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On the Rationality of Medium-Term Tax Revenue Forecasts: Evidence from Germany

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On the Rationality of Medium-Term Tax Revenue Forecasts: Evidence from Germany*

Abstract

In the present paper I examine tax revenue projections in Germany over the period 1968 to 2012 with a focus on forecasting rationality. I show that tax revenue forecasts for the medium-term are upward biased. Overoptimistic revenue projections are particularly pronounced after the German reunification and reflect upward-biased GDP projections in this period. The predicted tax-GDP-ratio appears to be upward biased, as well. The forecasts are likely to overestimate tax revenues if the predicted tax-GDP-ratio exceeds its structural level of approximately 22 ½ percentage points. The results also indicate that forecast errors of short-term projections for the current year exhibit serial correlation. It is conceivable that the specific institutional setting can explain this non-rational behaviour to some extent.

JEL Code: E62, H20, H68.

Keywords: Tax revenue forecasting, forecast rationality, budgetary Planning.

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1. Introduction

Public budgeting receives increasing attention in the course of the fiscal crisis in the Eurozone and other OECD countries. The Treaty on Stability, Coordination and Governance (TSCG) in the Economic and Monetary Union (EMU) gives rise to a stronger focus on budgetary planning and monitoring at the European level. For European countries, a newly adopted fiscal rule postulates a tight limit of a structural budget deficit of 0.5 % of the gross domestic product (Art. 5 TSCG).

Accurate revenue forecasts are necessary to meet the budgetary targets. Chatagny and Soguel (2012) show that tax revenue forecast errors influence the budget balance, probably because overestimated revenue projections may be a substitute for explicit deficits in legislative budgets (Bischoff and Gohout, 2010). The analysis and improvement of fiscal planning and revenue forecasting practices is, thus, of interest for the scientific community as well as policymakers.

In Europe, Germany is seen as an example for successful public budgeting. Tax revenue forecasting has a long tradition in Germany. Since 1955 the Working Group on Tax Revenue Forecasting (AKS)¹, an advisory board at the federal ministry of finance, provides official tax revenue forecasts for the purpose of public budgeting in Germany.²

It is, however, controversial whether tax revenue projections in Germany are unbiased and efficient. Only a few studies analyse the rationality of tax revenue forecasts. A large part of the literature focuses on revenue forecasting at the federal level. According to Heinemann (2006), the forecasts of the tax-GDP-ratio in the medium-term financial plans at the federal level do not pass standard tests of (weak) rationality. In this line the German Federal Court of Auditors criticised the forecasting quality of the AKS. The forecasts appear to be over-

¹ Arbeitskreis "Steuerschätzungen" (AKS).

² See Fox (2005) on the institutional background and the history of the AKS.

optimistic and the Court proposed to examine the methodology of the AKS (Bundesrechnungshof, 2006). Recent studies, however, did not confirm that tax revenue forecasts in Germany are over-optimistic. They state that tax revenue forecasts at the federal level are unbiased in the short-run (Becker and Büttner, 2007, Lehmann, 2010, Büttner and Kauder, 2011). In a comprehensive study, Gebhardt (2001) examines the forecasting quality of tax revenue projections by the AKS. He stresses that the AKS provides conditional forecasts and that the forecast errors of the AKS may reflect overoptimistic GDP projections or inaccurate revenue estimations of tax policy changes.

Recent studies analyse the influence of political factors (Bischoff and Gohout, 2010, Büttner and Kauder, 2011,). Election-motivated politicians may try to manipulate revenue forecasts to increase the probability of re-election. In Germany, however, politicians hardly influence tax-revenue forecasts because the AKS is strongly independent (Büttner and Kauder, 2010). The federal government can, however, influence tax revenue forecasts by biasing the macroeconomic forecast of the government (which is conditional for tax revenue forecasters), or by tax policy changes (Gebhardt, 2001).

This study contributes to the discussion on the rationality of German tax revenue projections by examining a new dataset on medium-term tax revenue forecasts over the period 1968 to 2012. Contrary to previous research I show that tax revenue forecasts for the medium-term are upward biased. Overoptimistic revenue projections are particularly pronounced after the German reunification and reflect upward-biased GDP projections in this period. The forecasts are likely to overestimate tax revenues if the predicted tax-GDP-ratio deviates from its structural level of approximately 22 ½ percentage points. The results also indicate that forecast errors of short-term projections for the current year exhibit serial correlation.

2. Institutional Background

Since 1955, the AKS conducts tax revenue forecasts for the purpose of budgetary planning in Germany. The AKS meets regularly twice a year. At the end of every year, usually in November, the AKS provides official revenue forecasts for the next year's budget. It includes an update for the expected value of revenues in the current year t and a forecast for the next year (budget year) $t+1$ (short-run horizon). The tax projections are the predominant component of the revenue-side budget and determine the maximum level of expenditures in the legislative budget under a given fiscal rule.³

Since 1968 the AKS produces revenue forecasts for the medium-term budgetary plan (regularly in May). The German federal government introduced medium-term fiscal planning after the first post-war recession in 1967. In contrast to the federal budget, the medium-term financial plan is not adopted by the parliament and not legally binding. It represents, however, planning intentions of the government.⁴

The AKS consists of representatives of the federal government, the central bank (*Bundesbank*), the German Council of Economic Experts (*Sachverständigenrat*), economic research institutes⁵, the German States (*Laender*), the German cities council, and the federal statistical office. Before the AKS meetings, the federal government, the German central bank, the Council of Economic Experts and the economic research institutes individually provide unpublished tax revenue projections. All individual projections are, however, based on unique

³ The newly adopted fiscal rule in Germany restricts the structural deficit of the federal budget to 0.35% of GDP.

⁴ See Heinemann (2006), Lübke (2008), and Breuer et al. (2011) on medium-term fiscal planning at the federal level in Germany.

