Lisbon School of Economics & Management
Universidade de Lisboa

MASTER
MONETARY AND FINANCIAL ECONOMICS

MASTER´S FINAL WORK
DISSERTATION

FISCAL REGIMES AND SUSTAINABILITY: INSIGHTS FROM POST-WAR GERMANY (1950-2023)

JOSHUA FELIX JABLONOWSKI

JUNE – 2025

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SUPERVISION:
ANTÓNIO AFONSO

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One day, the time will come
when the citizen must realize
that he has to pay the debts
that the state incurs and declares to us
for the 'welfare of the people'.
- Ludwig Erhard

Glossary

AIC Akaike Information Criterion. i, 22, 23, 26, 37

DGE Dynamic General Equilibrium. i, 6

DSGE Dynamic Stochastic General Equilibrium. i, 6

ECB European Central Bank. i, 6, 24

EU European Union. i, 5, 7, 13

FD Fiscal-Dominant. i, 4–7, 11, 22, 24–26, 28

FTPL Fiscal Theory of the Price Level. i, 2–6, 9

GDP Gross Domestic Product. i, 1, 6, 7, 10–18, 22, 24–27, 36–39

IBC Intertemporal Budget Constraint. i, 1, 4, 5, 9–11, 20, 27

IR Impulse Response. i, 6, 24–28

JEL Journal of Economic Literature. i, ii

LP Local Projection. i, 3, 24, 26

MD Money-Dominant. i, 4, 5, 7, 10, 11, 22, 25, 26, 28

NLS Non-Linear Least Squares. i, 22

NW Newey-West. i, 27

OLS Oridnary Least Squares. i, 22, 39

SECM Single Equation Error Correction Model. i, 3, 21, 24, 27

SGP Stability and Growth Pact. i, 2, 13

SVAR Structural Vector Auto Regression. i, 24, 25

TC Transversality Condition. i, 9, 11, 20, 27

U.S. United States. i, 6, 7

VAR Vector Auto Regression. i, 6, 24, 37–39

ABSTRACT, KEYWORDS, AND JOURNAL OF ECONOMIC LITERATURE (JEL) CODES

This work investigates fiscal sustainability and the prevailing fiscal regime in the Federal Republic of Germany. First, using annual data from 1950 to 2023, the analysis assesses the time series properties of key fiscal variables via unit root tests that account for multiple structural breaks (Carrion-i Silvestre et al. 2009). The long-term relationship between the primary balance and government debt is then estimated using a single-equation error correction model (SECM). The results from this long-term analysis do not support the hypothesis of fiscal sustainability, and the SECM proves inconclusive in identifying a dominant fiscal regime, showing a statistically insignificant long-run coefficient and bidirectional Granger causality. To analyze recent fiscal dynamics, this work then employs the local projections method described by Jordà (2005) on quarterly data from 2002 to 2023. In stark contrast to the long-term findings, this impulse response analysis reveals a clear Money-Dominant (MD) regime. A discretionary positive shock to the primary balance leads to a significant a decrease in real government debt, a result consistent with the MD regime. The divergent findings suggest that while Germany's long-run fiscal framework is ambiguous, its policy dynamics in the 21st century have been characteristic sustainable fiscal practices.

KEYWORDS: Fiscal Sustainability; Fiscal Theory of the Price Level; Unit Root Test; Cointegration Test; Local Projection.

JEL CODES: E31; E62; E63; H63; C12; C22.

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Fiscal Regimes and Sustainability: Insights from Post-War Germany (1950-2023)

By Joshua F. Jablonowski

This work investigates fiscal sustainability and the prevailing monetary-fiscal regime in Germany using annual data from 1950 to 2023. Stationarity and cointegration between government debt and the primary balance are analyzed using unit root tests and an error correction model, while impulse responses are generated via local projections to assess robustness. The tests do not support the hypothesis of fiscal sustainability. While the cointegration analysis is inconclusive and fails to identify a fiscal regime, the impulse response analysis indicates a Money-Dominant (MD) regime, where positive primary balance shocks significantly decrease real government debt.

1 Introduction

Fiscal policy and its objectives have long been the subject of discussion among both economic and political experts. In particular, the sustainability of public finances has gathered significant interest from researchers and policymakers, leading to extensive exploration by numerous authors.

An entity is fiscally sustainable when it can sustain its current activities in the indefinite future. In terms of accounting, a fiscal authority acts sustainable if it respects Intertemporal Budget Constraint (IBC). A government can borrow only if it is believed that it can commit to repay its debt in the future through its surpluses. Thus, imposing an IBC on the government which requires that the stock of debt be matched by future surpluses. However, as long as the economy's growth rate exceeds the interest rate on its debt, the dynamics of the debt remain stable, preventing the debt as a ratio of Gross Domestic Product (GDP) from exhibiting explosive behavior. Afonso (2005) notes that fiscal sustainability is essential to ensure that the trajectory of macroeconomic variables remains unaffected by the fiscal authority's decision to issue public debt or raise revenue.

The primary balance, which is government revenue less government expenditure excluding interest payments, is the main policy tool. Fiscal authorities may use this to balance the budget constraint. Adjustments to the primary balance can be achieved through changes to the revenue, i.e. alter the tax income, or through changes in expenditure, e.g. revise social transfers.

In the orthodox macroeconomic approach, fiscal authorities set the sequence of debt and primary balance such that it ensures that the IBC holds at any given price level. Therefore, following the classical moneatarist manner, the monetary authority is free to set its policy without considering any constraints, thereby fully determining the price level. In this scenario, monetary policy is considered "active", setting the price level, while fiscal policy acts "passive", determining the primary balance endogenously given the price level. In such a model, expansionary fiscal policy will only influence the price level by stimulating the economy, leading to a positive impact on inflation through the Phillips curve (Congregado et al. 2023).

In the 1990s, a new approach emerged, led by Leeper (1991), Sims (1994), Woodford (1994), and Cochrane (1998). In contrast to the aforementioned case of active monetary policy and passive fiscal policy, this theory is built on the assumption that fiscal authorities choose the sequence of debt and primary balance exogenously following an arbitrary process. To maintain government solvency, the price level must adjust endogenously in response to changes in the primary balance. Thus, the path of the price level is determined by the active fiscal authorities, while the monetary authority only acts passively. Consequently, it becomes clear that popular macroeconomic models based on monetarist intuition are a special case where fiscal policy is constantly passive and monetary policy is active.

This work will investigate the interaction of fiscal and monetary policy in Germany. Long disregarded by traditional macroeconomics, the Fiscal Theory of the Price Level (FTPL) has found renewed attention following the surge in inflation in the aftermath of the COVID-19 pandemic, reversing a trend of around four decades of relatively low inflation rates between the 1980s and 2020. The FTPL establishes a direct link between fiscal expansion and the price level.

Since its establishment, the fiscal policy of the Federal Republic of Germany has been characterized by several major transformation phases, each shaped by economic and political circumstances. Making Germany an interesting case study for examining whether unexpected shocks, such as a pandemic, alter the path of fiscal sustainability. With the signing of the Maastricht treaty in 1992, Germany joined the Economic and Monetary Union, thus giving up monetary sovereignty while retaining fiscal autonomy. This presents an interesting case, as deviations from a sustainable fiscal path in one member country of a monetary union can also have implications on the other members. As demonstrated by Bergin (2000), an idiosyncratic shock to one country's public finances will result in a correction of the price level if it affects the consolidated balance of the monetary union's member states. Therefore, if the surpluses of one member decrease, this must be offset by increases in surpluses of other member states. Ultimately, the present value of future budget surpluses of all member countries should be equal to the value of outstanding debt. The fiscal rules imposed by the Maastricht Treaty and the Stability and

Growth Pact (SGP) can be regarded as ensuring a passive fiscal regime by improving the response of primary surpluses to changes in debt to maintain a budget close to equilibrium (Congregado et al. 2023).

This work will contribute to the growing body of empirical literature investigating fiscal sustainability and the prevalence of passive versus active fiscal policy, providing additional evidence on the fiscal solvency of German public finances. It will follow a popular approach of using formal stationarity and cointegration analysis of relevant fiscal series. To validate the results, impulse responses will be formed that estimate the effect of a shock to the primary balance on the government debt. Stationarity will be determined using a Carrion-i Silvestre, Kim & Perron (2009) unit root test that accounts for up to three structural breaks at unknown break dates. The cointegration analysis will be performed using a model Single Equation Error Correction Model (SECM) and supplemented by a Sims, Stock & Watson (1990) Granger causality test. Impulse responses will be calculated using the Local Projection (LP) procedure described by Jordà (2005). The first two tests will use yearly longitudinal data for German public finances derived from Mauro et al. (2013) for the period between 1950 and 2023. The Impulse Response functions will be generated using quarterly data for the period between 2002 and 2024, as high-quality longitudinal quarterly data is scarce.

The remainder of this work is structured as follows. Section 2 presents an overview of the current literature surrounding the FTPL and fiscal sustainability. Section 3 presents a simple model of the FTPL. Section 4 describes the empirical methodology employed, provides a brief history of the conduct of German fiscal policy, and presents the data. Section 5 outlines the empirical results and presents the impulse-response function. Finally, Section 6 concludes this work.

