Forecasting fiscal aggregates in an emerging market economy: the role of macro variables and fiscal plans §

Javier J. Pérez
Bank of Spain

A. Jesús Sánchez-Fuentes
U. Complutense Madrid & GEN

Engin Yılmaz
Ministry of Finance of Turkey

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Abstract

In this paper we estimate the general government balance throughout a suite of models which combines not only fiscal but also macroeconomic indicators by using "mixed-frequency approach". We carry out a recursive pseudo real-time estimation from 2006M1 to 2015M12 to compare the performance of these models, with the aim of comparing their accuracy and determining the role of macroeconomic variables. Our results show that purely fiscal models are between the best performers if complementary indicators are included (expenditures for revenues models and vice versa). Moreover, not all the macroeconomic indicators seem to be equally helpful. Particularly, those related to the financial markets may induce much more volatility in the forecasts estimates and are associated with a poorer performance of models.

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Corresponding author: A. Jesús Sánchez-Fuentes (ajsanchezfuentes@ucm.es)

1. Introduction

Turkey is an important emerging country in the all around the world. After the disastrous 2001 financial crisis, Turkey has begun to make significant progress in economic area. Moreover, Turkey has progressed significantly in membership of European Union and has been important economic partner of European Union. Turkish successful economic policy is greatly originated from sound fiscal policy. Sound fiscal policy helped to reduce interest rates to the normal levels and in the same time total government debt ratio tends to converge towards the European Union levels. Sound fiscal policy makes a great contribution to economic stability and gives support to monetary authorities in obtaining stable prices at low interest rates.

Fiscal forecasting has been a significant issue in the last two decades because countries understood that fiscal policy is a very important tool for sound economic stability. The Maastricht Treaty and the Stability and Growth Pact (SGP) have significantly increased interest in fiscal forecasting and fiscal monitoring in Europe, as budgetary forecasts play a crucial role in the implementation of the European fiscal framework. On the other hand, OECD, IMF, international financial institutes and rating agencies have prepared regular forecasting reports which include fiscal forecasting values.

Turkey has not advanced in fiscal forecasting area both from the academic and institutional point of view. Only a few academic works have analysed this issue for the particular case of Turkey. Government institutions have carried out fiscal forecasts in some regularly government plans (Medium Term Programme and Medium Term Fiscal) but these forecasts are very far away from realized values. These plans contain only central government expenditures, revenues and balance for the following 3 years and gives detailed only sub-items of expenditures.

In this paper, it is created the econometric short-term fiscal forecasting model for Turkey fiscal system using fiscal sector variables, real sector variables, financial sector variables and price indicator. It is evaluated that fiscal sector and real sector variables are much useful than financial sector variables and price indicator in forecasting fiscal data. It is obtained more accurate forecast results when compared to government plans forecasts.

This paper is organized as follows. In the first section, fiscal forecasting literature for Turkey and emerging countries are presented. In the second section, Turkish fiscal regime is explained in detail. Methodological issues which include econometric modelling, empirical strategies and data are presented in the third section. In the fourth section, results are described in detail. Finally, last section presents our concluding remarks.

2. Literature review

There are not specific papers in the area of fiscal forecasting in Turkey. As far as we know, IMF workshop notes (IMF, 2000) could be seen as the first study facing this issue. Classical regression methodology was used there for forecasting government revenues and expenditures in this study. Aladağ *et al* (2012) applied years later various artificial neural networks models to forecast expenditures of two Turkish public institutions in the period of 1973-2008. Authors concluded that artificial neural approach is a very useful predictive tool in order to forecast public institutions expenditures.

When the macroeconometric modeling works[1] in Turkey were examined, it is find out that these works only tried to calculate the effect of the tax revenue or government expenditure on the national income. Özatay (2000) developed a quarterly macro econometric model for Turkey considering it as a highly inflationary and indebted country. The model was constructed in the framework of a disequilibrium monetary model. It dealt with the outcomes of various stabilization scenarios in highly inflationary and indebted country. They concluded that same stabilization policy mildly reduces the inflation rate unless regarded as credible by the public while it significantly lowers the inflation rate if regarded credible. Kıpıcı and Aysoy (2005) focused on understanding the reasons behind the high and persistent inflationary process in Turkey. Authors used quarterly data covering the period from the first quarter of 1987 to the third quarter of the 2002. An important contribution of this work was the handling of the relation between the government bonds, as a financing item of the debt stock, and the inflation using the expectations (Kıpıcı and Aysoy, 2005). Coşkun (2007) tried to develop an optimal monetary and fiscal policy mix for Turkish economy. The behavioral equations were estimated by ordinary least squares (OLS) using quarterly data for the 1987-2006 periods. Coşkun (2007) reached the conclusion that the continuity of fiscal discipline is important

[1] Uygur and Tuncer (2004) have researched macroeconometric modeling history in Turkey in the period of 1960-1990.

to maintain and sustain price stability in the economy. Özdemir and Gündoğdu (2012) developed a structural macro econometric model for Turkey, to assess the role of structural characteristics of an emerging economy on macroeconomic indicators. The model structure was divided into five blocks: monetary, government, production, trade and national income. Authors concluded that all the variables reach their steady state growth path between 2030 and 2040. However, the aforementioned papers don't give any series formulation or methodology for predicting / forecasting the government revenues and expenditures.

Budget balance projections/targets have received most of the attention of analyses related to emerging economies. Zhang and Cai (2009) compared support vector machine (genetic algorithm) with artificial neural network in terms of forecasting tax revenues in China. They found some evidence indicating that support vector machine (genetic algorithm) is much better than artificial neural network in forecasting tax revenues. Navon and Brander (2010) examined alternative models for the prediction of government tax revenues in Israel. Authors found that the model including GDP, imports of consumption goods, wage per employee post, sales of shares by parties of interest abroad, and credit denominated in foreign currency successfully described the development of total revenues in Israel. Liu *et al* (2011) proposed the novel forecasting method based on the combination of support vector machine (SVM) and particle swarm optimization (PSO) for forecasting tax revenues. Liu *et al* (2011) demonstrated that the proposed model has a suitable forecasting performance. Vizek and Botric (2012) specified alternative time series models – trend model, random walk, ARIMA, regression and error correction models – in modelling tax revenues in Croatia. Vizek and Botric (2012) suggested that forecasting accuracy increases with the complexity of the method. Srivastava *et al* (2012) presented a highly detailed fiscal forecasting for India using the systems of equations approach. All equations were initially estimated using Ordinary Least Squares and then by Two-Stage Least Squares. The model proved an analytical framework for studying issues of sustainability of government debt and deficit. Medrano *et al* (2013) modeled the taxes (at a disaggregated level) in Brazil using monthly data of a 1995-2010. Authors employed a Dynamic Linear Model (DLM) which performance leaded to satisfactory results. Ali (2013) formulated a macroeconomic and fiscal model for forecasting and decision purposes for Bangladesh economy. This model was based on specifying and structuring a variety of simultaneous equations, systems relationships and a hybrid approach of

