Evaluating Government Tax Revenue Forecasts: Czech and Slovak Cases

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Abstract

The paper deals with the accuracy of tax revenue forecasts produced by the Czech and Slovak governments in the 2004-2013 period. Utilizing a combination of scale-dependent (AFE, RMSE), percentage (MAPE) as well as relative (MASE) error measures, a common pattern of three distinctive phases was identified: (i) the growth period (2004-2006) with prudent under-shooting of the real revenues and relatively low errors, (ii) the recession period (2007-2010) with strong tendency to over-forecast and substantially higher errors and (iii) the stagnation period (2010-2013) with a gradual return to conservative under-shooting and reduction of errors to pre-recession level. Comparison of both countries´ accuracy showed that although the Czech forecasts generally achieved lower standard errors, the Slovak forecasts performed better versus the naïve benchmark, offering higher added value in the more volatile environment. However, international comparison showed that both countries failed to successfully absorb the 2007-2008 crisis impact and reached comparatively high error magnitudes, putting them in line with accuracy-wise inferior countries such as Greece or Spain. With respect to this, the article is concluded with a set of recommendations for both CZ and SK tax forecasting processes as well as for their overall fiscal behaviour.

Key words

Tax forecast, Scale-dependent error measures, Percentage error measures, Relative error measures, Fiscal policy

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Abstrakt

Hodnotenie vládnych prognóz daňových príjmov: prípad Českej a Slovenskej republiky

Článok sa zaoberá presnosťou prognóz príjmov tvorenými českými a slovenskými rozpočtovými úradmi (MF ČR a IFP SK) v rokoch 2004-2013. S využitím kombinácie absolútnych (AFE, RMSE), percentuálnych (MAPE) a relatívnych (MASE) prognostických chýb bol v danom intervale identifikovaný podobný priebeh o troch základných fázach (i) rastové obdobie (2004-2006), kedy dochádzalo ku konzervatívnemu „podstreľovaniu" prognózovaných daňových príjmov a relatívne nízkym prognostickým chybám, (ii) obdobie recesie (2007-2010) so silnou tendenciou k „prestreľovaniu" prognóz a výrazne vyššími chybami a konečne (iii) obdobie stagnácie (2010-2013), charakteristické postupným návratom ku konzervatívnym prognózam podhodnocujúcim skutočné príjmy a znižovaním chyby prognóz na predkrízovú úroveň. Zrovnanie presnosti prognóz obidvoch zemí indikuje, že zatiaľ čo české Ministerstvo financií (MF ČR) dosiahlo v priemere nižšie štandardné chyby (AFE, RMSE, MAPE), slovenský Inštitút finančnej politiky (IFP) si viedol lepšie v porovnaní s benchmarkom naivnej prognózy (MASE), čo naznačuje možnú vyššiu pridanú hodnotu prognózy vo viac volatilnom ekonomickom prostredí. Medzinárodné zrovnanie ale ukazuje, že čo sa presnosti rozpočtových prognóz týka, tak obidve krajiny nedokázali úspešne absorbovať náraz krízy v rokoch 2007-2008 a ich predikcie vykazovali pomerne vysoké hodnoty chybových ukazovateľov, čo ich zaraďuje medzi prognosticky skôr slabšie krajiny Európy ako sú Grécko alebo Španielsko. S ohľadom na tento fakt je článok ukončený sériou doporučení pre českých aj pre slovenských rozpočtových prognostikov ako aj pre celkovú rozpočtovú politiku obidvoch krajín.

Kľúčové slová

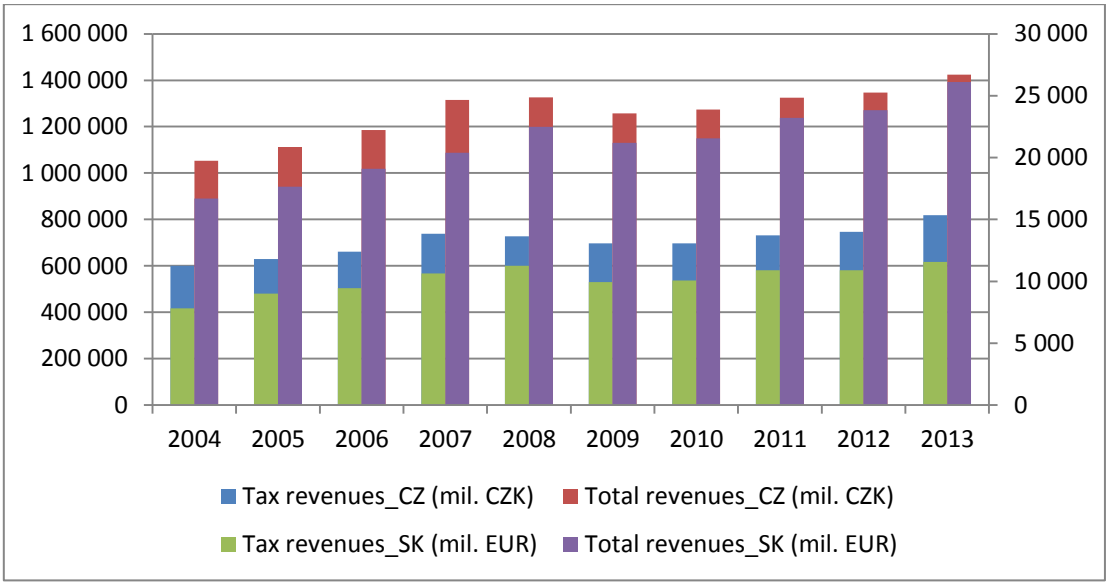
Daňová prognóza, Absolútna prognostická chyba, Percentuálna prognostická chyba, Relatívna prognostická chyba, Fiškálna politika