2 LITERATURE REVIEW

Arguably, the most influential explanation of prices, which serves as a foundation for many modern macroeconomic models, is the monetarist explanation of the price level, as presented, among others, by Friedman and Fisher. This quantity theory of money is centered around a money demand function that links the quantity of money in an economy to the level of prices of goods and services, establishing a proportional relationship between changes in the money supply and the price level. Therefore, an independent monetary authority would have complete control over the price level by controlling the supply of the monetary base. This leads Friedman to conclude that «Inflation is always and everywhere a monetary phenomenon» (Friedman 1996).

In contrast to the monetarist view, a new discussion has emerged that suggests that when fiscal authorities fail to obey the solvency condition, the price level must adjust to ensure a stable equilibrium. This is the Theory of the Price Level. The precursors of this idea include the seminal work of Sargent & Wallace (1981), who developed a simple theory linking fiscal policy and inflation. Their work shows that in order to maintain the solvency condition when the present value of future surpluses does not equal the current stock of government debt, the monetary authority must supply the necessary seigniorage revenue. This may involve accepting higher inflation now in exchange for lower inflation in the future when the debt is to be repaid.

However, since seigniorage revenues are relatively small in most developed economies, the FTPL argues that the price level adjusts directly in response to an imbalance in the solvency condition. The fiscal authority must choose whether to coordinate its policy with the monetary authorities or set its policy activities independent of the monetary authority activities.

The FTPL then gained momentum with the work of Leeper (1991), in which he defines a stochastic general equilibrium model that extends the work by Sargent & Wallace (1981). Fiscal and monetary authorities can decide to set their policy "actively", meaning they are not constrained to budget conditions and can set their policy freely. Meanwhile, a "passive" authority must take into consideration the actions of the other authority and the state of the government debt to ensure that IBC balances. The novelty of Leeper (1991) lies in demonstrating numerically that only regimes with one active and one passive authority will have a unique and stable price level outcome. These possible regimes are also sometimes referred to in the literature as "Money-Dominant (MD)" versus "Fiscal-Dominant (FD)" or "non-Ricardian" versus "Ricardian". The following parts of this work will use the abbreviations "FD" and "MD".

Building on this theory Sims (1994) shows that monetary policy may not be able to control the price level and that an interest rate peg can lead to price level determinacy under active fiscal policy. Woodford (1994) further supports the existence of a deterministic equilibrium when fiscal authorities act actively, emphasizing that the monetary authority must consider how fiscal policy is conducted to determine the effectiveness of monetary policy in achieving price stability. In other words, as Favero & Monacelli (2005) state, the existence and uniqueness of rational expectation equilibria is dependent on the monetary-fiscal mix. Wallace characterizes this interaction between the monetary and fiscal authority as a "game of chicken", concluding their paper with the question «Which authority moves first, the monetary authority or the fiscal authority? In other words, who imposes discipline on whom?» (Sargent & Wallace 1981).

However, there are also critics of the FTPL. Most notably, Buiter (2002) describes the FTPL as «fatally flawed» arguing that the theory incorrectly treats the government's IBC as an equilibrium condition rather than an identity. This mischaracterization would imply that the government can deviate from the path dictated by the identity. Similarly, McCallum (2001) agrees with Buiter, asserting that models lacking the enforcement of the IBC are poorly formulated. In addition, he questions the fiscal authority's ability to control the primary surplus directly.

The empirical literature on fiscal regimes has been ambiguous due to the variety of econometric methods employed. Recent studies examining the fiscal regimes of Euro area countries include Afonso (2008), which analyzes data for the European Union (EU)-15 countries that span the years 1970 to 2003. The results generally do not support the existence of an FD regime characterized by active fiscal policy. Similarly, Bajo-Rubio et al. (2009) find that most members of the Economic and Monetary Union have operated sustainably, except Finland. However, further tests could not substantiate the hypothesis of an FD regime in Finland. In their respective studies, Bajo-Rubio et al. (2014) and Congregado et al. (2023) investigate the existence of FD versus MD regimes using longitudinal data for Spain and Italy. For Spain, the authors conclude that the entire sample period can be characterized by a regime of active fiscal policy. In contrast, the study on Italy finds no evidence of an FD regime throughout the sample period, suggesting that fiscal policy was carried out sustainably. Afonso & Jalles (2017) report no support for an FD regime among a sample of 11 Euro area countries. Furthermore, the evidence presented by Panjer et al. (2020), utilizing a multivariate approach, is inconclusive and does not support the existence of active fiscal policy in Eurosystem countries between 1982 and 2021. Overall, the evidence for active fiscal policy in Euro area countries appears sparse and inconclusive.

Fratianni & Spinelli (2001) analyze annual data from Italy from 1862 to 1998 to determine the fiscal regime. They employ a money growth accounting approach to assess the quantitative impact of treasury base growth on money growth and test the causal relationship between budget deficits and the treasury base. Their findings indicate that, particularly during World War II, money growth was influenced by the budget deficit, and the evidence from the Vector Auto Regression (VAR) analysis does not reject the hypothesis of an FD regime. Similarly, Tanner & Ramos (2003) investigate Brazil's fiscal regime using data from 1991 to 2000, a period marked by high deficits, inflation, and significant policy changes. They employ a backward-looking univariate approach similar to that of Bohn (1998) and a forward-looking bivariate VAR approach comparable to Canzoneri et al. (2001). Their analysis reveals several regime switches during the period covered by the data. Sala (2004) defines a Dynamic General Equilibrium (DGE) model to establish identifying assumptions and subsequently use a VAR to estimate the system's coefficients and obtain impulse responses. They analyze quarterly data for the United States (U.S.), divided into two periods: the first covering 1960 to 1979 and the second from 1983 to 2003. Their findings suggest that an FD regime was prevalent before 1979 but shifted to a passive stance in the 1990s.

As Cochrane (2023) describes, recent advances in the FTPL focus on building Dynamic Stochastic General Equilibrium (DSGE) models rather than testing the prevalence of regimes. In their work, Leeper & Leith (2016) provide an overview of developments in model making that describe fiscal price determination through fiscal policy rules and interest rate targets. These models are used in simulation exercises to estimate the effects of policy changes by computing an Impulse Response (IR) function. However, these advancements have not yet been integrated into larger DSGE models, such as the New Area-Wide Model II used by the European Central Bank (ECB) for policy simulations, which relies on the simplifying assumption that Ricardian Equivalence holds and that the fiscal authority's budget is balanced in each period (European Central Bank. 2018). Moreover, more complex models allow for the incorporation of time- and state-dependent policy-rule variations, which can be tested using Markov-switching processes to account for regime switches and structural breaks over the duration of the sample. The work of Bianchi & Ilut (2017) employs a Markov-switching process within a DSGE framework to analyze locally active fiscal and locally active monetary regimes. Their findings indicate that the inflation experienced in the 1970s was driven by loose fiscal policy and was subsequently reversed by the fiscal reforms implemented in the 1980s in the U.S..

Previous works in this area that cannot be overlooked include Bohn (1998), which employs a backward-looking univariate regression to test whether primary surpluses respond to changes in the lagged debt-to-GDP ratio. After correcting for cyclical fluctuations and wartime spending, the study finds no evidence of an FD regime in the U.S. using annual data between 1916 and 1995. However, this approach may suffer from identification problems and might not accurately identify an active fiscal policy if current surpluses and future surpluses are negatively correlated. This limitation led Bohn (2007) to define a set of three conditions that must be met for an accurate identification. Another notable approach is presented by Canzoneri et al. (2001), who develop a forward-looking bivariate model to identify the direction of causality between the current stock of debt and future surpluses. Their VAR analysis tests whether changes in the primary budget balance negatively affect government liabilities. In a MD regime, the expected result should indicate a negative correlation, as some of those surpluses could be used to pay down government liabilities. Using a smaller data set with annual data from 1951 to 1995 for the U.S., they conclude that the data disfavor an FD regime, and their analysis of different subsamples finds no evidence that the U.S. switched regimes.

Furthermore, this work is related to the field of fiscal sustainability. Empirical studies investigating the degree of fiscal sustainability using unit root tests and cointegration tests include Afonso (2005), who analyzes the relationship between the primary budget surplus and the debt-to-GDP ratio. The author concludes that, for the EU countries in the 1970-2003 period only with some exceptions the fiscal policy of EU government's exhibit some sustainability issues. In the case of Germany Afonso (2005) found that it appears to be less likely to have sustainability problems. Other studies that use unit root and cointegration tests to determine fiscal sustainability for Euro countries include Burret et al. (2013) using a longitudinal data set that spans from 1850 until 2010 for the case of Germany to perform fiscal sustainability tests, such as unit root tests and cointegration tests. Their findings show that fiscal sustainability cannot be rejected in the period prior to World War I, however, in the period between 1950 and 2010 the data allow for a rejection of the hypothesis of fiscal sustainable policy. Semmler & Zhang (2004) perform a test of the fiscal regime of EMU countries between 1967 and 1998 using a VAR approach and find that both France and Germany have followed an FD regime. This is followed by a Markov-switching State-Space model which suggests that there have been regime switches in monetary and fiscal policy interactions in both France and Germany. Another study investigating the sustainability of the public finances in 11 countries in the Euro area between 1999 and 2013 is Afonso & Jalles (2017). They find that fiscal policy appears to have been sustainable only in Belgium, France, Germany, and the Netherlands and a MD regime might have been present.