⁵ The Institute for the World Economy at the University of Kiel (IfW), the Halle Institute for Economic Research (IWH), the Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI) Essen, the German Institute for Economic Research (DIW) Berlin and the Ifo Institute – Leibniz Institute for Economic Research at the University of Munich (ifo) represent the German research institutes at the AKS.

assumptions about the macroeconomic outlook and conditional to the macroeconomic forecast of the federal government.⁶

The AKS enjoys a relatively high degree of independence, compared to international standards (Büttner and Kauder, 2011) because a large number of non-governmental institutions participate at the AKS meetings. The government would be able to influence the tax revenue projections of the AKS only by a strategic setting of the macroeconomic forecast and by changes in tax policy, which are both conditional for the AKS forecast. Tax projections are based on assumptions about the impact of changes in tax policy and, thus, tax revenue forecast errors may result from erroneous assumptions about tax policy (Auerbach, 1999 and Gebhardt, 2001). The AKS assumes no future changes in tax policy, if the change didn't pass the legislative process at the time of the forecast. The AKS incorporates revenue effects of changes in tax policy only when the appropriate bill passed the parliamentary process. Since policy-makers often change the tax code, these changes might significantly influence revenue forecast errors, particularly in the medium-term.

The AKS produces a joint tax revenue forecast at the general government level. Later, the AKS distributes the estimated sum of total tax revenues at the general government level to the territorial entities, the federal level, the state level and municipalities (regionalization). Different from previous analyses of fiscal forecasts at the federal – or state level (Heinemann, 2006, Bischoff and Gohout, 2010, Büttner and Kauder, 2011), in this paper I analyse tax revenue forecasts of the AKS at the general government level. I do not analyse forecast errors at the federal or state level to abstract from changes in the regional distribution of tax revenues.

⁶ The VAT revenue forecast is based on the forecast of the level of private consumption. The wage tax is linked to the expected growth rate of the national wage bill, and expected employment. See Körner (1983), Flascha (1985) and Gebhardt (2001) on the revenue dynamics of selected taxes and on the relationship between selected taxes and their tax bases.

3. Data and Descriptive Statistics

After the meeting of the AKS, the federal ministry of finance publishes the results of the official tax revenue forecast and releases a press statement (BMF 1968 – 2012a; BMF 1968 – 2012b). In the present study, I use data on tax revenue forecasts and respective forecasts of the nominal GDP by the federal government (GNP before 1994) for the current year (t) to the fourth year to the future ($t+4$) based on the regular AKS reports during the years 1968 to 2012. To construct forecast errors for tax revenue projections at time t for the year $t+h$, I use the first official realization, which is available in the AKS reports of the year $t+h+1$, where t denotes the date of the forecast and h indicates the forecast horizon.

The GDP forecast error $e_{t,t+h}^y$ is the difference between realization $y_{t,t+h}$ and forecast $y_{t,t+h}^f$ of the GDP growth rate for year $t+h$ at time t :

$$e_{t,t+h}^y = y_{t,t+h} - y_{t,t+h}^f \quad (1)$$

The tax revenue forecast error is the difference between realization and forecast of the growth rate of tax revenues r for the year $t+h$ at time t :

$$e_{t,t+h}^r = r_{t,t+h} - r_{t,t+h}^f \quad (2)$$

Finally, the forecast error of forecast for the tax-GDP-ratio q is

$$e_{t,t+h}^q = q_{t,t+h} - q_{t,t+h}^f = \frac{r_{t,t+h}}{y_{t,t+h}} - \frac{r_{t,t+h}^f}{y_{t,t+h}^f} \quad (3)$$

Figure 1 shows the forecast errors of tax revenue forecasts, the appropriate GDP projections and the tax-GDP-ratio. A positive value indicates an underestimation (of tax revenues, GDP or the tax ratio), and a negative coefficient denotes an overestimation. I classify forecast errors of the same forecast made in year t with the number 0 to 4, indicating the forecast horizon h . In this study, the forecast error of the year 1968 with the forecast horizon 4 describes the forecast error of a revenue projection made in the year 1968 and projecting revenues for the year 1972.

The German reunification causes a structural break in the time series. German federal taxes do not distinguish between new and old German Laender. Because of this, forecast errors of forecasts made in a year before reunification, predicting revenues for a year after the reunification contain a bias. Therefore, I exclude forecasts conducted before 1991 and predicting periods after 1991 to control for the effect of reunification. I distinguish between two periods: (1) the pre-reunification period 1968 – 1990 and (2) the post-reunification period, starting in 1991.

Table 2.1 shows standard measures of forecasting quality, the mean error (ME), mean absolute error (MAE), root mean squared error (RMSE) and Theil's (1966) inequality coefficient (U) for the forecast errors of tax revenues, GDP and the tax-GDP-ratio. The mean error shows a negative sign for multi-year forecasts, indicating a propensity to overestimate tax revenues. The prediction quality decreases with the forecast horizon h , since the MAE and the RMSE increase with h . Theil's inequality coefficient compares the observed mean square error to the mean squared error of a benchmark forecast. I define the benchmark projection as the last observed value in the year prior to conducting the forecast. If the coefficient exceeds one, the benchmark forecast would improve the prediction quality of the forecast at the respective horizon. A comparison between the benchmark forecast and the forecast by the AKS shows that the AKS forecasts of tax revenues and of GDP perform better than a benchmark forecast. A naïve projection of the tax-GDP-ratio would better match the future

tax ratio than the AKS forecast in the medium-term. Given a conditional forecast for GDP, it is conceivable that a naïve extrapolation of tax revenues, keeping the tax-GDP-ratio constant, improves the forecasting quality of the AKS.

4. Empirical Analysis

A) Unbiasedness

Rational forecasts presuppose unbiasedness and efficiency. An unbiased forecast implies that the mean forecast error is not significantly different from zero. To test for unbiasedness, Holden and Peel (1990) suggest estimating the condition of $\alpha_0 = 0$ in the following equation:

$$e_{t,t+h}^r = r_{t,t+h} - r_{t,t+h}^f = \alpha_0 + u_t \quad , \quad (4)$$

where $e_{t,t+h}^r$ is the forecast error of the h -step ahead forecast of tax revenues $r_{t,t+h}^f$ at time t and $r_{t,t+h}$ denotes the realized tax revenue at time $t+h$. I apply equation (4) for the analysis of tax revenue forecasts, GDP forecasts and forecasts of the tax-GDP-ratio. The forecasts are unbiased if the null-hypothesis of unbiasedness ($\alpha_0 = 0$) cannot be rejected.

