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## Abstract

This paper decomposes the fiscal balance into a cyclical and a structural component using an optimal fiscal stabilisation rule derived from a loss function where the government is assumed to keep structural balance close to the targeted surplus for fiscal balance while at the same time stabilising the GDP- and the inflation gap. A first-order Taylor expansion of fiscal balance is then used to further disaggregate the different components of fiscal balance. These practical policy rules can be used to calculate the magnitude of automatic stabilisers and the appropriate discretionary fiscal policies conditional on the state of the economy.

JEL Codes: E61, E62, H20, H50, H60

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## 1. Introduction

The government's fiscal balance is the difference between revenues and expenditures. If the government spends more (less) than it collects in revenues, it will generate a fiscal deficit (surplus). The primary balance is the fiscal balance excluding net interest payments on public net debt. Fiscal policy refers to policies that change the public sector's expenditure or revenue with the aim of influencing the economy in different aspects. Fiscal policy can affect primary balance through discretionary policies and through automatic stabilisers.[1]

Automatic stabilisers are features of the structure of government budgets that are directly affected by fluctuations in GDP without any (active) decisions.[2] Usually, automatic stabilisers are calculated as the average change which fiscal balance, expressed as a percentage of GDP, undergoes when the GDP gap changes by 1 percentage point.[3] Among the advanced economies, the U.S. has relatively weaker automatic stabilisers (with an elasticity of about 0.35,) while Sweden has relatively stronger automatic stabilisers (about 0.5).[4]

Discretionary fiscal policies are changes to tax rates and/or levels of government expenditures. Most empirical studies that study the impact of fiscal policy on GDP find positive effects of increased government spending

[1] The automatic stabilizers affect the cyclical component of fiscal balance while the discretionary fiscal policy measures affect the structural component of fiscal balance.

[2] Government's tax revenues decline when economic activity declines. Higher unemployment increases at the same time unemployment-related expenditures. The reverse occurs when economic activity increases. The fiscal balance, as a percentage of GDP, is also automatically affected by the economy if e.g. government consumption is maintained while government revenues change in line with GDP. These changes in public revenues and expenditures result in smaller variations in households' income and firms profits and hence smaller variations in private sector aggregate demand. The size of the automatic stabilizers is closely linked to the tax burden in the economy and the size of the public sector. Moreover, it also depends on how spending and tax systems are designed.

[3] In more detailed calculations, automatic stabilisers (or the budget elasticity) are calculated by weighing together how the revenues from different taxes vary with the economy. This is done by considering how different tax bases vary with the GDP gap, how different tax revenues varies with the tax bases and how important different tax bases are. In addition, it is usually considered that the expenditure on unemployment benefits varies with the economy. The public expenditure's share of GDP has, however, been shown to be a good approximation of the budget elasticity when compared with more detailed calculations for different countries.

[4] The literature review by Boije (2004) showed that the estimated budget elasticity for Sweden was 0.7–0.9. Price et al. (2015) calculations indicate that the elasticity for Sweden is 0.66. The range of the budget elasticity for different countries in their study is 0.21–0.66. Flodén (2009) calculates the size of the automatic stabilizers in 1998–2009 for Sweden, using the approach proposed by Girouard and André (2005). The analysis distinguishes between personal income taxes, social security contributions, corporate taxes, and indirect taxes (on consumption), and the expenditure on unemployment benefits. According to this study, the budget elasticity fell from about 0.6 in 1998 to about 0.5 in 2009. Almenberg and Sigonius (2021) replicate Flodén (2009) study, but for the period 1998–2019. Their estimations for Sweden indicate that the budget elasticity fell from about 0.55 in 1998 to about 0.47 in 2019

and tax cuts.[5] The positive impact becomes higher in the case of effective lower bound for monetary policy.[6]

Before the Great Financial Crisis (GFS) in 2008–09, the general belief among economists was that the best way for fiscal policy to support monetary policy to stabilise the economy was through the automatic stabilisers and by maintaining public confidence concerning the long-term sustainability of public finances. Discretionary fiscal stabilisation policy should be used in sparingly.

After GFS, many economists noted that in a world with low neutral interest rates there is a risk that monetary policy may not suffice to counteract an economic downturn.[7] In such a case, it may be necessary to resort to fiscal policy to counteract an economic downturn. Research in recent years has highlighted that monetary and fiscal policies always interact to jointly determine aggregate demand and the overall level of prices in the economy.[8] It is reasonable to assume that a country planning to undertake fiscal stabilisation policy would be benefited of a fiscal stabilisation rule that can be used to guide policy decisions.[9, 10]

One question that this paper addresses is therefore how much discretionary fiscal policies, in addition to the automatic stabilisers, that is needed to stabilise output and inflation without jeopardizing the supply target for the fiscal balance in the public sector (Section 2) and the impact these may have

[5] The overview by Hall (2009) of the literature before 2009 showed that multipliers reach unity or close to unity in most studies, but he couldn't rule out larger values. Caldara and Kamps (2017) found that the median tax multipliers range between 0.5 and 0.7, while the spending multipliers range between 1 and 1.3. Ramey (2019) summarizes the literature and finds that fiscal cumulative multipliers for public consumption appear to be in the range of 0.6–1 for industrialized countries. Different studies have found that the conduct of monetary policy is of major importance when studying fiscal multipliers. Erceg and Lindé (2014) found that the spending multiplier in liquidity traps is much larger than in normal circumstances (see also Ramey, 2019 and Almerud and Laun, 2021). In general, model-based and econometric studies find that the output effect of an exogenous fiscal shock vanishes within five years (see the overview in Batini et.al., 2014).

[6] When non-linearities are taken into account the multipliers become even higher (See i.e. Owyang et.al., 2013, Hjelm and Stockhammar, 2016, Miyamoto et. al., 2018, and Ankargren and Shahnazarian, 2019).

[7] See i.e. Woodford (2011), Farhi et al. (2013), and Calmfors et.al. (2022). These papers propose that fiscal and other policies should take on some of the burden to help sustain economic growth and stability. Furman (2016) described this as "the new view" of fiscal policy.

[8] See i.e. Leeper (2016) and Molteni and Pappa (2017) for good surveys of the relevant literature within this area.

[9] See Chadha and Nolan (2007) for arguments for the Conduct of optimal simple rules for monetary- and fiscal policy rules.

[10] A decision that monetary and fiscal policies will interact to counteract an economic downturn can be perceived as a powerful forward guidance. Therefore, a fiscal stabilisation rule can in these contexts be perceived as the likely course of fiscal policy and government's assurance to the public about its intended fiscal policy. If so, the fiscal policy can influence the financial decisions of households, businesses, and investors by providing a guide for the expected path of fiscal policy. By doing so, the government can prevent surprises that might disrupt the financial markets.

on debt ratio (Section 2). Furthermore, a first-order Taylor expansion of fiscal balance is then used to disaggregate the cyclical and the structural component of the fiscal balance. The decompositions are finally used to discuss the budget elasticities in more detail in Section 3 and discretionary fiscal policies in Section 4. Section 5 concludes. All necessary technical derivations and details are summarized in an appendix.[11]

One important contribution of this paper is that it provides a simple and practical fiscal stabilisation rule that policymakers can use as a benchmark to calculate the size of the discretionary measures, in addition to the automatic stabilisers, that they may need to undertake when the economy is exposed to various shocks. The second contribution of this article is that it also provides a tool to distribute the discretionary fiscal measures as well as the automatic stabilisers between different taxes and expenditures.

## 2. Fiscal stabilisation rule: The Cyclical and the Structural Components of Fiscal Balance

A government planning to undertake fiscal stabilisation policy needs a fiscal stabilisation rule that can be used as a benchmark to guide the policymakers to decide how much discretionary fiscal policy that can be undertaken to, at least partially, stabilise output and inflation without jeopardizing the medium-term sustainability of the public finances.