econometric methods, algebraic settings, and mathematical techniques and algorithms. Zhijun (2013) showed that RBF Neural Networks Optimization Algorithm gives very sound results in forecasting tax revenues with scarce data. Jinlin (2014) analyzed short-term tax changes in China using ARMA model. Author discovered that tax growth is quicker than economic growth and the economic burden of taxpayers is increasing year by year. Nandi et al (2014) attempted to find an appropriate forecasting model through analyzing various time series forecasting models for Bangladesh. They concluded that Holt-Winter multiplicative method is very appropriate forecasting tax revenues in Bangladesh. Makananisa (2015) used ARIMA/SARIMA and Holt-Winters models to forecast tax revenues of South Africa showing that both the SARIMA and Holt-Winters models perform well in modeling and forecasting personal income tax and value added tax, however the Holt-Winters model outperformed the SARIMA model in modeling and capturing the highercorporate income tax volatility and total tax revenue. Chimilila (2017) applied ARMA and combined forecast models, and GARCH models to forecast tax revenue in Tanzania. Author results would lead to consider combined forecasts and GARCH(1,1) models for forecasting monthly revenue and its volatility in Tanzania.

3. The institutional framework

3.1 The Institutional framework

The general government sector in Turkey is classified in three blocks: the central government, social security institutions and local governments. This classification is compatible with national accounting standards (SNA93[2] and ESA95[3]). Local governments and social security institutions set independently their budgets. The central government also sets its budget but comprising the current and capital transfers to social security institutions and local government[4]. The central government budget is subject to the parliament authorization but local governments and social security institutions are not subject to the parliament authorization. The central government budget includes that of general budget agencies, special budget agencies and regulatory (supervisory) agencies.

[2] System of National Accounts 1993

[3] European System of Accounts 1995

[4] Hawkesworth et al (2007) give detailed information in this issue

These agencies are determined in Public Financial Management and Control Law (PFMC).

[insert Table 1 about here]

Turkey has published the general government sector statistics since 2009 but only five years (2012-2016) had quarterly information and others had only yearly data. On the other hand, there is no exact publishing date for general government accounts. Transparency continues to suffer from the lack of timely information in accordance with international standards on the fiscal account for general government (EU, 2014). Accrual-based general government accounts need to be aligned further with international standards, and fiscal and quasi-fiscal transactions associated with public-private partnerships need to be reported more systematically (OECD, 2004).

Turkey implemented serious fiscal consolidation after the 2001 banking and financial crisis. Fiscal consolidation, which was the most significant component of the policy framework, was achieved through implicit fiscal rules and a strong reform initiative (Yılar and Kaya, 2011). These fiscal rules are defined in the 18th IMF-Turkey stand-by arrangement in the period of 2002-2005 and the 19th IMF-Turkey stand-by arrangement in the period of 2005-2008. One of the important fiscal rules is primary balance target which was implemented in the period of 2002-2008.

The average primary balance as a share of GDP was 4.5% in the period of 2002-2008. This is a very high proportion and indicates how a serious fiscal consolidation is applied in Turkey. On the other hand, Public Finance and Debt Management Law was adopted on 2002 and the public borrowing was limited. The Public Financial Management and Control Law (PFMC) was adopted on 2003 which determines mainly other fiscal rules in Turkey[5].

The global downturn in 2008-2009 affected Turkish economy growth which depends on foreign demand. The distinctive characteristic of the crisis was a severe export shock which can account for an important part of the decline in production in Turkey (Çolak and Cömert, 2014). Turkey responded to this crisis with varies instruments in monetary,

[5] 14., 16., 20., 21., 23., 24., 27., 35. and 70. articles of Public Financial Management and Control Law (PFMC).

fiscal and financial area. Tax cuts and government spending are used counter–cyclical policy instruments in this process[6]. Turkey fiscal situation has been deteriorated in 2009 and 2010 with these policies. However, this deterioration was temporary and budget deficit as a share of GDP decreased following years. As a conclusion of these developments, Central Government budget deficit as a share of GDP decreased from -11.5 in 2002 to -1.3 in 2015.

3.2 The budgetary process

The Constitution of the Republic of Turkey and the Public Financial Management and Control Law constitute legal basis for the state budget. The Public Financial Management and Control Law sets forth the provisions on the basis and form of the state budget, the preparation principles and the budget implementation, and defines the required legal principles (GDBFC, 2015). Turkey performs multi-annual budgeting approach. The multi-annual budget preparation process begins with the adoption of Medium Term Programme which is declared priorities. The Medium Term Programme, prepared by Turkish Ministry of Development, contains a macroeconomic forecast of general and central government expenditures, revenues and balance for the following 3 years. When Medium Term Programme is adopted, Turkish Ministry of Finance prepares Medium Term Fiscal Plan which is the other document issued in budget preparation process. It contains only central government expenditures, revenues and balance for the following 3 years and gives detailed only sub-items of expenditures. It includes overall expenditure targets for central government but, more importantly, it divides these overall figures over separate ministries and special budget agencies for all three years of the plan (Hawkesworth et all, 2007). The Medium Term Fiscal Plan is prepared so as to carry out the basic goals and policies defined in the Medium Term Program, and sets out the central government budget figures and the institutional appropriation proposal ceilings (GDBFC, 2015). The goals can be adjusted from year to year having regard to the recent macroeconomic changes. After publishing the Medium Term Programme and the Medium Term Fiscal Plan, Ministry of Finance publishes Budget Call, is the guide for the preparation budget proposals, in June. The General Directorate of Budget and Fiscal Control and public administrations start to negotiate on budget proposals in September.