B) Weak rationality

The literature on forecasting accuracy applies models in the tradition of Mincer and Zarnowitz (1969), to test for (weak) rationality (Feenberg et al. 1989):

$$r_{t,t+h} = \alpha_0 + \alpha_1 r_{t,t+h}^f + u_t \quad (5)$$

where $r_{t,t+h}^f$ describes the h -step ahead revenue forecast at time t , and u_t is an error term which coincides with the forecast error when the forecast is unbiased (Mocan and Azad, 1995). I rearrange (2) to obtain the forecast error on the left-hand side:

$$e_{t,t+h}^r = r_{t,t+h} - r_{t,t+h}^f = \alpha_0 - (1 - \alpha_1)r_{t,t+h}^f + u_t \quad (6)$$

Weak rationality requires that $\alpha_0 = 1 - \alpha_1 = 0$. While a positive (or negative) coefficient α_0 suggests a tendency towards under- (or over-) estimation, the coefficient $(1 - \alpha_1)$ indicates a relationship between the forecast value and the forecast error. The forecasts are (weakly) rational, if the individual null hypothesis $\alpha_0 = 1 - \alpha_1 = 0$ cannot be rejected.

C) Strong rationality

Strong rationality implies that the forecast is unbiased and efficient. An efficient forecast contains all relevant information that is available at the time of the forecast (Nordhaus, 1987). I test for efficiency by using equation (7), where $X_{i,t}$ represents n variables assumed to be part of the information set of the forecaster at time t :

$$e_{t,t+h}^r = r_{t,t+h} - r_{t,t+h}^f = \alpha + \sum_{i=1}^n \beta_i X_{i,t} + u_t \quad (7)$$

If we cannot reject the null-hypothesis ($\beta_i = 0$), the forecasts $r_{t,t+h}^f$ are efficient and, thus, (strongly) rational. $X_{i,t}$ include the previous year's forecast error for the current-year forecast (forecast revision for year $t-1$) to test for serial correlation of forecast errors. Additionally, I include the projected tax-GDP-ratio. Moreover, it is conceivable that forecasts appear to be particularly optimistic in a certain macroeconomic environment, i. e. when budget deficits are

large, or in times of economic crisis. Particularly in times of large budget deficits, governments might tend to produce over-optimistic forecasts. To control for these factors, I additionally include the (previous year's) general government deficit, as well as the (lagged) GDP growth rate, and assume that both variables are part of the information set of the forecasters at the time when the forecast is made.

5. Results

A) Unbiasedness

Table 2 shows the results of equation (4), the coefficients (α_0) and the respective standard errors. The coefficients for $h > 0$ are negative, indicating that the AKS overestimated tax revenues for multi-year forecasts during the period 1968 – 2011. Forecasts with multi-year forecast horizons are prone to autocorrelation (McNees, 1978). All numbers in parentheses report autocorrelation-consistent (Newey-West) standard errors.⁷

Panel A) shows that tax revenue forecasts for the current and the subsequent year are unbiased, however, the mean error for the horizon $h = 4$ is 7.2 % and significant at the 10 % level (row no. 5). The results are not very pronounced before the reunification, but statistically significant for medium-term forecasts after 1991. After the reunification, the forecasts overestimated tax revenues on average by 10.9 % at the end of the forecast horizon ($h = 4$). The results are, however, sensitive to sample variations.

⁷ The Durbin-Watson statistics indicate the presence of positive autocorrelation, particularly for medium-term forecasts.

Figure 2 shows the results of recursive estimations of equation (4) for different forecast horizons ($h = 1, \dots, 4$). For short-run tax revenue forecasts, the coefficient α_0 does not turn out to be statistically significant at conventional levels for any sample variation. Forecasts for the medium-term start (e. g. $h = 4$) with a positive coefficient α_0 , indicating that the AKS underestimated tax revenues at the beginning of the sample in the late 1960s and early 1970s. The coefficient decreases in the 70s and changes the sign in the 80s, reflecting a tendency towards overestimation in this period. The coefficient increases again after 2003, indicating that the forecasts are less overoptimistic after 2003. The right-hand side of figure 2 displays recursive estimations of the post-reunification sample, starting in 1991. The coefficient α_0 appears to be negative at all horizons. The forecasts are particularly prone to over-optimism in the post-reunification episode. The results are significant already for the short-run ($h = 1$), but particularly striking for medium-term forecasts. The tendency towards over-optimism decreases after 2003, but the overoptimistic bias for multi-year forecasts (horizon 2, 3 and 4) is statistically significant for the entire post-reunification sample.

The GDP projection of the federal government has been overoptimistic during the period 1968 and 2011 as well (row no. 6 to 10 of table 2). The overoptimistic bias of the GDP forecast is particularly pronounced and statistically significant at conventional levels only after reunification, indicating that the forecast uncertainty of GDP projections after German reunification increased and the positive expectations in the aftermath of the German reunification have not been realized. The bias is significant after reunification, already for forecasts with the horizon $h=1$ (short-run). It seems that the overoptimistic GDP projections after reunification influenced the overoptimistic tax revenue forecasts, so that the forecast of the tax-GDP-ratio does not exhibit a significant bias in this period (row no. 11 to 15).

Panel C) of table 2 shows the results of equation (4) for the tax-GDP-ratio. The results show that we can reject the hypothesis of unbiasedness for forecasts of the tax-GDP-ratio with the horizon 3 and 4 (row no. 14 and 15). The projected tax-GDP-ratio, thus, exhibits an

overoptimistic bias. The bias increases with the forecast horizon. At the end of the forecast horizon ($h=4$) the AKS overestimated the tax-GDP-ratio by 0.64 percentage points. This result is statistically significant at the 5 % level.

B) Weak rationality

Table 3 shows the results of the tests for weak rationality. Row no. 1 to 5 show the results for tax revenue forecasts, and row no. 6 to 10 depict the results for GDP projections of the federal government. The results show that we cannot reject the hypothesis of (weak) rationality for both, tax revenues and GDP projections, at all horizons ($h=0, 1, \dots, 4$). The forecasts of the tax-GDP-ratio, however, do not pass the tests of weak rationality. The respective F-statistics reject the hypothesis that $\alpha_0 = 1 - \alpha_1 = 0$ at conventional levels (p-value < 10 %). The results are stronger pronounced for medium-term forecasts, but even short-run forecasts of the tax-GDP-ratio are not (weakly) rational (row no. 11). Equation (5) implies that if the tax ratio forecast denoted by the coefficient $-\frac{\alpha_0}{1-\alpha_1}$ is exceeded, the forecast is likely to overestimate the tax-GDP-ratio. According to the results in table 3, this coefficient turns out to be close to the historical trend of the tax-GDP-ratio of 22 ½ percentage points.