An optimal fiscal stabilisation rule is used to decompose the fiscal balance into a cyclical and a structural component.[12] This is done by first assuming that the government puts different weights on three important policy variables,

[11] The interested reader is advised to read this appendix first to gain a better formal understanding of the issues addressed and discussed in the main text.

[12] The interested reader is refereed to Boije (2004) for a detailed description of structural balance.

namely the gap between the structural balance and surplus target[13] for fiscal balance, the difference between real GDP and potential GDP (GDP gap), and the difference between (actual) inflation and the inflation target (inflation gap).[14, 15] The sum of the weights multiplied by these policy variables gives a so-called loss function for the government.[16] The government is assumed to minimize this loss function with respect to GDP. The solution to this minimization problem, which is summarized in equation (1), gives each year's fiscal stabilisation rule that satisfies medium-term objectives for public finances (namely the surplus target) and avoids pro-cyclical fiscal policy (see Appendix).[17, 18] The rule is

$$b_t = b^T + \theta \bar{y}_t + \left(\frac{\beta_Y^F}{\theta \beta_B^F}\right) \bar{y}_t + \left(\frac{\beta_\pi^F}{\theta \beta_B^F}\right) \gamma \bar{\pi}_t \qquad (1),$$

where $b_t$ is the government's fiscal balance as a share of potential GDP, $b^T$ is the surplus target, $\bar{y}_t$ is the GDP gap, $\bar{\pi}_t$ is the inflation gap, $\gamma$ is the slope of the Phillips curve capturing how the GDP gap influences inflation, $\theta$ is the budget elasticity, $\beta_Y^F$ is the weight that the government puts on stabilising GDP

[13] The fiscal framework in Sweden consists of budget policy targets (surplus target, debt anchor, expenditure ceiling, and balanced local government budgets), a disciplined central government budget process, external monitoring of fiscal policy, and transparency. The surplus target for the fiscal balance in the public sector should is one-third of percentage point of GDP on average over a business cycle. The debt anchor for consolidated gross debt (which is not an operative target) is set at 35 per cent of GDP. If the consolidated gross debt deviates by more than 5 per cent of GDP, the Government must present a communication to the Riksdag explaining the cause of the deviation and how it will be managed. The expenditure ceiling – the upper limit that expenditure must not exceed – is established three years in advance.

[14] In some countries fiscal stabilisation rules may emphasis that fiscal policy should stabilizes the level of debt. However, that could probably require greater variations in structural balance. In Sweden, the surplus target is (considered to be) the most important operational objective of fiscal policy. In this paper, the policy maker is assumed to stabilise the structural balance around the supply target for the fiscal balance. This means that the debt ratio will evolve as in equation (2) given the outcome of the primary fiscal balance.

[15] We are thus disregarding the case when the level of the government debt itself may constitute an obvious problem in addition to the structural deficit, i.e. times of a severe government debt crisis.

[16] Fiscal policy is assumed to react to the effect that monetary policy has on the economy but does not react to the monetary policy stance as such. The reason for this is that it is not certain that monetary policy has succeeded to stabilise the economy, i.e., because of the efficient lower bound of monetary policy. There may also be other reasons as well, such as different views concerning the GDP gap and the inflation gap. It may also be that the central bank and government do not place the same weight on stabilising GDP gap and inflation gap.

[17] Monetary policy rules have been used at central banks for policy guidance for long time (See i.e. Woodford, 2001). However, the use of fiscal stabilization rule is rare of obvious reasons since fiscal policy, according to "the old view" of fiscal policy, should only deal with specific problems that may arise in a "mild" recession.

[18] The optimal fiscal stabilisation rule used in this paper was introduced in Ankargren and Shahnazarian (2019), which in turn was inspired by Yoshino et.al. (2017). In Yoshino et.al. (2017), the government aims to stabilize government debt as close as possible to its desired level, with GDP close to the full employment level of GDP, and with a smooth change of government spending, taxation, and flow of bonds. In a recent report, Calmfors et.al. (2022) use fiscal- and monetary stabilisation rules (Inspired by the work of Lambertini and Rovelli, 2003 and Dixit and Lambertini, 2003) to discuss policy coordination problems.

gap, $\beta_{\pi}^{F}$ is the weight that the government puts on stabilising inflation gap, $\beta_{B}^{F}$ is the weight that the government puts on stabilising structural surplus around surplus target.[19].The parameters $\frac{\beta_{\pi}^{F}}{\theta\beta_{B}^{F}}$ and $\frac{\beta_{Y}^{F}}{\theta\beta_{B}^{F}}$, state by how much the government's fiscal balance reacts to inflation gap and GDP gap, respectively due to discretionary fiscal measures.

According to the fiscal stabilisation rule in equation (1), the fiscal balance is equal to the surplus target when both the GDP and the inflation gap are closed. The second term on the right-hand side of equation (1), is the cyclical component of fiscal balance which captures the aggregated impact of the automatic stabilisers. The third term in equation (1) captures the size of government's discretionary policies if real GDP deviates from potential GDP. The last term in equation (1) captures the government's discretionary fiscal policies if inflation deviates from the inflation target.[20]

*Calibration*: Following Almenberg and Sigonious (2021), the budget elasticity is assumed to equal $\theta = 0.47$ per cent for Sweden. Following Karlsson and Österholm (2020), we assume that the slope of the Philips curve is equal to $\gamma = 0.3$. According to fiscal policy framework in Sweden, the surplus target is $b^{T} = 0.33$ per cent of GDP or SEK 17 billion.[21] Moreover, we assume that the government puts more weight on stabilising structural balance around the targeted surplus than on stabilising GDP and inflation gap: $\beta_{B}^{F} = 2, \beta_{Y}^{F} = 0.5, \beta_{\pi}^{F} = 0.5$.[22]

[19] The choice of weights depends on a variety of political considerations such as the tax burden in the economy, the size of the public sector, the size of the long-term public debt as a share of GDP, the importance of the surplus target, the historical volatility of GDP and inflation gap, expectations concerning the path of the GDP and inflation gap in near future etc. If important economic variables, for some reason, overreact to discretionary fiscal measures, then the weights that the government places on the fulfilment of various goals may also need to be changed.

[20] It should be emphasized that many government expenditures are not indexed, which means that the structural component of fiscal balance changes despite the absence of fiscal policy measures. We have chosen to ignore this budgetary policy peculiarity because it is of little importance for the conclusions in this article.

[21] GDP in current prices in Sweden was about SEK 5370 billion in the end of 2021.

[22] The calibrated weights are intended to capture the importance of the fiscal policy framework in Sweden.

*Numerical calculations*: Table 1 shows the contribution of automatic stabilisers and discretionary fiscal policies to fiscal balance given the state of the business cycle. The fourth column in Table 1 shows the isolated effect of the automatic stabilisers. At a GDP gap of -1 per cent of GDP, the impact of automatic stabilisers on fiscal balance would be -0.47 per cent of GDP (SEK 25 billion). Moreover, the rule stipulates that additional discretionary fiscal policy measures should be undertaken to stabilise the GDP gap, amounting to -0.53 per cent of GDP (SEK 29 billion), and to stabilise the inflation gap, amounting to -0.05 per cent of GDP (SEK 3 billion)[23, 24, 25] In this case, the fiscal balance will be -0.72 per cent of GDP (SEK -39 billion).

**Table 1. The contributions of automatic stabilisers and discretionary fiscal policies to fiscal balance, Per cent of GDP**

| GDP gap | Inflation gap | Surplus target | Automatic stabilisers | Discretionary fiscal policy to stabilise GDP gap | Discretionary fiscal policy to stabilise inflation gap | Fiscal balance |
|---|---|---|---|---|---|---|
| -1.0 | -0.3 | 0.33 | -0.47 | -0.53 | -0.05 | -0.72 |
| -0.5 | -0.2 | 0.33 | -0.23 | -0.27 | -0.02 | -0.20 |
| 0.0 | 0.0 | 0.33 | 0.00 | 0.00 | 0.00 | 0.33 |
| 0.5 | 0.2 | 0.33 | 0.23 | 0.27 | 0.02 | 0.86 |
| 1.0 | 0.3 | 0.33 | 0.47 | 0.53 | 0.05 | 1.38 |

*Note: It is assumed that that* $\beta_B^F = 2$, $\beta_Y^F = 0.5$, $\beta_\pi^F = 0.5$, $\theta = 0.47$, and $\gamma = 0.3$.

