RADBOUD UNIVERSITY NIJMEGEN

Public debt sustainability: an inquiry into 13 OECD countries in light of the COVID-19 pandemic and the current shift in theoretical paradigm

Master's Thesis

Jesse Diks, s4805593

15-8-2021

Supervisor: Stefan Erik Oppers

Abstract

Public debt levels are reaching dimensions that were unthinkable decades ago. Recent developments have given rise to a new paradigm regarding sustainable debt levels. This new outlook finds substantial support in this inquiry. The popular fiscal reaction test by Bohn (1998) is used to determine whether countries show a sufficient direct fiscal response to the growing gross debt levels. The panel data estimation indicates that there is significant proof that countries jointly adhere to a mean reversion process, suggesting sustainable fiscal policy. Time series analysis shows that Denmark, France, Germany, Japan, Norway Portugal, Spain, the UK, and the USA exhibit a sustainable policy. Greece and Italy have unsustainable policies, while Belgium and Finland show inconclusive results. The impact of the COVID-19 pandemic is also investigated by analysing forecasts of the IMF (2021) for 2021-2026. Surprisingly, most countries tend to have stronger mean reversion when the predictions of the IMF are included, giving this research an interesting twist.

Table of contents

1. Introduction

As a consequence of the credit crisis in 2008, government debt levels have reached new dimensions and debt sustainability has consequently become one of the hottest topics of the current political debate. Besides, the more recent COVID-19 crisis has additionally emphasised the importance that government debt sustainability should be one of the main agenda points. For instance, Dalia Hakura (2020), deputy division chief at the IMF, stressed that with the current uncertain outlook for growth, strengthening debt management and debt data should be top priorities. These top priorities revolve around seeing debt in such a way that these elevated debt levels can be maintained short- and long-term. Therefore, the political debate should be based on thorough analysis of deriving and eventually implementing accurate policy measures. Contradictory, one of the biggest reasons for debt accumulation in developed countries seems to be short-sightedness of politicians (Forte et. al., 2018). In order to achieve popularity among the citizens, eventually leading to their re-election, most politicians apply this myopic view, in which debt is used as a tool to finance their excessive spending. This doesn't necessarily lead to structural problems. There's enough evidence to prove that debt can be used as fiscal boost to increase public investment during times of recessions (e.g. Petrovic, et. al. 2021). Public spending can be used as an instrument to soften times of contraction. Especially now, as the extensive quantitative easing policies have led to the partial inability of central banks to increase investments by lowering interest rates even further. On the other side, Keynes (1923) warned that deficits as a result of crises should be counteracted in times of an economic upturn. When debt levels are sustainable, default can be avoided and countries don't have to cope with the negative externalities of high debt (Lukkezen & Rojas-Romagosa, 2013). Currently, we see that excessive spending has led to an increase in debt levels over the last decades (Rosen & Gayer, 2014). For example, in 2020, the government debt of the United States of America quoted at 131.2% of GDP (IMF, 2020), and the Congressional Budget Office (2021) expects this number to rise to 202% in 2051. Times have arrived in which these levels are becoming more normal than extraordinary, meaning that there is a severe shift in the paradigm occurring.

The sovereign debt crisis drew global attention to public debt policy, reaching a far bigger audience than just the academic and political scene. Serious societal concern started to emerge, which was raised to an even higher level due to the COVID-19 pandemic outbreak at the end of 2019. This concern seemed to be ignored by politicians, as mainly primary balance deficits have been the trend last decades (Rosen & Gayer, 2014). However, the combination of high debt levels of developed countries and seemingly stable governments gave new reason for thought concerning the actual sustainability of these towering debt levels. While the danger zones from Rogoff and Reinhart in 2010 (90%) and the Maastricht treaty in 1992 (60%) seemed to warn governments for extensive accumulation of debt, the number of advanced countries in 2020 with debt above 90% of GDP was 12

out of 38 (IMF, 2020)[1]. This situational change forces scientists to revise their view on what sustainable debt levels actually are. Therefore, in the theoretical section, a more recent view will be developed by first analysing conventional literature on debt levels, as well as the evolution of vital influential factors and their impact. Afterwards, the current shift in the paradigm will be addressed.

The sustainability of public debt is not captured with a concrete measure. As governments are assumed to have an infinite time horizon, with the future being unknown, it's extremely hard to develop a single measure that will reflect the true underlying sustainability of a given government. Therefore, numerous of different tests were developed to come close to an appropriate approximation of fiscal durability. However, to take a step back, the main question revolves around what sustainability is about. The answer to this question will be addressed in the theoretical framework section, but a tip of the iceberg reveals that sustainability is about fiscal solvency. Derivation of the intertemporal budget constraint is a commonly used practice in public debt analysis. The intertemporal budget constraint describes that the current discounted value of all future primary balance surpluses should equal the current outstanding debt (Arestis & Sawyer, 2009). In the empirical part of this paper a conventional, but frequently used methodology from Bohn (1998) will be used to analyse recent debt sustainability. This paper predicates upon the intertemporal budget constraint, and explains that sustainability can be measured based on the fiscal reaction as a response to an increasing public debt. Meaning, does the government correctly take actions as a response to rising government debt, in the form of increasing the primary balance? A more detailed explanation of the fundamental concept behind sustainable debt analysis will be given in the theoretical overview section. In order to measure the impact of the COVID-19 crisis, forecasted deficit and debt levels will be used to analyse the impact of the pandemic on the sustainability of these government debts. In short, this paper adds to the theoretical and empirical evidence on recent developments concerning debt levels, while taking an extra outlook at the expected impact of the COVID-19 crisis. Therefore, the main research question is the following: *What can we say about public debt sustainability in 13 selected OECD countries[2] in view of the unprecedented rise in debt levels, partly as a result of the COVID-19 crisis, and the possibly shifting theoretical paradigm on sustainable debt levels?*

This paper continues with a general understanding of public debt, in which the definition and main characteristics are given. After this, the theoretical consideration will be presented. Then, the research design will follow. After this, the results for each country will be discussed. The results section also contains a panel data estimation and evaluation. This paper will end with a conclusion and discussion.

[1] Belgium, Canada, Cyprus, France, Greece, Italy, Japan, Portugal, Singapore, Spain, UK and USA.
[2] The countries for analysis are Belgium, Denmark, Finland, France, Germany, Greece, Italy, Japan, Norway, Portugal, Spain, the United Kingdom, and the United States of America.

2. Definition and characteristics of public debt

Public debt, or also referred to as 'government debt', 'national debt', or 'sovereign' debt, represents the total amount of outstanding debt of a country's central government. Government debt is a stock variable and measured at a specific point in time. An important distinction is usually made between gross public debt and net public debt. Gross public debt can be described as the total financial liabilities of a given government, where net public debt is defined as all the gross financial liabilities minus financial assets of the government (Chouraqui et. al., 1986). In this research, gross government debt will be used, as there are a few notable advantages of using gross debt in statistical analysis over net debt. The first advantage is simply the fact that data on gross government debt is more readily available and thus more widely published (Choraqui et. al., 1986). Also, Eurostat (2018) notes: "the relevant measure for the purposes of formal fiscal monitoring in the EU is general government gross debt at nominal value and measures of net government debt should be considered as supplementary information" (p. 5). As fiscal monitoring has common ground with scientific research, it's rational to use gross public debt. The last and justifiably the most important argument is the fact that net government debt is subject to certain limitations, in particular when using it as a measure to assess the future creditworthiness of a government (Eurostat, 2018). As the near exact purpose of this research is assessing the future creditworthiness of governments, it's more than logical to use gross government debt as measure. An important shortcoming of using gross debt is the fact that it does not account for financial assets. Eurostat (2018) notes that the increase in government debt for the European countries during the financial crisis has been accompanied by a sizable increase of financial assets in some countries. This disadvantage can be considered as a shortcoming when using gross debt, but the advantages simply outweigh this when considering sustainability of public debt.

Deliberate decisions of the government to borrow significant amounts to cover fiscal deficits are usually the cause for the accumulation of debt (Filip, 2019). Fiscal deficits are simply the result of government spending exceeding government revenue over a certain amount of time. As a result of taking on debt, all preceding budget deficits amount up to the total current public debt (Rosen & Gayer, 2014). Besides the issuance of debt, the government also has another option at disposal: issuing currency, which proves to be more complex in practice than it seems in theory. Issuing currency is categorised under monetary policy, which is often separated from fiscal policy in most advanced countries. When a government wants to issue new currency, it often has to do this through the central bank. However, most central banks are independent and therefore don't act solely on the government's behalf. Issuing new currency is possible when laws are shaped to assist this, but this option is often not easily carried out in practice.