Introduction

Tax revenues form the backbone of modern public finance. With respect to this, forecasts of tax income hold a crucial position in governmental fiscal policy, as they determine not only the amount of money available, but also projected government debt and, to a large extent, a country´s overall macro-development (Arnold et al., 2011). There is a clear linkage documented between forecasted tax revenues and government fiscal behaviour (e.g. Chatagny & Soguel, 2012, Fjelstad et al., 2014), further underlining the crucial position tax revenue predictions hold in the budgeting process.

In a Czech and Slovak context, tax revenues[2] constitute a strong majority of total revenues the government (public administration) has available (graph 1).

Graph 1: Tax vs. total general government revenues



Source: MF SK, Czech Statistical Office (2014)

In both cases, revenues from taxes are divided almost equally into indirect (ESA 95 code D5 – mostly VAT, consumption tax) and direct (ESA 95 code D2 – mostly personal and corporate income tax) taxes, with the indirect receipts forming a strong majority of the total income[3]. In the Czech Republic as well as in Slovakia, the overall tax revenue increased substantially in the surveyed period; in the first case from over 600 billion CZK in 2004 to 747 bln. CZK in 2013, while in the second from 7.8 bln. EUR (2004) to 11.5 bln. EUR (2013). However, in the

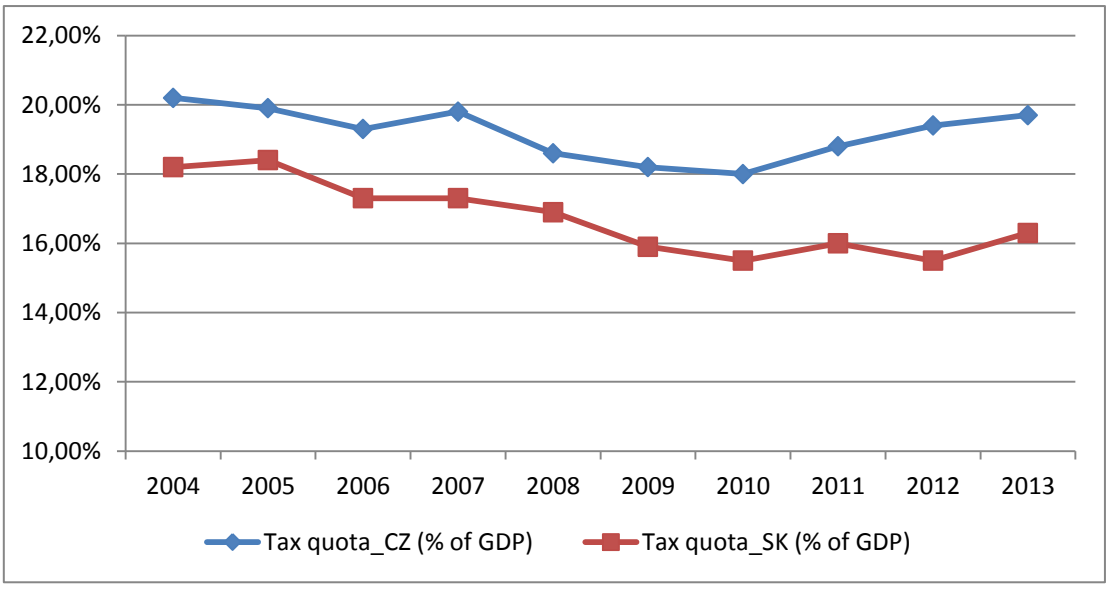
[2] We deal only with tax revenues as such (ESA 95 methodology aggregates D2, D5 and D91). Social insurance and other Czech/Slovak government revenues follow a different infrastructure, hence they are not part of this proportion and are not included in the analysis. Further details are outlined in the Data part.

[3] As of 2013, indirect taxes accounted for 63.08% (CZ) / 65.7% (SK) of the total tax revenues, while direct taxes comprised 36.89% / 34.4%.

same period both countries experienced rising government debt and exhibited difficulties in complying with the Maastricht criteria. As in the whole of Europe, a macroeconomic cool down was felt as well, with Czech Republic real GDP going down by 4.5% in 2009 and Slovakia following the same year with -4.9%. All of these circumstances put additional pressure on accurate and reasonable tax forecasts, which underpin government decision-making and crucial fiscal projections.