3 THEORETICAL BACKGROUND

The intuition of achieving fiscal solvency through either regime can be illustrated using a simple frictionless intertemporal model proposed by Cochrane (2023). Initially, the model economy starts with outstanding debt B_{t-1}, leading the government to face the following budget constraint:

$$M_{t-1} + B_{t-1} = P_t s_t + M_t + Q_t B_t \tag{1}$$

where M_t is the money supply at time t, B_t is the outstanding debt at time t, P_t is the price level at time t, and Q_t is the price of a one period nominated bond at time t, that is, $Q_t = 1/(1+i_t)$. The term s_t denotes the primary balance of the government at time t, that is, the government's revenue less the government's expenditure. The representative household maximizes their utility:

$$\max\ \mathrm{E}_t \sum_{t=0}^{\infty} \beta^t u(c_t) \tag{2}$$

with β being a subjective discount factor and $u(c_t)$ being the utility derived from consumption. In a complete asset market where households have a constant income endowment $y_t = y$. The household budget constraint is analogous to the government budget constraint. At the beginning of the period, the household is endowed with money M_{t-1}, holds nominal bonds B_{t-1}, and receives income $P_t y$. during the period the household consumes $P_t c_t$, pays net taxes of $P_t s_t$ and buys bonds B_t. At the end of the period, households' bonds and money holdings must be non-negative i.e. $B_t \geq 0$ and $M_t \geq 0$:

$$M_{t-1} + B_{t-1} + P_t y = P_t c_t + P_t s_t + M_t + Q_t B_t \tag{3}$$

Cochrane (2023) shows that from the household maximization, budget constraint, and the complete asset market constraint that $c_t = y$ the gross real interest rate $R = 1/\beta$, the nominal interest i_t and the bond price Q_t follows:

$$Q_t = \frac{1}{1+i} = \frac{1}{R}\,\mathrm{E}_t\left(\frac{P_t}{P_{t+1}}\right) = \beta\,\mathrm{E}_t\left(\frac{P_t}{P_{t+1}}\right) \tag{4}$$

When $i_t > 0$ households have no demand for money and when $i_t = 0$ money and bonds are interchangeable, thus B_t can be interpreted as the total amount of money and bonds. This allows to eliminate money from Equation (1) resulting in

$$B_{t-1} = P_t s_t + Q_t B_t \tag{5}$$

This is the crucial point of the FTPL because it establishes a relation in which the price level is not determined by money. Substituting (4) into (5) and dividing by P_t provides the following.

$$\frac{B_{t-1}}{P_t} = s_t + \beta B_t \,\mathrm{E}_t \left(\frac{1}{P_{t+1}} \right) \tag{6}$$

The household's constrained maximization and complete asset market condition $c_t = y$ result in the following Transversality Condition (TC):

$$\lim_{T \to \infty} \mathrm{E}_t \left(\beta^T \frac{B_{T-1}}{P_T} \right) = 0 \tag{7}$$

Indicating that the household's terminal value of discounted real holdings of bonds is equal to zero, otherwise, the household could increase their utility from consumption. In other words, the government cannot sustain debt indefinitely. Equation (7) establishes what is known as a no-Ponzi condition for the government.

As mentioned in Section 1, the sustainability of the government balance requires that all outstanding debt be repaid with future government surpluses. As noted by Afonso (2008), satisfying IBC is a necessary but not sufficient condition for sustainability. The result of Equation (2) subject to the constraints is

$$\frac{B_{t-1}}{P_t} = \mathrm{E}_t \sum_{j=0}^{\infty} \beta^j s_{t+j}. \tag{8}$$

The left-hand side of Equation (8) represents the real value of the outstanding nominal debt, while the right-hand side denotes the present value of future primary surpluses. In this model, the government chooses the primary balance by raising taxes or lowering expenditure, which means that surpluses cannot be considered exogenous (Cochrane 2023). As Afonso (2008) states, the government is more likely to adjust the primary balance by changing the primary expenditure. According to the FTPL when either the current stock of nominal debt or the present value of future primary surpluses changes with the other one unchanged, the price level must adjust.

The rationale for relating the current stock of debt to the present value of future surpluses at a given information set can be found in an epistemic game. The government will attempt to roll over debt each period; therefore, investors will sell debt if they fear future investors will not be there to roll over debt (Cochrane 2023). The government may run a deficit by selling additional debt if investors believe that the additional debt today will be matched by higher future surpluses (Cochrane 2023). Sargent (1993) demonstrates that as long as the economy's growth rate exceeds the real interest rate on government debt, the government may roll over its debt and continue increasing the stock of debt.

4 EMPIRICAL METHODOLOGY, FISCAL BACKGROUND, AND DATA

4.1 Empirical Methodology

As pointed out by Sala (2004), testing for a fiscal regime can be challenging because the IBC from Equation (8) holds by definition at all times regardless of the regime. As pointed out by Cochrane (2023), this is a common identification phenomenon when testing equilibrium conditions of New-Keynesian and monetarist models known as observational equivalence.

The key aspect that can be tested is the causal link between government liabilities and the primary balance. Therefore, researchers must establish identifying assumptions to distinguish the particular mechanism that ensures government solvency. As shown by Bajo-Rubio et al. (2009), most empirical research conducted uses one of two approaches:

1. A *backward-looking* approach as proposed by Bohn (1998), based on the premise that in a MD regime, a sudden increase in debt will be followed by higher surpluses in the future $\Delta b_{t-1} \rightarrow \Delta s_t$.
2. A *forward-looking* approach as proposed by Canzoneri et al. (2001), which claims that in a MD regime, a sudden increase in the current primary balance will be used to repay some of the debt in the next period $\Delta s_t \rightarrow \nabla b_{t+1}$.

Where b_t represents the government's debt-to-GDP ratio, and s_t denotes the primary balance as a share of GDP.

This work will apply both backward-looking and forward-looking approaches to assess fiscal sustainability. The backward-looking analysis will follow common empirical methods, which involve using historical fiscal data to test for stationarity in government debt and the primary balance, and to estimate their long-run relationship with cointegration models. To model this relationship, a simple linear fiscal reaction function can be formulated, as proposed by Bohn (1998):

$$s_t = \alpha + \beta b_{t-1} + \upsilon_t. \tag{9}$$

Where υ_t is an error term. If fiscal authorities comply with the present value budget constraint and conduct fiscal policy sustainably, the estimate of β is expected to be positive and statistically significant, as the government must increase its primary balance in response to previous increases in the stock of debt. Furthermore, this implies that the fiscal authority acts passively, responding to meet the exogenous level of b at a given price level, thereby indicating a MD regime.

Another way of testing for sustainable practices involves testing the relationship between government revenue and expenditure using a simple linear model, as suggested by Bajo-Rubio et al. (2014).

$$rev_t = a' + \beta' exp_t + \varepsilon_t \tag{10}$$

Here, rev_t and exp_t refer to the total government revenues and expenditures, respectively, both scaled by GDP, and ε_t is an error term. Fiscal sustainability would be present when the stock of debt would be stationary or, in other words, when the fiscal authorities do not run structural deficits, thus when $\beta' = 1$.

In Bohn (2007) the author claims that most stationary and cointegration tests are not suitable to reject the hypothesis of sustainability. He then suggests a set of three propositions that identify the requirements necessary to determine fiscal sustainability, as shown by Bajo-Rubio et al. (2014).

1. If the debt series, b_t, is integrated of order m, for any finite $m \geq 0$ then debt satisfies the TC and debt, revenue and spending satisfy the IBC.

2. If exp_t and rev_t are integrated of orders m_G and m_T, respectively, then b_t is integrated of order $m \leq (m_G, m_T) + 1$, ensuring that TC and IBC are satisfied. This follows from Equation (10).

3. If b_t and s_t can be described by an error correction model given by $s_t - \rho b_{t-1} = z_t$, where z_t is integrated of order m, provided $\rho < 0$ and $\rho \in (0, 1 + r]$ with r as the constant interest rate, then the debt series satisfies TC and IBC.

These three conditions may help identify whether the fiscal government complies with TC and IBC and thus maintains sustainable public finances. When determining whether a MD regime is prevalent, the estimate for β in Equation (9) must be strictly positive. However, as mentioned by Afonso & Jalles (2017) a positive value for β may also be consistent with an FD regime. In the case of a MD regime, an increase in debt in period t will require the fiscal authority to raise primary surpluses ex-post in the subsequent period, represented as $\Delta b_t \rightarrow \Delta s_{t+1}$. In contrast, in an FD regime, a decline in the expected future primary surpluses can cause the debt ratio for period t to decrease as a consequence of a rise in the price level, as shown by $\nabla E_t s_{t+1} \rightarrow \nabla b_t$. This would also suggest a positive estimate for β in Equation (9). Therefore, a test for Granger causality will be implemented to determine the direction of the relationship.

4.2 Fiscal Background of Germany

4.2.1 Foundational Years and Economic Miracle (1949-1960s)

In the aftermath of World War II, Germany underwent a currency reform in 1948, abolishing the Reichsmark, the currency of the previous National Socialist regime, and introducing the Deutsche Mark as the new currency of the Federal Republic of Germany (Burret et al. 2013). The exchange rate for one Reichsmark in return for Deutsche Mark was 10:1 in designated Federal Reserve Banks supervised by the Bank Deutscher Länder (Burret et al. 2013). Alongside the currency reform, the Federal Republic of Germany also ceased payments on the liabilities of the National Socialist regime, as the legitimacy of these debts was highly contested, effectively defaulting on the inherited liabilities (Guinnane 2004).

