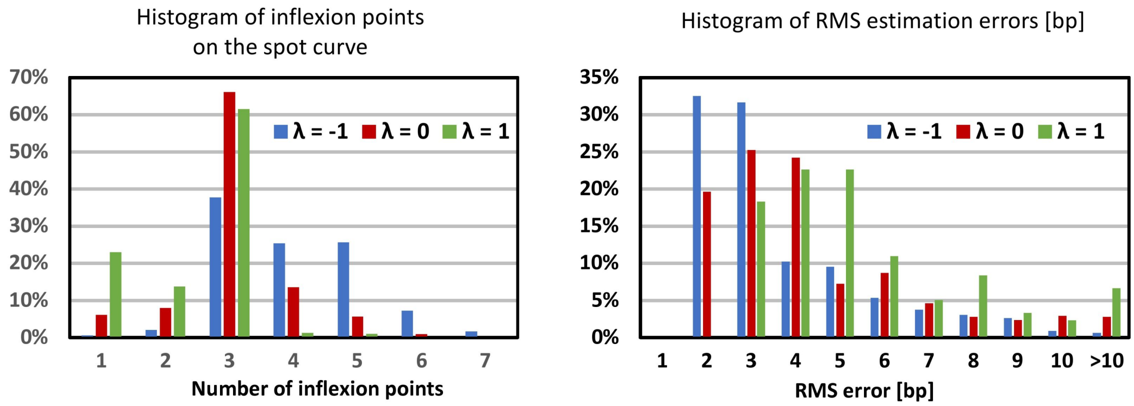


Fig. 2 Number of inflexion points on the estimated spot curves and RMS errors as a function of the level of smoothing. There seems to be prevalence of three inflexion points in our data. (The additional inflexion points occur mainly at short maturities, where the density of cashflows is greater and the time knots are denser.) Subjective observation leads to an assessment that five or less inflection points makes the spot curve look "smooth". The RMS errors of estimation can be roughly classified as follows: about two thirds of specimens have the RMSE less than 3 bps for $\lambda = -1$, less than 4 bps for $\lambda = 0$, and less than 5 bps for $\lambda = 1$. The last value of $\lambda$, however, gives an increased percentage of large estimation errors.

In our view, $\lambda = 0$ seems to be the most appropriate smoothing level: the cases of excessive number of inflection points are at about 5 per cent and the distribution is near symmetric.

We observe that these estimation errors compare favorably with the (half of) yield quotation error levels (Fig.1).

On the next page, the development of the Czech zero-coupon yields is presented. The Figure plots 96 curves, two for each month, computed as an average of daily yield curves over a fortnight, i.e., from November 2015, as an average of 10 working days. From the Figure, the extent and the maturity depth of negative yields can be assessed (red and blue colors).