C) Strong Rationality

Table 4 shows the results of equation (7), where $X_{i,t}$ includes variables that are part of the information set when the forecasts are made. I include the previous year's forecast error for the current-year forecast (forecast for year $t-1$ made in $t-1$) to test for serial correlation of forecast errors. It is conceivable that forecasts appear to be particularly optimistic in a certain macroeconomic environment, e. g. when deficits are large, or GDP growth is low. To control

for these factors, I additionally include the (previous year's) general government deficit, the (previous year's) GDP growth rate, as well as the predicted tax-GDP-ratio, which are part of the information set of the forecasters at time t .

The AKS forecast of tax revenues do not pass this test for (strong) rationality. The results in table 4 suggest that forecast errors of projections for the very short-run (current year) exhibit positive serial correlation (column 1). It is, thus, likely that the AKS forecast for the current year is overoptimistic, if the forecast of last year's tax revenues turned out to be overoptimistic as well. Serial correlation in revenue forecast revisions seems to be a prevalent issue. Auerbach (1999) pointed to the appearance of serial correlation of tax revenue forecast revisions in the United States. For multi-year forecasts, however, the results do not indicate that previous errors determine future forecast errors. Tax revenue forecasts are, however, likely to overestimate tax revenues if the projected tax-GDP-ratio exceeds $-\frac{\alpha}{\beta}$. The critical tax ratio $-\frac{\alpha}{\beta}$, again, turns out to be close to the structural tax ratio of approximately 22 ½ percent.

In table, I repeat the regressions of equation (7), but exclude variables that turn out to be insignificant for most of the specifications, and test, whether the predicted tax-GDP-ratio, influences the tax revenue forecast error. I do not include (lagged) forecast error for the horizon $t=0$, because it has been significantly affecting the forecast error only in column 1 of table 2.4.⁸ The predicted tax-GDP-ratio turns out to be significantly correlated with the forecast error of tax revenues with the same horizon in most of the specifications, indicating that the predicted tax-GDP-ratio influences the tax revenue forecast error. The p-value of the appropriate F-statistics shows that we can reject the hypothesis of (strong) rationality at every horizon. The results are particularly pronounced for multi-year forecasts, but statistically significant for short-run tax revenue forecasts, as well.

⁸ I show the results, including the lagged forecast error for current year's forecasts, in the appendix.

6. Determinants of Forecast Errors

The results, as presented in table 4 and 5 imply that the AKS fails to forecast tax revenues efficiently. It is, however, conceivable that other unknown determinants influence the forecast error (unobserved variable bias). To account for other factors and to analyse the determinants of tax revenue forecast errors, I apply regressions of equation (7), where $X_{i,t}$ includes determinants of tax revenue forecast errors, known or unknown a time t . I include the GDP forecast error of the GDP forecast by the government with the same forecast horizon, as well as tax policy changes to account for the influence of political and economic factors. Both variables are not available at the time when the forecast is made, but certainly influence the forecast error of tax revenue forecasts.⁹ The variables are influenced by decisions of the federal government, so that it is worthwhile to analyse whether the test for efficiency shows the same results after controlling for these factors. Figure 3 depicts the estimated influence of tax policy changes on tax revenues, based on published calculations by the German federal government.¹⁰

Table 6 shows the estimated influence of potential determinants on the tax revenue forecast errors. It turns out that the GDP forecast error positively influences the tax revenue forecast at every horizon. The coefficient is approximately one, what is in-line with assumptions about the GDP elasticity of tax revenues. Moreover, changes in tax policy affect the forecast error positively.

⁹ In this line Büttner and Kauder (2011) analyze the influence of GDP forecast errors, as well as changes in tax policy, on short-term revenue forecast errors.

¹⁰ Since 1967, the German federal government estimates the impact of tax policy changes at the general government level and publishes the estimations in the annual reports of the federal ministry of finance (BMF, 1968-2012c). For every year t , I calculate the sum of the estimated impact of changes in tax policy, and afterwards, the estimated impact per (last year's) tax revenue.

The estimated coefficient, however, turns out to be low, indicating that the estimated impact of tax policy is overestimated.¹¹ The integration of GDP errors and tax policy changes, however, does not diminish the effect of serial correlation in current year forecast errors (column 1). Moreover, the estimated tax ratio has a significant positive influence on the forecast error, indicating that an above-average forecast of the tax ratio increases the likelihood of an overoptimistic tax revenue forecast, even after controlling for GDP forecast errors and tax policy changes. These findings suggest, that GDP forecast errors, as well as tax policy changes (tax cuts), do not explain the forecast errors of the predicted tax-GDP-ratio. The effects of (previous year's) deficit and growth, however, does not have a significant impact on the tax revenue forecast error.

7. Conclusion

In the present paper I analyse the forecasting performance of the official tax revenue projections in Germany. Tax revenue forecasts and the forecasts of the tax-GDP-ratio are overoptimistic for projections in the medium-term. The overoptimistic bias of tax revenue forecasts, as well as GDP projections is particularly pronounced after the German reunification, so that the overoptimistic tax revenue projections may reflect overoptimistic GDP forecasts made by the federal government. It is conceivable that the uncertainty about

¹¹ It is conceivable that the government overestimates the revenue effect of policy changes and probably underestimates the potential feedback effects of tax changes on GDP. The estimation is based on assumptions about the timing of tax policy and it is conceivable that it is not possible to account perfectly for the influence of tax policy changes on revenue forecast errors with the measure of tax policy. For the regressions in table 6, I e. g. assume that tax policy in year t influences tax revenue forecast errors of the same year (column 1). For forecasts with the horizon 1, I assume that next year's tax policy changes influence the forecast error (of forecasts made in year t). For medium-term forecasts, I assume that all tax policy changes in the forecast horizon influence the forecast error, but excluding policy changes in a year when the forecast is made. This treatment is based on the assumption that the tax revenue forecasts do not include policy changes for the next year, because these policy changes didn't pass the parliamentary process at the time when the AKS meets (regularly in May).

potential GDP in the aftermath of the German reunification contributed to the overoptimistic bias of the GDP- and tax revenue forecasts, or that a decrease in trend growth rates affected GDP forecast errors for the medium-term in this period. It is also conceivable that the federal government decided to overestimate GDP and to improve fiscal forecasts in the medium-term budget outlook in order to cover the true costs of the German reunification. The propensity towards overestimation, however, decreased after 2004. Upward-biased GDP-projections and tax revenue forecasts may, thus, be a transitory phenomenon.