In 1953, a debt agreement was reached in London, which included a restructuring of Germany's external debt (Guinnane 2004). The remaining debt was to be repaid over an extended repayment period (Guinnane 2004). During the following two decades, the debt-to-GDP ratio of the general government oscillated around a mean of 22 percent (Burret et al. 2013). This stability was largely due to substantial economic growth, which prevented the ratio from increasing. GDP growth peaked at almost 10 percent between 1953 and 1973, during which the nominal debt rose from 14.78 billion Marks to 86.42 billion Marks (Burret et al. 2013).

4.2.2 Oil Crisis (1970s)

The late 1960s were marked by a significant shift in German economic policy. With the implementation of the "Law for Stability and Growth" (StabG) in 1967, the German government was allowed to use Keynesian policy measures to address negative output gaps (Burret et al. 2013). Furthermore, a new constitutional fiscal rule was introduced, restricting the government to run deficits only in relation to the volume of public investments (Burret et al. 2013). This led to the primary balance falling from -1.1 percent in 1970 to -6.2 percent of GDP in 1975 due to an increase in transfers and subsidies (von Hagen & Strauch 2001). Around 40 percent of the rise in public expenditure was caused by higher social security benefits. In the years following this introduction, the debt-to-GDP ratio increased due to higher public spending and the economic downturn that followed the oil crisis of the 1970s. With the election of a Conservative-Liberal government in 1982, under chancellor Helmut Kohl, fiscal deficits were consolidated (Burret et al. 2013).

4.2.3 Reunification (1990s)

Following German unification in the early 1990s, public debt increased as a result of substantial infrastructure and social investments (Burret et al. 2013). Between 1990 and 1995, government spending rose from 34.8 percent to 46.3 percent of GDP, primarily due to transfers and subsidies, including health care services (von Hagen & Strauch 2001). Because substantial portions of the transfers originated from special funds, the integration of these into the government accounts caused government liabilities to increase significantly, rising from 42 percent of GDP in 1990 to 59.1 percent in 1995 (von Hagen & Strauch 2001).

With the signing of the Maastricht Treaty in 1991, the countries of the EU, as well as those that would subsequently join, became subject to a set of fiscal rules outlined in the Treaty on the Functioning of the EU, Article 126 (2-3). These rules specify that member states should (i) maintain a budget deficit of no more than 3 percent of GDP and (ii) ensure that the ratio of public debt-to-GDP does not exceed 60 percent. Furthermore, since its introduction in 1997, member states are subject to the SGP (Regulation (EC) No. 1466/97), which reinforces these fiscal rules by providing a framework for monitoring and coordinating economic policies among member states.

Following this through fiscal consolidation efforts on the expenditure side, which decreased from 47.3 percent of GDP in 1996 to 45.6 percent of GDP by 1999, the German government managed to stabilize the debt-to-GDP ratio around 64 percent in 1999 (von Hagen & Strauch 2001).

4.2.4 Great Financial Crisis and Eurozone Crisis (2010s)

In 2009, the Great Financial Crisis struck, leading to an increase in general public debt to more than 80 percent of GDP, amounting to approximately 2 trillion euros by 2010 (Burret et al. 2013). In response, the government attempted to introduce stimulus packages aimed at supporting the export sector (Seelkopf & Haffert 2024). The main components of these packages included a short-time work scheme and a "Cash-for-Clunkers" program designed to strengthen the automotive industry, costing the government around 5 billion euros (Seelkopf & Haffert 2024). The additional burden of these countercyclical policy measures added around 2.8 percent to the national debt in 2010 (Blömer et al. 2015). Furthermore, asset purchases conducted to stabilize the financial markets amounted to 240 billion EUR in 2010 which was around 9.5 percent of GDP (Blömer et al. 2015).

Seelkopf & Haffert (2024) assert that as a consequence of the Great Financial Crisis, Germany committed to austerity in its fiscal policy. This commitment resulted in the introduction of a constitutional debt brake in March 2009, which allowed the federal government to run a structural deficit of no more than 0.35 percent of GDP. The federal states were required to maintain a balanced budget and cannot incur structural deficits. These restrictions were implemented for the federal government in 2016 and for state governments in 2020. However, the law allows exceptions during crisis periods. In cases of severe economic downturns or national emergencies, deviations from these rules are allowed, provided they are temporary. These emergency cases are defined more strictly than similar previous rules and are out of the control of the states, as they are overseen by a "Stability Council" (Blömer et al. 2015).

4.2.5 COVID-19 Pandemic and War in Ukraine (2020s)

The COVID-19 pandemic, which began in early 2020, posed enormous challenges not only for civil society, but also for public finances. The government had to finance increased spending in the health sector and implement large relief packages in an effort to partially mitigate the economic impact of lockdowns through fiscal expansion. The measures in response to the pandemic, implemented until July 2021, included: (i) spending on healthcare equipment, hospital capacity, and R&D for vaccines; (ii) expanded access to the short-time work subsidy ("Kurzarbeit") to preserve jobs and workers incomes, along with increased childcare benefits for low-income parents and easier access to basic income support for the self-employed; (iii) 50 billion EUR in grants to small business owners and self-employed individuals severely affected by the COVID-19 outbreak, in addition to interest-free tax deferrals until year-end and 2 billion EUR in venture capital funding for start-ups; (iv) temporarily extended duration of unemployment insurance and parental leave benefits; (v) a VAT reduction from 19 percent to 16 percent and from 7 percent to 5 percent for the reduced VAT; (vi) expanded credit guarantees for exporters and export-financing banks; and (vii) subsidies and investments in green energy and digitization (IMF 2021). In total, the German government adopted three additional budgets: (i) 156 billion EUR (4.7 percent of GDP) in March 2020, (ii) 130 billion EUR (3.9 percent of GDP) in June 2020, and (iii) 60 billion EUR (1.7 percent of GDP) in March 2021 (IMF 2021). This marked the first time that the debt brake was temporarily suspended, as enormous efforts were needed to counteract the crisis, which would have been impossible within the constraints of the debt brake. However, the regulations of the debt brake allow for such exceptions during extraordinary periods.

> In cases of natural catastrophes or unusual emergency situations beyond governmental control and substantially harmful to the states financial capacity, these credit limits may be exceeded on the basis of a decision taken by a majority of the Members of the Bundestag.
>
> In: Bundesministerium der Justiz (2009), Art. 115 GG

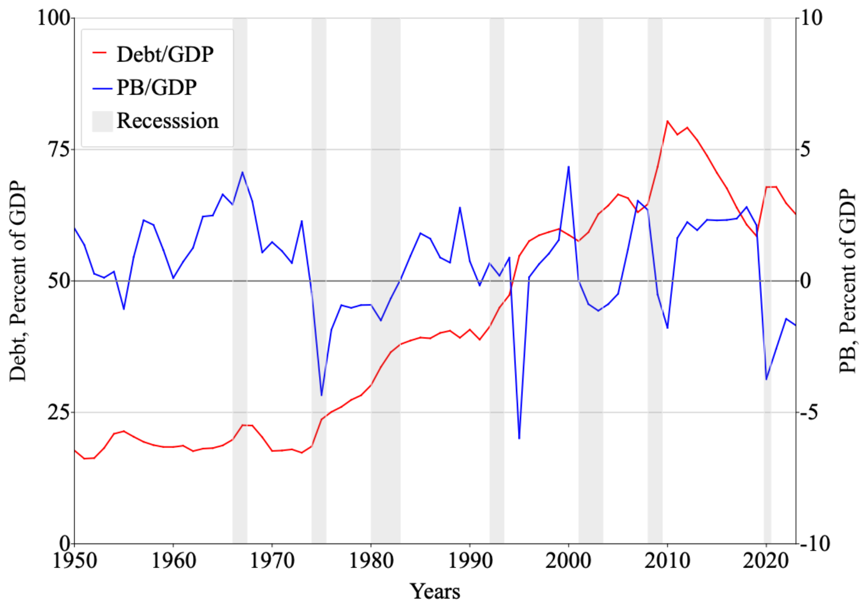
As Seelkopf & Haffert (2024) point out, compared to the previous Great Financial Crisis, the main focus of the COVID relief package was a short-time work retention scheme. The number of recipients increased from 133,000 before the pandemic to more than 6 million during the pandemic (Seelkopf & Haffert 2024). The total cost of this scheme until February 2022 was estimated to be around 46 billion EUR (Seelkopf & Haffert 2024). Following the onset of the Ukraine war in February 2022 the German parliament approved 100 billion special funds to finance the epochal shift ("Zeitenwende"), as proclaimed by the German Chancellor Olaf Scholz. This included substantial investments in the German Armed Forces and aid to Ukraine.

This brief overview of fiscal policy conduct from the end of World War II to the recent conflict in Ukraine illustrates the numerous structural changes in how German authorities have conducted fiscal policy in response to sudden shifts in the political and economic environment. In the following section, This work will use formal econometric tests to assess the sustainability of the fiscal policy conduct and to assess the regime prevalent over the sample period.

4.3 Data

The data used in the empirical analysis of this work consists of government revenue, non-interest government expenditure, the primary balance, and gross public debt, all expressed as a share of GDP. This analysis uses annual data on the public finances of the German government during the period 1950 to 2023 using annual data. The primary balance is calculated as the difference between government revenue and non-interest government expenditure. It is important to note that the primary balance is a flow variable, while government debt is a stock variable.