Usually, public debt is issued in the form of government bonds with different maturities and coupon payments, but it can also be issued through other securities. As the amount of public debt usually

doesn't say much about relative value, often the government debt-to-GDP ratio is used for the purpose of comparability (OECD, 2021a). Therefore, when debt is quoted in this paper, know that debt as percentage of GDP is what is spoken about. Government debt can be held by anyone, but an important distinction between external and internal debt is made. External debt is the total amount of debt owed to foreign creditors, whereas internal debt is the total debt owed to domestic creditors (Rosen & Gayer, 2014). Last decades, due to increased international relationships as a result of globalisation, there has been more emphasis on the increasing role of external borrowing. One important problem arises due to this increased role of external debt. Internal debt is often, but not exclusively, issued in domestic currency (UNCTAD, 2008). When debt is issued in domestic currency, by definition, it can always be paid back, as governments consistently have the option to increase the monetary base by means of money creation through central banks. This means that when governments only issue currency in their domestic currency, bankruptcy is highly unlikely. However, when it reaches such an extreme situation, there will be a lot of other negative consequences as a result of having to resort to extensively printing money to avoid default. Nonetheless, when external debt is issued in foreign currency, it has to be paid back with this foreign currency. When countries arrive at the point when debt obligations issued in foreign currency can't be fulfilled, currency issuance is not available, which results in the fact that government default is possible.

Lastly, it's also important to note that central banks are often big holders of government debt. Central banks are required to hold government debt as a result of their goal to spur economic growth, achieve price stability and high employment. Quantitative easing is when central banks influence the money supply by buying government bonds in order to set interest rates in such a way to optimally achieve their goals. The extensive quantitative easing policies have led to central banks having significant portions of government debts. Other big debtholders are pension funds, which often invest a decent proportion of the money they manage in government bonds. These pension fund holdings are part of intragovernmental holdings, which are holdings held by other parts of the government. As an example, these intragovernmental holdings account for 23% of the national debt in the United States (US Department of the Treasury, 2021). So, intragovernmental holdings (mainly pension funds) and central bank holdings also account for a big proportion of national debt, which means that central banks and pension funds also play an important role in the current economic state of most countries.

Public debt in itself is a concept that has much controversy around it. It's not exclusively good or bad, as its value is mostly drawn from its purpose. People supporting governments taking on debt see public debt as a tool, used for example to shift burden or benefit among generations, to publicly invest with, or to spur economic growth. Critics of the accumulation of public debt often use the 'generational theft' argument. This argument comes down to the fact that the current generation is taking away future consumption, meaning future generations will suffer from this. Despite the fact that

there are many arguments to give for both sides, discussion about public debt will remain to dominate economic policy. Therefore, it's vital to conduct scientific research that investigates the impact of taking on public debt.

Theoretical framework

3. Sustainability of public debt

The debt of the government is seen as sustainable when the government is able to fulfill its future financial obligations without extensive financial assistance (Hakura, 2020). When a country cannot meet this obligation, it risks going into default. Sustainability of public debt is an extremely sensitive term. Where one country with 200 % debt-to-GDP can continue its everyday fiscal policy without any worries, other countries might get in danger of defaulting with debt as low as 30% of GDP (Debrun et. al., 2019b). A known saying regarding public debts on such a high level is: 'If a government with such a higher level of debt would be a company, it would have defaulted years ago.' For governments with debt levels above reasonable height, this statement is undoubtedly true. However, it's important to note that governments are different from companies in such a way that they can achieve a debt level as high as 263.9% of GDP (Statista, 2021). Japan has reached this debt in 2021 and seems to be the telling example of extreme government debt while still seeming to continue everyday fiscal policy in a normal fashion. Debt levels are reaching 2.6 times the size of their economy, while 10-year bond yields are currently still around 1% (Bloomberg, 2021). Despite the fact that the Bank of Japan has carried out a quantitative easing policy over the last decades (Bank of Japan, 2021), these low bond yields prove that trust of investors is at relatively high levels. Japan is one of the extreme examples, but government debts for the advanced economies have also increased last decades. To put more visualisation to the rising government debts last decades, figure 1 shows the gross debt levels as % of GDP of the advanced countries from 1992 to 2020, with the data retrieved from the IMF (2020) database. Besides the rising gross debt over these years, something else stands out, namely that there is a steep rise in debt during times of the crises around 2008-2010 and 2019-2020, while reductions of debt seem much rarer and less steep during better times.

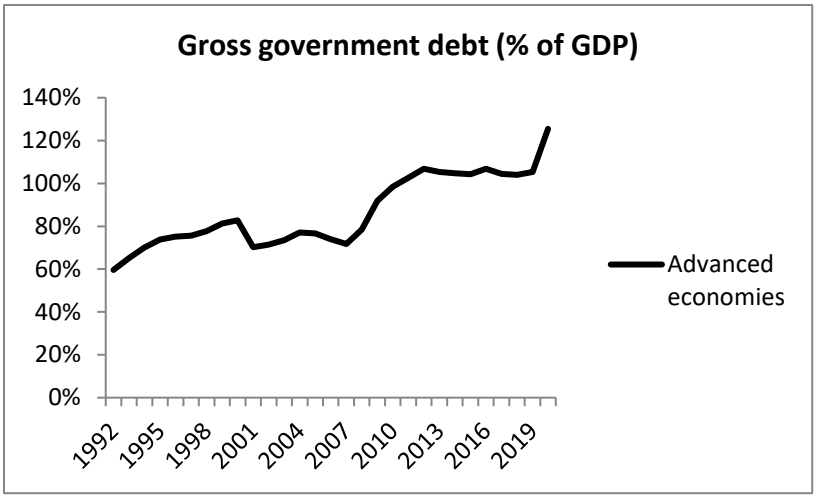


Figure 1: Gross government debt (% of GDP) for the advanced economies from 1992-2020.[3]

The question remains when a government will go bankrupt. Standard economic principles teach us that an entity will go into default due to a liquidity or solvency problem, resulting in respectively being unable to fulfill short- or long-term obligations (Dietz, 2021). Macroeconomic fundamentals and arguably also common sense indicate that a government should always be committed to repay its financial obligations (Debrun, et. al., 2019a). However, rationally one could also argue that this tipping point of default is exactly when the benefits of going into default exceed the contradictory benefits. Obviously, there is much calculation and uncertainty that goes into this equations, and therefore this decision can only be optimised ex-post. However, the existence of this cost-benefit principle might result in distrust and doubt concerning the commitment of governments to pursue their full obligation. Even though previous evidence concerning the cost part of this analysis might have indicated that defaults only have minor effects on future borrowing costs and access to credit, Cruces and Trebesch (2013) find that higher investor losses (haircuts) lead to longer periods of capital market exclusion and higher bond yield spreads. Despite the fact that this evidence should be concerning for investors, it might not necessarily indicate that governments will declare themselves bankrupt for the slightest insufficiency. Furthermore, almost all data in the research from Cruces and Trebesch (2013) is from non-advanced economies, meaning that interpreting these results as a general rule for all countries is dangerous. The only advanced country that defaulted on debt was Greece in 2015 when it wasn't able to repay 1.6 billion USD to the IMF (Harrison & Liakos, 2015). Due to the lack of actual defaults, there isn't much knowledge on this matter regarding advanced economies. Hence, it's very hard to assess what the costs and consequences would be when an advanced country does go into

[3] The advanced economies are Australia, Austria, Belgium, Canada, Cyprus, Czech-Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong SAR, Iceland, Ireland, Israel, Italy, Japan, Republic of Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States (IMF, 2020).

default. Consequences for advanced economies could be fundamentally different than the results from Cruces and Trebesch (2013) impose.

In this paragraph, the main conceptual foundation behind sustainable debt analysis is discussed to get a better understanding of what sustainability is dependent on, which is mainly based on a published document, being a chapter of an educational book with the title: "Sovereign debt: A Guide for Economists and Practitioners" by Debrun, Ostry, Willems & Wyplosz, (2018) of the IMF. Governments are special borrowers for a few reasons. In short, the reasons are that we do not have an indication about when governments will disappear, which means there is no clear end-period when all debts should be repaid. Next, default of governments is a scary thought, which brings huge destruction of wealth, reduced national income, and negative consequences for those who are not insured against this default risk. Lastly, a government is sovereign, resulting in three things: that there is no well-defined bankruptcy procedure in which lenders have any rights to claim their money, that it can issue currency to pay for debt issued in domestic debt, and that it can increase taxes to gain more revenue, up till a certain point. Also note that governments, just as all entities, are exposed to scarcity, meaning that governments are subject to an intertemporal budget constraint. However, since governments are these special kinds of borrowers, their budget constraint isn't clear cut. The budget constraint applies over an infinite time horizon and reflects the spending choices that a government has to undergo over time, so that the current outstanding debt is equal to the discounted present value of all future primary surpluses.

This equation has a lot to do with solvency, as this is the ability of the government to meet its long-term financial obligations. Solvency can be assessed by predicting the future primary (im)balances over an infinite time period, which is obviously exposed to extreme uncertainty. Therefore, accurately assessing solvency in practice based on the fundamental values could be seen as extremely hard and close to impossible. However, as insight into solvency of governments is of crucial importance to politicians, economists, scientists, and any other interest groups, so it's logical to attempt to assess whether the intertemporal budget constraint holds or not. Therefore, scientists came up with a lot of different approaches to assess what sustainable debt levels are, of which most have in common that they investigate whether fiscal behaviour concerning primary balances guarantees solvency.