To avoid a suspicion that the federal government may influence tax revenue forecasts for a political purpose by strategically influencing the conditional macroeconomic forecast, it would be reasonable to rely on a more independent macroeconomic projection and by providing more independence to the AKS (Heinemann, 2006). The independent economic research institutes that are involved in the '*Gemeinschaftsdiagnose*' (GD)¹² prepare a macroeconomic forecast just before the government present its macroeconomic forecast.¹³ It would be worthwhile to use the joint economic forecast as the conditional benchmark projection for fiscal planning in Germany to avoid a possible political influence.

The forecasts of the tax-GDP-ratio fail tests for efficiency. My results show that short-run forecasts for the current year exhibit serial correlation. Additionally, if the forecasts of the tax-GDP-ratio deviates from the structural level (of approximately 22½ %), the forecasts are likely to over-/underestimate this ratio as well as the amount of tax revenues. According to my results, even a naïve projection of the tax-GDP-ratio for the medium term exhibits a better forecast quality than the AKS forecast. Keeping the tax-GDP-ratio constant would improve the forecasting accuracy of the AKS in the medium-term.

¹² A joint economic forecast of different research institutes on behalf of the federal government in Germany.

¹³ See Kirchgässner and Savioz (2001), Döpke and Fritsche (2008), and Döhrn and Schmidt (2011) on the joint economic forecast in Germany.

The AKS forecast is a conditional forecast based on assumptions about the macroeconomic outlook and tax policy changes.¹⁴ It is conceivable that overoptimistic GDP projections and regular tax reductions cause non-rational revenue projections. After controlling for the estimated impact of policy changes and GDP growth forecast errors, however, the results remain quite unchanged. Identifying the true reasons for a non-rational behaviour of government revenue forecasts in Germany would be a challenge for future research.

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¹⁴ See Don (2001) and Gebhardt (2001) on the problem of conditional forecasts.

Table 1

Summary Statistics

A) ME (%)			
	Tax revenue	GDP	tax-GDP-ratio
current year	0.27	0.03	0.01
year t+1	-0.39	-0.53	-0.07
year t+2	-2.23	-1.55	-0.28
year t+3	-4.68	-3.14	-0.49
year t+4	-7.20	-4.96	-0.64

B) MAE (%)			
	Tax revenue	GDP	tax-GDP-ratio
current year	1.57	0.83	0.29
year t+1	4.82	2.83	0.70
year t+2	7.86	5.20	1.00
year t+3	10.59	7.40	1.01
year t+4	14.00	10.16	1.04

C) RMSE			
	Tax revenue	GDP	tax-GDP-ratio
current year	1.99	1.08	0.39
year t+1	6.07	3.59	0.85
year t+2	9.38	6.35	1.19
year t+3	12.49	9.10	1.28
year t+4	16.60	12.37	1.32

D) Theil's U			
	Tax revenue	GDP	tax-GDP-ratio
current year	0.37	0.33	0.56
year t+1	0.58	0.51	0.89
year t+2	0.57	0.60	1.09
year t+3	0.53	0.58	1.13
year t+4	0.51	0.56	1.09

Note: The table shows the mean error (ME), mean absolute error (MAE), root mean squared error (RMSE), as well as the Theil's inequality coefficient (Theil's U) for tax revenue forecasts, GDP forecasts, as well as predicted tax-GDP-ratios, with the horizon 0 to 4.

Table 2

Tests of Unbiasedness

Row no.	h	Full Sample		D-W	Pre-Reunification		Post-Reunification	
A) Tax revenue								
1	0	0.27	(0.33)	1.49	0.19	(0.31)	0.36	(0.61)
2	1	-0.39	(1.05)	1.19	0.32	(1.34)	-1.17	(1.66)
3	2	-2.23	(1.80)	1.02	-0.58	(2.52)	-4.06	(2.49)
4	3	-4.68	(2.82)	0.52	-2.02	(4.15)	-7.63**	(3.24)
5	4	-7.20*	(4.00)	0.35	-3.89	(6.06)	-10.90**	(3.93)
B) GDP								
6	0	0.03	(0.20)	1.43	0.09	(0.29)	-0.02	(0.25)
7	1	-0.53	(0.72)	1.01	0.05	(1.20)	-1.17*	(0.59)
8	2	-1.55	(1.43)	0.52	0.06	(2.40)	-3.33***	(0.79)
9	3	-3.14	(2.18)	0.27	-0.67	(3.68)	-5.88***	(0.97)
10	4	-4.96	(3.01)	0.24	-1.90	(5.07)	-8.38***	(1.34)
C) Tax-GDP-ratio								
11	0	0.01	(0.06)	1.62	0.00	(0.07)	0.02	(0.11)
12	1	-0.07	(0.15)	1.13	-0.01	(0.18)	-0.14	(0.26)
13	2	-0.28	(0.21)	1.12	-0.21	(0.25)	-0.36	(0.38)
14	3	-0.49*	(0.25)	0.88	-0.37	(0.27)	-0.62	(0.46)
15	4	-0.64**	(0.30)	0.58	-0.51	(0.30)	-0.78	(0.52)

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Table 3

Weak Test of Rationality

Row no.	h	α_0	S. E.	$1 - \alpha_1$	S. E.	R ²	p-value	D-W
Tax revenue								
1	0	0.15	(0.50)	0.02	(0.05)	0.00	0.71	1.50
2	1	0.33	(1.83)	-0.06	(0.12)	0.01	0.60	1.15
3	2	-0.80	(3.48)	-0.08	(0.19)	0.01	0.61	0.95
4	3	-5.13	(5.74)	0.02	(0.22)	0.00	0.92	0.53
5	4	-6.72	(6.81)	-0.01	(0.19)	0.00	0.94	0.34
GDP								
6	0	0.33	(0.34)	-0.06	(0.05)	0.04	0.22	1.34
7	1	0.12	(1.28)	-0.06	(0.14)	0.01	0.53	0.96
8	2	-1.00	(2.32)	-0.03	(0.17)	0.00	0.80	0.50
9	3	-3.95	(3.40)	0.03	(0.19)	0.00	0.82	0.28
10	4	-4.75	(4.05)	-0.01	(0.17)	0.00	0.97	0.23
Tax-GDP-ratio								
11	0	1.90	(1.18)	-0.08	(0.05)	0.07	0.08	1.61
12	1	6.19**	(2.65)	-0.27**	(0.11)	0.17	0.01	0.99
13	2	10.26***	(3.37)	-0.45***	(0.14)	0.27	0.00	0.86
14	3	10.80***	(3.75)	-0.48***	(0.16)	0.29	0.00	0.68
15	4	10.18***	(3.58)	-0.45***	(0.15)	0.30	0.00	0.47