Apart from exogenous changes in the macroeconomic environment, changes in the underlying tax system are frequent in both countries. In the surveyed period, numerous modifications of tax legislation were undertaken, influencing the total tax revenue as well as its distribution among taxpayers. As documented by the tax quota (% of GDP – graph 2), these changes affect the gross tax system substantially and often go contra to the macro economy trend[4], thus altering its forecastability. This raises additional concerns: it is actually possible for the relevant bodies to accurately predict tax revenues in the medium and long term, i.e. offer better performance than for example a naïve forecast? Without a doubt, the answer is of critical importance for the government itself as well as for its taxpayers.

Graph 2: Tax quota (tax revenues v. GDP)



Source: Eurostat, 2014.

From a theory perspective, the topic of tax revenues forecasting has drawn considerable attention in recent (e.g. Krause & Douglas, 2013; Krause & Lewis, 2013; Frankel, 2011;

[4] Probably the most pregnant example, as a result of 2006 tax reform, the Czech tax quota was re-structuralized and lowered by an amount equal to 4.7% of GDP in 2009-2011 (MF, 2009; MF, 2011). In the same period, substantial reforms were undertaken in Slovakia as well.

Buettner & Kauder, 2010; Goeminne et al., 2008) as well as in the earlier (e.g. Auerbach, 1999; Rodgers & Joyce; 1996, Brettschneider & Gorr, 1992; Cassidy et al., 1989) international literature. Most of the research is directed towards three main topics: organizational policy and political influences on tax forecasting (Krause & Douglas, 2013; Krause & Lewis, 2013, Brettshneider & Gorr, 1992), different model synthesis and assessment (Kaiser & Yu, 2012; Grizzle & Klay, 1994; Fullerton, 1989) and, finally, direct evaluation of forecasting accuracy of institutions (Frankel, 2011; Buettner & Kauder, 2011; Auerbach, 1999). Geographically, most of the relevant papers mentioned come out of Northern America or Western Europe, but only very few cover tax forecasting in Central or Eastern Europe, which for the most part is not within the Eurozone (Frankel & Shreger´s 2012 paper being a rare exception). Czech and Slovak tax forecasts, in particular, are avoided in nearly all such analyses, with only very few papers making at least a passing reference to our content (Sancak et al., 2010). This creates a remarkable gap in comparison with the domestic literature outlined below.

From a factual perspective, the papers dealing with tax revenues brought up diverse evidence. A notable part discovered significant forecasting bias both predominantly upward (e.g. Auerbach, 1999; McNab et al., 2007; Forni & Momigliano, 2004; Frankel & Schregel, 2013), but also downward (Rodgers & Joyce, 1996; Williams, 2012), with political influences being cited as the main reason (Frankel & Shreger, 2012; Alesina & Perotti, 1999). While there are also papers with more positive conclusions (e.g. Becker & Buettner, 2007), the concurrent research provides a strong message that tax revenue forecasts are (i) potentially prone to systemic bias and (ii) the performance of different institutions varies greatly. The second point is further amplified by comparative studies available, which mostly indicate significant differences between two or more surveyed countries/institutions (e.g. Afonso & Carvalho, 2014; Frendreis & Tatalovich, 2000). In a methodological sense, most of the papers rely on a combination of scale-dependent (MAE, RMSE) and percentage errors (MAPE), with comparisons with the naïve benchmark (relative errors family) also available. A relative minority then employ more exact methods (t-test, serial correlation, structural equations), possibly because of data issues related to frequent reporting changes.

From a Czech and Slovak perspective, tax forecasting maintains a relatively decent foothold in academic literature, mainly in the Czech context. As with the international papers, some studies focus on the method part of the problem (Bezděk & Stiller, 2000), yet many others

deal directly with the accuracy of published forecasts (Špalek & Moravanský, 2005; Hering, 2010; Bayer, 2011; Sedmihradská & Čabla, 2013). The majority of the papers (Špalek & Moravanský, 2005; Hering, 2010) agree that the Czech Ministry of Finance (MF) tax revenue forecasts exhibit a cautious approach with regular under-forecasting and competitive accuracy. This outcome corresponds with the evaluation conducted by the MF itself (Lang, 2008), where it claimed almost constant under-forecasting and identified problems with long-term (3-year) predictions, particularly in comparison with the naïve forecast. There is some evidence pointing to a deteriorating performance in the recession years, yet rather limited in scope and method employed (Blažek et al., 2013). In the Slovak context, fiscal forecasting is delegated to the separate Financial Policy Institute (FPI), which also conducts periodical evaluations (e.g. Remeta & Strížencová, 2014; Remeta, 2013). Apart from that, however, very few independent research papers on the topic are available, and where they exist they deal with a model (Pavlik, 2008, Pavlik 2011) perspective. The FPI in its analysis identifies diverse performance, with mostly under-forecasting in the pre-crisis years of 2004-2008, then over optimism in 2009-2010 (accompanied by substantial errors) and finally gradually improving accuracy reaching peak levels in 2011-2013.