Automatic stabilisers and discretionary fiscal policy affect the fiscal balance mainly by affecting the primary fiscal balance. A primary financial deficit

[23] The reason why inflation affects public finances is the fact that the GDP gap has a positive relationship with the inflation gap via the Philips curve. This means that a positive GDP gap leads to inflation rising, which results in a positive inflation gap. High inflation is usually considered harmful to the economy and that is why central banks around the world try to stabilize inflation with monetary policy. However, monetary policy reactions affect market interest rates which in turn affect the public sector's net interest expenditure. Higher interest rates and lower economic activity therefore weaken the public finances. Since the government realizes that high inflation and unsustainable public finances are harmful to the economy, it should place some emphasis on balancing inflation gap (as well as GDP gap) in its loss function.

[24] This means that the government pursues a negligible discretionary fiscal policy to stabilise the inflation gap. However, in Tables 5 and 3 we show that this largely depends on the assumed weight for stabilising the inflation gap in the loss function as well as the assumed slope of the Phillips curve.

[25] In the loss function for fiscal policy, it is assumed that the weights that the government places on stabilising various economic variables are symmetrical over the business cycle. In reality, governments will probably place greater emphasis on stabilising the GDP gap and the inflation gap in a recession than in boom, especially when monetary policy is constrained by the effective lower bound on the interest rate.

results in higher debt and interest expenses. The debt ratio evolves over time because of these mechanisms (see appendix).[26]

$$pd_t = \left(\frac{1+r^{PD}}{1+g^N}\right) pd_{t-1} - b_t^P \quad (2)$$

where $pd_t$ is debt-to-GDP ratio, $b_t^P$ is the primary fiscal deficit as a share of GDP, $r^{PD}$ is the nominal interest rate, $g^N$ is the nominal GDP growth. Using (2) and the results from Table 1, the debt ratio for different assumptions concerning the GDP-gap and interest-growth differentials are calculated (see Table 2).

Following the assumption made by National Institute of Economic research (NIER) in their fiscal sustainability analysis, we assume that the long-term interest-growth differential is on average 0.2% in column 5. This means that we assume that $r^{PD} = 4.2\%$ and $g^N = 4\%$.[27]. In column 4 and 6 we assume that the nominal interest rate changes in different directions while nominal GDP growth is maintained at 4 per cent. We assume further that the debt ratio in *t-1* is $pd_{t-1} = 35\%$ when the GDP gap is closed. Equation (2) is then used to calculate the debt ratio assuming that the GDP-gap in each period changes linearly (in different directions).

When the GDP-gap successively decreases from 0 to -1 per cent, the debt ratio increases from 35 per cent to 36.1 per cent due to automatic stabilisers and additional discretionary fiscal policies. Table 2 also shows that as the interest-growth differential become more positive, the debt ratio increases even further and vice versa.

[26] For simplicity this paper ignores the public sector's financial assets such as assets that are managed by the Swedish pension system, assets within government owned enterprises, and interest-bearing and non-interest-bearing assets (shares) owned by the public sector.
[27] National Institute of Economic Research (2021) assumes that the inflation target is 2% and that the potential growth in the economy is 2%. The assumption in column 4 in Table 2 is the assumption that NIER makes concerning the interest-growth differential from 2051-2100. NIER assumes that the interest-growth differential becomes negative between 2022-2050.

**Table 2. Debt dynamics given different assumptions concerning interest-growth differential and GDP gap, Per cent of GDP**

| GDP gap | Inflation gap | Fiscal balance | $r^{PD} = 2.6\%$ $g^N = 4\%$ $R = -1.3\%$ | $r^{PD} = 4.2\%$ $g^N = 4\%$ $R = 0.2\%$ | $r^{PD} = 5.2\%$ $g^N = 4\%$ $R = 1.2\%$ |
|---|---|---|---|---|---|
| -1.0 | -0.3 | -1.3 | 35.0 | 36.1 | 36.7 |
| -0.5 | -0.2 | -0.5 | 34.7 | 35.3 | 35.6 |
| 0.0 | 0.0 | 0.3 | 35.0 | 35.0 | 35.0 |
| 0.5 | 0.2 | 1.1 | 33.7 | 34.2 | 34.5 |
| 1.0 | 0.3 | 1.9 | 31.8 | 32.9 | 33.6 |

*Note: It is assumed that that* $\beta_B^F = 2$, $\beta_Y^F = 0.5$, $\beta_\pi^F = 0.5$, $\theta = 0.47$, and $\gamma = 0.3$. *The debt ratio in t-1 is assumed to be* $\mathrm{pd}_{t-1} = 35\%$ *when GDP gap is closed.*

### 2.1. Sensitivity analysis

In this Section, a sensitivity analysis is undertaken concerning some important parameters to highlight how important parameter values are for the results regarding automatic stabilisers and discretionary fiscal policies.

***Sensitivity analysis of the results regarding the weights that the government puts on stabilising GDP gap ($\beta_Y^F$) and inflation gap ($\beta_\pi^F$):*** Assume that the government puts lower/higher weights on stabilising GDP and inflation gap. From Table 3, it is evident that the size of the discretionary measures changes quite substantially when the calibrated weights on the GDP gap and the inflation gap are changed. For example, the magnitude of the discretionary fiscal policies increases from 0 per cent to -1.17 (SEK 62 billion) when the weights are increased from 0 to 1.0.

**Table 3. The fiscal balance and its decomposition given different weights on GDP gap and inflation gap, Per cent of GDP**

| $\beta_Y^F$ | $\beta_\pi^F$ | Surplus target | Automatic stabilisers | Discretionary fiscal policy to stabilise GDP gap | Discretionary fiscal policy to stabilise inflation gap | Fiscal balance |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.33 | -0.47 | 0.00 | 0.00 | -0.14 |
| 0.25 | 0.25 | 0.33 | -0.47 | -0.27 | -0.02 | -0.43 |
| 0.5 | 0.5 | 0.33 | -0.47 | -0.53 | -0.05 | -0.72 |
| 0.8 | 0.8 | 0.33 | -0.47 | -0.86 | -0.08 | -1.07 |
| 1.0 | 1.0 | 0.33 | -0.47 | -1.07 | -0.10 | -1.30 |

*Note: It is assumed that* $\bar{y}_t = -1$, $\bar{\pi}_t = -0.3$, $\beta_B^F = 2$, $\theta = 0.47$, *and* $\gamma = 0.3$.

***Sensitivity analysis of the budget elasticity (θ):*** Assume that the government strengthens/weakens the automatic stabilisers in the tax and expenditure systems (thus strengthening/weakening the cyclical component of fiscal balance). If the automatic stabilisers are strengthened the government do not need to undertake discretionary measures to the same extent compared to the situation before the change. This is evident from Table 4 where we assume that the GDP gap is -1 while we change the budget elasticity. The magnitude of the discretionary fiscal policy decreases from -0.69 per cent of GDP (SEK 37 billion) to -0.49 per cent of GDP (SEK 26 billion) when the budget elasticity is increased from 40 to 55 per cent.