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Table 4

Strong Test of Rationality

Horizon	current year	t+1	t+2	t+3	t+4
Constant	0.09 (0.06)	0.36** (0.17)	0.62** (0.27)	0.72** (0.32)	0.82** (0.33)
Lagged Forecast Error (h=0)	0.35** (0.17)	0.46 (0.59)	-0.74 (0.78)	-1.14 (0.76)	-0.64 (0.64)
Tax Ratio Forecast	-0.39 (0.26)	-1.56** (0.72)	-2.87** (1.11)	-3.65*** (1.31)	-4.17*** (1.30)
Deficit (t-1)	-0.04 (0.11)	-0.01 (0.53)	-0.06 (0.77)	-0.85 (1.03)	-0.65 (1.10)
GDP Growth (t-1)	-0.17 (0.11)	-0.35 (0.44)	0.89 (1.02)	2.52 (1.64)	2.59 (2.02)
R ²	0.19	0.17	0.21	0.30	0.26
F- statistics	2.16	1.86	2.22	3.41	2.62
p-value	0.09	0.14	0.09	0.02	0.05
Observations	43	41	39	37	35

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Table 5

Tax Revenue Forecast Error and Tax Ratio Forecast

Horizon	current year	t+1	t+2	t+3	t+4
Constant	0.10 (0.07)	0.35* (0.18)	0.55** (0.27)	0.61* (0.33)	0.68** (0.33)
Tax Ratio Forecast	-0.43 (0.31)	-1.53* (0.79)	-2.46** (1.15)	-2.80* (1.41)	-3.19** (1.42)
R ²	0.08	0.11	0.13	0.12	0.10
F-statistics	3.43	4.88	5.93	4.70	3.78
p-value	0.07	0.03	0.02	0.04	0.06
Observations	44	42	40	38	36

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Table 6

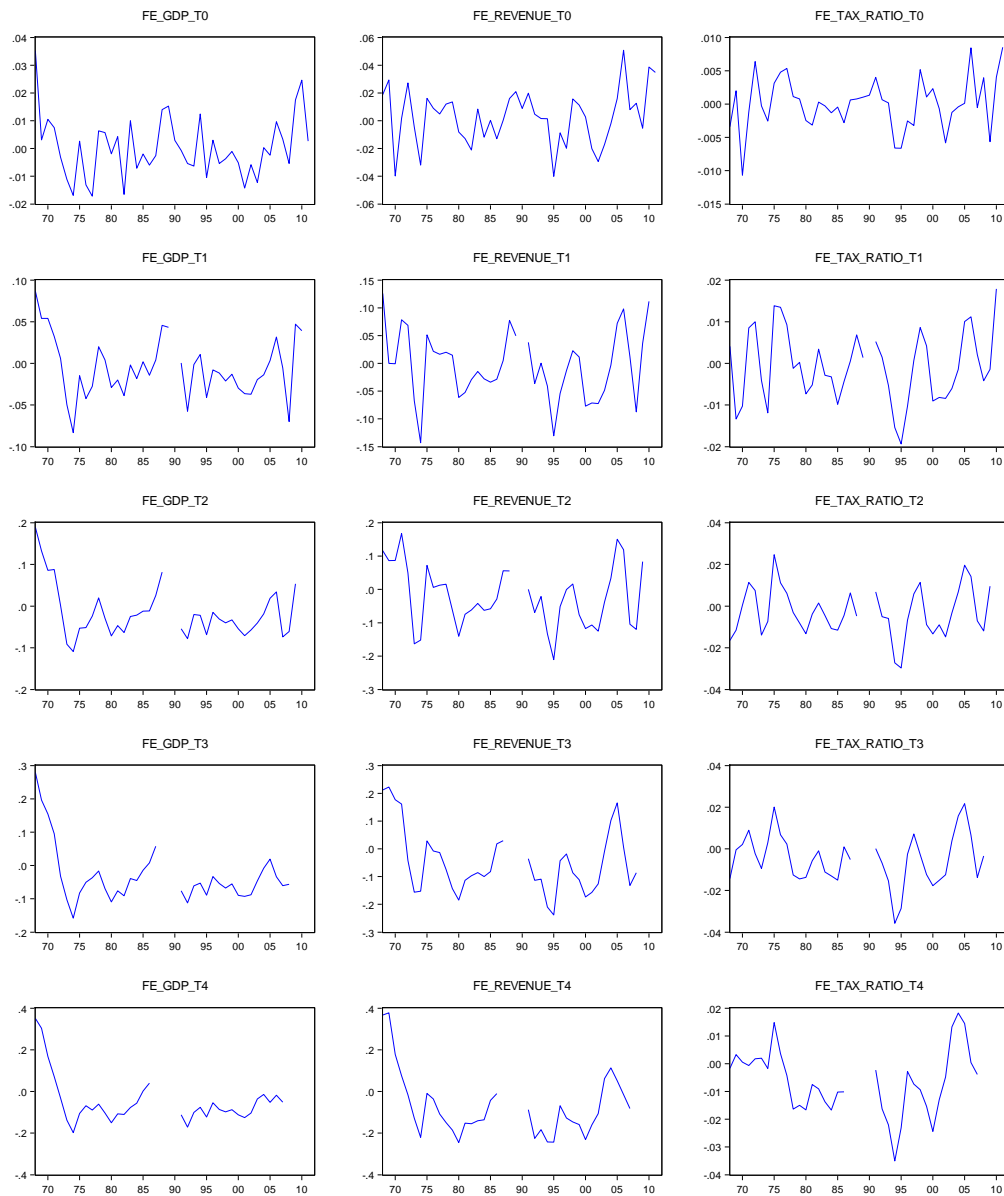
Determinants of Tax Revenue Forecast Errors