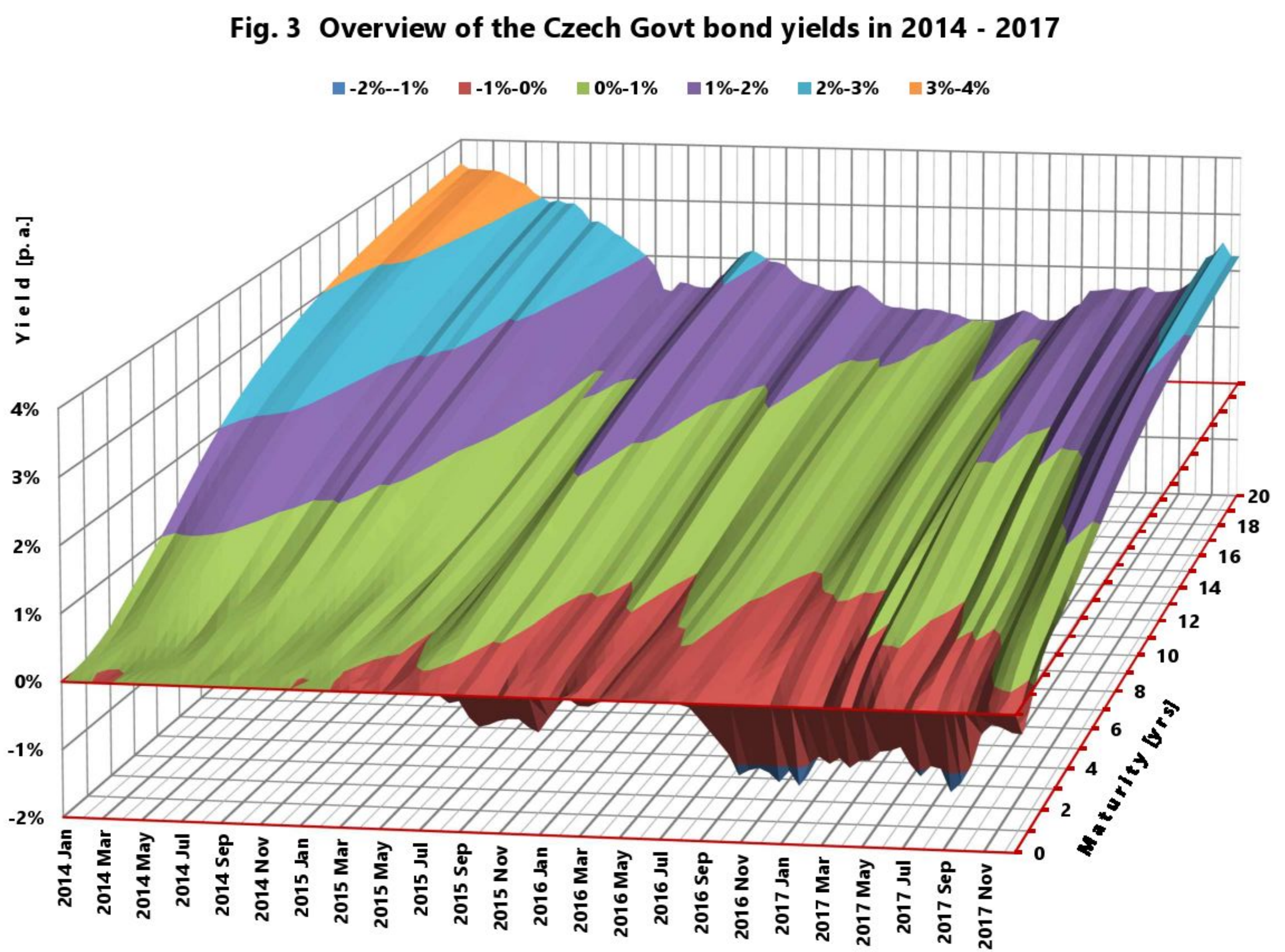
Fig. 3 Overview of the Czech Govt bond yields in 2014 - 2017
-2%--1%
-1%-0%
0%-1%
1%-2%
2%-3%
3%-4%
Yield [p. a.]
4%
3%
2%
1%
0%
-1%
-2%
2014 Jan
2014 Mar
2014 May
2014 Jul
2014 Sep
2014 Nov
2015 Jan
2015 Mar
2015 May
2015 Jul
2015 Sep
2015 Nov
2016 Jan
2016 Mar
2016 May
2016 Jul
2016 Sep
2016 Nov
2017 Jan
2017 Mar
2017 May
2017 Jul
2017 Sep
2017 Nov
Maturity [yrs]
0
2
4
6
8
10
12
14
16
18
20

