

Estimating Bohn's Fiscal Sustainability Model with Temporal Variation: Evidence from Turkey^{*}

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Abstract

This study aims to estimate a dynamic fiscal reaction function in a state-space setting to obtain time-varying reaction parameters for appraising the evolution of public debt sustainability in Turkey. The data set used for estimation is the longest for Turkey in the literature. Succinctly speaking, this function quantifies the corrective fiscal efforts exerted to preserve the stability of public debt. The time-varying estimation findings in this study suggest that the recent fiscal history of Turkey can be divided into two subperiods in terms of fiscal stability. Before the mid-1990s, no systematic fiscal response existed to restore the stability of public debt, whereas after the mid-1990s, a remarkable effort was evidenced by the positive fiscal reaction parameters. Notwithstanding some 20 years of strong positive reactions, the former performance appears to be far-off in recent years, and the strength of fiscal reaction has waned gradually, which is perturbing for the future course of fiscal sustainability.

Keywords: Debt sustainability, fiscal reaction function, state-space model

JEL Classification: H63, E62, C32

* The empirical analysis in this study is a more advanced derivative of the analysis in the Ph.D. thesis of the author.

Introduction

The recent fiscal history of Turkey has been shaped to a large extent by malfunctioning economic policies, volatilities and snowballing public debt accumulation, which have jointly destabilized the fiscal posture of the country on a continuous basis. The precarious fiscal dynamics, in turn, have constantly tamped down the economic potential of the country since the vast proportion of the fiscal space is to be devoted to debt servicing. In developing countries such as Turkey, shrinking fiscal space constitutes a hindrance to economic and social promotion since budgeting becomes more challenging in each round. Hence, it is of utmost importance to scrutinise the past and the present trajectory of debt dynamics and relevant government policies to shun the adverse effects of unsustainable fiscal balances.

Turkey has recently seen delicate fiscal postures and shrinking fiscal spaces, which have rendered the country vulnerable to outside shocks and sudden stops of the influx of international finance on which the country predominantly relies for budgeting. Malfunctioning fiscal policies have carved out a fiscal fragility problem in the country and reduced the overall maturity of government bonds while heightening the risk premium. The financial liberalisation during the 1980s generated debt and thereby culminated in even higher borrowing requirements since the country suffered from insufficient domestic savings to roll over ever mounting debt, finally resulting in snowballing public debt which topped out in 2001 by hitting levels as high as 70% of the GDP.

This unpleasant trend was reversed by the IMF-backed recovery programme in the first half of the 2000s and the debt snowball melted gradually throughout the decade. Nevertheless, the recent fiscal performance is not on a par with the fiscal triumph of the early 2000s. The country was put on “*The Fragile Five*” list by Morgan Stanley. Also, recent data imply a worsening scenario for the fiscal posture of the country and looming fiscal distress. The debt-GDP ratio increased from 22% to 32% in the last three years and the contemporaneous borrowing requirements faced a more than three-fold increase from 1.8% to 6.1%, which can be considered a premonition for an incoming fiscal calamity.

In view of these arguments, this paper aims to appraise Turkey's fiscal sustainability in a dynamic setting and offer caveats about the ongoing trends in the fiscal balances. For this purpose, we undertake an analysis taking Bohn's fiscal sustainability hypothesis as a basis. Put briefly, this approach quantifies the government's fiscal responses to mounting public debt to restore sustainability in fiscal balances should departures from the stable path occur. According to Bohn, the existence of such retaliation is measured by the fiscal reaction parameter, whose positive values indicate fiscal sustainability. Nevertheless, especially for developing countries, performing a positive fiscal reaction for each year is not feasible since their fiscal space is narrow relative to the developed world. Thus, in order to test the longevity and the positivity

of fiscal reactions, we conduct the estimations in a time-varying setting, which is also advocated by Bohn since fiscal sustainability is inherently a dynamic and evolving concept. Furthermore, for developing countries such as Turkey, the aforementioned precariousness in fiscal balances entails a time-varying estimation to fully grasp the intertemporal evolution of fiscal sustainability since those countries exhibit a volatile fiscal posture stemming from the unsteady nature of the economy. For these reasons, we transform Bohn's equation into a state-space representation to execute the estimation of the fiscal reaction parameter with a temporal variation using annual Turkish data.

To accomplish this objective, the paper is developed under three sections. Section 1 is devoted to a literature review. Section 2 elaborates on the basics of the fiscal reaction function and introduces the variant thereof that we used for the estimation. Section 3 deals with the empirics along with interpretation of the estimation results. The final part concludes.

1. Literature Review

Nguyen *et al.* (2016), on which our empirical analysis is based, is a seminal contribution to the fiscal sustainability literature. They build a state-space setting to integrate the time-varying properties to the model so as to analyse the US public debt sustainability from a dynamic perspective. Their findings indicate that the time-varying fiscal reaction parameter was positive until 2005, translating into a sustainable public debt posture. However, from 2005 onwards, the reaction parameter turns negative, which corresponds to a deteriorating fiscal position.

Belguith and Gapsi (2016) carry out a similar analysis for Tunisia. They obtain the time-varying parameters using the smoothing spline technique. According to their results, the fiscal reaction parameter is primarily positive, indicating an overall sustainable public debt position.

Campos and Csyne (2019) employ both spline smoothing and state-space techniques to obtain time-varying fiscal reaction parameters for Brazilian public finances. The empirical findings in their study suggest that the magnitude of the fiscal reaction parameter becomes weaker over time, and thereby the government can respond to rising public debt in waning intensities. This declining trend is worrisome for the sustainability of Brazilian public finances.

Burger *et al.* (2012) is another study that incorporates the state-space technique into the fiscal reaction function methodology. Their results are indicative of a transformation in South African fiscal posture to stabilize public debt in the 1990s.

Fincke and Greiner (2011) also use the spline smoothing technique to capture the time variation in the reaction parameter. They focus on the fiscal data of several Eurozone countries, and their findings suggest that the fiscal postures of the countries they analyse are sustainable except Greece and Italy.