[6] Çolak and Cömert (2014) give detailed information in this issue

The Ministry of Finance prepares the draft budget in the end of September and sends to the Parliament. The draft law adopted[7] by the Parliament is submitted to the approval of the President. President approves the law and it enters into force as of January 1st. Central government budget expenditures, budget revenues, budget balance and primary balance are published in monthly in Monthly Budget Figures Report[8].

4. Methodological issues

4.1 The data

Figure 1 shows the series involved in our analysis. The first panel includes the fiscal series considered; Total revenues (TOR) and Total expenditures (TOE). It can be observed that Total revenues and Total expenditures both have had an increasing trend from 2006 to 2015. The only exception is a small decreasing in the total expenditures due to 2008-2009 global crisis.

[insert Figure 1 about here]

Turkey has published the general government sector statistics since 2009 but only five years (2012-2016) had quarterly information and others had only yearly data. For this reason, it is used the fiscal variables of the central government which are easy to reach and contained much more data. Particularly, the monthly data of central government regarding these fiscal variables span the period from 2006:01 to 2016:03. This means 127 monthly observations, being suitable for realizing time series analysis. All the data are taken from the General Directorate of Public Accounts.

Regarding the macro-economic variables, we include in our analysis three different indicators which are all included in Figure 1, panel B. All of them are monthly indicators and aim to capture complementary signals regarding the evolution of Turkish economy. They all spans the period from 2006:01 to 2016:03.

First, we choose the Weighted Average Interest Rate (Repo) (2 to 14 days) of the Central Bank of the Republic of Turkey - Short term interest rate (STI) - to capture the signals

[7] For more information (GDBFC, 2015) : http://www.bumko.gov.tr/EN,2707/budget-preparation-calendar.html

[8] http://www.bumko.gov.tr/EN,2712/budget-realizations-reports.html

from the financial markets. This may be relevant in terms of financial sustainability of Turkish public finance. This time series is taken from the Central Bank of the Republic of Turkey and spans the period. Second, we include the Inflation (INF) as the natural candidate to summarize the movements related to price evolution. The data is taken from Turkish Statistical Institute (TUIK) and expressed as annual changes in consumer price index. Third, we consider the Turkish composite leading indicator (LEI), constructed jointly by the Central Bank of the Republic of Turkey and the OECD as a way to include all the real economy fluctuations. This index combines 18 different indicators to create the optimal leading indicator. See Atabek *et al.* (2005) for further technical details.

In the second panel of Figure 1 can be seen how they evolve within our sample period (2006-2015). It can be observed a serious deterioration due to 2008-2009 global economic crisis but showing a relatively quick recovery in the subsequent years. Moreover, when comparing how fiscal and macro indicators evolve, the correlation between seems not to be very strong.

4.2 Econometric modelling

All the models developed in our paper fit with the following general discussion. The description follows quite closely Pedregal and Pérez (2010). The starting point of the modeling approach is to consider a multivariate Unobserved Components Model known as the Basic Structural Model (Harvey, 1989). A given time series is decomposed into unobserved components which are meaningful from an economic point of view (trend, T_t, seasonal, S_t, and irregular, e_t). Equation (4) displays a general form, where t is a time sub-index measured in quarters, z_t denotes the variable in ESA terms expressed at an annual and quarterly sampling interval (depending on availability) for our objective time series, and u_t represents the vector of quarterly indicators.

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \mathbf{T}_t + \mathbf{S}_t + \mathbf{e}_t \tag{4}$$

The general consensus in this type of multivariate models in order to enable identifiability is to build SUTSE models (Seemingly Unrelated Structural Time Series). This means that components of the same type interact among them for

different time series, but are independent of any of the components of different types. In addition, statistical relations are only allowed through the covariance structure of the vector noises, but never through the system matrices directly. This allows that, trends of different time series may relate to each other, but all of them are independent of both the seasonal and irregular components. The full model is a standard BSM that may be written in State-Space form as (see Harvey, 1989)

$$\mathbf{x}_t = \mathbf{\Phi x}_{t-1} + \mathbf{E w}_t \qquad (5)$$

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \begin{bmatrix} \mathbf{H} \\ \mathbf{H}^u \end{bmatrix} \mathbf{x}_t + \begin{bmatrix} \boldsymbol{\varepsilon}_t \\ \mathbf{v}_t \end{bmatrix} \qquad (6)$$

where $\boldsymbol{\varepsilon}_t \sim N(0, \Sigma_E)$ and $\mathbf{v}_t \sim N(0, \Sigma_{\mathbf{v}_t})$. The system matrices $\mathbf{\Phi}$, $\mathbf{E}$, $\mathbf{H}$ and $\mathbf{H}^u$ in equations (5)-(6) include the particular definitions of the components and all the vector noises have the usual Gaussian properties with zero mean and constant covariance matrices ($\boldsymbol{\varepsilon}_t$ and $\mathbf{v}_t$ are correlated among them, but both are independent of $\mathbf{w}_t$). The particular structure of the covariance matrices of the observed and transition noises defines the structures of correlations among the components across output variables. The mixture of frequencies, and the estimation of models at the quarterly frequency, implies combining variables that at the quarterly frequency can be considered as stocks with those being pure flows. This may be achieved in two steps: i) rewritting system (5)-(6) in a convenient way and ii) adding a accumulator variable to such system as defined below.

It is easy to check that model (5)-(6) is exactly equivalent to model (7)-(8), by extending the state vector with the output variables.

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} = \begin{bmatrix} \mathbf{0} & \mathbf{H\Phi} \\ \mathbf{0} & \mathbf{\Phi} \end{bmatrix} \begin{bmatrix} \mathbf{z}_{t-1} \\ \mathbf{x}_{t-1} \end{bmatrix} + \begin{bmatrix} \mathbf{I} & \mathbf{HE} \\ \mathbf{0} & \mathbf{E} \end{bmatrix} \begin{bmatrix} \boldsymbol{\varepsilon}_t \\ \mathbf{w}_t \end{bmatrix} \qquad (7)$$

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \mathbf{H}^u \end{bmatrix} \begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} + \begin{bmatrix} \mathbf{0} \\ \mathbf{I} \end{bmatrix} \mathbf{v}_t \qquad (8)$$

In order to take into account time aggregation, i.e. the fact that the output variable and the inputs are sampled at different frequencies (annual vs quarterly), an accumulator variable in the fastest sampling interval ought to be defined as in equation (9). Beware that the sampling interval of the output variable does not need to be regular.

$$C_t = \begin{cases} 0, & \text{t = every January (monthly data) / first quarter (quarterly data)} \\ 1, & \text{otherwise} \end{cases} \tag{9}$$

In this way system (7)-(8) becomes (10)-(11). Beware that by setting $C_t = 0$ we return actually to the previous system.