# 4 Zero-coupon yields

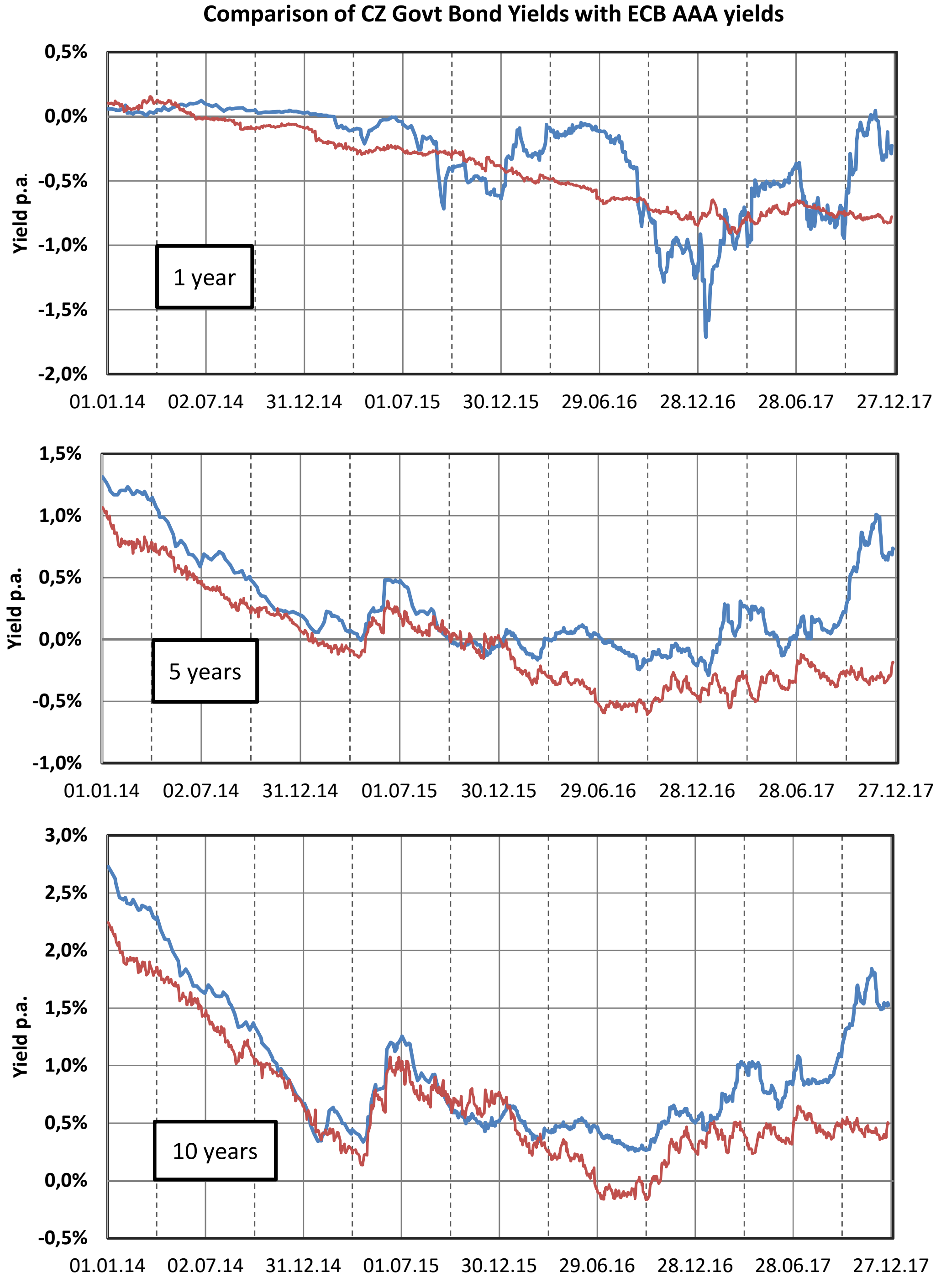


Fig. 4 Comparison of Czech Govt Bond yields with ECB AAA yields in the period 2014–2017. The Czech benchmark zero-coupon yields at 1, 5, and 10 years (in blue) are from our computations. The red curves plot the data available from the ECB ([2]).

An interesting point is the propagation of the short-term negative rates in the second half of 2015 up to 10 years of maturity. At that time, the credit spread of the 10 Y Czech zero-coupon yields with respect to the Eurozone AAA (in fact, Germany's ones) reached units of bps. Despite the differences of the estimation methods and their standard errors, this demonstrates that the 10 Y benchmark credit spread, frequently taken as a sign of the credit situation of the sovereign issuer, can be strongly influenced by the central bank policies.

Another period worth of interest is the last quarter of 2016 and the first of 2017. Such yield depression could hardly be tenable for long. The impact on the 5 Y and 10 Y spreads is visible but short-lived. To our pity, we do not possess information that could explain a swift return of the short-term rates back to more sustainable levels.

From Fig. 4 it may be seen that the CNB decision on April 6, 2017, did not change the picture too much. In the following months, however, the return to the standard FX regime had led to adequate yield spreads.