Critical dissemination of both Czech and Slovak papers reveals two important weaknesses. In the Czech context, the methodological background of the evaluations is sufficient following recommendations by Hynman & Koehler (2006) or Armstrong (2001), with diverse error measures applied (MAE, RMSE, MAPE, Theil´s U). Even exact test methods (F-test) were to be found, yet with limited scope. But the key limitation here consists of the time frame taken into account – all of the papers combined cover the period from 1993 to 2008, omitting the crucial years of 2009-2013. In the Slovak research, the situation is quite contrary: the whole 2004-2014 time frame is well covered, but by a limited combination of error metrics, consisting basically only of AE and MAPE. No squared measures or confrontation with a naïve forecast were provided. Furthermore, any international comparison or benchmarking is sorely missing.

With respect to the above, this paper seeks to critically evaluate tax revenue forecasts produced both by the Czech Ministry of Finance and the Slovak Financial Policy Institute, using a conclusive set of accuracy measures in the most recent time frame of 2004-2013. In order to achieve this goal, the paper is divided into three sections: first, selected evaluation methods and data parameters are outlined, then error measures are calculated for both the CR

and SR, and lastly, results are discussed in an international context and conclusions drawn. The outcomes of the research not only dispel uncertainty covering the forecasting performance of both countries, but also provide strong arguments in relation to the forecastability of government tax revenues as a whole.

Data and method

The paper deals with evaluation of the accuracy of total tax revenue forecasts produced by Czech and Slovak central authorities in the period 2004-2013. The projected tax revenues are defined on the basis of the ESA 95 method and are delimited by the following aggregates:

- D2 – Taxes on production and imports (indirect tax component)
- D5 – Taxes on income, wealth etc. (direct tax component)
- D91 – Capital taxes

In both the Czech Republic and Slovakia, these aggregates cover all of the general government tax revenues. In both surveyed countries, the analysed forecast (F_t) and real (Y_t) values are provided on an accrual basis, in accordance with the ESA 95 standard, thus reflecting the real economic nature of transactions instead of pure cash payments. Both countries transferred their reporting and data structures to ESA 95 (accrual) method in 2003/2004, with previous tax revenues depicted by a different (cash) method. This creates a substantial discontinuity that prevents extending the analysis further into the past, to pre-2004 years.

From a chronological perspective, the forecast values taken into account are provided by the autumn fiscal forecasts, which is in both countries commonly produced in October. Current year and next year forecasts as well as the two-year outlook are analysed, which enables us to evaluate a total number of four forecast horizons (t_Y-t_F): 3 months, 15 months, 27 months and 39 months. Such variance enables dissemination of performance in all fiscally vital horizons, i.e. short, medium and particularly the long-term one, crucial for budget outlooks and country expenditure frameworks. The real value data were provided by the Czech Statistical Office (CZSO) government sector evidence in the first case and by the Ministry of Finance, Slovak Republic (MF SK) budget statistics[5], in the other one.

[5] For the conversion of the data in relation to Slovakia´s 2009 adoption of the EURO (affects 2004-2007 forecasts), an official exchange rate of 30.126 SKK per EUR was used.

Method

Following the recommendations provided by literature (predominantly Hynman & Koehler, 2006 and Armstrong, 2001) a total set of four error measures was selected for the evaluation. Denoting forecast error (E_t) as ($Y_t - F_t$), we can define them as follows:

- **Average Forecasting Error (AFE)** – representative of a simple scale-dependent method, indicating the direction of the error deviation

$$AFE = \frac{E_t}{T}$$

- **Root Mean Square Error (RMSE)** – representative of a squared scale-dependent method, inherently putting contrasting heavier penalties on larger errors

$$RMSE = \sqrt{mean({E_t}^2)}$$

- **Mean Absolute Percentage Error (MAPE)** – percentage error family, enabling projection of error extent on the predicted quantity

$$MAPE = mean\left(\left|100 * \frac{E_t}{Y_t}\right|\right)$$

In addition, comparison with the naïve benchmark (forecast) is also provided. This metric holds special importance, as it indicates value added by active forecasting versus the passive extension of recent real values; it is also the most advanced evaluation method permitted herein by the restricted data time-frame. However, instead of the common Theil Inequality Coefficient (TIC), the author chose to use the **Mean Absolute Scaled Error (MASE)**. Apart from evading TIC´s inherent weakness to extreme values (Makridakis, 1993), application of MASE enables us to obtain an innovative, bias-resistant view of in-sample forecast accuracy, complementary to measures found in the already existing studies (e.g. Moravanský & Špalek, 2005):