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} = \begin{bmatrix} C_t \otimes \mathbf{I} & \mathbf{H\Phi} \\ \mathbf{0} & \mathbf{\Phi} \end{bmatrix} \begin{bmatrix} \mathbf{z}_{t-1} \\ \mathbf{x}_{t-1} \end{bmatrix} + \begin{bmatrix} \mathbf{I} & \mathbf{HE} \\ \mathbf{0} & \mathbf{E} \end{bmatrix} \begin{bmatrix} \boldsymbol{\varepsilon}_t \\ \mathbf{w}_t \end{bmatrix} \tag{10}$$

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \mathbf{H}^u \end{bmatrix} \begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} + \begin{bmatrix} \mathbf{0} \\ \mathbf{I} \end{bmatrix} \mathbf{v}_t \tag{11}$$

Given the structure of the system and the information available, the Kalman Filter and Fixed Interval Smoother algorithms provide an optimal estimation of states. Maximum likelihood in the time domain provides optimal estimates of the unknown system matrices, which in the present context are just covariance matrices of all the vector noises involved in the model. The use of the models selected and the estimation procedures described in the previous paragraph, allows the estimation of models with unbalanced data sets, i.e. input variables with different sample lengths. This is a feature of relevance for the construction of the database at hand, given occasional differences in temporal coverage of indicators.

4.3 A suite of models

In our case, we focus our analysis in three fiscal aggregates; Total revenues (TOR) , Total expenditures (TOE) and Government Deficit (DEF) computed as the difference between them. For the sake of concreteness, for each objective series (TOR/TOE), we combine four indicators to consider two set of models (see Table 1 for further details). In the first one (DIRECT), we leave out any other fiscal indicator whereas in the second one

(JOINT), we also add the counterpart indicator (TOR or TOE) to account for the feedback effects between these two variables.

[insert Table 2 about here]

With respect to the role of macroeconomic variables, we propose to use a variety of indicators which capture movements emerging from meaningful components of economic activity. First, we consider a synthetic leading indicator (LEI) which summarizes different signals from the real economy. Second, we select the natural choice to capture all the signals related to the prices evolution, the "inflation" (INF). Last, from the financial side of the economy, we include the short-term interest rate (STI) as it seems to match perfectly with the timing we are interested in our posterior forecasting exercise.

4.4 Empirical strategy

We perform a rolling forecasting exercise in which the selection of the forecast origin and the information set available at each date are carefully controlled for. In particular we evaluate the forecasts generated from twelve forecast origins per year from January 2006 to December 2015, which makes up to 10×12 projections at each forecast horizon. The first forecast origin is January 2006, adopting the timing convention that current month figures are not yet available, so that December 2005 is the last figure published. The second forecast origin is February 2006, with monthly information up to January 2006. This process iterates up to our last origin, December 2015, generating forecasts from each forecast origin for the end of the current year, as this is the main horizon of use for mechanical, time-series based forecast. From the point of view of a practitioner, forecasts of fiscal variables for a horizon longer than the current year is of less importance.

The next stage of our analysis is to define how we will quantify the forecasts errors of alternative models. In short, the forecast error committed for year t by model J from forecast origin Q is defined as

$$\varepsilon_{t,Q}^{V,J} = V_t - E_{\Omega,Q}^{J}[V_t] \qquad (2)$$

where V=TOR, TOE, DEF and Ω makes reference to the information set available at the time of generating a given forecast.

Then, we carry out two differentiated analyses. On the one hand, we compute two standard quantitative measures of forecasting performance. First, we compute the ratio of the Root Mean Squared Errors (RMSE) of the different alternative models with respect to an annual random walk (i.e. no-change) alternative. Second, we consider the Diebold-Mariano tests in order to identify whether the differences obtained in the RMSE analysis are statistically significant.

On the other hand, we also look at a qualitative measure of forecast performance, namely, whether the predicted change coincided or not with the actual change observed in the variable of interest.

5. Results

The results of our exercise are presented in Tables 3-5. First, Table 3 presents the evidence related to the RMSE analysis.

[insert Table 3 about here]

In that table we show the relative root mean squared error of our models compared to the annual random walk extrapolation for a number of cases: (i) aggregate of the forecast errors generated for the whole year from all forecasts origins (baseline); (ii) forecasts errors computed on the basis of forecasts computed taking as forecasts origin the first quarter (Q1), the second (Q2), the third (Q3) and the fourth (Q4).

First, when looking at the full sample, and pooling all forecast errors (resulting from forecast origins Q1 to Q4), the most aggregated models (i.e. those that include both fiscal indicators) presents a most accurate overall performance. Apart from this general conclusion, more interesting findings may be extracted. First, all the estimated models overcome the government performance when setting the end-of-year official target. Second, across quarters, in line with Pedregal et al. (2014), we find that the forecasting performance of all models improves when more information about revenue collection and the implementation of spending plans kicks-in. This is quite clear in the second half of the year compared to forecasts prepared in the first half. In particular, in Q3 the first half of the year is fully known. For projections prepared from forecast origin is located at Q2 quite different conclusions are obtained. Third, FISCAL -JOINT- model shows, in relative terms, one of the most accurate performances, indicating that forecasts solely

based on fiscal information includes a significant proportion of relevant signals for forecasting purposes. Four, not all the macro variables have the same role. Particularly, indicators which includes financial markets signals seems to be the most noisy at the beginning of year whereas indicators capturing signals from real economy and prices help to introduce stability and accuracy in the estimated figures (especially when DIRECT models are used).

It can be also relevant to compare the relative performance when compared figures related to Government balance (DEF), Total revenues (TOR) and Total expenditures (TOE). The expenditures side shows lowers relative RMSE, followed by those related to revenues and, lastly, those related to DEF. This may reflect that both errors -those related to revenues and expenditures sides- are being accumulated when forecasting the government balance (DEF).