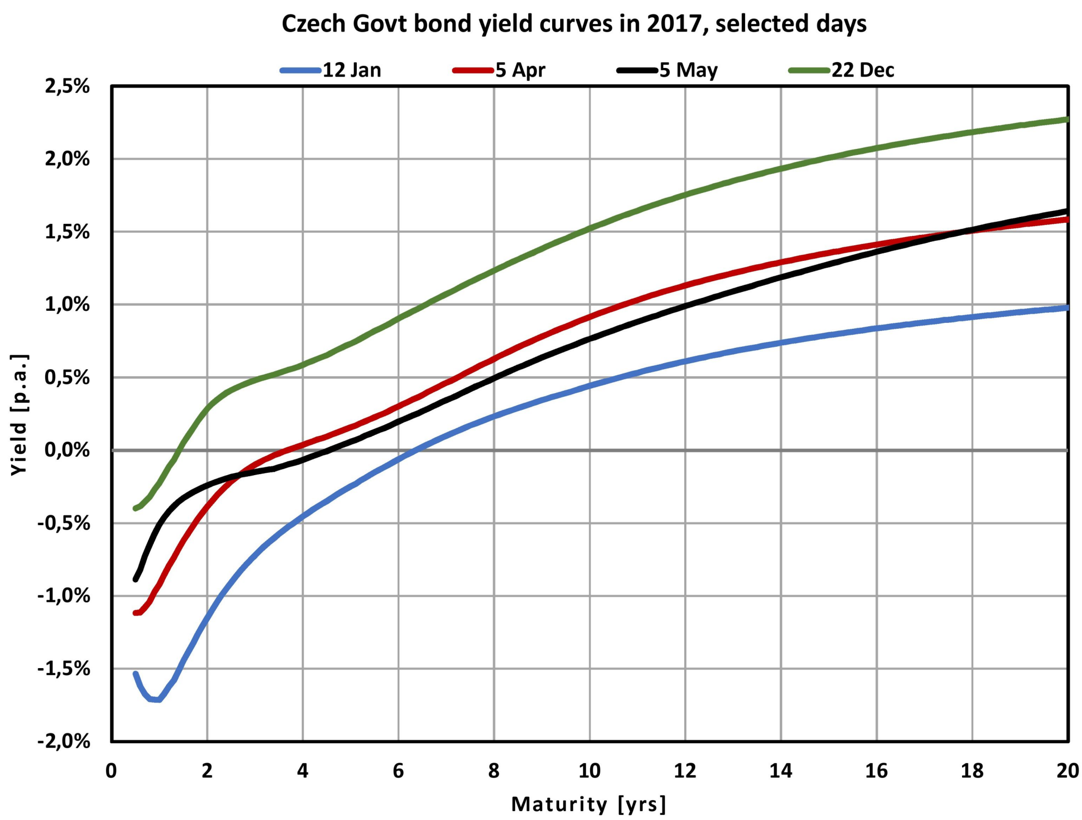


Fig. 5 Czech Govt Bond YCs on specific dates. The most negative short-term rates took place in mid-January (12 Jan, blue). The CNB decision to stop, after more than three years, the FX interventions, did not cause any upheaval in the bond market - here the YC one day before the announcement (5 Apr, red) compared with that one month later (5 May, black). At the end of the period of our data (22 Dec, green), the level of yields was substantially higher.

# 5 Conclusion

In this paper, we tried to demonstrate that the procedure we have been using for the estimation of the Czech Government zero-coupon yield curves for some time, as evidenced on our site www.zyc.cz, offers a viable alternative to existing parametric and nonparametric methods.

The CNB action gave us an opportunity to encounter some strangely shaped YCs, not yet considered in the common literature on this subject matter. The reverse of the medal was a substantial worsening of the daily fixing data quality. The problem started approximately half a year before April 2017 and continued until the end of that year. In the future, we would try to find an opportunity to test our procedure on more "precise" price quotations, either real, or simulated.

Finally, we note that in the community of Czech economic experts the reception and appraisal of the CNB measures have been far from unequivocal. Not a surprise, if we believe that Clarke's Law – aka Coulomb's Law – on experts holds (the latter name may reflect a widely accepted idea that the overall electric charge of the Universe is zero).

# References

[1] http://www.cnb.cz/en/financial_markets/money_market/pribor/index.html

[2] https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves

[3] https://www.mtsdata.com/content/data/public/cze/fixing/index.php

[4] https://www.mtsdata.com/content/data/public/cze/anagraph/member.php

[5] Simersky, M., *Zero-coupon yields estimated by zero-degree splines* (2018), www.zyc.cz https://mpra.ub.uni-muenchen.de/id/eprint/86268

**Acknowledgments:** to my first wife