**Table 4. The fiscal balance and its decomposition given different assumptions concerning the budget elasticity, Per cent of GDP**

| $\theta$ | Surplus target | Automatic stabilisers | Discretionary fiscal policy to stabilise GDP gap | Discretionary fiscal policy to stabilise inflation gap | Fiscal balance |
|---|---|---|---|---|---|
| 0.40 | 0.33 | -0.40 | -0.63 | -0.06 | -0.82 |
| 0.47 | 0.33 | -0.47 | -0.53 | -0.05 | -0.72 |
| 0.55 | 0.33 | -0.55 | -0.45 | -0.04 | -0.63 |

*Note: It is assumed that* $\bar{y}_t = -1$, $\bar{\pi}_t = -0.3$, $\beta_B^F = 2$, $\beta_Y^F = 0.5$, $\beta_\pi^F = 0.5$, *and* $\gamma = 0.3$.

***Sensitivity analysis of the slope of the Philip's curve (γ):*** The calibrated value for the slope of the Philip's curve is retrieved from the empirical study by Karlsson and Österholm (2020). To illustrate the impact different assumptions regarding the slope of the Philips curve have on the size of the discretionary measures needed, the slope of the Philip's curve is changed in different directions while assuming that the GDP gap is unchanged at -1 (Table 5). It is evident from Table 5 that the slope of the Philip's curve is important for the size of the government's discretionary fiscal policy. The magnitude of the discretionary policies increases from -0.53 per cent of GDP (SEK 29 billion) to -0.83 of GDP (SEK 45 billion) when the slope of the Philips curve is increased from 0.05 to 0.75 per cent.

**Table 5. The public sectors fiscal balance and its decomposition given different assumptions concerning the slope of the Philip's curve, Per cent of GDP**

| $\gamma$ | Surplus target | Automatic stabilisers | Discretionary fiscal policy to stabilise GDP gap | Discretionary fiscal policy to stabilise inflation gap | Fiscal balance |
|---|---|---|---|---|---|
| **0.050** | 0.33 | -0.47 | -0.53 | -0.001 | -0.67 |
| **0.3** | 0.33 | -0.47 | -0.53 | -0.05 | -0.72 |
| **0.75** | 0.33 | -0.47 | -0.53 | -0.30 | -0.97 |

*Note: It is assumed that* $\bar{y}_t = -1, \bar{\pi}_t = -0.3, \beta_B^F = 2, \beta_Y^F = 0.5, \beta_\pi^F = 0.5$, *and* $\theta = 0.47$.

## 3. A decomposition of the cyclical component of fiscal balance

In Appendix C, government's fiscal balance is decomposed into three components; the surplus target ($b^T$), the cyclically adjusted balance ($b_t^C$) and the structural balance ($b_t^S$), that is

$$b_t = b^T + b_t^C + b_t^S \quad (2)$$

where $b_t^C = \theta \bar{y}_t$. From Appendix C, it is evident that the budget elasticity can be calculated as the sum of the elasticity for each tax, weighted with that tax share of GDP, minus the elasticity of primary expenditures, weighted with primary expenditures´ share of GDP, that is

$$\theta = \sum_i \left[ \varepsilon_{TA_i,TB_i} \varepsilon_{TB_i,Y} \frac{TA_i^e}{Y^e} - \varepsilon_{G,U} \varepsilon_{U,Y} \frac{G^e}{Y^e} \right] \quad (3)$$

where $\varepsilon_{TA_i,TB_i}$ is the elasticity of tax revenue from tax *i* with respect to the tax base *i*, $\varepsilon_{TB_i,Y}$ is the elasticity of the tax base *i* with respect to GDP, $\varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,Y}$ is the elasticity of tax revenue from tax *i* with respect to GDP, $\frac{TA_i^e}{Y^e}$ is tax $i$:s share of GDP, $\varepsilon_{G,U}$ is the elasticity of government expenditures with respect to unemployment, and $\varepsilon_{U,Y}$ is the elasticity of unemployment with respect to GDP, $\varepsilon_{G,U}\varepsilon_{U,Y}$ is the elasticity of government expenditures with respect to GDP, and $\frac{G^e}{Y^e}$ is primary expenditures as a share of GDP.[28]

*Calibration*: Almenberg and Sigonious (2021) estimate the size of Sweden's automatic fiscal stabilisers over the period 1998–2019, using the approach proposed by Girouard and André (2005).[29] This method decomposes the elasticity of the fiscal balance to the business cycle into two components: a structural part reflecting tax and benefit rules, and a cyclical part reflecting how tax bases and benefit-related aggregates respond to the state of economy. The budget elasticity is constructed using separate estimates for tax revenues and expenditures. The revenue side is constructed from separate estimates for four tax categories: direct taxes on labour (denoted by subindex 1), payroll tax (denoted by subindex 2), corporate income tax (denoted by subindex 3), and indirect taxes (denoted by subindex 4). In their baseline estimate of the elasticities, Almenberg and Sigonious (2021) found that: $\varepsilon_{TA_1,TB_1} = 1.5$, $\varepsilon_{TB_1,\mathrm{Y}} = 0.82$, $\varepsilon_{TA_2,TB_2} = 1$, $\varepsilon_{TB_2,\mathrm{Y}} = 0.82$, $\varepsilon_{TA_3,TB_3} = 1$, $\varepsilon_{TB_3,\mathrm{Y}} = 1.46$, $\varepsilon_{TA_4,TB_4} = 1$, $\varepsilon_{TB_4,\mathrm{Y}} = 1$, $\varepsilon_{G,U} = 1.01$, and $\varepsilon_{U,Y} = -6.06$[30] for year 2019. To get an estimate of the overall budget elasticity – and hence of the automatic stabilisers – they finally aggregate the estimated elasticities using GDP shares

[28] The calibrate elasticities are taken from Almenberg and Sigonius (2021) where it is assumed that unemployment benefits are the only primary expenditure that varies with the economic cycle. This is of course a simplification. For example, they ignore the cyclical sensitivity and procyclicality of municipal expenditures that are linked to balanced local government budgets.
[29] This approach was also applied in Price et.al. (2015).
[30] Almenberg and Sigonious (2021) write that their estimate implies that when the equilibrium unemployment level is, for example, 7 percent, a 1 percentage point increase in the GDP gap lowers the unemployment rate by 0.4 percentage points. This is in line with, but in the lower bound of, the estimation of the Okun's law (which is an empirical relationship between unemployment and production growth), presented in Aranki et al. (2010).

as weights. The weights that they use for 2019 are $TA_1^e/Y^e = 0.11$, $TA_2^e/Y^e = 0.15$, $TA_3^e/Y^e = 0.03$, $TA_4^e/Y^e = 0.14$, and $G^e/Y^e = 0.48$. The baseline aggregate estimate of the size of the automatic stabilisers is then $\theta = 0.47$.

*Numerical calculations*: Following Almenberg and Sigonious (2021), Table 6 decompose the contribution of automatic stabilisers to the cyclical component of fiscal balance, but for different assumptions concerning GDP gap. At a GDP gap of -1 per cent of GDP, the impact of automatic stabilisers on fiscal balance is -0.47 per cent of GDP (SEK -25 billion). The contribution of labour taxes, payroll taxes, corporate taxes and indirect taxes to automatic stabilisers are -0.14 per cent of GDP (SEK -7 billion), -0.12 per cent of GDP (SEK -7 billion), -0.04 per cent of GDP (SEK -2 billion), and -0.14 per cent of GDP (SEK -8 billion) respectively. The contribution of expenditures is at the same time 0.03 per cent of GDP (SEK 2 billion). The decomposition in Table 6 reveals that labour taxes, payroll taxes and indirect taxes contribute mostly to the cyclical component of fiscal balance. Moreover, the cyclical component of fiscal balance improves as the economic situation improves.