A complementary view of these findings is provided by Figure 2. The intra-annual evolution of relative RMSE figures helps to understand the accuracy gains obtained as new available information is included in the model. The main findings described above are confirmed here.

The next step of our analysis is to test whether relative differences in accuracy detailed previously are significant or not from the statistical point of view. In this regard, Table 4 presents the results related to Diebold-Mariano tests, when setting the significance levels at 95%. Our findings confirmed that the null hypothesis can be rejected mostly when compared FISCAL and FISCAL+REAL+PRICE models with others. Particularly, when JOINT models are estimated. Moreover, the inclusion of indicators capturing signals from different areas of economy (real economy, financial markets or prices) seems to modify the accuracy of models in a significant way.

[insert Table 4 about here]

The final stage of our analysis implies a qualitative evaluation of models performance. Turning now to Table 5, we present the percentage of correctly predicted changes in the case of government balance, government revenues and expenditures. It can be seen that our models all outperform the government performance. Perhaps in the cases of total revenues and expenditures this result may not be surprising given that the incrementalism

is mostly present in the actual evolution of these fiscal aggregates (Figure 1 confirms this trend). On the contrary, for models based on government balance, the comparison is clearly favorable to any of our estimated models. Moreover, the degree of agreement is especially high from Q2 to Q4. This finding could be translated to truly real-time forecasting exercises which could use any disagreement as an early warning. To conclude, there is no significant differences between the different alternatives indicating that macroeconomic indicators have not a discriminatory power, perhaps due to the high degree of fulfillment of purely fiscal models.

[insert Table 5 about here]

6. Conclusions

In this paper we estimate the general government balance throughout a suite of models which combines not only fiscal but also macroeconomic indicators by using "mixed-frequency approach". We consider the case study of Turkey, an interesting emerging economy which may be accepted within the European Union in the short-term.

It is used a variety of fiscal and macro data in this analysis. Fiscal data included central government revenues and central government expenditures and budget deficit. Macro data included a number of macro-economic variables capturing signals from different blocks of the Turkish economy in a complementary way. Particularly, short-term interest rates, inflation and leading indicator are used. These monthly data fully covers our sample period (2006-2015) resulting 120 observation, a sample size suitable for realizing time series analysis.

We combine alternatively these indicators to define a suite of models which allow us to analyse both in quantitative and qualitative terms their performance and, consequently, to identify the role of alternative combinations of fiscal and macroeconomic indicators.

We carry out a recursive pseudo real-time estimation from 2006M1 to 2015M12 providing a number of replications enough to achieve robust results. We find that purely fiscal models are between the best performers if complementary indicators are included (expenditures for revenues models and vice versa). Moreover, not all the macroeconomic indicators seem to be equally helpful. Particularly, those related to the financial markets may induce much more volatility in the forecasts estimations and are associated with a poorer performance of models.

We think this analysis may be expanded in some directions. First, considering alternative models (bottom-up or top-down models, for instance) which potentially may capture complementary

signals from disaggregated revenues/expenditures indicators. Second, alternative macroeconomic indicators may be included in posterior analysis to determine which key characteristics of macroeconomic indicators should be present to result helpful when forecasting fiscal aggregates.

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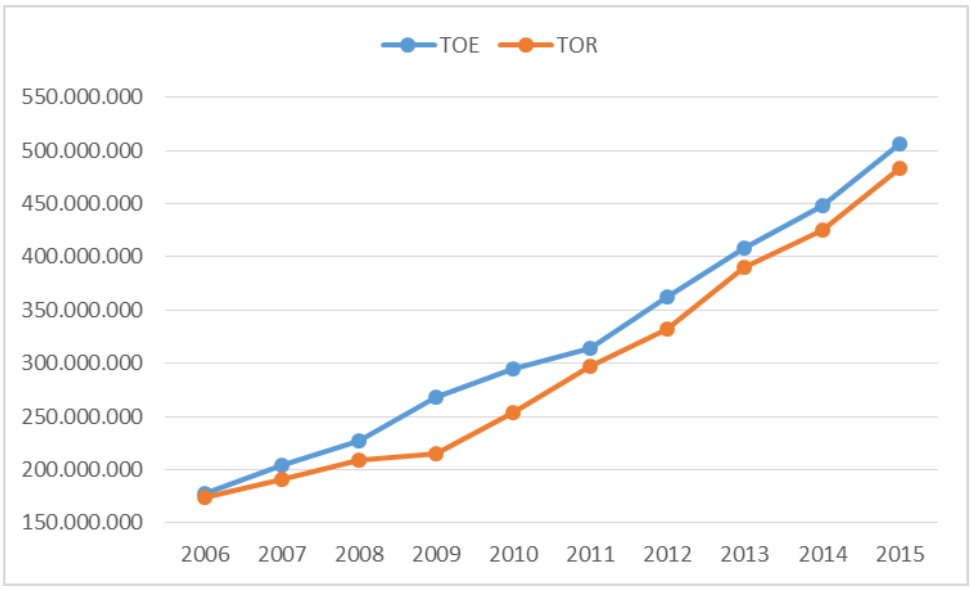
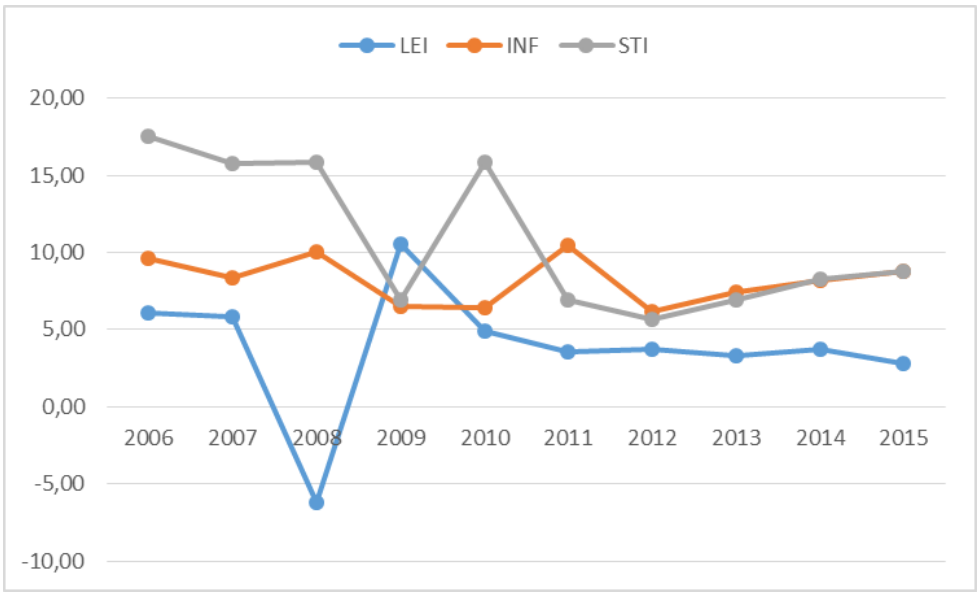
Figures and Tables