When assessing sustainability based on future expectations, two problems arise. The first problem is that statistical testing of future sustainability based on historical consistency to solvency can result in conclusions that require the assumption that the future will look like the past. Just looking at the past could be a pitfall, as consulting historical data might be a poor way to predict future solvency. The other problem is that ignoring the past completely can lead to the fact that a fiscal policy is labelled sustainable when commitment towards sufficient primary surpluses at some point in the future is

made, regardless of current debt levels. When assessing sustainability of debt, one has to deal with these problems, as predicting future primary balances has to be done in order to know whether governments are expected to be sustainable or not. As a result of this framework, definitions on sustainability of public debt often focus on fiscal behaviour, as the government ultimately controls the primary balance, while volatility in public debt is exposed to a range of shocks that aren't a result of policy choices (Debrun et. al., 2018).

4. Historical views on public debt

In this section, a rough overview of public debt theories will be provided to get a better insight into the history of economic thought regarding debt policy. It's important to note that only the main theories will be discussed which are relevant for this inquiry. Theories will be included when they are/were broadly supported and provide any normative idea about public debt policy.

4.1 Classical debt theory

No historical economics textbook goes without mentioning Adam Smith, David Ricardo, John-Stuart Mill, and Jean-Baptiste Say. These people were important thinkers within the classical school, that dominated economic thought around the 18th and 19th centuries. The classical view is characterised by the preference for 'laissez-faire', in which the government should only fulfil the role of regulating financial markets to smoothen economic activities. Private instances should be left alone to freely engage in business without government intervention. The classical economists therefore disliked state indebtedness, as it draws capital away from the purposeful uses of the private sector towards the unproductive public sector. The public sector would use the money for funds as healthcare, national defence, public order, etc., which all don't attribute to economic growth (Grant & Brue, 2012). Adam Smith (1723-1790), the portrayed founder of economic thought, said that indebtedness of the state will delay the road towards wealth and prosperity. Extracting capital from the productive capital sector towards the unproductive public sector was seen as even more harmful than collecting taxes, since public debt leads to reduction of production capacities (Grant & Brue, 2012). David Ricardo (1772-1823) goes even further with his Ricardian equivalence theory, saying that government indebtedness won't even stimulate the economy, as households will counteract this economic progress by increasing savings to anticipate future tax rises. Some economists, such as John Stuart Mill (1806-1873), added that government debt can also result in positive outcomes, such as when the debt does not increase interest rates, and when it does not result in competition over capital with national private markets. In brief, the main idea within the classical school was that public debt is not preferred, mainly for the reason that the government is not supposed to compete with private markets for capital.

4.2 Keynesian view

One of the first to address the soundness of accumulating public debt after the classical school was John Maynard Keynes (1883-1946). Keynes was a supporter of avoiding structural budget deficits and advocated for running deficits in recessions and offsetting these deficits with surpluses in times of economic expansion. The Keynesian way of thought was mainly fuelled by the cyclical up- and downturns at the start of the 20th century. Keynes believed that running structural deficits would lead to a lasting problem, in which the government will create the expectation that it will never be able to repay its debt (Keynes, 1923). These expectations would become vulnerable to the self-fulfilling prophecy, as deficits would lead to distrust and subsequently to default. Keynes loosened the strict classical thought, seeing public indebtedness as a tool to smoothen out times of expansion and contraction. In this structure, the government should supplement actions of the market and correct the imperfections of the private sector. Balanced growth of the economy through time is the end goal, without consistent accumulation of national debt (Bilan, 2016).

4.3 Neoliberal debt theory

Neoliberalism finds its origin in the Chicago school of economics and started around the 1970s. It can be seen as a shift in paradigm as opposed to the Keynesian view. The period of stagflation in the 1970s was one of the big events that caused disaffection in society, leading to a renewed preference for deregulation and economic liberalisation. One of the main focuses of neoliberal debt theory is the crowding-out hypothesis, which has its roots in classical debt theory. The crowding-out hypothesis means that public sector spending will ‘crowd out’ private spending, eventually leading to inefficiencies. When governments cover budget deficits through debt, the demand for loanable funds increases, while supply remains the same. As a result, governments drive the interest rates up, resulting in less (efficient) capital allocation to private markets. This event nullifies or drastically decreases the positive effects on GDP growth intended by public indebtedness. As one might expect, this completely contradicts the (neo)Keynesian school, which states that public loaning does not necessarily have to crowd out private investments. The Keynesian school thinks that unused resources can still be drawn into the economic system in an economy working at full capacity, causing the supply of money to grow equally to the demand, keeping interest rates the same (Grant & Brue, 2012). Monetarism is another train of thought and has a lot in common with neoliberal debt theory. The main focus of monetarism is the role of central banks in the money supply. Milton Friedman (1912-2006) is mostly associated with monetarism, who thought that central bank policy should be aimed at maintaining price stability. Excessive quantitative easing policies will inherently lead to inflation, meaning central banks should not participate in excessively increasing the money supply (Bilan, 2016).

4.4 Conventional view

The conventional view combines insights from the Keynesian view and neoliberal debt theory. The conventional view is supported by a decent amount of economists and some policymakers in the last decades. The main idea behind the conventional view is the important distinction made between the long run and the short/medium run. Conventional economists say that long-term economic growth mostly depends on the supply of factors of production, therefore returning to the classical 'crowding out' theory. In the short to medium run, the Keynesian view is applied, stating that public borrowing can be a tool to spur economic growth and GDP in times of contraction (Elmendorf & Mankiw, 1998). For example, during the crisis of 2009, Paul Krugman (2009) noted that the Keynesian way is the best framework we have for making sense of recessions and depressions. A combination of the two main theories regarding public debt seems to be one of the more recent ways of thinking by economists. The conventional view is one of the recent opposing views to the paradigm which is presented in this research. Both classical debt theory and the Keynesian view advocate against heavy structural increases in debt, but according to figure 1, most policymakers think otherwise. The next section will describe the biggest factors that led to the opposed paradigm shift.

5. Situational change

The unprecedented accumulation of public debt has mainly happened throughout the last decades. When revising figure 1, we note that the debt of the advanced countries has more than doubled, from 59.6% in 1992 to 125.46% in 2020. Furthermore, the biggest spike happened after 2007, when the debt increased from 71.68% in 2007 to 125.46% in 2020, which sums up to an outstanding yearly increase of 3.84%. It's clear that our vision on public debt has changed as opposed to the historical theories described above, but the question remains why this steep increase suddenly occurred in the last decades. Therefore, the three biggest factors that played an important role in the development of the debt climb will be discussed.

5.1 Interest rate and QE policy

Consistent budget deficits only point towards an unsustainable government debt conditionally that interest rates are not under the growth rate. The rationale behind this is as follows. When interest rates are at a certain level, let's say 5%, it will always be financially unfavourable to loan for this rate when you can't achieve a rate of return above this 5%. Now, for governments, this rate of return can be reflected by the growth rate, as the return on the government's investments is essentially the growth rate. If we now look at this in the debt framework, we can say that when the government loans for 5%, while achieving a growth rate of anything above 5%, it can essentially make a financial 'profit' from borrowing. Hence, structural government deficits don't necessarily mean that a government's debt is unsustainable. These deficits can be a result of borrowing, but can also create future profits that exceed

the interest rate payments. This implies that government primary balance deficits are not an instant indication of unsustainable public debt policy. Bohn (1998) shows for example that the United States ran deficits from 1916-1995 while exploiting low interest rates.

This reasoning completely contradicts the classical thought in which the government is assumed to only make unproductive investments, essentially not contributing to GDP growth. In current times we know that government spending plays an essential role in boosting GDP. As an example, Chu, et. al. (2020) find that a shift in government spending from unproductive expenditures towards productive investments is associated with higher levels of growth in both middle- and low-income countries. Furthermore, responsive government spending to crises throughout the years has been the main trend in order to support growth rates. Other studies such as Kahn (2011), attempt to determine the optimal size of the government under the assumption that a bigger government isn't always better. Anyhow, the main catch is that government spending can attribute to economic growth, whether or not to a certain extend.

'Quantitative easing (QE) is a monetary policy whereby a central bank purchases government bonds or other financial assets in order to inject money into the economy to expand economic activity' (Bank of England, 2021). The main goal is to increase the money supply, in order to boost spending in the economy as a whole, while maintaining inflation at 2%. The first bank that started with quantitative easing was the central bank of Japan in 2001, followed by the FED (2008), the bank of England (2009), and the ECB in 2015 (Lennkh et. al., 2019). As a result of the extensive QE policies of the central banks over the last decades, interest rates have significantly dropped. The 10-year treasury bond interest rates from 1992 to 2019 for the Euro area, the USA, and Japan are presented in figure 2.