Using a data set for the period 1970–2013, Mutuku (2015) analyses the fiscal stability in Kenya using the same technique. His findings imply no systematic government response to the debt realizations, which in turn leads to the conclusion that Kenya's debt profile is not sustainable. Fiscal adjustments for restoring sustainability are recommended in the study.

De Mello (2011) uses a monthly dataset covering the period 1995–2004 to estimate the fiscal reaction function for Brazil. The paper concludes that the Brazilian fiscal policy appropriately reciprocates the mounting debt realizations which enable the establishment of fiscal sustainability in the country. The author states that the debt ceiling reform introduced in 1998 facilitated the execution of a higher level of fiscal response to alleviate fiscal hardships even during economic downturns.

Mauro *et al.* (2015) apply a panel version of the same model. Their dataset covers 55 countries. They use the fiscal reaction function to appraise the level of fiscal profligacy in those countries. For this purpose, they calculate the rolling window technique, which is similar to time-varying estimation, using a dataset comprising indicators such as fiscal revenues, primary expenditures, government debt and GDP. Similar to our work, they use Bohn's (1998) approach for the analysis. They detect temporal variation in the level of fiscal prudence in those countries driven by alterations in economic growth and borrowing costs.

Afonso and Jalles (2011) is another contribution to the fiscal literature. They test the fiscal reaction function for selected OECD countries. They conclude that the OECD countries overall implement Ricardian fiscal policies and succeed in restoring fiscal sustainability whenever a divergence from the stable path occurs.

Burger and Marinkov (2012) also employ a time-varying coefficient approach to the fiscal reaction function and use GMM and Markov switching techniques for this purpose to analyse the status of fiscal stability in South Africa. Their overall conclusion is that the fiscal dynamics in South Africa are stable. Besides, they propose setting fiscal rule bands to preserve stability in the public finances.

Paniagua *et al.* (2017) employ a time-varying approach to the fiscal reaction function to assess the fiscal stability in selected Eurozone countries. They use Kalman filtering to obtain varying coefficients and use Barro's (1986) approach to account for the business cycle factor in determining the variations in the primary balance. Their findings imply that fiscal reaction counteracts debt accumulation in those countries with a certain degree of heterogeneity. As such, Eurozone countries involved in bailouts such as Greece, Spain, Ireland and Portugal could only react to debt accumulation in isolated and extreme case scenarios, unlike other countries which perform fiscal reaction in a systematic manner.

Can (2021) uses the flexible least squares technique to estimate time-varying coefficients for gauging the evolution of fiscal sustainability. He adds a standard output gap as a control variable. His findings show that the fiscal stability attempts in Turkey exhibit a time-varying pattern and that the country is currently heading towards an unsustainable position.

2. Theoretical Framework

Empirical appraisal of fiscal sustainability is categorized into two groups. The methods in the first group chiefly focus on the time series properties of the fiscal data, whereas the second group offers a model-based approach. Despite their methodological differences, both approaches take the intertemporal budget constraint as the basis for analysis which is formulated as follows:

$$G_t + iD_{t-1} - R_t = (D_t - D_{t-1}) \quad (1)$$

where D_t is debt stock, R_t is government revenues, and G_t is primary spending.

Equation (1) represents the law of motion for the public debt. Since subtracting primary spending from the government revenues reveals the primary balance (PB_t), the equation can be reformulated as follows:

$$-PB_t + i_t D_{t-1} = (D_t - D_{t-1}) \quad (2)$$

Solving for D_t we get:

$$D_t = (1 + i_t)D_{t-1} - PB_t \quad (3)$$

Equation (3) exhibits the dynamics of public debt. Accordingly, the current level of public debt is the sum of the previous period's public debt, interest paid thereon and the current level of primary balance. This equation is essentially a budget constraint for one period. The intertemporal budget constraint can be obtained by forward iteration.

$$D_1 = (1 + i)D_0 - PB_1$$

$$D_2 = (1 + i)D_1 - PB_2$$

$$D_2 = (1 + i)((1 + i)D_0 - PB_1) - PB_2$$

$$D_N = (1 + i)^N D_0 - \sum_{j=1}^N (1 + i)^{(N-j)} PB_j \text{ and thereby:}$$

$$D_0 = \sum_{j=1}^N \left(\frac{1}{1+i} \right)^j PB_j + \left(\frac{1}{1+i} \right)^N D_N \quad (4)$$

Equation (4) denotes the bond between the initial and terminal debt levels along with the primary balance. Without imposing any restrictions on the terminal debt level, any primary balance level would satisfy the intertemporal budget constraint, and it would be impossible to assess public debt sustainability. As such, in the literature, to avoid such a scenario, the transversality condition is imposed as a restriction on the intertemporal budget constraint. Formally:

$$\lim_{N \rightarrow \infty} \left(\frac{1}{1+i} \right)^N D_N = 0 \quad (5)$$

This constraint nullifies the Ponzi scheme and thereby guarantees public debt sustainability. The Ponzi scheme entails new borrowing to service existing debt in every round, which is obviously not sustainable. Thus, by overriding this condition, we avoid an unsustainable position that is characterized by a continuous temporary suspension of maturing debt. Since the debt is not covered by primary balance generation, such a system is not sustainable since the snowballing public debt accumulation will generate a disincentive for new lenders. The system will eventually fail to attract an influx of new financial resources. Hence, in the existence of the transversality condition, the government needs to run sufficient primary surpluses to shun unsustainable fiscal postures.

After imposing the transversality condition which prohibits the Ponzi game, the intertemporal budget constraint, which impels the government to generate primary surpluses to satisfy intertemporal solvency, reads as follows:

$$D_0 = \sum_{j=1}^{\infty} \left(\frac{1}{1+i} \right)^j PB_j \quad (6)$$

The time series-based analysis of public debt sustainability investigates whether the intertemporal solvency condition is met in the long term. This type of analysis is mostly carried out using techniques such as stationarity and cointegration tests. For intertemporal solvency to occur, the fiscal series need to preserve their past patterns. When fiscal policy elements appear to deviate from their usual course, the fiscal position of the economy becomes unsustainable. In this sense, the stationarity of the public debt series might reveal some important insights since non-stationarity implies unpleasant diversions from the sustainable pathway. Besides, cointegration is another technique used in the linear time series literature of public debt sustainability. This type of analysis seeks a cointegration among fiscal variables to test whether a stable long-run relationship exists among the variables if the stationarity is violated (Jha, 2012). Also, according to Afonso (2005), government expenditures and revenues imply no Ponzi scheme, which further suggests that the fiscal posture is sustainable.