Figure 1: Data description (Levels)

Fiscal variables



Macro variables



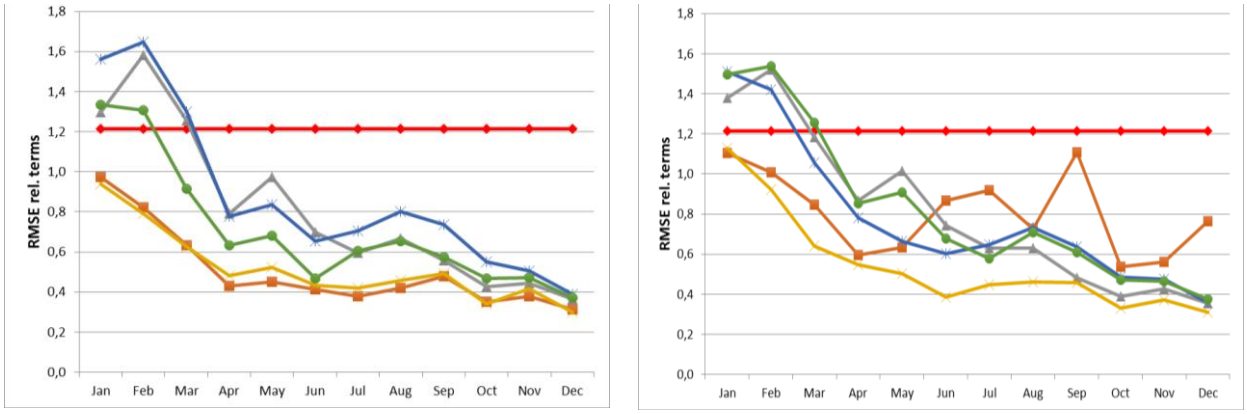
Source: Authors' calculations

Notes: 1) TOR = Total revenues, TOE=Total expenditures, LEI=Leading indicator, INF=inflation, STI=Short-term interest rate

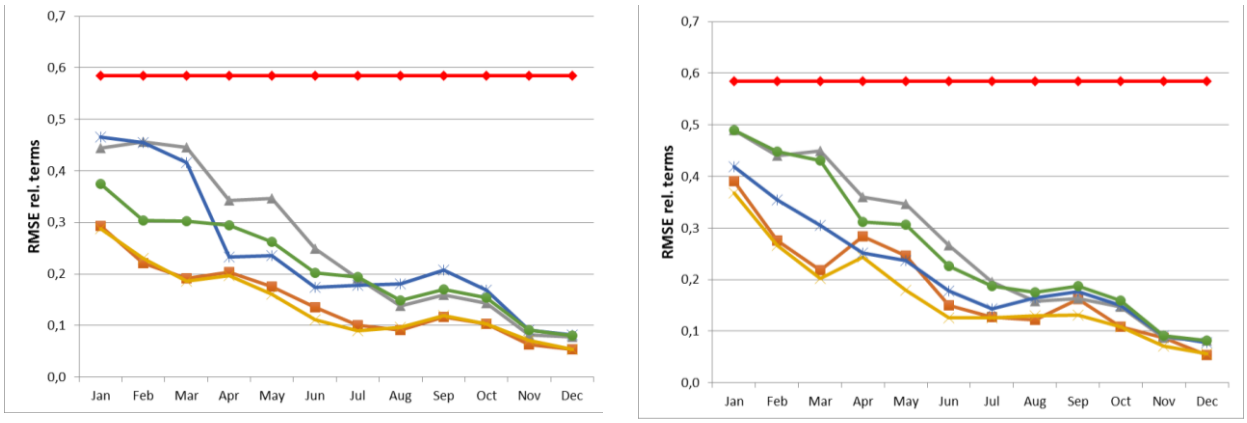
Figure 2: Quantitative forecasting performance: Intra-annual evolution.

(Column 1: Joint model) (Column 2: Direct model)

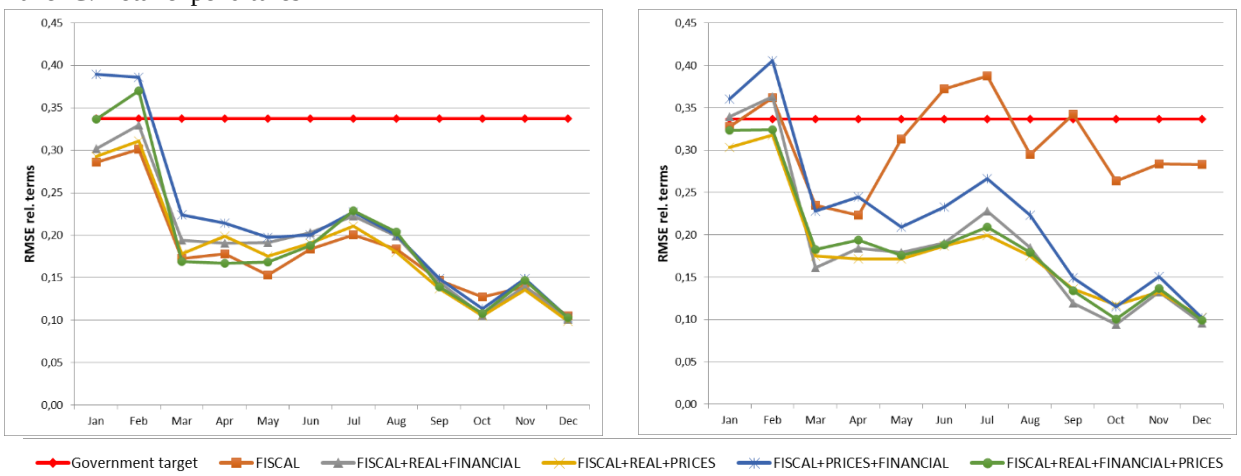
Panel A: General government balance



Peanel B: Total revenues



Panel C: Total expenditures



Source: Authors' calculations

Note: 1) The numbers in the graph are the ratios of Root Mean Squared Errors of the errors obtained with each alternative with respect to an annual random walk approach (no-change baseline).