Data for public finances are derived from Mauro et al. (2013), who collected information from both cross-country and country-specific sources. In the case of Germany, 26 percent of the data comes from country-specific sources, while 14 percent is obtained from other hand-collected sources, the rest comes from cross country sources. Figures (1) and (2) visualize the development of the data over the 74-year span.

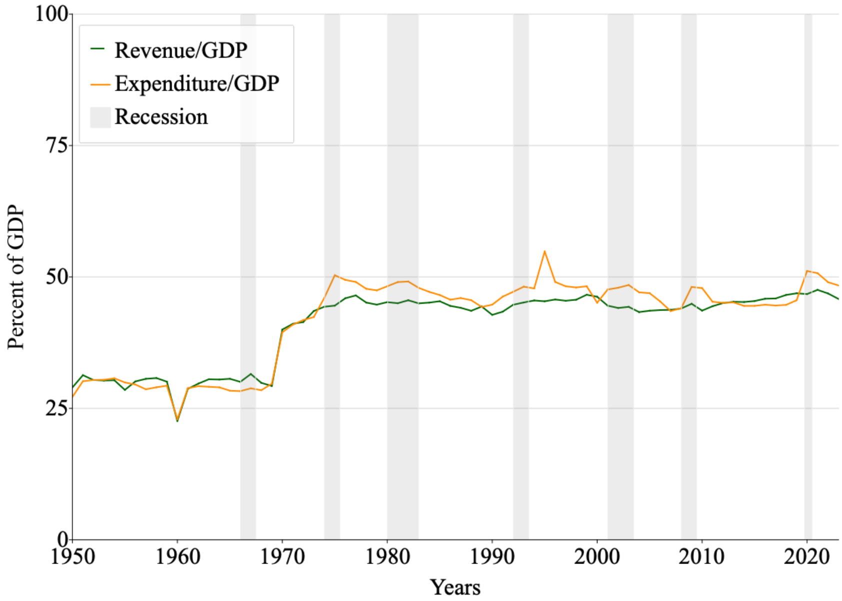


Sources: Debt/GDP and Primary Balance/GDP from IMF Public Finances in Modern History dataset, with recession dates from German Council of Economic Experts (German Council of Economic Experts 2022). Created by the author.

FIGURE 1: GERMAN PUBLIC DEBT AND PRIMARY BALANCE (1950-2023)

In their data collection process, Mauro et al. (2013) emphasized preserving source continuity over time to reduce potential inconsistencies in the series that may arise from changes in data sources. To maintain consistency in concepts, they aimed to obtain all fiscal variables from one unified data source each year. However, when these conditions conflicted, particularly with respect to the computation of the primary balance, which is derived from the overall fiscal balance minus interest payments, they generally favored source consistency across concepts over continuity across time. To achieve this, Mauro et al. (2013) aimed to use a given data source spanning uninterrupted periods of no less than a decade, except when shorter durations were required to fill gaps. Their objective was to use data related to the most comprehensive sector of government available. Consequently, the final spliced series reflects a switch from central government to general government coverage that occurred at the beginning of the 1970s.

The general government consists of all institutional units that are non-market producers, which includes the central government, state and local governments, as well as social security and public non-financial corporations (Eurostat 2013). Mauro et al. (2013) indicate that the change in sector coverage led to a significant break in the revenue and primary expenditure series, whereas the disruptions in the debt and primary balance series were relatively minor. In the case of Germany, the data collection process resulted in a



Sources: Revenue/GDP and Expenditure/GDP from IMF Public Finances in Modern History dataset, with recession dates from German Council of Economic Experts (German Council of Economic Experts 2022). Created by the author.

FIGURE 2: GERMAN GOVERNMENT REVENUE AND EXPENDITURE (1950-2023)

data set that includes information from the sources listed in Table V in Appendix A.

Beginning in 2011, the most recent data for all indicators in the dataset come from the Biannual World Economic Outlook. As reported in the statistical appendix of International Monetary Fund (2025), the data reported to the IMF by the national desk in Germany follow the ESA 2010 standard described in Eurostat (2013).

4.3.1 Government Revenue

This indicator includes all sources of income for the government, such as total taxes, social contributions, sales of goods and services, and other current and capital revenues. The data provide the most comprehensive view of government sectors available, ensuring a complete understanding of fiscal inflows (Eurostat 2013).

4.3.2 Non-Interest Government Expenditure

This indicator includes all categories of government spending, including intermediate consumption, compensation of employees, social benefits, subsidies, and capital expenditure, excluding interest payments. The data capture the full range of expenditures, providing insight into fiscal policy priorities (Eurostat 2013).

4.3.3 Primary Balance

The primary balance is calculated as the difference between government revenues and non-interest government expenditures. A positive primary balance indicates a surplus, while a negative balance signifies a deficit.

4.3.4 Gross Government Debt

This is recorded at market value, with short-term debt securities valued at market value or approximated by nominal value when market values are unavailable, provided there are no conditions of high inflation or nominal interest rates. Long-term debt securities are also valued at market value, regardless of their interest payment structure. The data reflect the overall debt obligations of the government, allowing for an assessment of fiscal sustainability (Eurostat 2013).

Unadjusted annual GDP data are utilized, ensuring a robust framework for analysis. To enhance the accuracy of the analysis, the data set incorporates consolidated statistics, eliminating internal transactions among government units to better assess the overall impact of government operations on the economy. This approach allows for a clearer understanding of revenue and expenditure ratios relative to GDP, facilitating a comprehensive evaluation of fiscal policy sustainability (Eurostat 2013).

5 EMPIRICAL RESULTS

5.1 Descriptive Statistics

To enhance the understanding of the basic characteristics of the data, including its central tendencies, dispersion, and distribution, descriptive statistics of the key variables are provided. These statistics include the mean, standard deviation, minimum, maximum values, and number of observations. The results are reported for all variables, including government debt (b_t), primary balance (s_t), government revenue (rev_t), and government expenditure (exp_t), as shown in Table I.

TABLE I: DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Min.	Max.	Obs.
Revenue	40.73	6.907	22.6	47.54	74
Expenditure	41.89	8.316	22.94	54.86	74
Primary Balance	0.6604	1.879	-5.983	4.337	74
Government Debt	41.72	21.05	16.19	80.38	74

5.2 Stationarity Tests

Following the descriptive statistics, this work will proceed to the estimation of the propositions developed by Bohn (2007).

In a first step, the order of integration for b_t, exp_t, and rev_t will be tested using the unit root tests proposed by Carrion-i Silvestre et al. (2009). This is a GLS-based unit root test that allows for multiple structural breaks under both the null hypothesis and the alternative hypothesis, which is useful to account for the structural breaks identified in Section 4.2. The test follows the modified unit root test (MZ_a^{GLS}, MZ_t^{GLS}) discussed by Ng & Perron (2001) which improves the Z test both with regard to size and distortions by allowing a series to converge with different rates of normalization under the null hypothesis and the alternative hypothesis. Previous unit root tests that account for structural breaks include tests such as those proposed by Zivot & Andrews (1992) or later Perron (1997). However, none of these uses GLS detrending procedures to estimate the parameter of the model. The findings of Elliott et al. (1992) show that the use of local GLS detrending may yield power gains that motivated Ng & Perron (2001) to apply GLS detrending to these tests. The test developed by Carrion-i Silvestre et al. (2009) is an extension of the M-class tests developed by Perron & Rodrguez (2003) but allowing multiple structural breaks at unknown break dates.

Carrion-i Silvestre et al. (2009) consider three models: Model 0 allows for an exogenous change in the level of the series ("level shift"), Model I permits an exogenous change in the rate of growth ("slope change"), and Model II admits both changes ("mixed change"). Similarly as in Congregado et al. (2023) in the analysis, breaks for the rev_t and exp_t series will be assumed to be of the Model 0 type and breaks for the b_t series of the Model II type. The rationale for choosing those models for the respective series is that the government revenue and expenditure are affected by sudden changes in fiscal policy, such as tax reforms or increases in spending on infrastructure, which will result in abrupt changes to the level. Using Model 0 for rev_t and exp_t the effect of those level shifts is accounted for while maintaining some degree of simplicity. To capture the more dynamic effects of government debt, Model II will be applied to the b_t series. That is because government debt is influenced by sudden events such as crises or policy changes triggering level shifts, but also by changes in growth rates such as economic growth or longer-term fiscal adjustments. Thus, Model II is a better fit that captures the complexity in the drivers of changes in the government debt series. The two M-class tests as described in Carrion-i Silvestre et al. (2009), used to estimate the following values, can be found in Appendix B.

Table II presents the results of applying the M-class tests by Carrion-i Silvestre et al. (2009) that allow for up to three structural breaks at unknown break dates. The Gauss code used for the test was obtained from Clower (2020). The critical values were obtained from the tables in Carrion-i Silvestre et al. (2009) who run simulations using 1000 steps to approximate the Wiener process and 10000 replications.

The results suggest that the government debt and revenue series are integrated of order one, I(1), becoming stationary after first differencing. The finding for the government expenditure series is more ambiguous; while the MZ_{α}^{GLS} and MZ_t^{GLS} tests do not reject the null hypothesis of a unit root, the ADF test indicates stationarity at the 5 percent significance level. By accepting the result of the ADF test, all series can be considered $I(1)$. Therefore, according to the first and second propositions of Bohn (2007), because the fiscal series are integrated of a finite order ($m = 1$), it can be concluded that debt satisfies the TC, and that debt, revenue, and spending jointly satisfy IBC. For convenience in the following analysis, the government expenditure series will be treated as $I(1)$, given that the results suggest near-stationary behavior after differencing.