$$MASE = mean\frac{|E_t|}{\frac{1}{n-1}\sum_{i=2}^{n}|Y_i - Y_{i-1}|}$$

The MASE method itself was introduced by Hynman & Koehler in their (2006) paper, particularly as a response to current relative measures (incl. the TIC value mentioned above). Contrary to most of these mainstream methods, which utilize a simple random walk as its

benchmark (naïve[6]) forecast, the MASE uses scaled MAE-based error calculated *in sample*. Such construction results not only in a measure resistant to outliers, but also robust when infinite and undefined values are present. In common with other relative methods, MASE keeps its critical value related to 1 – when the error figure exceeds one, the evaluated forecast offers higher error than one-step naïve benchmark, conversely a figure lower than one indicates on average a smaller forecasting error v. benchmark. Moreover, with macro-fiscal time series being sometimes prone to quasi-martingale[7] composition (Thompson & Gates, 2007), we can assume institutional forecasts having difficulties surpassing the naïve forecast. This fact should be taken into account when going through the results.

According to evidence provided by available empirical research (e.g. Armstrong & Collopy, 1992; Makridakis and Hibon, 2000), the selected set of accuracy measures covers all important aspects of forecasting error, such as direction, magnitude and performance in changes, while offering fair construct validity (RMSE), fair reliability (MAPE) and high outlier protection (MASE). Furthermore, based on the review of relevant international literature in the introduction (particularly Auersbach´s and Frankel´s papers), it allows us to follow and complement the current evaluation mainstream in tax forecasting and ensures direct international comparability.

Results

Czech Tax Revenues Forecasts

The results of the analysis are calculated in three time intervals: on a yearly basis, for the whole time frame and in the three separate sub-intervals: growth years of 2004-2007, recession of 2008-2010 and stagnation (recovery) of 2011-2013. The accuracy of Czech tax forecasts is portrayed first (Table 1).

[6] **Naive forecast** is a model that assumes things will remain as they have been in the past; in time series, the naïve model extends the latest observation (Armstrong, 2001).

[7] **Martingale** is a sequence of random variables for which the expected value of the series in the next time period is equal to the actual value in the current time period (Armstrong, 2001).

	AFE (bln. CZK)				**RMSE** (bln. CZK)				**MAPE** (%)				**MASE**			
	3M	15M	27M	39M	3M	15M	27M	39M	3M	15M	27M	39M	3M	15M	27M	39M
2004	0,64	23,52	18,35	62,59	N/A				0,11%	3,73%	2,78%	9,47%	0,01	0,79	0,60	0,81
2005	14,97	28,03	79,01	16,29					2,38%	4,24%	10,71%	2,21%	0,50	0,92	1,02	1,46
2006	-1,06	25,12	-2,64	-54,57					0,16%	3,40%	0,36%	7,51%	0,03	0,32	0,24	1,82
2007	47,25	-21,90	-74,12	-108,5					6,40%	3,01%	10,63%	15,57%	0,61	1,96	2,47	236,92
2008	-8,81	-78,60	-114,4	-127,7					1,21%	11,28%	16,43%	18,34%	0,79	2,62	249,81	3,59
2009	41,24	-7,19	2,43	-11,47					5,92%	1,03%	0,33%	1,57%	1,38	15,71	0,07	0,75
2010	-6,16	1,02	-5,60	-9,42					0,89%	0,14%	0,75%	1,26%	13,46	0,03	0,37	0,48
2011	-5,44	-24,67	-29,60	N/A					0,74%	3,30%	3,86%	N/A	0,15	1,61	1,51	N/A
2012	17,10	-0,19	N/A	N/A					2,29%	0,02%	N/A	N/A	1,12	0,01	N/A	N/A
2013	15,04	N/A	N/A	N/A					1,96%	N/A	N/A	N/A	0,77	N/A	N/A	N/A
2004-2007	15,45	13,69	5,15	-21,05	24,79	24,74	54,96	68,80	2,26%	3,60%	6,12%	8,69%	0,29	1,00	1,08	60,25
2008-2010	8,75	-28,26	-39,20	-49,53	24,60	45,57	66,15	74,23	2,67%	4,15%	5,84%	7,05%	5,21	6,12	83,41	1,61
2011-2013	8,90	-8,29	-9,87	N/A	13,52	14,25	17,09	N/A	1,66%	1,66%	3,86%	N/A	0,68	0,81	1,51	N/A
2004-2013	11,48	-5,49	-12,66	-23,28	21,96	30,48	51,07	59,55	2,20%	3,35%	5,73%	7,99%	1,88	2,66	32,01	35,12

Czech MF´s forecasting performance visibly worsened in the recession (and reform) years of 2007-2008. While the MF was able to keep reasonable and conservative ("sandbagged") forecasts in 2004-2006, the year 2007 brought up a dramatic change. Not only did the MF exhibit substantially higher forecasting errors across all horizons, but the sign changed as well: from conservative undershooting this period successful. After that, however, the MF corrected its forecasting tools to the new reality and beginning with 2009 returned to conservative and mainly, much more accurate forecasts, compressing its MAPE errors under 5% or even 3%. The Year 2010 is the best example of this Going through the standard error measures (AFE, RMSE, MAPE), two trends are apparent. First, the transformation, with the lowest cumulative forecasting error of all the time frame.