Another seminal contribution to the time series-based analysis of public debt sustainability is by Hamilton and Flavin (1986). Instead of focusing on revenue and expenditures, their approach tests the validity of the intertemporal budget constraint directly. It aims to verify whether the sum of discounted values of future primary surpluses is equal to the current level of public debt. Their argument is also based on the stationarity of public debt. According to them, if the public debt series fluctuates around a stable equilibrium, the intertemporal budget constraint will be satisfied.

Nevertheless, seeking stationarity for public debt sustainability has been criticized in the literature on several accounts. For instance, according to Trehan and Walsh (1988), public debt and primary balance series are generally nonstationary, especially for developing countries. Also, according to Bohn (2007), appraising public debt sustainability based on stationarity properties of data might reveal misleading results. Besides, Bohn (1998) states that time series-based public debt sustainability analysis is flawed for several reasons. One of the reasons for the inappropriateness of time series-based analysis is that the results of formal unit root tests are generally not as precise as they need to be for drawing inferences about the stationarity properties of the data series. Conducting public debt sustainability analysis based on stationarity tests alone might bring about erroneous results since the formal tests generate mixed outcomes and mostly lack the precision needed to detect stationarity accurately. In addition, the inherent backwards-looking nature of time series-based analysis poses another challenge for proper assessment of public debt sustainability. This feature leads to the fallacious assumption that the future trend of the fiscal series will exhibit the same pattern as the past, which is too stringent, especially for developing countries. Finally, time series-based testing of public debt sustainability is unable to detect the cause of a fall in public debt. This approach fails to discern the difference between a random fall in public debt or a systematic fall occurring as an outcome of a fiscal policy design. Thus, time series-based methodology malfunctions in terms of revealing sensible conclusions about public debt sustainability.

Taking these shortcomings into account, Bohn (1995) proposes a novel model-based approach to public debt sustainability analysis, namely the fiscal reaction function. Unlike the time series methodology, which measures the soundness of policies solely through time series properties of data series, the model-based approach tests the government's ability to trim excessive upward movements in public debt using primary balance as a tool. The strength of the model lies in its ability to decompose underlying causes of movements in public debt trends. In other words, with this model, it is possible to verify that movements in public debt are realizations of intended outcomes of active fiscal policies. According to this model, a sustainable public debt posture occurs when excessive public debt is reverted to a stable equilibrium through fiscal

reciprocations in the form of primary surplus. Such a scenario overrides the occurrences of random falls in public debt, which are not necessarily sustainable.

The fiscal reaction function serving this function reads as follows in a concise form:

$$pb_t = \beta d_t + AZ_t + \eta_t \quad (7)$$

where pb_t is primary balance, d_t is public debt, Z_t is a set of control variables, and $\eta_t \sim NIID(0, \sigma^2)$.

In this articulation, the existence and strength of fiscal responses are measured by the β coefficient. According to Bohn (1995), a positive and statistically significant β coefficient is sufficient for establishing public debt sustainability. Nevertheless, this assumption is only sensible in a time-invariant setting, but public debt sustainability is inherently a dynamic and time-varying concept. Thus, as Greiner *et al.* (2009) suggested, the appraisal of the fiscal reaction coefficient needs to be carried out in a model with a temporal variation. There are proponents of stringent rules in the literature, such as Canzoneri *et al.* (2001) or Bohn (1998), who suggest that the fiscal reaction parameter should be non-negative for the entire sample. However, especially for developing countries, exerting a positive reaction for consecutive periods is quite challenging and unlikely. Thus, setting up the model in a time-varying framework and expecting a non-negative reaction parameter for a more significant portion of the data set appears to be a more viable approach, particularly for developing countries since fiscal volatilities mostly shape their economies.

Bearing this point in mind, we estimate a time-varying fiscal reaction function for Turkey, which is classified as a developing country whose recent economic history is characterized by financial crises and fluctuations. For this purpose, we prefer the model introduced in Nguyen *et al.* (2016).

This version of the fiscal reaction function is a modified version of Equation (6) above based on the tax smoothing model of Barro (1979). Accordingly, the set of control variables, Z_t , comprises two elements which represent temporary government spending and business cycle indicators and are deemed to affect the level of primary surplus. As such, this variant of the fiscal reaction function reads as follows:

$$pb_t = \beta_0 + \beta_1 d_{t-1} + \beta_2 GVAR_t + \beta_3 YVAR_t + \eta_t, \quad (8)$$

$$\beta_{1t} = \beta_{1(t-1)} + \eta_t, \quad \eta_t \sim N(0, \sigma_\eta^2) \quad (9)$$

In Nguyen *et al.* (2016), following Barro (1986) the $GVAR_t$ and $YVAR_t$ are calculated as:

$$GVAR_t = (g_t - g_t^*) / y_t, \quad (10)$$

$$YVAR_t = \left(1 - \left(\frac{y_t}{y_t^*}\right)\right) \times \left(\frac{g_t^*}{y_t}\right) \quad (11)$$

where g_t and y_t are government spending and national income levels respectively and g_t^* and y_t^* are their trend levels. In this articulation, the GVAR measures the temporary government spending $g_t - g_t^*$ scaled by the national income, which directly affects primary balance as the dependent variable since there is an inverse relationship between government spending and primary balance generation. Besides, the YVAR is defined as the cyclical variable in Barro (1986). According to him, this variable captures the cyclical behaviour of national income more appropriately since it accounts for the permanent shifts in the level of output.

The trend series required for the construction of these variables are obtained using the BN filter to decompose the corresponding variables. We refrain from other techniques such as the HP filter, which requires a large number of estimation revisions and is predominantly unreliable in out-of-sample forecasting as reported by Orphanides and Van Norden (2003) and Hamilton (2018). In addition, the BN filter performs better and requires fewer estimation rounds to match the true data characteristics (Kamber *et al.*, 2018).