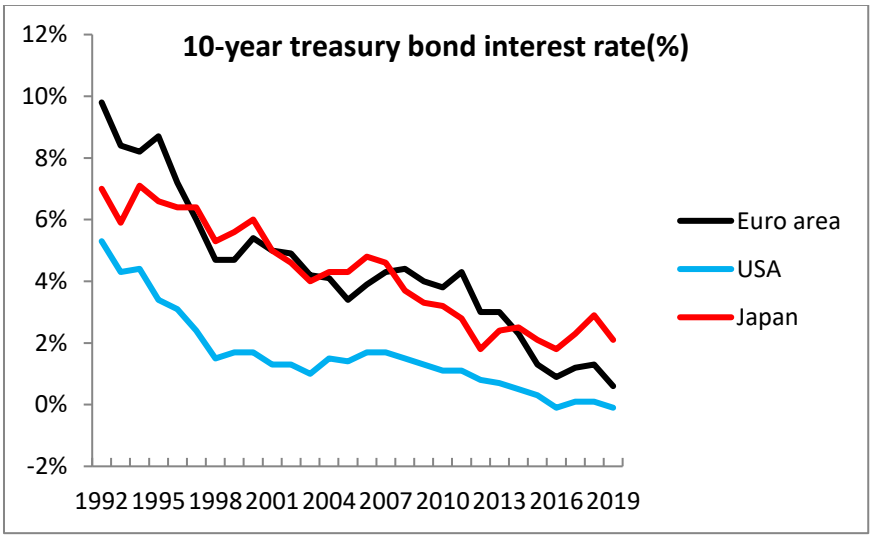


Figure 2: 10-year treasury bond interest rate for Euro Area, USA, and Japan (1992-2019), from OECD (2021b).

The biggest decrease happened in the Euro area, where the interest rate dropped from 9,8% in 1992, to 0.6% in 2019. This steep decrease was predominantly fuelled by asset purchasing programs, as the central banks have the ability to artificially control the interest rate through QE policy (Huston & Spencer, 2016). These low interest rates made capital extremely cheap, making borrowing very attractive for governments. Besides, the crowding-out hypothesis from the neoliberal economists is almost completely mitigated, as the money supply is so high that there is an abundance of money in the economy. The practise that governments compete for capital with private markets is currently almost gone. Central banks are artificially keeping the interest rate close to the 0% mark, using whichever tools necessary. Governments that did base their policy partly on the crowding-out hypothesis get incentivised to borrow even more, as the effect of the hypothesis is currently so small. When governments can successfully allocate the borrowed money in such a way that it results in eventual cash inflows through investments, there shouldn't be concern regarding long-term solvability. Nevertheless, whether the low interest rate is accurately exploited or not, the low cost of borrowing is still a significant cause for the high debt levels.

5.2 Credit crisis and COVID-19 pandemic

The occurrences of the credit crisis in 2008 and the COVID-19 crisis in 2020 are two other evident worldwide events that contributed to the high indebtedness of governments over the last decades. The sovereign debt crisis that took place in 2011 had less detrimental impact on the debt levels worldwide (except for Greece), and it was mainly a consequence of the credit crisis in 2008 (Briceno & Perote, 2020). As this section focuses on the biggest factors, only the credit crisis and the COVID-19 crisis will be discussed more extensively.

The credit crisis in 2008, introduced by the collapse of Lehman Brothers, was the first time that the debt ratio of most advanced countries took a big hit since 1992. The build-up of excessive risk-taking, the housing market bubble, and high worldwide interconnectedness among financial institutions eventually made it so the crisis spread from the United States to the rest of the world. Stacks of negative consequences came with it, such as financial uncertainty, high unemployment, and on top of all, extensive debt growth (Arner, 2009). As depicted in figure 1, debt levels drastically rose from 71,68% in 2007 to 91,85% in 2009, accounting for an increase of 20.17% over two years. The years after the credit crisis was the first time when most countries experienced ratios that were closing the gap to 100% of GDP.

Even though the world is still right within the COVID-19 crisis, the biggest economic hit has already been taken. After the first outbreak of the pandemic, it quickly became evident that governments were going to be the biggest payers (Briceno & Perote, 2020). Just from 2019 to 2020, gross government debt of the advanced countries has risen from 105.27% to 125.46%, which is a huge increase of 20.19%. This crisis is different from others in the sense that a proportion of economic activity is

essentially forced to stop. On top of this, the uncertainty caused the economy to shrink in general, just like in other crises. The pandemic is currently still happening, making it an interesting topic for analysis. The main goal of this research is to investigate the sustainability of sovereign debt over the last three decades. In addition, the COVID-19 period and its aftermath will be included, to investigate whether the pandemic will significantly influence the sustainability of debt of the chosen 13 countries. The exact way in which this will be done will be described in the methodology section.

6. Shift in paradigm

Despite certified theories and historically supported views on indebtedness, the question about what the perfect level of debt is, remains unanswered and widely debated. Since the Maastricht treaty in 1992, several papers have attempted to determine what the optimal level of sovereign debt should be. Previous thinking about debt levels gave indication to a certain paradigm in which debt levels were ought to be unsustainable and unfavourable when they reached a certain limit. Concrete examples are the 60% debt limit suggested by the Maastricht treaty and the 90% level pushed forward by Rogoff and Reinhart (2010). The 90% debt limit was shaped around the fact that Rogoff and Reinhart (2010) found that reaching above this 90% debt threshold generally leads to lower GDP growth for emerging and advanced countries. The 60% threshold of the Maastricht treaty was based upon an optimization formula that assumes 5% GDP growth and a 3% budget deficit. When there is a 3% deficit, a 5% nominal growth (3% real growth with 2% inflation), and a 60% debt in this year, there will be no change in the debt ratio next year, meaning that the debt ratio will remain stable over time. These assumptions about the 5% nominal growth, the 2% inflation, and the 3% budget deficit were found to be realistic for European countries when the treaty was signed. Both the 60% level and the 90% level resulted in concrete benchmarks. In addition, Cecchetti et. al. (2011) found that debt higher than 85% of GDP might show a significant negative impact on economic growth. These benchmarks are useful in the sense that they attempt to assess a critical point that debt levels shouldn't reach when countries don't want to deal with significant negative consequences. However, we now know that these benchmarks have been breached by numerous countries, generally, without severe consequences. It's key to note that there was plenty of criticism and debate as a response to the imposed debt limits. Most criticism on the Rogoff and Reinhart (2010) paper was due to the fact that the methodology and data turned out to be questionable.

It seems to be the recent trend that debt levels for most countries follow an upwards slope. A few examples of these extremely high debt levels from developed countries are Japan (266.2%), Greece (205.2%), Italy (161.8%), Portugal (137.2%), United States (131.2%), and Spain (123%) (IMF, 2021). More generally, the higher debt levels, represented most accurately in figure 1, show that governments are not acting according to this previously described paradigm, let alone by the earlier discussed theories about public indebtedness. The high-debt countries are breaking through the benchmarks of

what we expected to be sustainable and plausible limits. The actuality is completely contradicting the conventional thought about what preferred debt levels are. The previous paradigm is broken into, and a new paradigm is developing. Paul Krugman (2015) explained in his article in the New York Times that governments might not even be deep enough in debt. The argument he makes comes down to the earlier explained exploitation of historically low interest rates. 'One answer is that issuing debt is a way to pay for useful things, and we should do more of that when the price is right' (Paul Krugman, 2015). With the price of money being close to nothing, this is the time when the price is right, credibly even extremely right. The question remains whether countries can maintain sustainable debt levels while exploiting these historically low interest rates. The results section will prove that there is justification for this new paradigm of high debts and expansionary fiscal policy. Before this, the most extreme proposition within this new paradigm will be discussed, being modern monetary theory.

6.1 Modern Monetary Theory (MMT)

The biggest supporters of an open attitude towards staggering debt levels are possibly the followers of modern monetary theory (MMT). MMT assumes that a government that issues its own currency can issue as much currency as it wants. This implies that bankruptcy is impossible and all future obligations can be fulfilled. Governments can therefore borrow as much as they want, as long as inflation remains at a stable level (Brady, 2020). Modern monetary theory challenges the complete framework where all orthodox theories about a sustainable debt are built upon. Despite the classical, Keynesian, the neoliberal, and conventional view having different insights, all of them have in common that there should be a certain limit to debt. MMT states that debt levels will be irrelevant when governments are the sole issuers of currency, under the condition that they can keep inflation down. Never having to worry about funding seems like a dream scenario for policymakers. Japan is often used as an example by advocates of MMT. The country shows high solvent debt, low interest rates, and low inflation. However, research finds that Japan is not following policy recommendations proposed by MMT (Wray & Nersisyan, 2021). In fact, not a single country currently completely follows the ideas from MMT, mainly because there are fundamental flaws within the reasoning (Palley, 2015). In his paper, Palley (2015) sets several critiques out, eleven to be precise. A main critique to which MMT seems to have no answer, is that governments are expected to keep inflation down. A steady and low inflation rate inherently contradicts the proposed increase of the money supply by governments. Printing money in order to close budget deficit gaps will lead to an increase in inflation. Even though this critique should hold long term, practical evidence suggests that central banks have held inflation rates around 2%, while still drastically increasing the money supply since 2009 through their QE policy. Anyhow, the purpose of this section isn't necessarily to advocate MMT, nor to criticise it. The purpose is to emphasize that new ways of thinking are being developed as response to the rising debt levels.

6.2 Final notes on the shift of paradigm

We could say that a transition happened through time regarding debt theory. From pleading against public indebtedness within classical economics, to advocating that public debt levels are conditionally irrelevant from modern monetary theory. It seems that there was a consistent fear through time for debt accumulation. Countries are reaching debt levels which were never thought to be possible, leading to believe that those fears were misplaced. The question remains whether this modern way of untroubled thinking is realistic concerning future solvability, which makes a good introduction to the empirical part of the paper, but first, some evidence from previous research will be reviewed.