Horizon	t	t+1	t+2	t+3	t+4
Constant	0.08 (0.05)	0.26* (0.15)	0.44** (0.18)	0.52** (0.21)	0.57*** (0.19)
GDP Forecast Error	0.76** (0.28)	1.12*** (0.20)	1.14*** (0.18)	1.17*** (0.13)	1.18*** (0.10)
Changes in Tax Policy	-0.11 (0.10)	0.39* (0.22)	0.53*** (0.19)	0.24 (0.26)	0.00 (0.24)
Lagged Forecast Error (h=0)	0.32*** (0.12)	0.11 (0.44)	-0.45 (0.42)	-0.70 (0.41)	-0.57 (0.40)
Tax Ratio Forecast	-0.34 (0.21)	-1.10* (0.65)	-1.92** (0.80)	-2.34** (0.89)	-2.58*** (0.80)
Deficit (t-1)	-0.10 (0.15)	-0.01 (0.48)	-0.13 (0.58)	-0.36 (0.60)	-0.23 (0.50)
GDP Growth Rate (t-1)	-0.03 (0.15)	-0.18 (0.37)	0.38 (0.50)	0.72 (0.57)	0.66 (0.51)
R ²	0.34	0.62	0.74	0.81	0.87
F-statistics	3.15	9.30	15.58	21.74	30.60
p-value	0.01	0.00	0.00	0.00	0.00
Observations	43	41	39	37	35

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Figure 1

Forecast Errors of GDP-, and Tax Revenue Forecasts (Percentage Points)

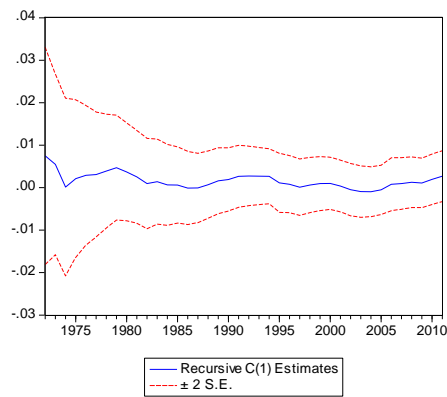


Source: BMF (1968-2012a, 1968-2012b), own calculations.

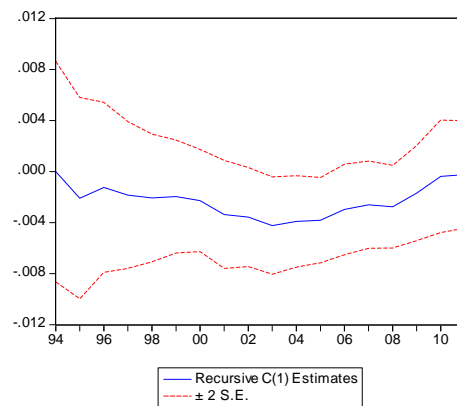
Figure 2 (I – X)

Recursive Estimations of Equation (4)