This model is a state-space representation of the fiscal reaction function where Equation (7) is the signal equation and the next one is the state equation which is designed as a random walk process. The fiscal reaction parameter, β_{1t} , is allowed to vary over time to capture the evolution of the strength of the government's fiscal reciprocation. The other parameters are assumed to be time-invariant. The state-space method is a flexible and practical technique for estimating time-varying parameter models in the econometrics literature. The main intuition behind this method is to incorporate hidden factors into the analysis.

Formally, the state-space representation is modelled as follows¹:

$$Y_t = \mathbf{G}_t X_t + W_t, \quad (12)$$

$$X_{t+1} = \mathbf{F}_t X_t + V_t \quad (13)$$

where $X_t \in R^v$, $Y_t \in R^w$, $\{\mathbf{F}_t\}$ are $v \times v$ matrices; $\{\mathbf{G}_t\}$ are $w \times v$ matrices and $\{V_t\}$ and $\{W_t\}$ are random disturbances.

1 Refer to Harvey (1993) or Neusser (2016) for an extensive explanation of the procedure.

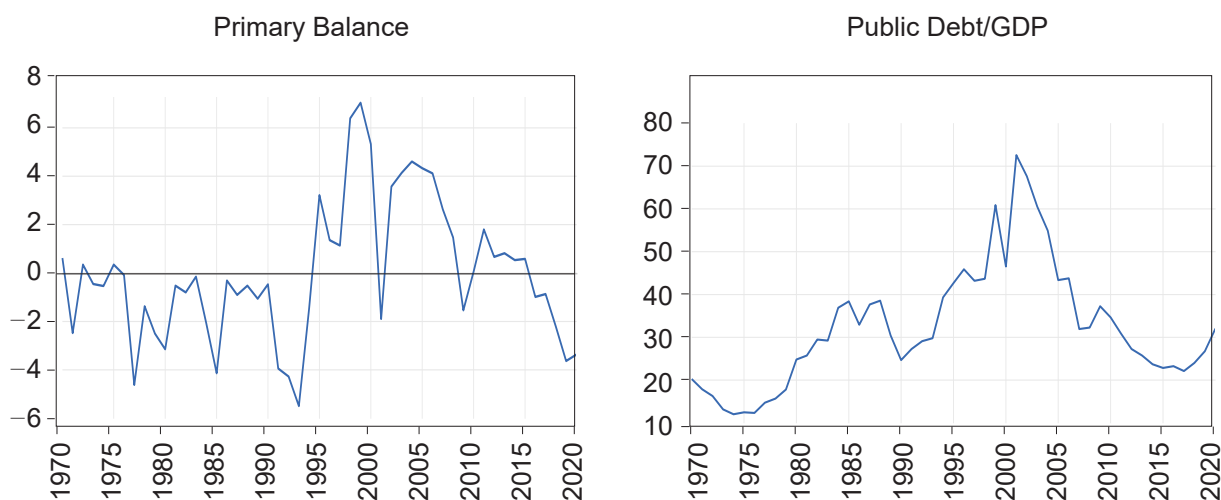
The above system is a condensed delineation of a state-space setup in W dimensions and with unseen hidden elements. The vector Y_t constitutes the dependent variables; it is a linear function of the unobservable vector of X_t . In this articulation, it is aimed to compute the estimators for the hidden signal (*i.e.*, X_t), given that the discernible vector Y_t is at hand. The Kalman filtering technique, which is made up of predictive and updating equations, is used to carry out these estimations. The equations used for this procedure are comprised of the variance and the expectation of the Y_t provided that the values until $t - 1$ are known. The update equation, which is also known as a filter, on the other hand, shows the expected value and the variance of X_t considering that the observations until the period t are available. Finally, the fixed coefficients are estimated via maximum likelihood.

3. Empirical Analysis of Fiscal Sustainability in Turkey

3.1 Salient features of data

The dataset used for estimating the model described in the previous section comprises four elements: primary balance to GDP, public debt to GDP, government final consumption expenditures and GDP. The first variable, primary balance to GDP, is compiled from the Fiscal Monitor and Public Finances in Modern History Databases of the IMF. The second variable, public debt to GDP is retrieved from the Global Debt Database of the IMF. The government final consumption expenditures series includes all current expenditures on the government purchases of goods and services as well as employee compensation, national security and defence expenditures. This series is taken from the World Bank national accounts data. Finally, the GDP is the current national income in US dollars also retrieved from the same database of the World Bank as the expenditure series. The data set covers the period 1970–2020 with annual frequency.

Figure 1 above displays the plots of the main data series used in the model. It can clearly be observed in the graph that the primary balance was negative until the late 1990s. After hitting record low levels during this period, the primary balance series reached positive territory at the end of the decade thanks to recovery programmes supervised by the IMF. Except for the great recession in 2001, the government performed considerably well in primary balance promotion until the global crisis in 2009. Thereafter, the primary balance stays in its downward trend and recently hits negative levels once again, which signals a deterioration in fiscal balances.

Figure 1: Data plots

Source: IMF Databases

The public debt series is relatively more stable with the exception of the 2001 crisis, during which it tops out. In 2001, the country faced its most severe economic crisis which resulted in an unprecedented rise in the public debt to GDP ratio. Skyrocketing public debt coupled with an abrupt fall in the GDP brought about the occurrence of the historical level of debt to GDP ratio in that year. Prior to the financial crisis of 2001, the country was already in a worsening economic condition triggered largely by the financial burden of the unprecedented earthquake in 1999 along with some other economic problems such as lack of sufficient savings, rising interest rates (during the 2001 financial crisis they reached levels as high as 7,500%), political turmoil between the prime minister and the president, excessive liquidity demand by the banks, large current account deficits, *etc.*

At the end of 2000, the banking system in Turkey collapsed and many banks went bankrupt due to the lack of sufficient liquidity in the economy, which deteriorated the conditions even further by leading to skyrocketing interest rates and consequently giving rise to an abruptly mounting public debt accumulation due to unexpectedly heightened interest payments. Not surprisingly, an outflow of international finance occurred in the country, which exacerbated the borrowing and the rollover requirements of the economy even further and thereby contributed to the historical zenith of the debt to GDP ratio in that year. Nevertheless, this summit in the public debt series was trimmed in the following years of the early 2000s by contemporaneous positive primary balances.