7. Overview of previous evidence

Public debt is a topic that is researched heavily within the economics profession, especially last decades. This section will contain interesting findings from other research, but it's crucial to emphasize that hundreds, maybe thousands, of inquiries have been performed on this topic. As mentioned before, public debt sustainability is an extremely sensitive term, as it's heavily dependent on the uncertain future. This implies that different tests and methods are used, resulting in a very broad theoretical base in which results often contradict. Some important findings for the relevant countries will be summarized below.

To start with the OECD countries, the first evidence comes from Corsetti and Roubini (1991), who looked at 18 OECD countries from 1960-1989, and find that there is much variation among EU countries. Major countries such as the US, Japan, Germany, the UK, Canada, and France did not have significant solvency problems, while smaller countries like Belgium, the Netherlands, Ireland, and Greece could be exposed to solvency issues, as their GDP ratios were high in that period. The results of Forte et. al. (2018) fit well to the previous time period, as they looked at panel data of 21 OECD countries from 1991-2015, and found that governments are not taking sufficient long-term actions to eventually counteract the accumulation of debt. These long-term actions are dependent on the fiscal reaction to the accumulation of debt. As stated before, solvency can be achieved when the value of the future discounted primary balances surpluses are such that they are all equal to the current debt. Therefore, in the long run, governments have to create these surpluses at some point, otherwise the intertemporal budget constraint does not hold, meaning debt policy will not be solvent, and thus public debt will not be sustainable. If governments want to be sustainable, they have to increase the primary balance surplus at some points to react to increasing debt. This is called the fiscal reaction, which is the reaction of governments represented by increases in the primary balance, to be able to offset the earlier accumulated debt (Bohn, 1998). Note that fiscal reaction to a rise in debt is often used as an indicator when determining sustainability of debt levels.

Another big study in 2011 was from Mendoza et. al. (2011), which inspected 24 advanced countries from 1970 to 2007 and created a new concept to measure sustainability. This measure is derived from Bohn's (1998) fiscal reaction function and looks at the difference between the current debt level and the estimated debt limit, called fiscal space. Fiscal space represents the flexibility of a government in its spending choices. Thus, the more fiscal space, the more room the government has in its budget. This room can be concretised as the amount of resources the government can use to achieve its desired purpose, without leading to financial instability. They find that Greece, Italy, Japan, and Portugal have the least fiscal space, while Iceland, Ireland, Spain, the US, and the UK are constrained in their degree of fiscal space. Korea, New Zealand, Australia, and the Scandinavian countries showed the most fiscal freedom. An influential paper that used a co-integration test to measure sustainability of debt was by Payne (1997). His paper examined the G7 countries in the timespan from 1949 to 1994 and found that France, Japan, and Italy might not be sustainable due to the lack of integration. The UK, Canada, and the USA experienced integration between revenues and expenditures, meaning these countries have sustainable debts.

Bohn (1998) finds that the United States of America shows to have a sustainable public debt during 1916-1995. Bohn (2005) backs this conclusion up and finds that the USA is taking necessary long-term action to counterbalance the rising trend in their debt levels from 1793-2003. More recent evidence comes from Paola et. al. (2020), who look at the United States in the period of 1948-2016, and forecasts from 2017-2027. They find a potential unsustainable fiscal policy from 2008 and further. Note that this trend starts in 2008 and takes the forecasts of 2017 till 2027 into account, which is why they find a potential unsustainable course. Their test results are based on fiscal policy, reflected in the measurement of primary surpluses and whether these are sufficient to offset accumulation of debt. They also note that this finding does require 'an urgent need for a structural change in the future stance of budgetary policy' (Paola et. al., 2020).

Lastly, more case-study-like research on Greece (Makrydakis et. al., 1999) for the 1958-1995 period, and on Germany (Greiner & Semmler, 1999) for the 1955-1994 period, finds that Greece and Germany have failed to adhere to the intertemporal budget constraint. As a reminder, not adhering to the budget constraint means that governments have historically not taken enough action to increase primary balance surpluses to counteract increases in debt. For Germany, the results were mainly influenced by the deficits around 1989, and the authors question whether these deficits will have a lasting impact. Germany is generally perceived as a stable state, which finds evidence in the paper from Greiner and Kauermann (2008), who find that German debt policy from 1960 to 2003 has been sustainable, but in a declining trend. Again, we see that opposing results in a close to similar time period are found due to the fragility of assessing debt sustainability.

Empirics

8. Research design

8.1 Methodology

As noted in the theoretical overview, sustainability of public debt has a lot to do with future prospects and is based on solvency. However, the simple assumption that the future is uncertain leads to the fact that one has to choose which empirical test is most appropriate to assess sustainability. As noted before, only using current data omits previous debt levels and other influential historical factors, while using only historical data might be a problem in the sense that history might not always accurately predict future sustainability (Debrun et. al., 2018). Nevertheless, the econometrical analysis will be performed in this research based on historical data, as foregoing fiscal behaviour plays a vital role when establishing future debt policy. Besides, numerous of other inquiries used this methodology, meaning this method is well accepted within the economics profession.

Bohn (1998) was the first to see sustainability represented by a debt-to-GDP ratio that is mean-reverting and stationary. The empirical test which will be conducted is based on the fiscal reaction to debt accumulation. The respective method is called the fiscal reaction function test, where policy reactions are reflected by the primary balance. When a country does prove to commit by offsetting debt accumulation with primary balance surpluses, it proves to have a solvent debt policy. Bohn (1998) notes that: "A positive response of primary surpluses to changes in the debt-income ratio does provide reliable information about sustainability, regardless of how interest rates and growth rates compare" (p. 960). Bohn (1998) points out that extensive periods of budget deficits don't necessarily mean that a state has unsustainable debt. When governments run these deficits in times where the government bond yield is below the growth rate, primary balance deficits can be a result of policy measures that exploit this low interest rate. However, if debt keeps increasing in contrast to GDP, sustainable policy measures must eventually be adopted to offset the earlier imbalances. This test dodges consequences of fluctuating interest rates and growth rates and is therefore useful in most economies. Bohn (1998) concludes that: "A strictly positive and at least linear response of the primary surplus to changes in the debt-income ratio turns out to be sufficient for sustainability" (p. 960). It's important to note that merely a positive response of the primary surplus will be sufficient to adhere to the intertemporal budget constraint, meaning public debt will be sustainable in the long run.

As Bohn (1998) is frequently cited in literature and praised for this method, exactly the same methodology will be used in this paper. Bohn only conducted his research on the United States in the time period from 1916 to 1995 and found a sustainable government debt in this period. As mentioned, this research is conducted mainly to find more recent evidence, while also looking at the impact of the

COVID-19 crisis. Therefore, this statistical test will be conducted on several countries in a more recent time horizon. More about the countries and time horizon is explained in the 'data' section. Needless to say, this inquiry will be quantitative. The empirical analysis will be performed with the statistical program STATA, and the regressions will use Ordinary Least Squares (OLS) estimation. Country-specific analysis is performed with time series data, while an overall evaluation of all countries together will be done with panel data.

Only including one explanatory variable will not suffice when assessing the underlying significant correlation between the two variables. Therefore, an equation from Barro (1979) with more than one explanatory variable will be used. Adding the GVAR and YVAR variables will account for omitted variable bias, while also supporting the conditional impact of debt on the primary surpluses (Bohn, 1998). The two variables will be calculated as in the tax-smoothing model of Barro (1979), where the variables are the non-debt determinants of the primary surplus. GVAR is the level of temporary government spending, which reflects the variation of real public expenditures from their trend. YVAR is the level of temporary government income, which reflects the variation of real public income from their trend. The exact explanation and calculation of the GVAR and YVAR variables will be further touched upon in the 'variables' section. The lagged debt ratio $b_{(t-1)}$ is included, as corrective action as a result of budget plan decisions are only seen when they are lagged. A one-year response window is often appropriate to measure the fiscal reaction to rising debt levels. The main idea is to find a relationship between the yearly marginal change of the debt-GDP ratio and the yearly marginal change of the primary surplus. To find this relationship, an autoregressive model is used with an identical functional form as in Bohn (1998):

$$s_t = \beta_0 + \beta_1 * b_{(t-1)} + \beta_2 * GVAR_t + \beta_3 * YVAR_t + \varepsilon_t \qquad (1)$$

Where s_t is represented by the marginal primary surplus in time t, $b_{(t-1)}$ is the marginal one-year lagged debt-income ratio, β_0 is the constant, $\beta_1; \beta_2$ & β_3 are the slope coefficients, $GVAR_t$ is the level of temporary government spending in time t, $YVAR_t$ is the temporary government income in time t, and ϵ_t is the error term in time t. Note that the primary surplus and debt are always relative to GDP. The main focus will be on the beta 1 coefficient, as this will indicate whether public debt is sustainable. The results can be interpreted as that a β_1 value of 0.5 implies that a marginal increase of public debt to GDP by 10 percent increases the primary surplus ratio next year by 5 percent. In addition, the data will be tested for autocorrelation. Autocorrelation can be a problem for time series data, as there is correlation among the residuals. Screening of autocorrelation will be done with the Durbin-Watson (DW) statistic, where autocorrelation occurs when the DW statistic takes on a value lower than a certain critical value, which will be calculated in the results section.