Secondly, the MF´s forecasts exhibited notable incremental improvement, i.e. decrease of forecast error with the shortening time horizon (and conversely, increase of error with the lengthening one). In the majority of the years, longer-term forecasts exhibited higher errors than the shorter ones, with only a few examples exhibiting the opposite rule. Substantial short-term deviances can be found as well, particularly in 2007 (47.25 bln. CZK) and 2009 (47.25 bln. CZK) 3M forecast, but these are largely compensated by the fact that the forecast underestimated the real revenue, which is policy-wise much less risky than the "debt increasing or cuts prompting" over-forecasting. Conversely, the highest negative errors (2007-2008) included 27M and 39M predictions, indicating that fiscal decisions based on them must have been highly erroneous. Indeed, in the relevant years 2010 and 2011, Czech general government balance exhibited an extensive deficit of 122 and 161 bln. CZK respectively.

Regarding the comparison with the in-sample naïve forecast (MASE), the MF was able to offer higher accuracy mainly in the shorter-term 3M and 15M forecasts. But as the horizon lengthened, the MASE value generally increased and more often surpassed the critical value of 1, indicating worse performance than the naïve benchmark. This pattern was particularly evident in the two and three year outlook (27M and 39M) and as with the previous, in the shorter-term forecasts (3M and 15M) in the turbulent years 2007-2009. From the aggregate perspective, large errors "compromised" also the interval errors, as indicated by the average 2008-2010 or total 2004-2013 figures. However, being the average and not median aggregates, these need to be interpreted on the basis of yearly results.

Slovak Tax Revenue Forecasts

As for Slovak FPI/MF forecasting performance, the corresponding error measures are introduced in the following Table (t. no. 2):

	AFE (bln. SK/bln. EUR)[8]				**RMSE** (bln. SK/bln. EUR)[5]				**MAPE** (%)				**MASE**			
	3M	15M	27M	39M	3M	15M	27M	39M	3M	15M	27M	39M	3M	15M	27M	39M
2004	3,96	24,16	21,24	37,28	N/A				1,66%	8,99%	7,57%	11,77%	0,19	0,80	1,77	1,03
2005	14,40	11,85	28,74	29,24					5,36%	4,22%	9,07%	8,67%	0,48	0,99	0,80	1,43
2006	2,59	12,52	13,18	-47,07					0,92%	3,95%	3,91%	15,81%	0,22	0,35	0,65	1,19
2007	5,98	1,53	-59,85	-76,16					1,89%	0,45%	20,11%	25,03%	0,17	0,07	1,52	11,52
2008	-0,16	-2,45	-3,30	-3,45					1,46%	24,82%	32,69%	31,46%	0,24	1,87	15,04	3,96
2009	-0,56	-0,69	-0,70	-1,73					5,69%	6,80%	6,40%	15,82%	0,43	3,13	0,81	36,42
2010	0,03	-0,29	-0,91	-1,04					0,32%	2,60%	8,28%	8,94%	0,15	0,33	19,07	1,58
2011	-0,14	-0,58	-0,34	N/A					1,29%	5,32%	2,97%	N/A	0,16	12,25	0,52	N/A
2012	-0,02	-0,11	N/A	N/A					0,18%	0,91%	N/A	N/A	0,42	0,16	N/A	N/A
2013	0,24	N/A	N/A	N/A					2,11%	N/A	N/A	N/A	0,37	N/A	N/A	N/A
2004-2007	6,73	12,51	0,83	-14,18	8,15	14,86	35,47	50,65	2,46%	4,40%	10,16%	15,32%	0,26	0,55	1,18	3,79
2008-2010	-0,23	-1,14	-1,64	-2,07	0,34	1,48	2,02	2,31	2,49%	11,41%	15,79%	18,74%	0,27	1,78	11,64	13,98
2011-2013	0,03	-0,34	-0,34	N/A	0,16	0,34	0,20	N/A	1,19%	3,11%	2,97%	N/A	0,32	6,20	0,52	N/A
2004-2013	-	-	-	-	-	-	-	-	2,09%	6,45%	11,38%	16,79%	0,28	2,22	5,02	8,16

Table 2: Error measures of Slovak tax revenue forecasts

[8] The data were divided into two periods: pre-EURO (2004-2007, unit SKK) and post-EURO (2008-2013, unit EUR). For the purpose of inter-year computations, the official exchange rate was used, as denoted earlier. An alternative method of data harmonization, i.e. converting the whole time frame to single currency, yields identical results.