Table 1: Summary statistics**Primary balance to GDP**

	Range	Mean		
1970–1976	3.09507	−0.31661	Mean	−0.0123
1977–1983	4.47347	−1.87171	Median	−0.4497
1984–1990	3.83048	−1.35124	Minimum	−5.4914
1991–1997	8.70993	−1.35033	Maximum	7.0329
1998–2004	8.93279	4.16740	Standard deviation	2.8559
2005–2011	5.87000	1.83857		
2012–2020	4.45016	−0.93778		

Public debt to GDP

	Range	Mean		
1970–1976	8.2219	14.9171	Mean	32.303
1977–1983	14.7394	22.4947	Median	29.795
1984–1990	13.9074	34.2296	Minimum	12.031
1991–1997	18.6481	36.7483	Maximum	72.599
1998–2004	28.9193	58.1187	Standard deviation	14.084
2005–2011	12.9072	36.3056		
2012–2020	9.9400	25.3033		

Source: Authors' own calculation

To get a better grasp of the data at hand, it is worthwhile to look through the summary statistics. Table 1 below exhibits the primary statistics for the data along with the allocation of the mean for several sub-samples. It can be noted in the table that the primary balance has a considerably volatile distribution of the mean, while public debt has a smoother averaging across sub-samples. The primary balance reaches positive territory after 1998, which corresponds to the implementation of IMF-backed policies. Notwithstanding almost a decade of positivity, this variable lies in the negative zone since 2012, which is quite a signal for the deterioration in the public finances. The overall average of this indicator is -0.0123 , which is below zero and implies insufficient fiscal reaction over the entire sample. Another point to note in the table is that the highest level of the primary balance is 7.03% and the country performed at this level when the public debt topped out in 2001. Put differently, if the country needs a primary balance generation involving levels higher than 7.03%, then fiscal fatigue is very likely

to occur since in this case required primary balance level will be higher than the natural capacity of the economy.

The public debt, however, at least on average, exhibits a more stable pattern and does not reach levels as high as 60%, which is recommended by the Maastricht criteria. The average public debt to GDP ratio for this period was 32.30, which is in fact quite reasonable. Despite hitting peaks as high as 72.59%, the average public debt level is within safety margins. Also, it is clear from the table that public debt continuously rises till the late 1990s, which indicates that till then no systematic fiscal policy was implemented in the country.

Besides, according to the table, the primary balance is stationary for all the tests, whereas the other variables are deemed stationary for four out of five tests. As such, it is safe to conclude that all the series are stationary.

Table 2: Formal stationarity tests

	ADF	DF-GLS	PP	KPSS	ERSP
Primary balance	−2.68	−2.72	−2.68	0.23	2.28
1%	−3.57	−2.61	−3.57	0.73	1.87
5%	−2.92	−1.94	−2.92	0.46	2.97
10%	−2.59	−1.61	−2.59	0.34	3.91
Public debt	−2.59	−1.83	−4.59	0.57	6.89
1%	−3.60	−2.62	−3.60	0.73	1.87
5%	−2.93	−1.94	−2.93	0.46	2.97
10%	−2.60	−1.61	−2.60	0.34	3.91
YVAR	−5.97	−3.83	−7.77	0.11	1.72
1%	−3.58	−2.61	−3.57	0.73	1.87
5%	−2.92	−1.94	−2.92	0.46	2.97
10%	−2.60	−1.61	−2.59	0.34	3.91
GVAR	−5.75	−3.34	−6.03	0.09	0.81
1%	−3.57	−2.61	−3.57	0.73	1.87
5%	−2.92	−1.95	−2.92	0.46	2.97
10%	−2.59	−1.61	−2.59	0.34	3.91

Source: Authors' own calculation

3.2 Estimation results

In this section, we report the estimation results of the time-varying state-space estimation results and discuss the results from a fiscal sustainability viewpoint. State-space is a recursive estimation technique carried out using Kalman filtering to estimate the time-varying coefficients.

Combining the model of Nguyen *et al.* (2016) with the estimation approach in Burger *et al.* (2012) and Greiner and Fincke (2009), we estimate the equation with lagged values of public debt and include no constant term to obtain the best results. Since the budget is prepared annually in Turkey, the government can reciprocate mounting public debt in the next period. Thus, it is sensible to estimate the model with lagged values of public debt.

Table 3: State-space estimation results

Fixed coefficients

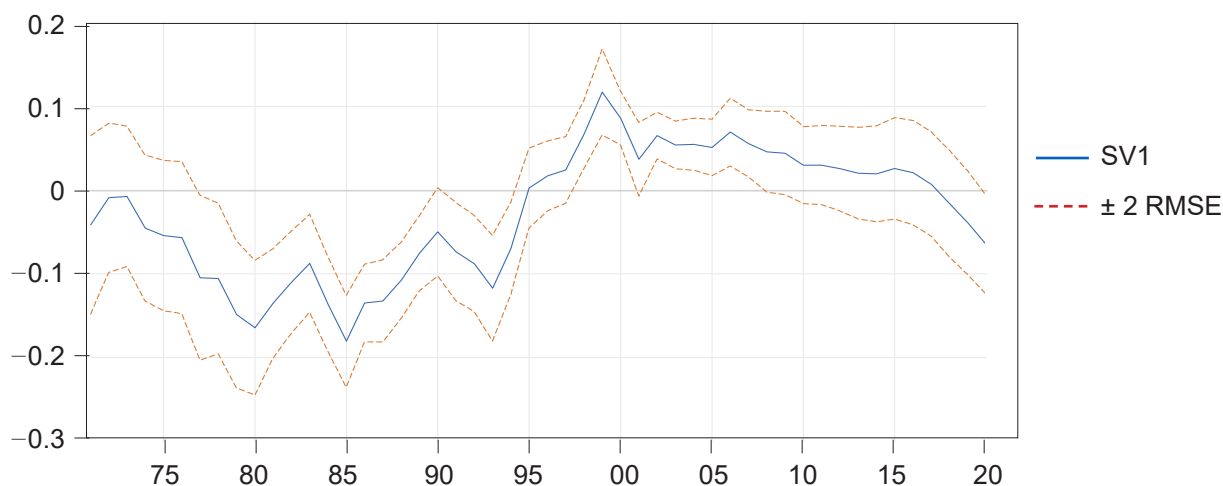
Variable	Coefficient	Std. error	z-statistic	Prob.
YVAR	−2.2385	0.3558	−5.49	0,0000
GVAR	−1.9545	0.3655	−6.12	0,0000