As this inquiry attempts to assess the effects of the COVID-19 pandemic and its aftermath, two time periods will be analysed. The first time period is without the pandemic and is from 1992 to 2019, while the second time period is with the pandemic period and its aftermath and is from 1992 to 2026. A more detailed explanation about the chosen time horizons will be given in the 'data' section. Just inspecting the coefficient values, and specifically the significance, will already provide a decent amount of information about the effect of the pandemic on the mean reversion process. Although, on top of that, a chow test will be done to estimate whether the COVID-19 crisis will cause a structural break in the estimation of the sustainability of public debt. The chow test inspects whether the coefficients over one group of data are equal to the coefficients estimated over another group. Logically, the different groups will be the two time horizons. The chow test is used to find whether the period including the pandemic structurally weakens the mean reversion of the time series. When mean reversion is significantly weakened, one could say that the COVID-19 pandemic has a significant influence on the long-term sustainability of public debt. The chow test itself uses the same logic as a joint-significant F-test and is very much alike. The chow test only tests whether there is a structural break at one specific point in time. The data will be divided into the pre-break sample and the post-break sample. This specific break point is set at 2020, as this is the first year when COVID-19 started showing its impact. The chow test statistic is calculated with the following formula:

$$Chow_{stat} = \frac{(RSS - (RSS_1 + RSS_2))/k}{(RSS_1 + RSS_2)/(n - 2k)}$$

Where RSS is the residual sum of squares of the whole time horizon, RSS_1 is the residual sum of squares of the pre-break period, RSS_2 is the residual sum of squares of the post-break period, k is the total number of coefficients estimated, and n is the number of observations in the full sample size. When the chow statistic is significant, we can say that the relationship would be better when the pre-break and post-break time periods would have different linear estimations, meaning there is a significant structural break. The chow test will be done for almost all countries. The results section gives more clarity about why the test will not be done for some countries.

Lastly, panel data is used to get a general overview of the entire sample. A similar regression will be performed as estimated in the time series data, with the same dependent and explanatory variables. The matching functional form looks as follows:

$$s_{it} = \beta_0 + \beta_1 * b_{i(t-1)} + \beta_2 * GVAR_{it} + \beta_3 * YVAR_{it} + \alpha_i + \mu_{it} \qquad (2)$$

Where s_{it} is represented by the marginal primary surplus of country i in time t, $b_{i(t-1)}$ is the marginal one-year lagged debt-income ratio of country i, β_0 is the constant, $\beta_1; \beta_2$ & β_3 are the slope coefficients, $GVAR_{it}$ is the level of temporary government spending of country i in time t, $YVAR_{it}$ is the temporary government income of country i in time t, α_i is the error term of country i which doesn't

vary over time, and μ_{it} is the error term which captures idiosyncratic risk of country i in time t. The Hausman test is used to determine whether the fixed effects model is preferred over the random effects model. The random effects model is generally more efficient but is potentially biased, while the fixed effects model corrects for this bias, but is less efficient. When the Hausman test statistic is significant, we can assume the random effects model is biased, which implicates that the fixed effects model should be used.

8.2 Data

The countries of interest that have been chosen for this research are all labelled as developed countries and are all part of the advanced countries (IMF, 2020). The underlying reason for this is that developing countries often show characteristics that fundamentally differ from developed countries. These characteristics could be, but are not limited to, governance structure, access to financial markets, monetary stability, currency issuance, etc. Due to these different characteristics, analysis is often based on different fundamentals and therefore also contrasting empirical tests are used. The countries which are chosen in this research are a selection of the 38 OECD countries, as this cluster of countries is seen as a reliable source of comparable statistical and economic data (OECD, 2013). Also, the data needed to conduct this inquiry is readily available in most databases.

As including all OECD countries in this research would lead to too broad of an analysis basis, a selection has been made: Japan, the United States of America, Germany, Belgium, Norway, Greece, Italy, Spain, Portugal, Denmark, the United Kingdom, France, and Finland. Japan and the United States are included as only non-European countries, as these countries have proven to be interesting for analysis concerning this matter, and can also serve as meaningful comparison. The countries in Europe are properly chosen such that South, North, and central Europe are well represented by a number of countries to serve as a balanced sample of the advanced countries. Furthermore, some south-European countries are included as these are generally known to have a different economic state than most north- and central-European countries. A telling example is that the governments of Portugal and Greece have received international financial support in 2011 and 2010 respectively. The south European countries are Portugal, Greece, Spain, and Italy. These countries have been selected because they are among the leading southern countries of Europe. The North-European countries are Finland, Denmark, and Norway, and the central European countries are France, Germany, Belgium, and the UK. There is an argument to be made that similar countries could have been selected for the middle- and North-European countries, such as the Netherlands, Sweden, Switzerland, Austria, etc. However, the North-, and middle-European countries are selected based on the fact that these countries are leading countries within this region. Furthermore, the data has to be available for the whole time period. It's important for the data to not have any missing values in the IMF database (2021), as filling in the missing values through other databanks can carry inconsistent data forward.

That said, some comparable countries did exhibit missing values. Consistency of data is required to dodge small estimation differences, and because the forecasted values for 2021 to 2026 will be in one line with the data from the actual time period.

The start of the time horizon for the data that has been chosen is 1992, as this is the year when the Maastricht treaty was conducted (Council of the European communities, 1992). The treaty did spread awareness for extraordinary public debts and laid emphasis on the fact that having too high debt will prove to be unfavourable in the long run. You could argue that awareness concerning extreme public debt has always been there. However, the Maastricht treaty marked the moment in time when the European Union noted its concern around debt levels that were exceeding the benchmark of 60% of GDP. This benchmark indicated that governmental concerns should arise regarding the sustainability of national debt when countries exceed this benchmark. Also, the benchmark didn't only serve as one of the first concrete standards, but it simply also touched upon the fact that an ever increasing debt is just not favourable in the long run. Despite the fact that this treaty was only signed by 12 European Union countries, the rationale behind this treaty did spread globally and the treaty can therefore be seen as the point in time when general awareness was spread about high public debt levels.

All needed data will be obtained from the World Economic Outlook (WEO) database from the IMF (2021). The databases are created during the WEO exercise in January and June and are published in April and September/October. Therefore, required data from the WEO of April 2021 will be used. Data is available from 1992 up till 2020. As this paper attempts to shed a light on changes we've seen last decade concerning the situational transition and our perspective on how we look at public debt, the end of the time horizon will be 2020. However, this research will also investigate the impact of the COVID-19 crisis, which means future predictions about the required variables will be used. These numbers are also in the WEO of the IMF (2021), up till 2026. Therefore, the COVID-19 crisis period will be represented by the time period 2019-2026. To be able to measure the influence of the COVID-19 crisis, two time periods will be investigated. The first time period is from 1992-2019 and represents the most recent data up till the point when COVID-19 showed its impact. The second period is from 1992-2026, which represents the same time period, but now with the years in which COVID-19 will be a factor. These time periods will be compared to be able to discover if the COVID-19 crisis will have a significant influence on sustainability of public debt of these 13 OECD countries. This time horizon could give reason for concerns regarding the recency of this time period with eyes on the modern angle of approach taken in this research. Even though a decent amount of years is needed in order to acquire significant results, a 28 and 35 year time period are believed to suffice for a recent look at the sustainability of debt.

8.3 Variables

Marginal primary surplus

The marginal primary surplus is the dependent variable and represented by s_t in the regression formula. The marginal primary surplus is based on the primary balance of a country and can either be positive (surplus) or negative (deficit). The primary balance is the government's revenue minus the non-interest expenditures. The primary surplus is given as percentage of GDP for the purpose of comparability between countries. By definition, the primary balance is identical to the general government primary net lending/borrowing as % of GDP, which means that this value can be used from the IMF (2021) WEO database to represent the primary surplus. The marginal primary surplus is simply calculated by subtracting the value of the primary surplus in time t-1 of the value in time t.

Marginal debt-income ratio

The marginal debt-income ratio is the only explanatory variable based on debt, and is represented by b in the regression formula. The debt-income ratio is the sum of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future, as percentage of GDP (IMF, 2021). The debt-income ratio is identical to the general government gross debt as % of GDP, which is the variable that is taken from the WEO database of the IMF (2021). The marginal debt-income ratio is simply calculated by subtracting the value of the debt-income ratio in time t-1 of the value in time t. The actual value which is used in the regression formula is shown as $b_{(t-1)}$, which is the marginal debt-income ratio in time t-1.

GVAR

GVAR is the level of temporary government spending, which reflects the variation of real public expenditures from their trend. First, total public expenditures and the GDP deflator are taken from the WEO for each country. When the total public expenditures are divided by the GDP deflator, we get the real public expenditures. Bohn (1998) notes that it's vital to correct for cyclical fluctuations and war spending, of which only the first one is relevant for this research. Correcting for cyclical fluctuations can be done through Hodrick-Prescott (HP) filtering. This method is commonly used to reduce short-term volatility as a result of business cycles to reveal long-term trends. First, the LOG is taken from the real public expenditures and the trend will be calculated with the HP filter. For the HP filtering process, a lambda of 100 is chosen, as this is generally accepted as an appropriate number for yearly data. Finally, the trend will be subtracted from the realized LOG values to arrive at the value which represents GVAR. A negative coefficient is expected because expenditures above the trend will have a negative effect on the primary surplus.