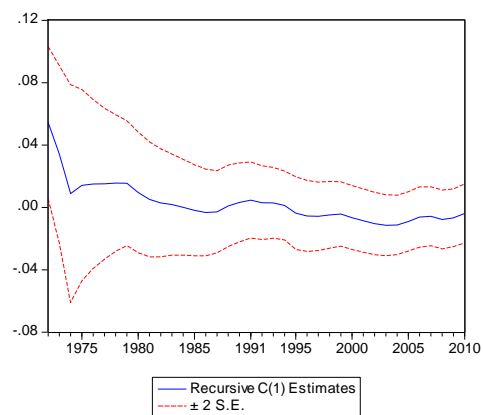
I: $h = 0$; 1968 – 2011



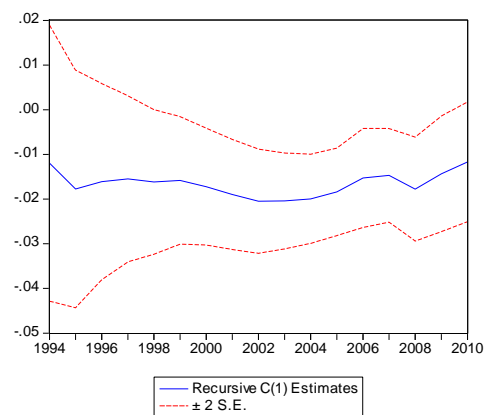
VI: $h = 0$; 1991 – 2011



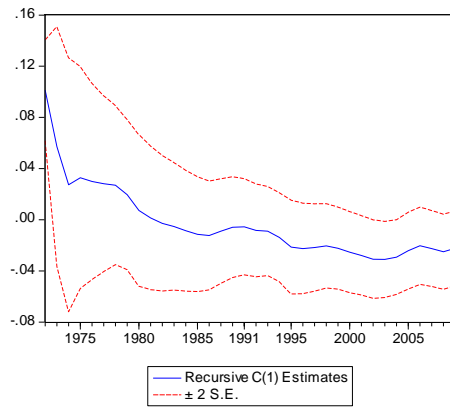
II: $h = 1$; 1968 – 2010



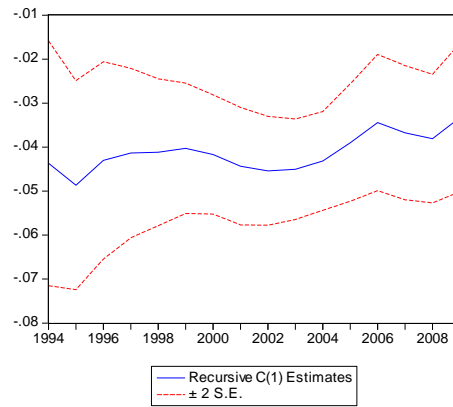
VII: $h = 1$; 1991 – 2010



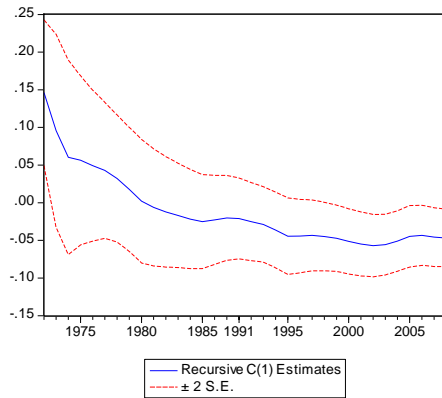
III: $h = 2$; 1968 – 2009



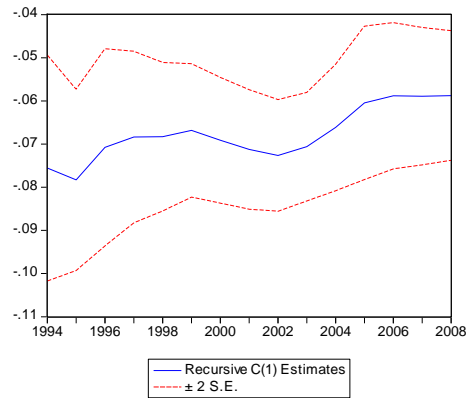
VIII: $h = 2$; 1991 – 2009



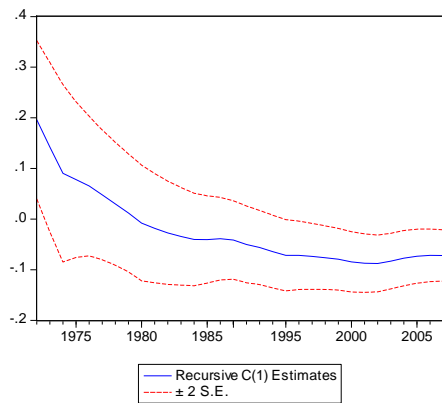
IV: $h = 3$; 1968 - 2008



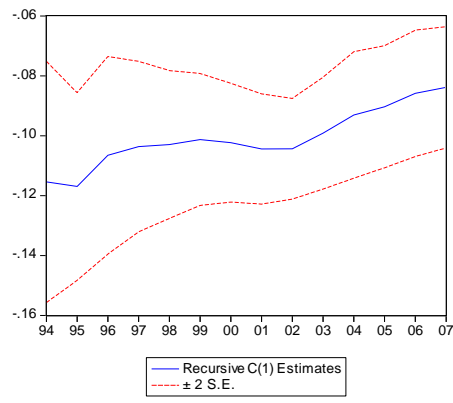
IX: $h = 3$; 1991 - 2008



V: $h = 4$; 1968 - 2007



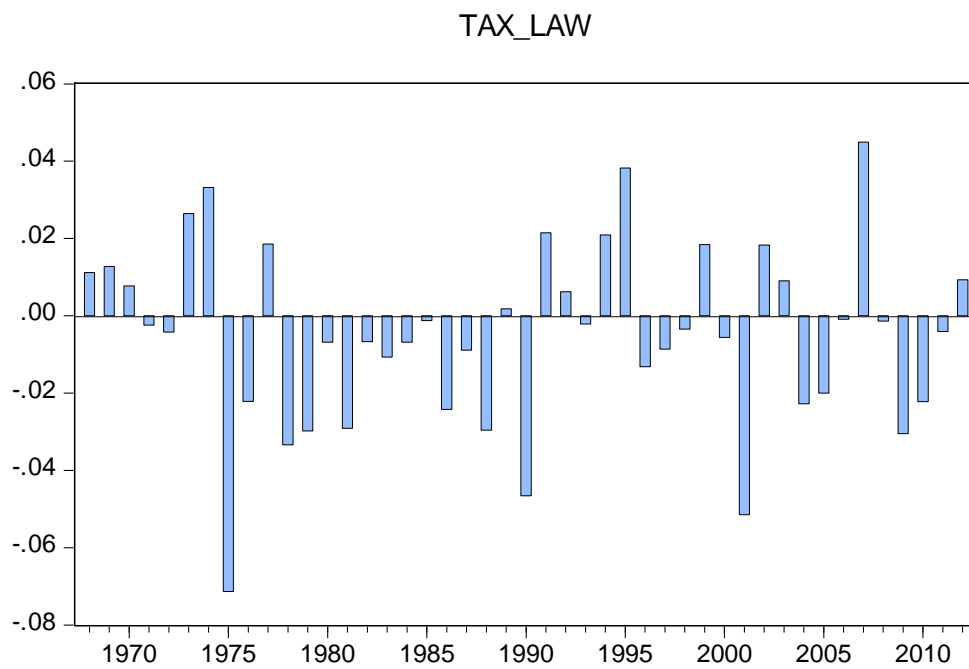
X: $h = 4$; 1991 - 2007



Note: The figures show the recursive coefficients of equation (2.4). Dependent variable: tax revenue forecast error (percent). The left panel depicts recursive estimations for the period 1968 to 2011, starting in 1968. The right panel restricts the sample to the post-reunification period.

Figure 3

Estimated Impact of Tax Policy on Tax Revenues



Source: BMF (1968-2012c), own calculations.

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Appendix

Table A1

Tax Revenue Forecast Error and Serial Correlation

Horizon	current year	t+1	t+2	t+3	t+4
Constant	0.12*	0.40**	0.56**	0.63*	0.73**
	0.06	0.16	0.26	0.31	0.31
Forecast Error (t-1)	0.28*	0.34	-0.46	-0.43	0.16
	0.14	0.42	0.67	0.84	1.06
Tax Ratio Forecast	-0.51**	-1.78**	-2.55**	-2.94**	-3.48***
	0.25	0.70	1.11	1.32	1.26
R ²	0.15	0.16	0.18	0.17	0.15
F-statistics	3.62	3.55	3.91	3.40	2.90
p-value	0.04	0.04	0.03	0.05	0.07
Observations	43	41	39	37	35

Note: Dependent variable: Tax revenue forecast error (percent). Numbers in parentheses are standard errors, corrected for autocorrelation using the Newey and West (1987) method; ***, **, * indicate significance at the 1, 5, 10 % level.

Table A2

Tax Revenue Forecasts (1968 – 1990)

Year	No.	Month	AKS no.
1968	1	3	23
1969	2	11	30
1970	3	5	32
1971	4	8	36
1972	5	8	38
1973	6	8	42
1974	7	6	44
1975	8	8	47
1976	9	12	50
1977	10	8	52
1978	11	7	56
1979	12	5	59
1980	13	5	62
1981	14	6	66
1982	15	6	69
1983	16	6	72
1984	17	6	76
1985	18	6	79
1986	19	5	81
1987	20	5	83
1988	21	5	85
1989	22	5	88
1990	23	5	90

Source: Federal Ministry of Finance (1968a – 2012a and 1968b – 2012b).

Table A3

Tax Revenue Forecasts, 1991 - 2012

Year	No.	Month	AKS no.
1991	24	5	92
1992	25	5	95
1993	26	5	98
1994	27	5	100
1995	28	5	103
1996	29	5	105
1997	30	5	107
1998	31	5	110
1999	32	5	112
2000	33	5	114
2001	34	5	117
2002	35	5	119
2003	36	5	121
2004	37	5	123
2005	38	5	125
2006	39	5	127
2007	40	5	129
2008	41	5	131
2009	42	5	134
2010	43	5	136
2011	44	5	138
2012	45	5	140

Source: Federal Ministry of Finance (1968a – 2012a and 1968b – 2012b).

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