Final state

	Final state	Root MSE	z-statistic	Prob.
SV1	−0.0773	0.0406	−1.602	0.109

Source: Authors' own calculation

Figure 2: Time-varying fiscal reaction parameter



Source: Authors' own calculation

Table 3 and Figure 2 above report the findings obtained from the state-space model estimations. The fixed coefficients shown in Table 3 indicate that the fiscal policy is procyclical in that a positive output gap (expansion) leads to a deterioration in the primary balance. In other words, when the economy grows, the government increases the transfer payments and other expenditures and cuts taxes. Alesina *et al.* (2008) claim that fiscal behaviours of this kind are common among emerging economies due to political-economic reasons. The demand for public goods and services soars during expansion; hence, instead of saving for future dire conditions, the government chooses to increase spending and reduces taxes during these periods.

The time-varying coefficient estimation divides the sample into two sub-samples. The turning point is 1995, when the fiscal reaction parameter turns positive for the first time. In the first part, longevity of the negative parameters is prevalent while the second part is dominated by the positive fiscal reaction. Put differently, a transformation in fiscal policy is visible in the graph. The attempts to rein in the fiscal conditions in the first sub-period apparently failed to reach sensible outcomes in that no positivity is exhibited in the graph during this period. The parameter topped out during the first few years of the early 2000s and, not surprisingly, a profound decline in public debt occurred contemporaneously. Nonetheless, it is also visible in the graph that following the global financial crisis the sturdy trend in the parameter was put on pause and since then it has not reached similar levels and has even hit negative levels recently.

As advocated by Bohn (1998) and Greiner and Fincke (2010), especially for developing countries the model needs to be estimated in a time-varying manner so as to capture their precarious and volatile economic structure. In this respect, the estimation results produce results which are consistent with the very nature of Turkey's economic history. This finding supports the argument in the aforementioned papers regarding the exigency of time-varying estimation for developing countries.

3.4 Robustness check

Before proceeding with the assessment of the results obtained from the state-space model, it is worthwhile to run a robustness check via an auxiliary model to test the sturdiness of the empirical findings above. For this purpose, we estimate the same model with a different technique, namely flexible least squares.

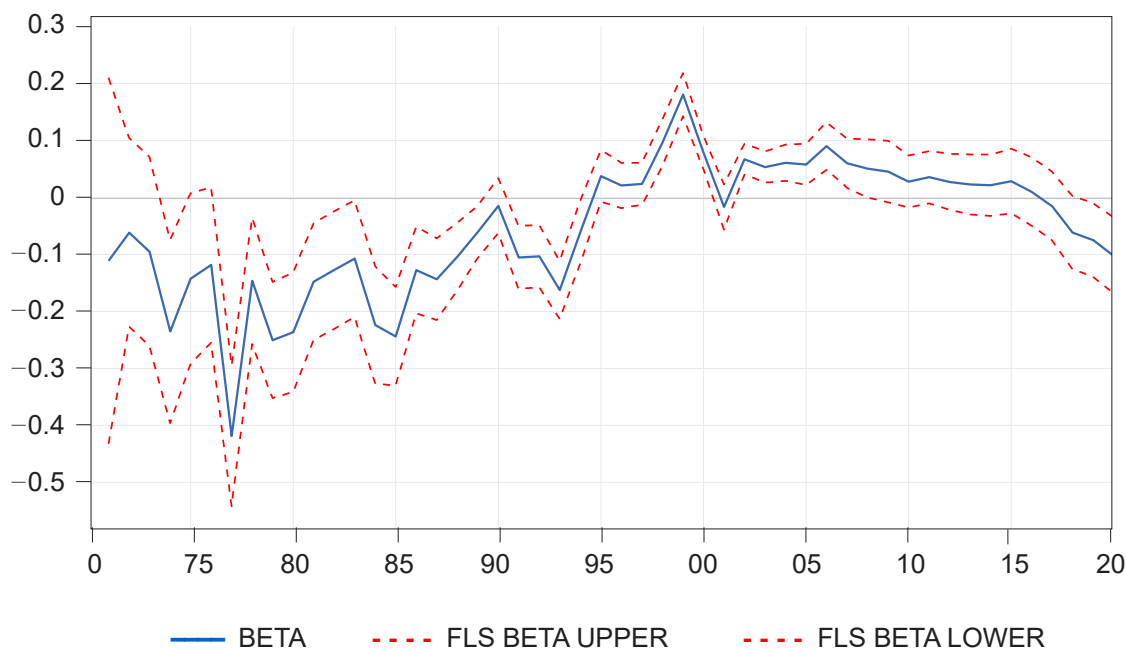
The flexible least squares technique is an alternative and practical method for estimating time-varying parameters. The method basically relaxes the assumptions of the OLS method and allows the parameters to vary over time. In their seminal paper, Kalaba and Tesfatsion (1989) described this method in detail. Basically, the method transforms the cost function to minimize

and thereby obtains the varying parameters via an altered function. In classical OLS taxonomy, the dependent variable y_t can be approximated by $x_t'\beta$, where $x_1, \dots, x_p$ represents the set of explanatory variables. In this case, the cost function is $C(\beta) = \sum_{t=1}^T (y_t - x_t'\beta)^2$, which is minimized based on the assumption that $y_t - x_t'\beta \approx 0$. However, in the case of FLS the cost function turns out to be $C(\beta; \mu) = \sum_{t=1}^T (y_t - x_t'\beta_t)^2 + \mu \sum_{t=1}^{T-1} \xi_t$, where $\xi_t = (\beta_{t+1} - \beta_t)'(\beta_{t+1} - \beta_t)$ with the additional assumption of $\beta_t = (\beta_{1t}', \dots, \beta_{pt}')'$ which enables the estimation of time-varying parameters. It is clear from these algorithms that OLS is a special case of the FLS which covers a larger set of possibilities including time-varying parameter estimation.