YVAR

YVAR is the level of temporary government income, which reflects the variation of real public income from their trend. Real public GDP can directly be taken from the WEO database. Identical to GVAR, YVAR is calculated with the HP filter. First, the LOG is taken from real public income, where after the trend is calculated with the HP filter, which also assumes a lambda of 100. If the trend is subtracted from the LOG of real public income, we get YVAR. A positive coefficient is expected, as revenues that exceed the trend will benefit the primary surplus.

9. Results

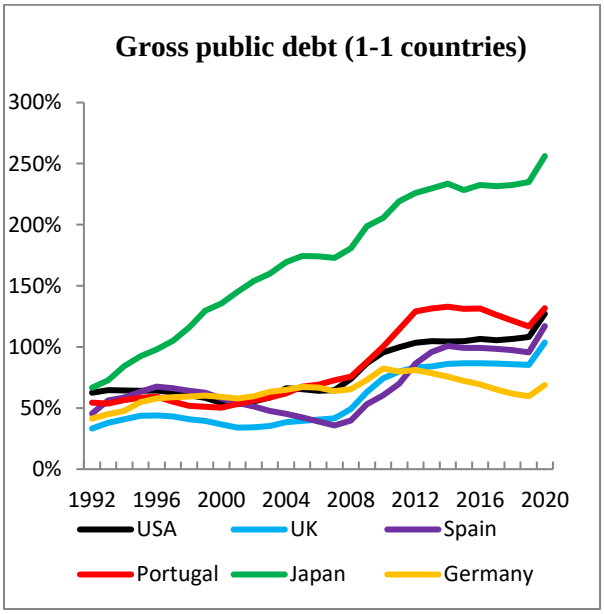
After acquiring the first results, it became clear that some countries show similar behaviour regarding the fiscal response, which means the countries can be clustered into three groups. Therefore, the results section will be divided up into five parts where the first three sections will show the results for a specific group of countries with similar characteristics. Within the sections, the countries will be reviewed as a group and separately. Mainly for reference purposes, the groups of countries will be labelled as the 0-0, the 0-1, and the 1-1 countries. The fourth section will contain the panel data estimations and the last section contains the evaluation of the results. The first group of countries will be labelled as the 1-1 countries, which are the USA, the UK, Spain, Portugal, Japan, and Germany. The second group of countries will be labelled as the 0-1 countries, which are Italy, France, and Belgium. The third group of countries will be labelled as the 0-0 countries, which are Greece, Norway, Finland, and Denmark. The rationale behind the labelling with these numbers is that both numbers represent a time period, where 0 means that there is no sign of sustainability, and where 1 means there is evidence for a sustainable debt. For instance, the 1-1 countries show sustainable debt in both the period from 1992 to 2019, as well as the period from 1992 to 2026, while the 0-0 countries show no sign of sustainable debts in both periods.

The first three sections will always commence with two graphs of the gross debt-to-GDP ratio and the primary surplus ratio, to get a general overview of the financial state of the countries. Then, the regression output for all the countries within that group will be provided. All data showed in the debt and primary surplus figures is retrieved from the WEO from April 2021 of the IMF (2021). Note that the value from specifically 2020 for the primary surplus and the debt is an estimation of the IMF for Belgium, Denmark, France, Greece, Japan, Portugal, Spain, and the USA. However, the report has been published in April 2021, meaning that the year 2020 already happened. The estimated values will most likely be very close to the actual value, knowing that these estimated values are not just predictions for the future. Lastly, the interpretation of the output tables should be quite straightforward. For the meaning of the variables, I refer back to the methodology and variables section. The ‘DW-stat’ shows the Durbin Watson statistic which allows testing for autocorrelation, ‘R-

squared' shows the goodness of fit of the model, the different columns represent the different time horizons, and at the bottom, the Chow test output is provided for the b(t-1) variable.

9.1 The 1-1 Countries

To provide a clear overview of the results, the countries are divided into three sections. The first section contains the 1-1 countries, which are the USA, the UK, Spain, Portugal, Japan, and Germany. As noted, the number 1 stands for the fact that there seems to be enough evidence in a certain time horizon to points towards a sustainable public debt. The first number is for the real time period, while the second number stands for the simulated time period which includes the COVID-19 pandemic period and its aftermath. The important figures will be displayed for all the countries below.



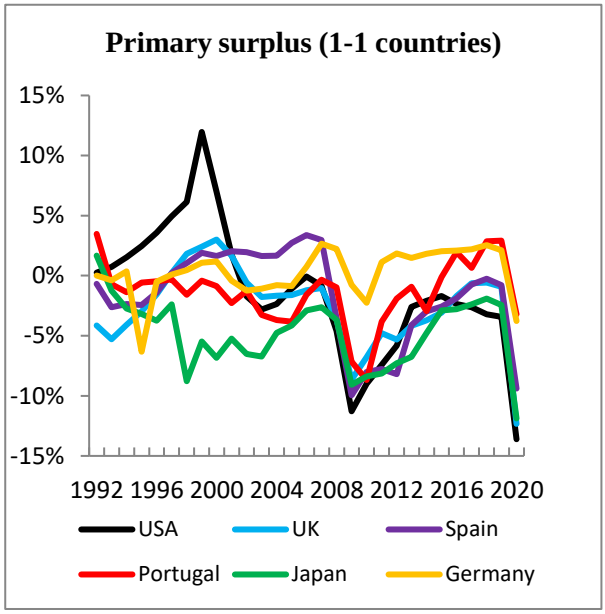


Figure 3: Gross public debt to GDP ratio of the 1-1 countries from 1992-2020.
Figure 4: Primary surplus to GDP ratio of the 1-1 countries from 1992-2020.

	USA (1992-2019) S(t)	USA (1992-2026) S(t)	UK (1992-2019) S(t)	UK (1992-2026) S(t)	Spain (1992-2019) S(t)	Spain (1992-2026) S(t)
b(t-1)	0.321**	0.498***	0.343***	0.494***	0.176**	0.286***
	(0.141)	(0.115)	(0.108)	(0.078)	(0.072)	(0.063)
GVAR	-1.037***	-1.119***	-1.009***	-1.335***	-0.935***	-1.005***
	(0.299)	(0.241)	(0.288)	(0.292)	(0.194)	(0.207)
YVAR	-0.298	0.684	0.410	0.918**	-0.124	0.473
	(0.790)	(0.704)	(0.435)	(0.387)	(0.313)	(0.279)
Constant	-1.057*	-1.234**	-0.925**	-1.201***	-0.486	-0.642*
	(0.538)	(0.490)	(0.386)	(0.330)	(0.333)	(0.334)
Observations	28	35	28	35	28	35
DW-Stat	1.873	1.778	1.218	1.184	1.497	1.074

R-squared	0.349	0.503	0.379	0.668	0.575	0.520
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						
Chow test	1992-2026		1992-2026		1992-2026	
F(4,27)	1.88		2.02		4.70	
Prob > F	0.1437		0.1207		0.0052	

	Portugal (1992-2019) S(t)	Portugal (1992-2026) S(t)	Japan (1992-2019) S(t)	Japan (1992-2026) S(t)	Germany (1992-2019) S(t)	Germany (1992-2026) S(t)
b(t-1)	0.226**	0.206***	0.189**	0.210***	0.367***	0.359***
	(0.083)	(0.067)	(0.081)	(0.070)	(0.076)	(0.076)
GVAR	-0.677**	-0.603**	-0.853**	-0.897***	-1.276***	-1.215***
	(0.252)	(0.239)	(0.310)	(0.272)	(0.198)	(0.215)
YVAR	0.772*	0.958**	0.968*	1.006	1.075***	1.084***
	(0.426)	(0.371)	(0.543)	(0.616)	(0.366)	(0.374)
Constant	-0.576	-0.302	-1.557**	-1.294**	-0.459*	-0.178
	(0.434)	(0.363)	(0.618)	(0.516)	(0.242)	(0.247)
Observations	28	35	28	35	28	35
DW-Stat	1.699	1.433	1.755	1.369	1.924	1.610
R-squared	0.300	0.297	0.382	0.466	0.706	0.639
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						
Chow test	1992-2026		1992-2026		1992-2026	
F(4,27)	2.07		3.60		2.10	
Prob > F	0.1127		0.0178		0.1085	

Figure 5: Regression output, DW-stat and Chow test results for the 1-1 countries.

9.1.1 The United States of America (USA)

The United States of America currently peaks at a GDP of 22,675.27 billion dollars, making it the biggest economy worldwide. The size of the economy could justify the 30,121.65 billion dollars in gross government debt the country currently has (IMF, 2021). Figure 3 shows that the gross public debt of the United States decreased during two periods, from 1994 to 2001 and from 2004 to 2006. However, US debt has been following an increasing trend over the 28 year time window. The US debt has more than doubled, from 62.52% in 1992 to 127.11% in 2020, which translates to an average yearly effective increase of 2.56%. Figure 4 shows the primary surplus of the USA from 1992-2020. One thing that stands out is the fact that it hasn't been positive for a single year after 2002.