**Table 6. The cyclical component of fiscal balance, Per cent of GDP**

| GDP gap | The contribution of labour taxes | The contribution of payroll taxes | The contribution of corporate taxes | The contribution of indirect taxes | The contribution of expenditures | The cyclical component of fiscal balance |
|---|---|---|---|---|---|---|
| -1.0 | -0.14 | -0.12 | -0.04 | -0.14 | 0.03 | -0.47 |
| -0.5 | -0.07 | -0.06 | -0.02 | -0.07 | 0.01 | -0.23 |
| 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.5 | 0.07 | 0.06 | 0.02 | 0.07 | -0.01 | 0.23 |
| 1.0 | 0.14 | 0.12 | 0.04 | 0.14 | -0.03 | 0.47 |

*Note: It is assumed that* $\varepsilon_{TA_1,TB_1} = 1.5$, $\varepsilon_{TB_1,Y} = 0.82$, $\varepsilon_{TA_2,TB_2} = 1$, $\varepsilon_{TB_2,Y} = 0.82$, $\varepsilon_{TA_3,TB_3} = 1$, $\varepsilon_{TB_3,Y} = 1.46$, $\varepsilon_{TA_4,TB_4} = 1$, $\varepsilon_{TB_4,Y} = 1$, $\varepsilon_{G,U} = 1.01$, and $\varepsilon_{U,Y} = -6.06$, $TA_1^e/Y^e = 0.11$, $TA_2^e/Y^e = 0.15$, $TA_3^e/Y^e = 0.03$, $TA_4^e/Y^e = 0.14$, and $G^e/Y^e = 0.48$.

## 4. A decomposition of the structural component of fiscal balance

In Appendix C, the structural component of government's fiscal balance ($b_t^S$) is shown to equal $b_t^{PS} = \rho\bar{y}_t = (\rho^s + \rho^d)\bar{y}_t$ where $\rho$ is the budget elasticity with respect to discretionary fiscal policy conditional on the state of the economy, $\rho^s$ is the budget elasticity with respect to the discretionary fiscal policies where it is assumed that the tax and expenditure bases are intact, and $\rho^d$ is the budgetary contribution, in elasticity terms, from the fact that tax and expenditure bases tend to change when tax/compensation rates are changed, that is

$$\rho^d = \sum_i \left[ \varepsilon_{TA_i,TB_i} \varepsilon_{TB_i,\tau_i} \varepsilon_{\tau_i,Y} \frac{TA_i^e}{Y^e} - \varepsilon_{G,U} \varepsilon_{U,\tau^G} \varepsilon_{\tau^G,Y} \frac{G^e}{Y^e} \right] \qquad (4')$$

$$\rho^s = \sum_i \left[ \varepsilon_{TA_i,\tau_i} \varepsilon_{\tau_i,Y} \frac{TA_i^e}{Y^e} - \varepsilon_{G,\tau^G} \varepsilon_{\tau^G,Y} \frac{G^e}{Y^e} \right] \qquad (4'')$$

where $\varepsilon_{TA_i,TB_i}$ is the elasticity of tax revenue from tax *i* with respect to the tax base *i*, $\varepsilon_{TB_i,\tau_i}$ is the elasticity of the tax base *i* with respect to the effective tax rate *i*, $\varepsilon_{\tau_i,Y}$ is the elasticity of the effective tax rate *i* with respect to the state of the economy, $\varepsilon_{G,U}$ is the elasticity of government expenditures with respect to unemployment, $\varepsilon_{U,\tau^G}$ is the elasticity of unemployment with respect to the compensation rate, $\varepsilon_{\tau^G,Y}$ is the elasticity of the compensation rate with respect to the state of the economy, $\varepsilon_{TA_i,\tau_i}$ is the static elasticity of tax revenue from tax *i* with respect to the effective tax rate *i*, and $\varepsilon_{G,\tau^G}$ is the elasticity of government expenditures with respect to the compensation rate. Comparing equation (1) with equation (C3) in Appendix C, one realizes that in optimum the structural component of government's fiscal balance ($\rho\bar{y}_t$) must equal $\left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t + \left(\frac{\beta_\pi^F}{\theta\beta_B^F}\right)\gamma\bar{\pi}_t$. The budget elasticity with respect to discretionary fiscal policy ($\rho$) is dependent of many different elasticities that need to be estimated or calibrated. Once it is done, the condition, that $\rho\bar{y}_t$ must equal $\left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t + \left(\frac{\beta_\pi^F}{\theta\beta_B^F}\right)\gamma\bar{\pi}_t$, can be used to decompose the discretionary fiscal policy between different taxes and expenditure. However, for this condition to be met, we allow the contribution of expenditure to be determined as a residual.

*Calibration*: The calibrations of most of the elasticities are based on calculations in Sørensen (2010), where he calculates the marginal deadweight losses and the degree of self-financing of different taxes in Sweden.[31] Sørensen (2010) shows that the marginal deadweight loss will equal the dynamic revenue loss from the behavioural responses to the tax change. Following Sørensen (2010), the following self-financing degree ($\varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,\tau_i}$) for different taxes in Sweden are used: taxes from labour (-0.24), payroll taxes (-0.24), corporate taxes (-0.294) and indirect taxes (-0.354). This gives us following elasticities between tax rates and tax revenue: $\varepsilon_{TA_1,\tau_1} + \varepsilon_{TA_1,TB_1}\varepsilon_{TB_1,\tau_1} = 1 - 0.24 = 0.76$, $\varepsilon_{TA_2,\tau_2} + \varepsilon_{TA_2,TB_2}\varepsilon_{TB_2,\tau_2} = 1 - 0.24 = 0.76$, $\varepsilon_{TA_3,\tau_3} + \varepsilon_{TA_3,TB_3}\varepsilon_{TB_3,\tau_3} = 1 - 0.294 = 0.706$, and $\varepsilon_{TA_4,\tau_4} + \varepsilon_{TA_4,TB_4}\varepsilon_{TB_4,\tau_4} = 1 - 0.1891 = 0.811$[32,33] We also

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[31] The marginal deadweight loss from an increase in some tax rate equals the difference between the maximum amount that taxpayers would be willing to pay to avoid the tax increase and the additional net revenue accruing to the government.

[32] Sørensen (2010) presents estimates of degree of self-financing for capital income (equal to -0.354) and indirect taxes (equal to -0.16). However, Almenberg and Sigonious (2021) include capital income taxes as part of indirect taxes. This means that we need to weight the degree of self-financing. We use the tax revenue from indirect taxes (654 SEK Billion) and households capital income (175 SEK Billion) to calculate the weighted average degree of self-financing: [654/(654+175) x -0.16 + 175/(654+175) x -0.354 = -0.189].

[33] Following Sørensen (2010), the marginal deadweight loss ($\Delta DWL$) from an increase in some tax rate equals the difference between the maximum amount that taxpayers would be willing to pay to avoid the tax increase ( $\Delta E$ ) and the additional net revenue accruing to the government ($\Delta R$ ), that is, marginal deadweight loss: $\Delta DWL = \Delta E - \Delta R$. The additional revenue generated by the tax increase can be split into the "static" revenue change $\Delta R^s$ that would occur if taxpayers did not change their behaviour, and the "dynamic" revenue change $\Delta R^d$ resulting from the behavioural responses to the change in the tax rate, i.e., $\Delta R = \Delta R^s + \Delta R^d$ . Hence, we may rewrite equation for the marginal deadweight loss as: $\Delta DWL = \Delta E - (\Delta R^s + \Delta R^d)$. Sørensen (2010), section 4 argues that optimizing household behaviour implies that $\Delta E = \Delta R^s$ so that $\Delta DWL = -\Delta R^d$. To obtain a measure of the efficiency loss that is independent of the units in which income and revenue are measured, it is useful to express the marginal deadweight loss as a fraction of the static revenue gain. When doing so, we obtain the so-called degree of self-financing: $DSF = \frac{\Delta DWL}{\Delta R^s} = -\frac{\Delta R^d}{\Delta R^s}$. Let us assume that $TA = \tau TB$. A total differentiation of this expression gives us the following: $\Delta TA = \Delta\tau TB + \tau\Delta TB$ or $\Delta TA = \Delta R^s + \Delta R^d$. Using the expression for the degree of self-financing we get $\Delta TA = \Delta R^s - DSF\,\Delta R^s = \Delta R^s(1 - DSF)$. This means that $\frac{\Delta TA}{\Delta\tau} = \frac{\Delta R^s}{\Delta\tau}(1 - DSF)$. But $\frac{\Delta R^s}{\Delta\tau} = TB$ so that $\frac{\Delta TA}{\Delta\tau} = TB(1 - DSF)$. By multiplying the left and the right-hand sides of this expression by $\frac{\tau}{TA}$ we get the following elasticity: $\varepsilon_{TA_2,\tau_2} = TB\frac{\Delta TA}{\Delta\tau}\frac{\tau}{TA} = \frac{\tau TB}{TA}(1 - DSF) = 1 - DSF$.