5.3 Single Equation Error Correction Model

As described previously, the empirical estimation of a long-run equilibrium condition can be quite challenging. A long-run equilibrium relationship indicates a systematic co-

TABLE II: CARRION-I-SILVESTRE ET AL. TESTS FOR UNIT ROOTS

	MZ_{α}^{GLS}	MZ_{t}^{GLS}	ADF^{GLS}
$I(2)$ vs. $I(1)$			
Δb_t	-31.20^{*}	-3.94^{*}	-5.80^{**}
Δexp_t	-11.65	-2.41	$-3.24*$
Δrev_t	-35.80^{**}	-4.23^{**}	-8.98^{**}
$I(1)$ vs. $I(0)$			
b_t	-20.60	-3.21	-3.87
exp_t	-17.275	-2.94	-3.40
rev_t	-25.91	-3.60	-3.88

$**$ Significance at the 1% level.
$*$ Significance at the 5% level.

movement among economic variables. Engle & Granger (1987) show that, an equilibrium relationship between the variables y and x can be described as $f(y, x) = 0$, provided that the deviation $\epsilon_t \equiv f(x_t, y_t)$ from this equilibrium is a stationary mean-zero process. Thus, the "equilibrium error" follows a constant distribution with a zero mean. Consequently, the equilibrium error cannot grow without bound. If x_t and y_t are $I(1)$ but there exists a linear combination $z_t = m + ax_t + by_t$ that is both $I(0)$ and has zero mean, then x_t and y_t are cointegrated (Engle & Granger 1987).

The empirical literature has developed methods for testing the cointegration of equilibrium variables. One such method is derived from the Granger representation theorem, as described in Granger (1986), which states that if a set of non-stationary series are cointegrated, they can also be represented by an error correction mechanism. Consequently, Equation (9) can be rewritten to express a change in s_t in terms of the change in b_t and the "equilibrium error." This class of models is known as error correction models, and as Hendry & Richard (1983) state, the error correction mechanism serves as an effective way of "providing a convenient means of implementing long-run economic theories in dynamic models." In the next step, a SECM will be established and estimated. The model specification will follow that proposed by Bajo-Rubio et al. (2014), which includes lags for both the dependent and independent variables:

$$\Delta s_t = \omega + \delta(L)\Delta b_{t-1} + \rho(s_{t-1} - \alpha - \beta b_{t-2}) + \gamma(L)\Delta s_{t-1} + \eta_t. \tag{11}$$

The specified model captures both short- and long-run dynamics. The error correction mechanism $(s_{t-1} - \alpha - \beta b_{t-2})$ tests the cointegration and thus captures the long-term effects, while the inclusion of lags allows the model to account for short-term deviations from the equilibrium. Although Granger (1986) suggest a two-step estimation process to estimate α and β of the error correction mechanism in a first step and then estimate the remaining coefficients of the model $\omega, \delta, \rho, \gamma$ using an Oridnary Least Squares (OLS) estimator. Phillips & Loretan (1991) recommend using a Non-Linear Least Squares (NLS) method for the simultaneous estimation of a cointegrating vector and an error-correction mechanism. Banerjee et al. (1998) show that the estimation of the model using NLS estimator can produce consistent and asymptotically efficient estimates of the coefficients under the assumption that b_t is strictly exogenous. The number of lags has been chosen using the Akaike Information Criterion (AIC). Table III shows the results.

TABLE III: ESTIMATION OF A LONG-RUN RELATIONSHIP

Variable	Coefficient
Error-correction coefficient (ρ)	-0.534 (0.0006 **)
Long-run coefficient (β)	0.0034 (0.856)

p-values are shown in parentheses.
$**$ Significance at the 1% level.

The results are well in line with the third proposition of Bohn (2007) which states that $|\rho|$ is within the $(0, 1+r]$ interval. The estimate of β is positive at 0.0034 but shows to be statistically not significant.

The negative estimate of ρ is consistent with economic theory, indicating that when the system deviates from a long-run equilibrium it corrects itself moving towards the equilibrium. However, the statistical insignificance of β indicates that there might not exist a linear relationship in the long run equilibrium at all and that fiscal policy might have been conducted unsustainable. Moreover, as pointed out by Canzoneri et al. (2001), the identification of a fiscal regime requires additional information, and the prevalence of a FD regime cannot be concluded immediately. In the case of a MD regime, an increase in debt today would result in the need to increase the primary balance in the next period by increasing revenue or decreasing expenditures, thus s_t and b_{t-1} are cointegrated with a positive estimate of β. In the case of an FD regime, a decrease in the expected future primary balance may lead to a decrease in the current debt ratio through price increases, which will also result in a positive estimate of β (Afonso & Jalles 2017). Therefore, to estimate the direction of the cointegration, the previous analysis will be supplemented with a Granger-causality test between the two series of primary balance and the debt to GDP ratio.

5.4 *Test for Granger Causality*

A series X is said to Granger cause Y if the ability to predict the current value of Y is enhanced by considering the past values of X. This concept was first brought forward by Granger (1986).

Non-stationarity can pose challenges when running inference tests, as it can lead to spurious results or non-normal distributions when directly included in regressions. The concern is not with respect to the integration of the data, but rather with respect to whether the estimated coefficients have a non-standard distribution as highlighted by West (1988). Therefore, to be able to run the F-test needed to determine Granger-causality it is important to ensure that all regression coefficients are stationary and normally distributed. This point was further developed by Sims et al. (1990) who point out that coefficients of stationary variables or variables that appear in any of the system's stationary linear combination follow standard distributions, and test statistics yield asymptotically correct results. Therefore, to test the null of Granger-causality a transformation will be used that has only stationary variables to facilitate the interpretation of the outcomes. The resulting regression suggested by Bajo-Rubio et al. (2014) is as follows:

$$X_t = \delta_1 X_{t-1} + \gamma_1 (X_{t-1} - \beta Y_{t-1}) + \sum_{i=1}^{m} \alpha_{1i} \Delta X_{t-i} + \sum_{j=1}^{n} \alpha_{2j} \Delta Y_{t-i} + \zeta_t \tag{12}$$

where ζ_t is an error term that is white noise. The estimated model was tested with s_t and b_{t-1} as dependent variable alternatively. The F-test to determine Granger causality will test whether the coefficients for are α_{2i} and γ_1. Thus, since the restriction being tested is solely stationary and zero mean, the distribution for the F-test will most likely follow a standard F distribution according to Sims et al. (1990). Equation (12) models both the short-run, through the lagged difference terms, and the long-run, through the error correction term, relationship between X_t and Y_t. The lag length is chosen using the AIC.

The results are presented in Table IV which presents the F statistics for the null hypotheses, specifically $\gamma_1 = 0$ indicating no long-term causality, and $\alpha_{2i} = 0$ signifying the absence of short-term causality. The results show that Granger causality is present in the short- and long-run in the direction from primary surplus to debt. However, the table also shows that long-run Granger-causality is present in the direction from debt to primary balance. These results are inconclusive, as they do not point towards a simple, single regime. Instead, it may be concluded that expected short-run fiscal decisions might affect government debt through the price level and that there exists a long-run feedback loop between government debt and the primary balance. In the short run the results behave unidirectionally along the line of an FD regime.

Thus, the results fail to accept the hypothesis of fiscal sustainability according to the third proposition of Bohn (2007), although the SECM results suggest that a long-term equilibrium exists. The Sims et al. (1990) test for Granger-causality failed to identify a single regime and found an interactive relationship between the debt-to-GDP ratio and the primary balance as a share of GDP. In an attempt to increase the understanding of the relationship, Section 5.5 presents an IR analysis.

TABLE IV: SIMS-STOCK-WATSON TESTS FOR GRANGER-CAUSALITY

H_0	$s_t \rightarrow b_{t-1}$	$b_{t-1} \rightarrow s_t$
$\gamma_1 = 0$	6.71*	3871.8**
$\alpha_{2i} = 0$	10.68**	0.46

The reported values are F-statistics.
$**$ Significance at the 1% level.
$*$ Significance at the 5% level.

5.5 Impulse Responses

As a last step in the analysis, this work will generate an IR-function to further check the robustness of the results. To achieve this, the methodology introduced by Jordà (2005), which employs local projections, will be utilized. The orthogonal innovations used in the LP model will be structural shocks that are obtained following the methodology of Burriel et al. (2010).

This method is rooted in the framework developed by Blanchard & Perotti (2002) to identify fiscal policy shocks within the context of a Structural Vector Auto Regression (SVAR). The objective is to isolate orthogonal, discretionary changes in fiscal variables from automatic responses to economic conditions and systematic policy reactions.

The core of the identification strategy relies on estimating a VAR model and then imposing theory-based restrictions to disentangle structural fiscal shocks from the reduced-form residuals. The identification approach will use decision lags in policy making and information about the elasticity of fiscal variables to economic activity. As this framework relies crucially on the assumption of quarter independence, the data that will be used for the estimation of the structural shocks and henceforth for the IR will be quarterly data of the public finance indicators derived for the period between 2002 and 2024. The following quarterly data were retrieved from ECB Data Portal: GDP at market prices, quarterly transformed GDP deflator (2020Q1=100), nominal absolute governemnt expenditure and revenue in millions of EUR, and a 10 year long-term interest rate.