The graph below plots the time-varying fiscal reaction function parameters obtained using the FLS estimation technique and their respective upper and lower bounds as a confidence interval.

It is clearly demonstrated in the graph that despite occasional deviations, the time-varying coefficients estimated by the FLS method correspond almost identically to their state-space counterparts. The former technique estimates the downward movement in the 1970s slightly more prominently, which is also the case in the early 2000s. Other than that, the evolution of the parameter is indistinguishable among the two methods, which implies that the estimation results of the state-space technique are reliable and pass the robustness test.

Figure 3: FLS estimation results



Source: Authors' own calculation

3.5 Discussion

Now that we have presented the estimation results and discussed their robustness, we can talk through the evolution of the parameter estimation and evaluate the results from the economic history standpoint. Figure 2 depicts the evolution of the time-varying fiscal reaction parameter. It can be noted in the graph that until the mid-1990s, there was no systematic reaction to stabilize public debt since the reaction parameter lies in the negative territory during that period. Nevertheless, following the 1994 economic crisis in the country, a recovery programme under the supervision of the IMF was established and was updated several times in the following years. The outcome of adherence to those programmes is noticeable in the figure. The reaction parameter moves to the positive zone in that period and stays there until recently. Put differently, the late 1990s and early 2000s are the fiscal transformation periods for Turkey, which is evidenced by the upward movement in the fiscal reaction parameter during that era.

This outcome is essentially a consequence of the neo-liberal policy shift in the economic structure of Turkey commencing in the early 1980s. Shaped to a large extent by IMF impetus and guidance, the liberal metamorphosis during the entire 1980s did not result in alleviating results for the economy from the outset, which is evidenced by the negative values of the reaction parameter corresponding to that period in Figure 2. In other words, it took an entire decade for the economy to adjust to the new paradigm shift. Also, the preceding decade was shaped, to a large extent, by the domestic and international economic events which caused discontinuities in the economic recovery periods such as the oil crises in 1973 and 1978, whose impairing effects also permeated to the 1980s. During that period, Turkey was offered several debt restructurings but none of them was in the form of debt relief; therefore, debt management failed to compensate even rising debt stock through primary balance generations, which are also revealed by the pattern of the time-varying reaction parameter. One of the challenges for debt management during the period was the short-term maturity profile of the debt structure, which was quite a hindrance to a proper debt reduction strategy (Celasun & Rodrik, 1989, p. 196). Low growth levels also posed a challenge for debt management by the diminishing capacity to pay.

Consequently, a debt crisis became inevitable which aroused due to the quasi-Ponzi scheme, which relied solely on the investment appetite of foreign investors which was apparently not abundant during the period. In order to curb the unpleasant economic conditions', a series of IMF-backed stabilisation policies were implemented whose alleviating impact was limited and did not result in a full-fledged recovery from the dire conditions. The policy measures implemented were either too shallow or too late to reciprocate the debt realizations which would entail a larger-scale transformation. In 1980, Turkey initiated a liberal economic transformation

programme which was more comprehensive than its predecessors. Doing away with the rigid economic policies, the new system was designed to be a liberal paradigm shift from the outset. Converting the country into an “open economy”, the new system provided the country with the opportunity to fully integrate into the international financial markets, which could potentially secure continuous influx of foreign financial investments into the country and thereby mitigate debt management problems.

During the first five years of the new programme, strong adherence was performed by the government, and therefore remarkable recovery was achieved in the economy, which is also reflected by the improvement in the capacity to pay. Not surprisingly, the period is associated with an upward movement of the fiscal reaction parameter. Nevertheless, in the rest of the decade, the fiscal and economic performance waned gradually and ultimately the intended outcomes could not be achieved. The strong commitment to the programme exerted by the military government in the first half of the decade could not be exhibited by the civil government in the second half of the decade, which resulted in a stringent divergence from the stable path of the economy. Another reason for the fall in economic performance was the end of the debt relief provided by the international community in 1984, which was far from sorting the debt servicing problems of the country. Conversely, generous debt relief provided by the international community at the beginning of the programme brought about a fatigue in fiscal management in that the fiscal authorities did not deign to design a full-fledged fiscal policy reform which could prove useful for the rest of the decade when the international debt relief was not available.

During the 1990s, the country was acting as a fully open internationally integrated economy thanks to the liberal transition in the 1980s. Despite its fruitful outcomes during the 1980s, the liberal policy shift culminated in a heightened financial vulnerability due largely to the abruptly increased flow of international financial resources. Removing the barriers to the influx of foreign capital rendered the country prone to the risk of sudden stops since debt financing was de facto not under the direct control of the government. Also, the profit appetite of the foreign investors shortened the maturity of the debt portfolio even further, which exacerbated the riskiness of debt management. Consequently, the country faced severe speculative attacks from international markets, which gave rise to a financial crisis in 1994. In Figure 2, the period is represented by a falling trend in the fiscal reaction parameter, which is in line with the economic outlook of the country in that period. Throughout the decade, public debt management was not controllable in the country due largely to compounding interest payments which constituted quite a hindrance to finding new sources with long maturities to refinance the existing debt, which in turn brought inevitable social spending cuts in the budget and thereby an overall decline in the welfare of the society. Temporary boosts originating from the immediate effects of short-term international investments were depleted swiftly through the malfunctioning

budgetary system and, in the next round, gave rise to even higher financing needs due to high-interest payments, which were definitely a Ponzi-scheme from the public finance management perspective. In addition, the contemporaneous Russian and Asian crises also worsened the already unhealthy fiscal condition of the country.