Table 1: Central Government Budget Classification in Turkey

Budget	**Definition**
General Budget	Budgets of public administrations, which are included in Chart I of (PFMC) and which are under the legal entity of the government.
Special Budget	The budget of each public administration, which is included in the Chart II of (PFMC) and established as affiliated or related to a ministry for performance of a defined public service, to which revenues are allocated, and which is authorized to spend from such revenues, of which establishment and operation principles are regulated by special law.
Regulatory (Supervisory) Agency	The budget of each regulatory and supervisory agency, which is included in the chart III of (PFMC) and established in the form of board, agency or supreme board by special laws.

Source: Public Financial Management and Control Law (PFMC).

Table 2: Models and Data description

Models / Indicators	Total revenues (TOR)	Total expenditures (TOE)	Leading indicator (LEI)	Inflation (INF)	Short-term interest rate (STI)
	Fiscal	*Fiscal*	*Macro, real*	*Macro, prices*	*Macro, financial*
DIRECT					
FISCAL	X	O			
FISCAL+REAL+FINANCIAL	X	O	X O		X O
FISCAL+REAL+PRICES	X	O	X O	X O	
FISCAL+PRICES+FINANCIAL	X	O		X O	X O
FISCAL+REAL+FINANCIAL+PRICES	X	O	X O	X O	X O
JOINT					
FISCAL	X O	X O			
FISCAL+REAL+FINANCIAL	X O	X O	X O		X O
FISCAL+REAL+PRICES	X O	X O	X O	X O	
FISCAL+PRICES+FINANCIAL	X O	X O		X O	X O
FISCAL+REAL+FINANCIAL+PRICES	X O	X O	X O	X O	X O

Notes:

1) ""X"" refers to models used for forecasting TOR, whereas ""O"" refers to the corresponding models for TOE.

Table 3: Quantitative forecasting performance I: Root Mean Squared Error (RMSE), relative terms

(Column 1: Joint Model)

Panel A: General government balance

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***1,21***	***0,54***	***0,89***	***0,55***	***0,96***	***0,77***
Q1	1,21	0,82	1,39	0,80	1,51	1,20
Q2	1,21	0,43	0,83	0,48	0,76	0,60
Q3	1,21	0,43	0,61	0,46	0,75	0,61
Q4	1,21	0,35	0,41	0,36	0,49	0,44

Panel B: Total revenues

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***0,58***	***0,16***	***0,29***	***0,16***	***0,27***	***0,23***
Q1	0,58	0,24	0,45	0,24	0,45	0,33
Q2	0,58	0,17	0,32	0,16	0,22	0,26
Q3	0,58	0,10	0,16	0,10	0,19	0,17
Q4	0,58	0,08	0,11	0,08	0,12	0,11

Panel C: Total expenditures

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***0,34***	***0,19***	***0,20***	***0,19***	***0,23***	***0,21***
Q1	0,34	0,26	0,28	0,27	0,34	0,30
Q2	0,34	0,17	0,20	0,19	0,20	0,17
Q3	0,34	0,18	0,19	0,18	0,20	0,19
Q4	0,34	0,12	0,12	0,11	0,12	0,12

(Column 2: Direct model)

Panel A: General government balance

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***1,21***	***0,83***	***0,89***	***0,59***	***0,86***	***0,91***
Q1	1,21	0,99	1,37	0,92	1,34	1,44
Q2	1,21	0,71	0,88	0,48	0,69	0,82
Q3	1,21	0,93	0,58	0,46	0,67	0,64
Q4	1,21	0,63	0,39	0,34	0,44	0,44

Panel B: Total revenues

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***0,58***	***0,21***	***0,30***	***0,19***	***0,23***	***0,29***
Q1	0,58	0,30	0,46	0,29	0,36	0,46
Q2	0,58	0,23	0,33	0,19	0,22	0,28
Q3	0,58	0,14	0,17	0,13	0,16	0,18
Q4	0,58	0,09	0,11	0,08	0,11	0,12

Panel C: Total expenditures

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***0,34***	***0,31***	***0,21***	***0,19***	***0,24***	***0,20***
Q1	0,34	0,31	0,30	0,27	0,34	0,28
Q2	0,34	0,31	0,18	0,18	0,23	0,19
Q3	0,34	0,34	0,18	0,17	0,22	0,18
Q4	0,34	0,28	0,11	0,12	0,12	0,11

Source: Authors' calculations. Note: 1) The numbers in the graph are the ratios of Root Mean Squared Errors of the errors obtained with each alternative with respect to an annual random walk approach (no-change baseline).

Table 4: Quantitative forecasting performance II: Diebold-Mariano test

(Column 1: Joint Model)

Panel A: General government balance

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	**H0 is rejected**	H0 prevails	**H0 is rejected**	H0 prevails
FISCAL+REAL+FINANCIAL		**H0 is rejected**	**H0 is rejected**	**H0 is rejected**
FISCAL+REAL+PRICES			**H0 is rejected**	**H0 is rejected**
FISCAL+PRICES+FINANCIAL				**H0 is rejected**

Panel B: Total revenues

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	**H0 is rejected**	H0 prevails	**H0 is rejected**	**H0 is rejected**
FISCAL+REAL+FINANCIAL		**H0 is rejected**	H0 prevails	**H0 is rejected**
FISCAL+REAL+PRICES			**H0 is rejected**	**H0 is rejected**
FISCAL+PRICES+FINANCIAL				**H0 is rejected**