As with the Czech Republic, Slovak tax forecasts exhibit substantial deficiencies in the 2007-2009 recession years. While the year 2008 should be treated cautiously (EURO transition), Slovak forecasts are disturbingly less accurate in almost every other year, particularly in the 2011-2013 period. While the long-term forecast errors can somehow be attributed to macroeconomic instability, the Slovak government still predicted its next-year tax receipts 5.32% (0.58 bln. EUR) higher in 2011. Prior to 2007, the Slovak MF was able to conservatively under-forecast its tax revenues, but the trend changed in 2008 to constant over-forecasting, with only the year 2013 showing the first sign of reverse. This development generally corresponds with the Czech parallel, but the MF CR seemed to reverse the trend one year earlier (at least in the case of short term 3M forecasts). Finally, the incremental improvement trend was in the case of Slovakia preserved as well, with longer-term forecasts almost constantly less accurate than their short-term counterparts.

From the naïve in-sample perspective, Slovak bodies were, contrary to the previous, able to achieve superior results. For all of the short-term 3M and six out of nine 15M forecasts, Slovak central forecasts fared notably better than the naïve benchmark. Such outcome can be interpreted as higher added value over the naïve extrapolation, reinforced by the higher underlying (tax revenues) volatility. In the 27M and 39M horizon, the balance equalled, but the Slovak tax predictions were much closer– more accurate – to the naïve forecast. Overall, the comparison of Czech-Slovak tax forecasts reveals similarities in the main trends, but also some differences: one in favour of the Czech MF in terms of standard error magnitudes (AFE, RMSE, MAPE) and the other in favour of the Slovak MF/FPI, in terms of performance vs. naïve benchmark.

Discussion

From a factual perspective, the common pattern of accuracy slump in 2007-2010 largely corresponds with the macroeconomic discontinuity, i.e. the transition from growth to a period of decline; the reasoning also offered by the relevant bodies themselves (e.g. MF, 2009; Bugyi, 2010). Arguably, the restrictive effect of the macro-slowdown was in both countries amplified by the consecutive tax reforms, aimed at restructuring of the tax quota and its decrease, whose impacts culminated in the period 2009-2011. Taking the aforementioned example, the Czech tax quota was affected by up to 174 bln. CZK (4.7% of 2008 GDP), potentially filling up much of the long-term errors in the crisis years (while the MF was able to accrue the impact of the changes in the short term, it is the long term forecasts, which are most affected). As a consequence, both countries failed to predict the incoming recession[9] and estimated unrealistically high tax receipts, resulting in ex-post corrective budget measures and stiff government debt increase. On the other hand, the post crisis performance in both countries improved considerably, indicating successful adaptation to changing conditions.

In a broader international (European) context, such accuracy pattern is not uncommon, as evidenced by the papers Jalles et al. (2011), Becker & Buettner (2007) and Alfonso & Carvalho (2013). What is disturbing is the magnitude of the errors attained: while Jalles et al. (2011) reported highest fiscal forecast errors (next year f. – recession) reaching 2-3% of GDP in the emerging countries panel, the relevant Czech and Slovak forecasts produced as much as 2.09/3.66% of GDP errors (2008), an outcome which would put them among the worst countries in the sample. This indicates inferior performance compared to most of the emerging economies, not to mention the advanced ones, generally more accurate. On the contrary, in the growth and post-recession periods, both Czech and Slovak bodies offered superior accuracy that prudently undershot the actual values most of the time, denying Frankel´s (2011) hypothesis of "higher over-optimism in booms" and not even approaching the systematically over-optimistic "PIGS" countries like Greece, Portugal or Spain (Alfonso & Carvalho, 2013).

As for the differences between MASE and standard error measures, these indicate on one hand superior accuracy of Czech tax forecasts in terms of standard error deviances (AFE,

[9] Similar forecasting performance pattern (over-optimism in the beginning of the cool down period) can be found in the background GDP forecasting as well, indicating a similar bias in the forecasting system.

RMSE, MAPE), yet on the other hand better performance in comparison vs. naïve benchmark in the case of the Slovak ones. Considering the construction of the MASE indicator, this outcome can be explained by either higher overall accuracy or increased background instability. Quick analysis reveals that Slovakia indeed dealt with higher volatility of tax revenues[10] (0.11 vs. 0.07 CZ) as well as the overall economy in terms of GDP growth[11] (4.15 vs. 3.57), the crucial impact of which on tax forecasting is well documented (Frankel, 2011; Sancak et al., 2010). These facts further support the thesis that although on average less accurate, the Slovak MF/FPI predictions contributed to the fiscal process with superior added value in the more difficult economic environment. Coming back to the martingale problem mentioned in the method part, this outcome can also be attributed to greater dissimilarity with a martingale-like process in the case of the Slovak data, meaning that a greater degree of volatility can be predicted using past values. Such hypothesis, however, requires additional verification.