Since the primary balance (PB_t) is defined as revenue (R_t) less government expenditure (E_t), the structural shock to the primary balance (e_t^{PB}) will be derived from the structural shocks to government revenue (e_t^R) and government spending (e_t^E).

The complete derivation of structural shocks using the Blanchard & Perotti (2002) SVAR method can be found in Appendix B.

Having derived the time series of structural government expenditure shocks (e_t^E) and the structural government revenue shocks (e_t^R), the structural shock to the primary balance (e_t^{PB}) is then computed as:

$$e_t^{PB} = e_t^R - e_t^E \tag{13}$$

This series represents exogenous discretionary changes in the primary balance and serves as a key input for the subsequent analysis of the effect of structural shocks on the primary balance on the stock of government debt.

Finally, to verify the robustness of the previous results, impulse responses will be produced following a forward-looking approach similar to Canzoneri et al. (2001). According to Canzoneri et al. (2001), in a MD regime, an increase in the primary balance will help pay off some of the government debt, thus reducing the future debt stock. Conversely, in an FD regime, an increase in the primary balance will lead to an increase in the debt stock, through a decrease in the price level. Thus, in a MD regime, this can be represented as $\Delta s_t \to \nabla b_{t+1}$. To eliminate any ambiguity, it will be assumed that an increase in the primary balance is not related to any future innovations in the primary balance.

To construct impulse responses of the primary balance innovations on government debt in the subsequent period, this study will employ the local projection method developed by Jordà (2005). This method is chosen for its robustness to model misspecification and its capability to handle non-stationary data effectively. Furthermore, as noted in Jordà & Taylor (2024), this approach allows for the direct estimation of impulse responses at various time horizons, eliminating the need for simulation-based methods. The estimated model takes the following form:

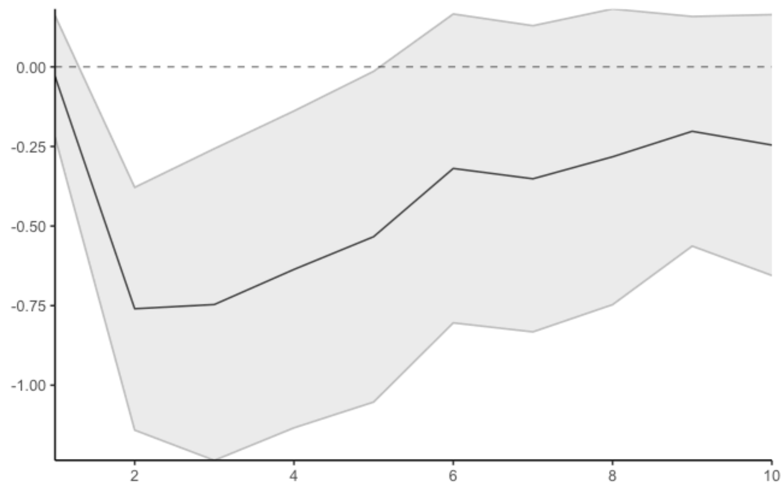
$$b_{t+h} = a_h + \beta_h e_t^{PB} + \sum_{k=1}^{p} \gamma_{h,k} b_{t-k} + \sum_{j=1}^{J} \sum_{k=1}^{q_j} \delta_{h,j,k} Z_{j,t-k} + \nu_{t+h}, \qquad h = 0, 1, \dots H-1. \tag{14}$$

In this analysis, b_{t+h} represents the variable of interest, specifically the government debt-to-GDP ratio. The term e_t^{PB} denotes the structural discretionary primary balance shock at time t, which was previously derived. The coefficient β_h is the key parameter of interest, representing the IR of b at horizon h to the primary balance shock e_t^{PB}. The sequence

$\{\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_H\}$ constitutes the estimated IR function. The terms b_{t-k} are p lags of the dependent variable, included to capture its own dynamics, while the terms $Z_{j,t-k}$ represent q_j lags of J control variables, consisting of lagged values of the logs of real government expenditure (E_t), real government revenue (R_t), real Gross Domestic Product (Y_t), and the GDP deflator as a price level indicator (P_t), and the nominal bond yield (i_t). The term ν_{t+h} is the horizon-specific error. For all estimations, following Jordà (2005), error bands will be calculated based on the standard errors proposed by Newey & West (1987), which are consistent in the presence of heteroskedasticity and autocorrelation.

The IR of the debt-to-GDP ratio to a one unit discretionary innovation in the primary balance, derived from the LP method, is illustrated in Figure (3). The results indicate that a shock to the primary balance leads to a decrease in the stock of real government debt, with the most pronounced effect observed in the second quarter following the shock. After that, the series converges back. The magnitude of the shock can be understood as an elasticity, since both the left-hand side and the right-hand side consist of logged terms. The structural shocks are also derived from logarithmic terms. Thus, a one percent discrete shock to the primary balance will result in a 0.75 percent decrease in real debt, peaking two periods after the shock.

The number of lags p and q_j for the control variables was determined using AIC, ensuring an optimal balance between the fit of the model and complexity. This contradicts the observation of an FD regime as Figure 3 clearly shows a steep decrease in real government debt as a response to a sudden shock in the primary balance. This aligns with the prevalence of a MD regime, as the fiscal authority will use the additional revenue to repay parts of its debt.



Note: Shaded areas indicate the 95% error bands using robust Newey-West (NW) standard errors. Created by the author using the lpirfs package for R by Adämmer (2019).

FIGURE 3: IMPULSE RESPONSE PRIMARY BALANCE SHOCK TO DEBT

6 CONCLUSION

Following the events of the two World Wars, Germany faced several significant shocks to its public finances, including reunification, the oil crises, and the Great Financial Crisis. Historically, the German public has been concerned about the sustainability of government finances. This work examines the question of fiscal sustainability in postwar Germany through stationarity and cointegration tests, as well as a IR analysis.

The evidence from the conducted tests is inconclusive and, to some extent, contradictory. The stationarity analysis yields ambiguous results for the government expenditure series, as the MZ_α^{GLS} and MZ_t^{GLS} tests fail to reject the null hypothesis of a unit root after first differencing. However, relying on the results of the ADF test, the analysis proceeds on the basis that all fiscal series are integrated of order one, $I(1)$. Following the propositions of Bohn (2007), this finding implies that the debt satisfies TC and that debt, revenue, and spending jointly satisfy IBC.

Despite this, the subsequent cointegration analysis cannot provide evidence for the hypothesis of fiscal sustainability, and it fails to identify a single dominant fiscal regime prevalent throughout the sample period. The results of the SECM are inconclusive due to a statistically insignificant long-run coefficient, and the Granger-causality tests find an interactive, bi-directional relationship between the debt-to-GDP ratio and the primary balance.

In contrast to these findings, the impulse response analysis suggests a clearer outcome.

The results show that the debt stock reacts negatively to a positive shock in the primary balance, which is consistent with the fiscal authorities having conducted policy according to a MD regime.

In conclusion, the lack of evidence for fiscal sustainability suggests a potential need for fiscal consolidation within the German fiscal budget. While the debt brake introduced in 2009 is intended to achieve this goal, recent exceptions in response to the pandemic and geopolitical events have led to new major deficits, which may counteract the intended effects of such a fiscal rule.

These results align with Burret et al. (2013), who found no evidence supporting the hypothesis of fiscal sustainability in post-World War II Germany. A similar conclusion is drawn by Semmler & Zhang (2004), who identify that Germany has been operating under an FD regime. Furthermore, using a Markov-switching approach, they find that the fiscal regime in Germany has experienced switches between 1967 and 1998. In contrast, Afonso (2005) reports that Germany is less likely to exhibit sustainability issues for the period between 1970 and 2003. Furthermore, Afonso & Jalles (2017) provide evidence that fiscal policy was sustainable in Germany during the 1999-2013 period. They characterize the fiscal regime as a MD regime, which aligns with the IR result that covers the period 2002 to 2024.

The limitations of this work include the scarcity of high-quality quarterly longitudinal data for public finances, resulting from changing conventions for data recording and significant historical events, including the World Wars and the division of Germany after World War II. Quarterly data would capture changes in fiscal policymaking more rapidly and provide a larger dataset, enhancing the accuracy of estimations. Furthermore, this would allow for the same dataset to be used to form impulse responses using the Blanchard framework for deriving orthogonal policy shocks.

Another limitation is the estimation over the entire sample period. Although the unit root test accounts for structural breaks, the results reflect an average of the regime and sustainability over the sample period. This limitation could be addressed by employing a Markov-switching approach, which can account for regime switches throughout the sample period using a probability transition matrix. A shortcoming of the constant-state estimators used in this work is that the effects of the debt brake have not yet appeared in the results. Furthermore, there are not enough data points to estimate a sample succeeding 2010, preventing any conclusions about the effectiveness of the debt brake and the implications of recent increases and announcements of new deficits.

As the German government prepares to take on larger deficits to finance investments, future research should focus on whether this will contribute to the fiscally unsustainable practices of the German fiscal authority and how this might affect the broader context of the currency union.