During the decade, a set of economic policy packages was implemented; however, the outcome was far from the desired level as far as the recovery of the fiscal balances was concerned. The most discernible stabilisation programme was launched in 1998 with disinflationary purposes, but two major earthquakes took place in the country, which depleted all the gains of the implemented programme. Ergo, in 1999 under the supervision of the IMF, a new recovery programme was announced. Despite the establishment of the new programme, the country was hit by another financial crisis in November 2000, which was succeeded by an even more severe financial crisis in 2001.

During the early 2000s, however, Turkey performed remarkably well thanks to strong adherence to the IMF recovery programme by the single-party government. This is also evidenced by the diminishing levels of debt levels and remarkably higher levels of primary surplus reactions displayed in Figure 2 above. Nevertheless, the primary balance generation required for this performance was achieved through tax hikes rather than spending cuts, which generated an excessive burden on the already shallow tax base of the country and posed quite a challenge for fiscal recovery. Moreover, there were large disparities between the written postulates of the recovery programme and the real occurrences of the economic indicators originating due largely to a lack of sufficient institutional governance, deferral of reforms from their pathways, *etc.* Another reason why the programme diverged from its designated path is that the programme officials concentrated solely on the primary balance generation to reduce the debt accumulation, but they paid less attention to the content and quality of the fiscal adjustments due largely to the country's immediate needs to restore fiscal sustainability.

In the rest of the decade, the country performed remarkably well in economic recovery. Nevertheless, this optimistic environment was facilitated by the strong flow of international capital into the country thanks to the above-average real interest rate offered by the treasury bonds. Until the global financial crisis in 2009, discernible debt reduction occurred in the country thanks to strong adherence to the programme along with the influx of foreign capital. However, even though the implemented procedures alleviated the accumulated debt to a large extent, the short-sighted nature of the policies exacerbated the tax burden on the economy even further.

During the 2010s, on the other hand, numerous economic events hit the economy including the war in neighbouring Syria, political turmoil starting in 2013, failed coup attempt in 2016, *etc.* In addition, during the 2010s, access to international capital was not as seamless

as it used to be during the early 2000s, which, coupled with the aforementioned problems, culminated in a deterioration in the fiscal performance and, as can be observed in the graph above, the fiscal reaction parameter was in a falling trend during that period and moved into negative territory after some 20 years of positivity, which raises concerns about the future course of fiscal stability and impels the government to find auxiliary sources of financing such as augmented privatisation.

In other words, recently the parameter is once again in negative territory, indicating that Turkey's recent fiscal performance is not on a par with its past achievements in the late 1990s and early 2000s. This alarming trend signals waning fiscal performance and a looming potential fiscal crisis if no preventive measures are implemented promptly.

All in all, it is clear from the above that the evolution of the time-varying fiscal reaction parameter is not random but is in harmony with the economic history of the country. The reaction parameter was in negative territory for several consecutive years during the 1970s, indicating a lack of systematic government response to restore fiscal stability, which implies that the debt to GDP ratio was not under the direct control of the government but was determined randomly by the market forces, which is not sustainable. The liberal transformation brings about a positive trend in the parameter, but it appears that this favourable condition was temporary since, from the mid-1980s, the parameter started to decline once again, which made the debt to GDP ratio to mount once again during the late 1980s and the 1990s. Starting from the mid-1990s, the reaction parameter reflects the outcome of the fiscal transformation in the economy through a transition to positivity in the second half of the decade. This transition signals that the government decided to take control over the fiscal balances in this period by positive fiscal reactions which oscillated in the negative territory during the former decades. Also, the recent falling trend in the reaction parameter is in line with the recent developments in the economic history of the country.

Conclusion

Public debt sustainability inherently possesses time-varying characteristics, especially in developing countries, whose economic conditions mostly exhibit strong fluctuations. The economic posture of those countries varies swiftly; thus, quantifying public debt sustainability in those countries requires time-varying estimations. In this study, considering this argument, we estimated a time-varying fiscal reaction function to appraise the evolving status of public debt sustainability in Turkey. The empirical findings suggest that the public debt sustainability is contingent and exhibits temporal variation. Particularly, public debt sustainability did not continuously exist in Turkey's recent fiscal history, but a transformation towards sustainability took

place in the late 1990s. Nonetheless, the positivity of the reaction parameter has recently ceased to exist, which is worrisome for the future course of fiscal sustainability in Turkey. The positive and corrective fiscal reaction performance has recently waned, and since 2015, the fiscal policy appears to lack a positive reaction to stabilize public debt, which is not on a par with its past achievements. It is apparent that a looming debt crisis is on the horizon if no measures are taken to reverse the recent trend in fiscal policy. However, the policy mix required for diverting the ongoing pessimistic trend is not as straightforward as the textbooks might suggest and also entails large social and economic sacrifices in the short term, which is mostly not welcomed by developing countries due to political-economic reasons. Thus, in such a scenario, a back-loading fiscal adjustment could potentially produce less painful and more efficient results in terms of fiscal stabilization while preserving the social aspects of the budgeting contrary to front-loading adjustments, where the desired fiscal stability outcomes are expected to arrive in a very limited time, which results in more severe social dramas. In addition, when designing the indicated less painful back-loading adjustments, it is more favourable to rely on expenditure cuts in lieu of tax hikes since, especially for emerging economies, this type of fiscal behaviour is less unpleasant for the household budget. In addition, reducing profligacy by proper scrutiny programmes also mitigates the fiscal conditions and facilitates improvement of the fiscal reaction parameter in the medium term.

This paper attempted to adapt a novel approach to fiscal sustainability, *i.e.*, a time-varying fiscal reaction function, to the case of Turkey. Thus, the main contribution of this paper to the academic literature is the use of the Kalman filtering method to estimate time-varying coefficients to appraise the level of fiscal sturdiness in Turkey. Nevertheless, the underlying model, the fiscal reaction function, suffers from some drawbacks despite its convenience and practicality in assessing fiscal sustainability. For instance, the model relies on the debt to GDP ratio as the sole indicator of fiscal sustainability. However, the composition of the debt also plays a role in the fiscal stability. The currency and maturity composition of the debt along with the amount of assets owned by the government also affects the status of fiscal dynamics in the country. In this sense, the analysis in this study might be deemed partial. A future study might incorporate these factors into the analysis for a more comprehensive framework of the fiscal stability problem.

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