Panel C: Total expenditures

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	H0 prevails	H0 prevails	**H0 is rejected**	H0 prevails
FISCAL+REAL+FINANCIAL		H0 prevails	**H0 is rejected**	H0 prevails
FISCAL+REAL+PRICES			**H0 is rejected**	H0 prevails
FISCAL+PRICES+FINANCIAL				**H0 is rejected**

(Column 2: Direct model)

Panel A: General government balance

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	H0 prevails	**H0 is rejected**	**H0 is rejected**	H0 prevails
FISCAL+REAL+FINANCIAL		**H0 is rejected**	H0 prevails	H0 prevails
FISCAL+REAL+PRICES			**H0 is rejected**	**H0 is rejected**
FISCAL+PRICES+FINANCIAL				H0 prevails

Panel B: Total revenues

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	**H0 is rejected**	**H0 is rejected**	H0 prevails	**H0 is rejected**
FISCAL+REAL+FINANCIAL		**H0 is rejected**	H0 prevails	H0 prevails
FISCAL+REAL+PRICES			**H0 is rejected**	**H0 is rejected**
FISCAL+PRICES+FINANCIAL				H0 prevails

Panel C: Total expenditures

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	**H0 is rejected**	**H0 is rejected**	**H0 is rejected**	**H0 is rejected**
FISCAL+REAL+FINANCIAL		**H0 is rejected**	**H0 is rejected**	H0 prevails
FISCAL+REAL+PRICES			**H0 is rejected**	H0 prevails
FISCAL+PRICES+FINANCIAL				**H0 is rejected**

Notes: H0: "forecasts have equal accuracy", Significance level at 95%

Table 5: Qualitative forecasting performance (% of correctly predicted signs)

(Column 1: Joint Model)

Panel A: General government balance

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***30,0%***	***71,7%***	***80,0%***	***73,3%***	***78,3%***	***80,0%***
Q1	30,0%	46,7%	66,7%	60,0%	56,7%	56,7%
Q2	30,0%	63,3%	76,7%	100,0%	76,7%	83,3%
Q3	30,0%	90,0%	86,7%	90,0%	90,0%	90,0%
Q4	30,0%	86,7%	90,0%	86,7%	90,0%	90,0%

Panel B: Total revenues

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***80,0%***	***96,7%***	***90,8%***	***97,5%***	***90,0%***	***92,5%***
Q1	80,0%	100,0%	90,0%	100,0%	80,0%	86,7%
Q2	80,0%	100,0%	86,7%	100,0%	96,7%	100,0%
Q3	80,0%	96,7%	96,7%	96,7%	93,3%	93,3%
Q4	80,0%	90,0%	90,0%	93,3%	90,0%	90,0%

Panel C: Total expenditures

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***100,0%***	***100,0%***	***100,0%***	***100,0%***	***99,2%***	***97,5%***
Q1	100,0%	100,0%	100,0%	100,0%	96,7%	93,3%
Q2	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Q3	100,0%	100,0%	100,0%	100,0%	100,0%	96,7%
Q4	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

(Column 2: Direct model)

Panel A: General government balance

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***30,0%***	***73,3%***	***77,5%***	***75,0%***	***73,3%***	***75,8%***
Q1	30,0%	50,0%	60,0%	53,3%	50,0%	53,3%
Q2	30,0%	66,7%	73,3%	70,0%	63,3%	70,0%
Q3	30,0%	90,0%	86,7%	86,7%	90,0%	90,0%
Q4	30,0%	86,7%	90,0%	90,0%	90,0%	90,0%

Panel B: Total revenues

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***80,0%***	***95,8%***	***90,0%***	***95,8%***	***92,5%***	***91,7%***
Q1	80,0%	100,0%	86,7%	100,0%	90,0%	90,0%
Q2	80,0%	100,0%	86,7%	100,0%	100,0%	96,7%
Q3	80,0%	93,3%	96,7%	93,3%	90,0%	90,0%
Q4	80,0%	90,0%	90,0%	90,0%	90,0%	90,0%

Panel C: Total expenditures

	Government target	FISCAL	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
ALL	***100,0%***	***100,0%***	***100,0%***	***100,0%***	***98,3%***	***100,0%***
Q1	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Q2	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Q3	100,0%	100,0%	100,0%	100,0%	93,3%	100,0%
Q4	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Notes: H0: "forecasts have equal accuracy", Significance level at 95%

A Annex: Complementary results

Table A1: Diebold-Mariano test: statistics

(Column 1: Joint Model)

Panel A: General government balance

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	-1,95	1,01	-2,23	-1,63
FISCAL+REAL+FINANCIAL		2,00	-2,15	2,02
FISCAL+REAL+PRICES			-2,27	-1,73
FISCAL+PRICES+FINANCIAL				2,49

Panel B: Total revenues

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	-2,47	-0,78	-2,81	-3,58
FISCAL+REAL+FINANCIAL		2,45	1,03	2,22
FISCAL+REAL+PRICES			-2,79	-3,44
FISCAL+PRICES+FINANCIAL				2,34

Panel C: Total expenditures

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	-1,26	-1,38	-2,46	-1,62
FISCAL+REAL+FINANCIAL		0,70	-2,62	-1,65
FISCAL+REAL+PRICES			-2,43	-1,55
FISCAL+PRICES+FINANCIAL				1,96

(Column 2: Direct model)

Panel A: General government balance

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	-1,41	2,62	-1,87	-1,56
FISCAL+REAL+FINANCIAL		1,75	0,69	-0,26
FISCAL+REAL+PRICES			-3,41	-1,92
FISCAL+PRICES+FINANCIAL				-0,80

Panel B: Total revenues

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	-1,98	2,29	-1,48	-1,98
FISCAL+REAL+FINANCIAL		2,14	1,60	1,19
FISCAL+REAL+PRICES			-2,40	-2,20
FISCAL+PRICES+FINANCIAL				-1,54

Panel C: Total expenditures

	FISCAL +REAL +FINANCIAL	FISCAL +REAL +PRICES	FISCAL +PRICES +FINANCIAL	FISCAL +REAL +FINANCIAL +PRICES
FISCAL	4,15	4,76	2,18	3,83
FISCAL+REAL+FINANCIAL		1,67	-3,31	1,02
FISCAL+REAL+PRICES			-2,57	-0,69
FISCAL+PRICES+FINANCIAL				2,27

Notes: H0: "forecasts have equal accuracy", Significance level at 95% (Reference value: 1,96)