assume that all tax rates and compensation rates change one-to-one with the state of the economy, that is $\varepsilon_{\tau_i,Y} = 1$ for $i = 1, \dots 4$, and $\varepsilon_{G,Y} = 1$.[34]

*Numerical calculations*: In Table 7, the intuition behind the structural component of fiscal balance is clarified by decomposing the contribution of different taxes using equation (4′) and (4′′), see column 2-4 in Table 7. As mentioned earlier, the calculated contribution of expenditures is done residually (see column 5 in Table 7). At a GDP gap of -1 per cent of GDP, the structural component of fiscal balance is -0.58 per cent of GDP (SEK -32 billion). The contribution of labour taxes, payroll taxes, corporate taxes and indirect taxes to the structural component of fiscal balance are -0.08 per cent of GDP (SEK -4 billion), -0.11 per cent of GDP (SEK -6 billion), -0.02 per cent of GDP (SEK -1 billion), and -0.11 per cent of GDP (SEK -6 billion) respectively. The contribution of expenditures is at the same time 0.3 per cent of GDP (SEK 14 billion).

[34] These are policy variables in the sense that the government needs to choose how much discretionary policy they should undertake given the state of the economy. However, the governments may choose to change taxes and expenditures more during a recession than a boom. The assumption in this paper is that the government behaves symmetrically in recession and boom. Moreover, the government may for example choose to change taxes more than expenditures depending on the state of the economy. In this paper, we do not take a position on the question of whether the government should change taxes or expenditures. Instead, we assume in our numerical example that taxes and expenditures will change in the same amount and calculate the impact they may have on fiscal balance.

**Table 7. A decomposition of the structural component of fiscal balance, Per cent of GDP**

| GDP gap | The contribution of labour taxes | The contribution of payroll taxes | The contribution of corporate taxes | The contribution of indirect taxes | The contribution of expenditures | Structural component of fiscal balance |
|---|---|---|---|---|---|---|
| -1.0 | -0.08 | -0.11 | -0.02 | -0.11 | 0.3 | -0.58 |
| -0.5 | -0.04 | -0.06 | -0.01 | -0.06 | 0.1 | -0.29 |
| 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0 | 0.00 |
| 0.5 | 0.04 | 0.06 | 0.01 | 0.06 | -0.1 | 0.29 |
| 1.0 | 0.08 | 0.11 | 0.02 | 0.11 | -0.3 | 0.58 |

*Note: It is assumed that* $\varepsilon_{TA_1,\tau_1} + \varepsilon_{TA_1,TB_1}\varepsilon_{TB_1,\tau_1} = 1 - 0.24 = 0.76$, $\varepsilon_{TA_2,\tau_2} + \varepsilon_{TA_2,TB_2}\varepsilon_{TB_2,\tau_2} = 1 - 0.24 = 0.76$, $\varepsilon_{TA_3,\tau_3} + \varepsilon_{TA_3,TB_3}\varepsilon_{TB_3,\tau_3} = 1 - 0.294 = 0.706$, and $\varepsilon_{TA_4,\tau_4} + \varepsilon_{TA_4,TB_4}\varepsilon_{TB_4,\tau_4} = 1 - 0.1891 = 0.811$, $\varepsilon_{TA_i,\tau_i} = 1$ for $i = 1, \dots 4$, $\varepsilon_{G,\tau^G} = 1$, $TA_1^e/Y^e = 0.11$, $TA_2^e/Y^e = 0.15$, $TA_3^e/Y^e = 0.03$, $TA_4^e/Y^e = 0.14$, and $G^e/Y^e = 0.48$. *The contribution of expenditures is calculated residually using the following condition:* $\left[\varepsilon_{G,\tau^G}\varepsilon_{\tau^G,Y} + \varepsilon_{G,U}\varepsilon_{U,\tau^G}\varepsilon_{\tau^G,Y}\right]\frac{G^e}{Y^e}\bar{y}_t = \sum_i\left[\varepsilon_{TA_i,\tau_i}\varepsilon_{\tau_i,Y} + \varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,\tau_i}\varepsilon_{\tau_i,Y}\right]\frac{TA_i^e}{Y^e}\bar{y}_t - \left[\left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t + \left(\frac{\beta_\pi^F}{\theta\beta_B^F}\right)\gamma\bar{\pi}_t\right]$.

## 5. CONCLUSIONS

The fiscal balance is highly dependent on the magnitude of automatic fiscal stabilisers and the government's discretionary fiscal policies. One of the contributions of this paper is that it provides a tool that can be used to calculate the magnitudes of these policies by decomposing the fiscal balance into a cyclical and a structural component using an optimal fiscal stabilisation rule. The rule is derived from a loss function where the government is assumed to keep structural balance close to the targeted surplus for the fiscal balance while at the same time stabilising GDP and inflation gap. The fiscal balance is also used to discuss the evolution of debt ratio.

A finding in this paper is that a country that uses fiscal policy to support monetary policy to stabilise inflation gap and GDP gap, will need to undertake more discretionary fiscal policies, in addition to automatic stabilisers. To put it in another way, if a government strengthens the automatic stabilisers or attaches lower importance to the stabilisation of the GDP gap and inflation gap, or greater importance on stabilising structural balance close to the surplus target, then it will undertake less discretionary fiscal policies.

Another contribution of this paper is that it provides a tool that can be used to further disaggregate the cyclical and the structural component of fiscal balance, given assumptions on how the tax rate and compensation rate respond to the state of the economy. This decomposition shows how much labour taxes, payroll taxes, corporate taxes, indirect taxes, and expenditures contribute to the cyclical and structural component of fiscal balance.

The proposed rule for fiscal stabilisation together with the decomposition of cyclical and structural components of fiscal balance provide practical policy tools that can be used by policy makers as guidelines to calculate the magnitude of automatic stabilisers and the discretionary fiscal policies without jeopardizing to deteriorate the public sector's finances.[35]

The fiscal stabilisation rule presented in this paper can be extended in several different dimensions depending on whether fiscal policy needs to address other macro variables than just the GDP gap and inflation gap, such as the real interest rate gap, the level of the government debt ratio, smooth change of government spending, taxation, and the flow of bonds, and/or the credit gap.[36] An important research question is whether an extension of the loss function in those directions can improve the coordination of fiscal, monetary and macroprudential policies. However, such an extension of the fiscal stabilisation rule is beyond the analysis in this paper and is left as suggestions for future research.[37]

[35] All calculations are made in an excel spreadsheet, which make the rule and the decompositions even more user-friendly for policy makers. The spreadsheet can be provided by the author upon request.
[36] Credit gap is the deviation of the private sector's credit-to-output ratio from the long run level. The real interest rate gap is the deviation of the real policy rate from the long-run equilibrium interest rate.
[37] The interested reader is referred to Jonsson and Moran (2014) for a description of the linkages between monetary and macroprudential policies.