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A APPENDICES

A.1 *Appendix A (Graphs, Figures, and Tables)*

TABLE V: SOURCE BREAKDOWN OF FINAL SPLICED SERIES

Variable	Period
Interest Expenditure	1950-1959 (UNSY/Mitchell*58/59 Calc) 1960-1969 (UNSY/OECD) 1970-1990 (Bundesbank) 1991-2010 (AMECO) 2011-2016 (WEO)
Revenue	1950-1969 (NS) 1970-1990 (Bundesbank) 1991-2010 (AMECO) 2011-2016 (WEO)
Expenditure	1880-1913 (FZ) 1925-1934 (LON/Mitchell) 1950-1969 (NS) 1970-1990 (Bundesbank) 1991-2010 (AMECO) 2011-2016 (WEO)
Gross Public Debt	1950-1975 (NS/WEO) *1976 Calc* 1977-2016 (WEO)

(AMECO) Data from the AMECO Database, (Bundesbank) Data comes from the German Central Bank, (Calc) indicates that the data was interpolated to fill persistent gaps, (FZ) Flandreau M. and F. Zumer (2004), (LON) League of Nations Archives, (Mitchell) B. R. Mitchell (2003), (NS) German National Statistics, (OECD) OECD Country Tables, (USNY) United Nations Statistical Yearbook, (WEO) World Economic Outlook, (UNSY/Mitchell) indicates that fiscal data was obtained from the United Nations Statistical Yearbook, while nominal GDP data was obtained from Mitchell. Table derived from Mauro et al. (2013).

A.2 Appendix B (Formulas and Mathematical Derivations)

A.2.1 Carrion-i-Silvestre M-Class Tests

$$MZ_{\alpha}^{GLS}(\lambda^0) = \left(T^{-1}\tilde{y}_T^2 - s(\lambda^0)^2\right)\left(2T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2\right)^{-1} \tag{A.1}$$

$$MZ_{t}^{GLS}(\lambda^0) = \left(T^{-1}\tilde{y}_T^2 - s(\lambda^0)^2\right)\left(4s(\lambda^0)^2T^{-2}\sum_{t=1}^{T}\tilde{y}_{t-1}^2\right)^{-1/2} \tag{A.2}$$

A.2.2 Derivation of Structural Shocks

In a first step, a reduced form VAR will be set up following Burriel et al. (2010). The vector of endogenous variables, X_t, includes government expenditure (E_t), government revenue (R_t), real Gross Domestic Product (Y_t), the GDP deflator (2020Q1=100) (P_t), and the nominal bond yield (i_t), all except i_t enter as logs. Thus, the VAR can be expressed as:

$$X_t = D(L)X_{t-1} + U_t \tag{A.3}$$

$D(L)$ represents a matrix polynomial in the lag operator L (i.e. $D(L) = D_1L + D_2L^2 + \cdots + D_pL^P$, with P denoting the lag order of the VAR), and U_t is the vector of reduced-form residuals, $U_t \equiv (u_t^E, u_t^R, u_t^Y, u_t^P, u_t^i)$. These residuals are generally contemporaneously correlated as noted by Burriel et al. (2010). The order of the lag length was chosen using the AIC.

As Burriel et al. (2010) point out, the reduced form residuals of have little economic meaning and the reduced form residuals for government expenditure and government revenue can be represented as linear combinations of:

- Automatic responses of fiscal variables to contemporaneous unexpected innovations in non-fiscal variables (e.g., Y_t, P_t, i_t).
- Random discretionary fiscal policy shocks, which are the structural shocks e_t^E and e_t^R.

Following Blanchard & Perotti (2002), it is assumed that discretionary fiscal policy actions do not respond to contemporaneous macroeconomic innovations within the same quarter due to decision and implementation lags. Consequently, any contemporaneous correlation observed between fiscal variables and macroeconomic innovations is attributed to automatic stabilizers and the discretionary fiscal response to changes in macroeconomic variables to zero.

Thus, the relationship between the fiscal reduced-form residuals and the structural shocks can be represented as:

$$u_t^E = \alpha_{E,Y} u_t^Y + \alpha_{E,P} u_t^P + \alpha_{E,i} u_t^i + \beta_{E,R} e_t^R + e_t^E \tag{A.4}$$

$$u_t^R = \alpha_{R,Y} u_t^Y + \alpha_{R,P} u_t^P + \alpha_{R,i} u_t^i + \beta_{R,E} e_t^E + e_t^R \tag{A.5}$$

where, $u_t^E, u_t^R, u_t^Y, u_t^P, u_t^i$ are the estimated reduced-form residuals of the VAR. The terms e_t^E and e_t^R represent structural shocks to government expenditure and government revenue, respectively. The coefficients $\alpha_{j,k}$ capture the automatic contemporaneous response of fiscal variable j where $j \in \{E, R\}$ to an innovation in macroeconomic variable k (where $k \in \{Y, P, i\}$). These are elasticities that are calibrated using external institutional information. The coefficients $\beta_{E,R}$ and $\beta_{R,E}$ denote the contemporaneous response of one fiscal instrument to a structural shock in the other.

Identification of e_t^E and e_t^R requires some assumptions regarding the coefficients α and β:

Elasticities (α coefficients):

- For government expenditure (E_t):

- $\alpha_{E,Y}$ (output elasticity of government expenditure): Set to zero, as government consumption and investment are not expected to react automatically to GDP within a quarter (Burriel et al. 2010).
- $\alpha_{E,P}$ (price elasticity of government expenditure): Calibrated to -0.5 by Burriel et al. (2010), following Perotti (2004), to reflect partial adjustment of nominal spending to price changes.
- $\alpha_{E,i}$ (interest rate elasticity of government expenditure): Set to zero, as interest payments are typically excluded from the definition of E_t in this context (Burriel et al. 2010).

- For government revenue (R_t):

- $\alpha_{R,Y}$ (output elasticity of government revenue) and $\alpha_{R,P}$ (price elasticity of government revenue): These are crucial and are computed based on the responsiveness of various tax and transfer components to changes in their respective bases, and the sensitivity of these bases to GDP and price level fluctuations. The values that will be used here are obtained from Wolff et al. (2006) who report values of 0.72 and 0.98, respectively, for Germany.
- $\alpha_{R,i}$ (interest rate elasticity of government revenue): Set to zero by Burriel et al. (2010), even though they acknowledge that the assumption is contested.

Ordering of Fiscal Shocks (β coefficients): To disentangle e_t^E from e_t^R, an ordering assumption is imposed. Following Perotti (2004), Burriel et al. (2010) assume that government expenditure decisions are made prior to tax decisions within a quarter. This implies that government expenditure does not react to a structural shock in government revenue, thus $\beta_{E,R} = 0$.

Now that output and price elasticities have been calibrated, the reduced-form fiscal residuals can be cleared of their automatic response to macroeconomic innovations. The cyclically adjusted residuals ($u_t^{E,CA}$ and $u_t^{R,CA}$) are computed as:

$$u_t^{E,CA} = u_t^E - (\alpha_{E,Y} u_t^Y + \alpha_{E,P} u_t^P + \alpha_{E,i} u_t^i) = \beta_{E,R} e_t^R + e_t^E \tag{A.6}$$

$$u_t^{R,CA} = u_t^R - (\alpha_{R,Y} u_t^Y + \alpha_{R,P} u_t^P + \alpha_{R,i} u_t^i) = \beta_{R,E} e_t^E + e_t^R \tag{A.7}$$

Given the ordering restriction that $\beta_{E,R} = 0$ it is possible to express e_t^E as a function of known coefficients and residuals of the reduced form VAR of Equation (A.6). Thus, e_t^E is known and it can be plugged into Equation (A.7) to estimate $\beta_{R,E}$ using OLS and thus obtaining e_t^R the residual of this regression.

A.3 Appendix C (Online Appendix for Code and Data)

This work is accompanied by an online Appendix, which contains all the necessary data and code to reproduce the empirical analysis and results presented. The repository is publicly hosted on GitHub.

`https://github.com/Joshuajab/iseg-mfw-joshua-jablonowski`

Repository Contents The repository includes the following:

- `/mfw_data/`: The raw and processed data files used in the annual and quarterly analyzes.

- `/mfw_code/`: All R and GAUSS scripts required to run the analysis, from data preparation to model estimation and figure generation.
- `/README.md`: A detailed guide providing step-by-step instructions on how to set up the environment and reproduce the entire analysis.

System and Software Requirements The analysis was performed using R (version 4.3.2) and GAUSS (version 25.0.1). To ensure full reproducibility in R, the scripts require the installation of several packages listed in the repository's `README.md` file.

A.4 Appendix D (Disclaimer Regarding the Use of Artificial Intelligence)

This master thesis was developed with strict adherence to the academic integrity policies and guidelines set forth by ISEG, Universidade de Lisboa. The work presented herein is the result of my own research, analysis, and writing, unless otherwise cited. In the interest of transparency, the following disclosures are provided regarding the use of artificial intelligence tools in the creation of this dissertation. The AI tools used during the development of this thesis are as follows:

- Improving Writing and Readability: AI was utilized as a writing assistant for proofreading, correcting grammar and syntax.
- Code Development and Debugging: AI tools assisted in generating code snippets in R for data analysis and visualization, as well as in troubleshooting and debugging errors within the econometric scripts.
- LaTeX Formatting and Typesetting: AI assistance was sought to resolve specific LaTeX formatting challenges.
- Structuring Supplementary Material: For the creation of the online appendix, AI was consulted for best practices in file organization and for generating the necessary structure to present supplementary data and results.

I have ensured that the use of AI tools did not compromise the originality and integrity of my work. All sources of information, whether traditional or AI-assisted, have been appropriately cited in accordance with academic standards. The ethical use of AI in research and writing has been a guiding principle throughout the preparation of this thesis.