From a fiscal-theory point of view, the Czech part of the study did not confirm continuation of trends identified by Blažek et al. (2013). From at least 2010, the Czech MF substantially reduced forecasting error on all horizons and even managed to change its sign, thus discontinuing the period of "systemic over-forecasting" and denying suspicion of "pro-cyclicality" of the forecast. This indicates successful absorption of the crisis shock in the forecasting model as well as strict budget targeting, fulfilling recommendations set by Blažek´s team. The results, on the other hand, did correspond with a dependence described by Chatagny & Soguel (2012). In both CZ and SK cases, the years where the forecast underestimated the real revenues mostly ended with lowest deficit and vice versa, seemingly suggesting positive effect of tax under-forecasting on sovereign fiscal behaviour. However, the systematic nature of the phenomenon is worth further investigation, as the "good years" were also frequently the ones with the highest GDP growth and government spending, implying the problem offers a strong alternative hypothesis in terms of business-cycle dependency.

[10] Because of different units (currencies), a variation coefficient was used.
[11] Standard deviation.

Conclusions

The aim of this paper was to critically evaluate Czech and Slovak central tax forecasting on a methodologically sound basis. Using a combination of four error measures, we discovered the following:

- The accuracy of tax forecasts in both countries was clearly related to overall economy development. While in the growth periods both countries produced relatively low and conservative ("undershot") errors, in the crisis years of 2008-2010 the error measures skyrocketed and both Czech and Slovak governments grossly overestimated its revenues. International comparison shows that this turning point was much less expected by both countries than their (western) European counterparts, particularly with respect to the long-term predictions.
- On the contrary, the overall shape of the forecasting error does not indicate the presence of a systemic error (i.e. persistent over or under-forecasting). Beginning 2011/2012, both countries returned to conservative forecasting and gradually changed the sign of their errors to prudent "sandbagging". In this, they surpassed most of the European countries considered as negative benchmarks (i.e. Greece or Portugal).
- Incremental improvement in the forecasting is clear. In nearly every year, the short-term predictions offered notably lower inaccuracy than the long-term ones, stressing the fiscal irreplaceability of 3M and 15M horizons along with periodic forecast revisions. This fact is further underlined by the in-sample naïve benchmark comparison (MASE), which highlights the fact that in whole periods (e.g. 2007-2009), the long-term forecasts (27 & 39M) offered little added value over the naïve benchmark.

Apart from the factual outcomes themselves, the performance of Czech and Slovak bodies also has vital implications towards both countries´ fiscal policy and forecasting process. These can be summed up in three general recommendations:

- While predicting trend breaking point remains a serious challenge of the forecasting discipline, both countries display significant room for improvement in their forecasting process in relation to this phenomenon. For this reason, an additional component of conservativeness should be incorporated in the forecasting process, particularly for the long-term outlooks (27 and 39M). Coming out of the 2007-2009

vs. 2010-2013 error, this mechanism should be explicitly triggered during long periods of high growth, when a reverse of the business-cycle can be expected[12]. Reflecting the complexity of tax-collecting procedures, the revision of forecasting model should not be a one-time step, but rather a continuous effort.

- Arguably, frequent changes of the tax system alter the forecastability of the tax revenues. While the study did not bring conclusive results in terms of the effect size, it is possible to assume that these changes affect predominantly the long-term forecasts. While a minor argument in favour of tax system stability, it is another reason for the obligatory conservativeness of the long-term forecasts. Also, incorporating meaningful scenarios of possible political incursions (based on the key parties´ programs) into the tax forecasting model seems vital, particularly for the long-term predictions.
- Finally, the study also provides indirect findings on the institutional framework of the forecasting, when comparing accuracy of the politically managed Czech Ministry of Finance and the quasi-independent Slovak Financial policy institute. The results mildly favour the Slovak FPI layout, which scored better performance over the naïve forecast in a more difficult environment, yet on the other hand detected lower standard errors in Czech forecasts, providing no definite answer. That can be potentially achieved after longer-term observation.

With respect to study limitations, the most notable one derives from the rather restricted time frame, resulting from methodological changes in the years 2003-2004. This limitation prevented meaningful application of exact tests (Diebold-Mariano, Wilcoxon t.) in order to evaluate the systemic nature of the proposed patterns. This creates two major implications for further research. First, longitudinal studies covering extended time frame are extremely important in order to analyse both countries performance in the repeated growth/decline situations. Secondly, with the longer dataset, application of exact tests is necessary to distinguish possibly random observations from statistically significant phenomena. Although experimental application of these on the current data-set revealed no major differences from the results described, this is of little statistical value and a future confirmation study is needed.

[12] For example, should the Czech government intentionally reduce their 27/39M tax forecast by 20% in the peak years of 2007 and 2008, where the impending recession was already felt, the AFE error would be reduced by 8.06% / 51.62% (2007) and 58.25% / 65.25% respectively (2008). Furthermore, all of the forecasts would be turned from over to under-shooting the real value. This is a fundamental improvement.

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