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## APPENDIX. Fiscal balance, debt ratio, and optimal fiscal stabilisation rule

The general government's fiscal balance ($B_t$) is defined as

$$B_t = \sum_i TA_{i,t} - G_t - r_t^{PD} PD_{t-1} + AX_t \qquad \text{(A1)},$$

where $TA_i$ is government's tax revenue from tax *i* (we assume four categories of tax revenues), *G* is the primary expenditures (expenditures net of interest payments), $r_t^{PD} PD_{t-1}$ is the interest paid on government bonds (where $PD_{t-1}$ is the gross debt and $r_t^{PD}$ is the nominal interest rate on government bonds), and $AX$ is the net auxiliary incomes and expenditures (mainly capital income, and income from capital depreciation). In equation (B1), $B_t^P = \sum_i TA_{i,t} - G_t + AX_t$ is called the primary balance. The fiscal balance is often stated as a share of nominal output ($Y_t^N$)

$$b_t = \sum_i ta_{i,t} - g_t - r_t^{PD} pd_{t-1} + ax_t = b_t^P - r_t^{PD} pd_{t-1} \qquad \text{(A2)},$$

where $b_t = \frac{B_t}{Y_t^N}$, $b_t^P = \frac{B_t^P}{Y_t^N}$, $ta_{i,t} = \frac{TA_{i,t}}{Y_t^N}$, $g_t = \frac{G_t}{Y_t^N}$, $ax_t = \frac{AX_t}{Y_t^N}$, and $pd_{t-1} = \frac{r_t^{PD} PD_{t-1}}{Y_t^N}$. Using fiscal balance in (A1), the evolution of government debt can be written as

$$PD_t = PD_{t-1} + r_t^{PD} PD_{t-1} - B_t^P \qquad \text{(A3)}.$$

Equation (A3) states that debt at the end of the year equals debt in the preceding year plus interest payment on that debt minus primary fiscal deficit in the current year. Dividing both sides of equation (A3) by nominal GDP in period *t* ($Y_t^N$), and assuming that the nominal GDP is assumed to increase with $g^N$ [that is $Y_t^N = (1 + g_t^N) Y_{t-1}^N$], equation (A3) can be rewritten as

$$pd_t = \left(\frac{1+r_t^{PD}}{1+g_t^N}\right) pd_{t-1} - b_t^P \qquad \text{(A4)},$$

where $pd_t = PD_t/Y_t^N$ is the debt-to-GDP ratio in period $t$ and $b_t^P = B_t^P/Y_t^N$ is primary fiscal deficit as a share of GDP. Assuming that $r_t^{PD} = r^{PD}$ and $g_t^N = g^N$ for all $t$, equation (A4) can also be rewritten as

$$pd_t = \left(\frac{1+r^{PD}}{1+g^N}\right) pd_{t-1} - b_t^P \qquad \text{(A5)}.$$

In a recent paper, Almenberg and Sigonious (2021) use the approach proposed by Girouard and André (2005) and Flodén (2009) to decompose the elasticity of the fiscal balance to the business cycle. However, this approach abstains from modelling how discretionary fiscal policies affect fiscal balance. Therefore, we introduce a new approach that model the impact of both automatic stabilisers and discretionary fiscal policies. This new approach arrives to the same conclusion as Girouard and André (2005) concerning the elasticity of the fiscal balance to the business cycle. However, the approach also provides the elasticity of the fiscal balance to discretionary fiscal policy.

Let us begin by assuming that government's tax revenue from tax $i$ is a function of both the effective tax rate ($\tau_{i,t}$) and the tax base $TB_{i,t}$, that is $TA_{i,t} = TA_{i,t}\left(TB_{i,t}\left(Y_t, \tau_{i,t}(Y_t)\right), \tau_{i,t}(Y_t)\right)$.[38] The tax base is assumed to change automatically with GDP ($Y_t$), and the effective tax rate ($\tau_{i,t}$) which is also assumed to change discretionary depending on GDP. On the expenditure side, it is assumed that expenditures are mainly a function of compensation

[38] Another way to define government's tax revenues is $TA_{i,t} = \tau_{i,t}(Y_t) \times TB_{i,t}\left(Y_t, \tau_{i,t}(Y_t)\right)$, that is by multiplying the tax rate with the tax base. However, this assume a taxation system that is proportional. The Swedish tax system has many non-linearities in the form of various deductions, reductions, and exceptions. Therefore, we have chosen to follow Almenberg and Sigonius (2021) and assume that the effective tax rate does not always have to be the same as the statutory tax rate.

rate ($\tau_t^G$) and unemployment ($U_t$), that is $G_t = G_t\left(U_t\left(Y_t, \tau_t^G(Y_t)\right), \tau_t^G(Y_t)\right)$. Unemployment is assumed to change depending on GDP and compensation rate. Finally, we assume that the interest paid on government bonds and the net auxiliary incomes and expenditures do not change with the state of the economy, that is $\overline{AX} = r_t^{PD} PD_{t-1} + AX_t$. First-order Taylor expansions of government taxes and expenditures gives us the following

$$TA_{i,t} - TA_i^e = \left[\frac{\partial TA_{i,t}}{\partial TB_{i,t}}\frac{\partial TB_{i,t}}{\partial Y_t} + \frac{\partial TA_{i,t}}{\partial \tau_{i,t}}\frac{\partial \tau_{i,t}}{\partial Y_t} + \frac{\partial TA_{i,t}}{\partial TB_{i,t}}\frac{\partial TB_{i,t}}{\partial \tau_{i,t}}\frac{\partial \tau_{i,t}}{\partial Y_t}\right](Y_t - Y^e) \quad \text{(A6)}$$

$$G_t - G^e = \left[\frac{\partial G_t}{\partial U_t}\frac{\partial U_t}{\partial Y_t} + \frac{\partial G_t}{\partial \tau_t^G}\frac{\partial \tau_t^G}{\partial Y_t} + \frac{\partial G_t}{\partial U_t}\frac{\partial U_t}{\partial \tau_t^G}\frac{\partial \tau_t^G}{\partial Y_t}\right](Y_t - Y^e) \quad \text{(A7),}$$

where $\frac{\partial TA_{i,t}}{\partial TB_{i,t}}$, is the partial derivatives of tax revenue from tax *i* with respect to the tax base *i*, $\frac{\partial TB_{i,t}}{\partial Y_t}$ is the partial derivatives of the tax base *i* with respect to GDP, $\frac{\partial TB_{i,t}}{\partial \tau_{i,t}}$ is the partial derivatives of the tax base *i* with respect to the effective tax rate *i*, $\frac{\partial \tau_{i,t}}{\partial Y_t}$ is the partial derivatives of the effective tax rate *i* with respect to GDP, $\frac{\partial G_t}{\partial U_t}$ is the partial derivatives of government expenditures with respect to unemployment and $\frac{\partial U_t}{\partial Y_t}$ is the partial derivatives of unemployment with respect to GDP, $\frac{\partial U_t}{\partial \tau_t^G}$ is the partial derivatives of unemployment with respect to the compensation rate, $\frac{\partial \tau_t^G}{\partial Y_t}$ is the partial derivatives of the compensation rate with respect to GDP.[39] By multiplying $1/Y^e$ in the left and right side of equation (A6) and (A7), and by extending the first term in the right-hand side of equation (A6) and (A7) with $\frac{TA_i^e}{TB_i^e}\frac{TB_i^e}{TA_i^e}\frac{Y^e}{Y^e}$ and $\frac{G^e}{U^e}\frac{U^e}{G^e}\frac{Y^e}{Y^e}$, the

[39] It´s important to notify that all partial derivatives are evaluated in their steady states.

second term in the right hand side of equation (A6) and (A7) with $\frac{\tau_i^e}{TA_i^e}\frac{TA_i^e}{\tau_i^e}\frac{Y^e}{Y^e}$ and $\frac{\tau^{G^e}}{G^e}\frac{G^e}{\tau^{G^e}}\frac{Y^e}{Y^e}$, and the third term in the right-hand side of equation (A6) and (A7) with $\frac{TB_i^e}{TA_i^e}\frac{TA_i^e}{TB_i^e}\frac{\tau_i^e}{\tau_i^e}\frac{Y^e}{Y^e}$ and $\frac{U^e}{G^e}\frac{G^e}{U^e}\frac{\tau^{G^e}}{\tau^{G^e}}\frac{Y^e}{Y^e}$, we arrive to the following expressions

$$\frac{TA_{i,t}-TA_i^e}{Y^e} = \frac{TA_i^e}{Y^e}\left[\varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,Y} + \varepsilon_{TA_i,\tau_i}\varepsilon_{\tau_i,Y} + \varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,\tau_i}\varepsilon_{\tau_i,Y}\right]\bar{y}_t \quad \text{(A6}'\text{)},$$

$$\frac{G_t-G^e}{Y^e} = \frac{G^e}{Y^e}\left[\varepsilon_{G,U}\varepsilon_{U,Y} + \varepsilon_{G,\tau^G}\varepsilon_{\tau^G,Y} + \varepsilon_{G,U}\varepsilon_{U,\tau^G}\varepsilon_{\tau^G,Y}\right]\bar{y}_t \quad \text{(A7}'\text{)},$$

where $\bar{y}_t = \frac{Y_t-Y^e}{Y^e}$ is the GDP-gap, $\varepsilon_{TA_i,TB_i}$ is the elasticity of tax revenue from tax *i* with respect to the tax base *i*, $\varepsilon_{TB_i,Y}$ is the elasticity of the tax base *i* with respect to GDP, $\varepsilon_{TB_i,\tau_i}$ is the elasticity of the tax base *i* with respect to the effective tax rate *i*, $\varepsilon_{TA_i,\tau_i}$ is the elasticity of tax revenue from tax *i* with respect to the effective tax rate *i*, $\varepsilon_{\tau_i,Y}$ is the elasticity of the effective tax rate *i* with respect to GDP, $\varepsilon_{G,U}$ is the elasticity of government expenditures with respect to unemployment and $\varepsilon_{U,Y}$ is the elasticity of unemployment with respect to GDP, $\varepsilon_{U,\tau^G}$ is the elasticity of unemployment with respect to the compensation rate, $\varepsilon_{G,\tau^G}$ is the elasticity of government expenditures with respect to the compensation rate, $\varepsilon_{\tau^G,Y}$ is the elasticity of the compensation rate with respect to GDP. A first order Taylor expansion of the fiscal balance in equation (A2) together with equation (A6′) and (A7′) yields

$$b_t = b_t^P = b^T + b_t^C + b_t^S = b^T + \theta\bar{y}_t + (\rho^s + \rho^d)\bar{y}_t = b^T + \theta\bar{y}_t + \rho\bar{y}_t \quad \text{(A8)},$$

where $b^T = \sum_i \left[\frac{TA_i^e - G^e}{Y^e}\right]$ is the surplus target for the fiscal balance, $b_t^C$ is cyclically adjusted balance, $\theta = \sum_i \left[\varepsilon_{TA_i,TB_i}\varepsilon_{TB_i,Y}\frac{TA_i^e}{Y^e} - \varepsilon_{G,U}\varepsilon_{U,Y}\frac{G^e}{Y^e}\right]$ is the budget elasticity, $b_t^S$ is the structural balance, $\rho^s = \sum_i \left[ \varepsilon_{TA_i,\tau_i} \varepsilon_{\tau_i,Y} \frac{TA_i^e}{Y^e} - \varepsilon_{G,\tau^G} \varepsilon_{\tau^G,Y} \frac{G^e}{Y^e} \right]$ is the budget elasticity with respect to the discretionary fiscal policies where it is assumed the tax and expenditure bases are intact, and $\rho^d = \sum_i \left[ \varepsilon_{TA_i,TB_i} \varepsilon_{TB_i,\tau_i} \varepsilon_{\tau_i,Y} \frac{TA_i^e}{Y^e} - \varepsilon_{G,U} \varepsilon_{U,\tau^G} \varepsilon_{\tau^G,Y} \frac{G^e}{Y^e} \right]$ is the budget elasticity with respect to discretionary fiscal policies given that tax and expenditure bases are assumed to alter because of tax/compensation rate changes.[40] Using (A8), the structural balance can be defined as

$$b_t^S = b_t - \theta \bar{y}_t \qquad \text{(A9)}$$

Next question of interest is whether the government can keep structural balance close to the targeted surplus for fiscal balance while at the same time trying to counteract an economic downturn. To answer this question, it is assumed that the objective function of the government is to minimize a loss function, where the government aims to stabilise structural balance ($b_t^S$) as close as possible to the targeted surplus ($b^T$) for the general government fiscal balance ($\bar{b}_t^S = b_t^S - b^T$), GDP ($y_t$) close to potential level of GDP ($\bar{y}_t = y_t - Y^e$), and inflation close to inflation target ($\bar{\pi}_t = \pi_t - \pi^T$),

$$L = \beta_Y^F \bar{y}_t^2 + \beta_\pi^F \bar{\pi}_t^2 + \beta_B^F \left( \bar{b}_t^S \right)^2 \qquad \text{(A10)},$$

where $\pi_t$ is the inflation, $\pi^T$ is the inflation target, $y_t$ is GDP, $Y^e$ is the potential level of GDP, $\beta_Y^F$ is the policy weight the government sets on stabilising the GDP gap, $\beta_\pi^F$ is the policy weight that the government put on stabilising inflation gap, and $\beta_B^F$ is the weight that the government puts on stabilising the structural balance around the targeted surplus. The government

[40] It should be notified that a first order Taylor expansion of the fiscal balance equals a first order Taylor expansion of the primary balance since it is assumed $\overline{AX} = r_t^{PD} PD_{t-1} + AX_t$. This imply that structural balance equals primary structural balance.

optimizes by minimizing its loss function (A10) subject to $\bar{b}_t^S$ and the Phillips curve expressed in gap form as below

$$\bar{\pi}_t = \bar{\pi}_{t-1} + \gamma\bar{y}_t \qquad \text{(A11).}$$

where $\gamma$ is the slope of the Philips curve. By substituting ($\bar{b}_t^S = b_t - \theta\bar{y}_t - b^T$) and (A11) into (A10) and differentiating with respect to $Y_t$, yields following fiscal stabilisation rule:[41, 42]

$$b_t = b^T + \theta\bar{y}_t + \left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t + \left(\frac{\beta_\pi^F}{\theta\beta_B^F}\right)\gamma\bar{\pi}_t \qquad \text{(A12).}$$

In optimum, actual fiscal balance varies around the surplus target to "automatically" return to the balance level when both GDP and inflation gaps are closed. The second term in (A12), $\theta\bar{y}_t$, is the aggregated impact of the automatic stabilisers. The next term in (A12), $\left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t$, captures the government's discretionary fiscal policy in the case that real GDP differs from potential GDP. The last term in (A12) captures the government's discretionary fiscal policy in the case that inflation differs from the inflation target.

Comparing (A8) with (A12), it is evident that

$$\rho\bar{y}_t = \left(\frac{\beta_Y^F}{\theta\beta_B^F}\right)\bar{y}_t + \left(\frac{\beta_\pi^F}{\theta\beta_B^F}\right)\gamma\bar{\pi}_t \qquad \text{(A13)}$$

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[41] Boije (2005) presents a fiscal stabilisation rule that resembles the one derived in this Appendix. However, he does not derive the fiscal stabilisation rule from a loss function which makes the interpretation of the coefficients rather imprecise. Neither does he consider that government may put some weights on stabilising inflation gap.

[42] Solving $b_t^S = b_t - \theta\bar{y}_t$ for $\bar{y}_t$ yields $\bar{y}_t = (1/\theta)(b_t - b_t^S)$. By using this and (A11) and by differentiating (A10) with respect to $b_t^S$ gives the same expression as in (A12).