At first sight, an increasing debt and a seemingly decreasing primary surplus might indicate weak fiscal policy. However, the regression results prove different. Both coefficients for the time periods

(0.321 and 0.498) are significant at the 1% level (figure 5), meaning there is strong evidence for an appropriate fiscal response in the form of increasing the primary balance when debt levels have increased in the foregoing year. Because of these intuitionally contradicting results, it's a good moment to discuss the underlying goal of the Bohn (1998) fiscal reaction function test. As stated before, public debt sustainability is a long-term phenomenon. An assumption of the Bohn (1998) model is that adhering to the intertemporal budget constraint carries out a sustainable debt policy. Any positive response of the primary surplus will be sufficient to adhere to the intertemporal budget constraint. Agreeably, there are arguments to be made against the assumption that any positive response will suffice. Questions arise like: is making the primary surplus less negative really a sufficient response for debt sustainability? However, due to the infinite time horizon of the intertemporal budget constraint, one can never tell whether the fiscal reaction is 'sufficient' in the short run. Therefore, merely a positive response of the primary surplus shows that countries prove to cling to mean reversion, which means that countries are taking actions to combat increasing debt levels. In the long run, this attitude will result in sustainable debt. Keep in mind, when assessing debt sustainability, one tries to estimate whether fiscal behaviour in a relatively short period will result in long-term debt sustainability.

Continuing with the results, the USA shows stronger mean reversion, represented by the higher b(t-1) coefficient (0.321** vs 0.498***), in the time period including the pandemic period and its aftermath, meaning that including the predictions of the IMF could potentially strengthen the mean-reversion process. For this reason, the chow test is performed, which tests for a potential structural break at the predetermined year 2020. As a reminder, the test checks if the coefficients are significantly different in the pre-break period from the post-break period. The significance value (Prob > F) is 0.1437, meaning that there is no structural break in 2020 at a significance level of 10%. Ultimately this means that the COVID-19 pandemic hasn't had a significant influence on the debt sustainability of the United States. The R-squared values are 0.349 and 0.503, which are adequate enough for the estimation. From now on, the R-squared value will only be mentioned when it's worryingly low or important to bring up. The regressions for the USA do not have autocorrelation.[4] Lastly, the GVAR value is significant on a level of 1% and has a negative coefficient, which was expected. YVAR is not significant. YVAR and GVAR are sometimes expected not to be significant, as some countries have fiscal characteristics that weaken the relationship between GVAR, YVAR, and the marginal primary surplus. Generally though,

[4] The lower and upper boundaries for the DW test are 0.901 and 1.512 for 28 observations. The boundaries are 1.028 and 1.512 for 35 observations. These boundaries will be the same for all countries. Any time the DW stat is in between 0.901 and 3.099 for the shorter time horizon with 28 observations, there is no evidence for autocorrelation. For the longer time period of 35 observations, there is no evidence for autocorrelation when the DW-stat is in between 1.028 and 2.972. For the USA, the DW-stats are 1.873 and 1.778, so there is no evidence for autocorrelation. In fact, all countries prove to have no autocorrelation, in neither time period, which is why this will not be discussed for all countries specifically. The DW-stats are provided in the output tables.

there should be a correlation between these variables, as expenditures/revenues above the trend often respectively lead to an increasing/decreasing primary surplus in that year.

9.1.2 The United Kingdom (UK)

The United Kingdom currently has the fifth biggest economy in the world with a GDP of 2,710.97 billion USD (IMF, 2021). The combination of the COVID-19 pandemic and the event of leaving the European Union shows a significant increasing effect on the debt ratio. It was estimated that Brexit would cost the United Kingdom 2 to 2.5 percent of its GDP (Born, et al., 2019). Forbes (2020) notes that there has been a contraction of 12.4% of the UK economy from august 2019 to august 2020, which will be seen in all aspects of the economy. The debt level of the UK is expected to rise from 85.243 in 2019 to 113.011 in 2026 (IMF, 2021). An increase from 33.241% in 1992 to 103.659% in 2020 results in the fact that the debt is 3.12 times higher in 2020 than it was in 1992 (figure 3).

Even though the United Kingdom has experienced a steep debt increase after 2008, both periods show strong mean reversion, with both b(t-1) coefficients being significant at the 1% level (figure 5). This indicates that there is strong evidence for debt sustainability in the United Kingdom. While the coefficient of the period including the pandemic is higher, the chow test statistic of 0.1207 is not significant at the 10% level. This suggests that despite the potential stronger mean reversion in the longer period, there is no significant proof for a structural break. Just as for the USA, the GVAR coefficient is highly significant and negative, which was predicted. In contrast to the USA, the YVAR variable is now significant in the long time period, meaning that the revenues above the trend have a positive influence on the marginal primary surplus. The R-squared values are 0.379 and 0.668, showing there is quite a big increase when the pandemic period is included. Taking this together with the fact that YVAR is insignificant for the real data and significant when the predicted data is included, one could potentially argue that the predictions of the IMF are at least partly based on normative trends. Nevertheless, there is barely any proof for this currently, so analysing further data from other countries is preferred.

9.1.3 Spain

Before 2008, it seemed like Spain had one of the most booming real estate markets, which proved to be a bubble in 2008 when the housing market collapsed. Most profits from the favourable economic boom back then were due to the housing market (Górniewicz, 2013). The housing crisis caused the mortgage sales to decrease to 66%, which caused a snowball effect of other structural problems, such as high unemployment and high allowance expenditures of the government which caused budget complications (Górniewicz, 2013). Looking at the primary surplus development of Spain represented in figure 4, a significant drop of the primary surplus from 2,959% in 2007 to -9,957% in 2009 can be

seen. Since 2009, Spain has been slowly steering the primary balance towards a surplus, but the COVID-19 pandemic has crushed those dreams ruthlessly. There are two things that characterise the Spanish debt (figure 3), extended periods of decreasing trends, followed by very sharp increases. It seems like the Spanish economy is extremely rigid, as cyclical shocks indicate a turning point, after which there barely is any form of reversal. To a smaller extent, it also seems that periods when the government is decreasing their liabilities, almost exactly the same progress is made each year. Once fiscal policy is focussed on either fiscal expansion or contraction, it seems quite inflexible to deviate from this path.

Both b(t-1) coefficients (0.176 & 0.286) are highly significant, with the long time horizon being significant at the 1% level (figure 5). Something noticeable is that for all countries up till now, the coefficient has increased when the COVID-19 pandemic period and its aftermath were included. Even though the main focus of this inquiry revolves around whether there is a fiscal reaction function at all, it's still interesting that the mean reversion effect tends to be stronger when the crisis period is included. For the UK and the USA, no evidence could be gathered that this escalated mean reversing effect was significantly present. However, the short time horizon for Spain has a significance level of 0.023, while the longer time horizon has a significance level of 0.000. On top of this incremental evidence, the chow test statistic is 4.7 with a significance level of 0.0052, meaning there is significant evidence on the 1% level that there is a structural break in 2020. This entails that the coefficients from the pre-break period significantly differs from the coefficients post-break. The chow analysis tests for all variables. So, the difference between the coefficients of b(t-1), GVAR, and YVAR between the different time periods is in fact a significant difference. This proves that the pre-break period is better represented by a different linear regression line than the post-break period. It's important to note that this finding is completely contradictory to the hypothesis that the COVID-19 period could weaken the mean reversion. In fact, including the COVID-19 period and its aftermath increases the b(t-1) coefficient, which suggests that including the extra 7 years will strengthen the mean reversion. Despite this interesting finding, we can still conclude that there is only a moderate practical meaning. The reason for this is the fact that both periods still show strong evidence for mean reversion.

As noted before, the main focus of the Bohn (1998) test is on whether there is a fiscal reaction, and the height of the b(t-1) coefficient is a second concern. A significant chow test result becomes considerably more telling when the b(t-1) coefficient in the short time horizon is insignificant, while the b(t-1) coefficient of the long time horizon is significant. Some countries show this phenomenon and are labelled as the 0-1 countries. Therefore, more discussion on this topic will follow in the next section. In addition, the evidence gathered in favour of mean reversion in the long time horizon evokes suspicion about the predicted data points of the IMF (2021) dataset. Therefore, additional analysis for this suspicion has been included in the section for the 0-1 countries, as this is where a significant chow test statistic has the most impact.

9.1.4 Portugal

Despite the GDP drop of 7.6% in 2020 as a result of the pandemic (European Commission, 2021), Portugal proved to be more resilient than expected, which is for example reflected by a relatively small drop of the primary surplus from 2.904% in 2019 to -3.205% in 2020. Despite the high uncertainty, the European Commission (2021) predicts a moderate recovery from the hard hit in 2020, which is also projected by the IMF (2021), expecting a decrease of the debt ratio in 2020 from 131.63% to 110.58% in 2026. While a debt increase from 50.337% in 2000 to 132.941% in 2014 seems unhealthy, the downwards spiral from 2014 to 2019 shows present initiative. Taking this together with Portugal's Recovery and Resilience Plan as a response to the pandemic (European commission 2021), and the consistent rise of the primary balance from 2010 to 2019, Portugal seems to be heading in the right direction.

The regression output is represented in figure 5 and proves that Portugal shows evidence from both periods to suggest that Portugal has sustainable public debt. The b(t-1) coefficients are not the highest (0.226 & 0.206), but a high significance for both periods proves that the government of Portugal has sufficiently responded to increases in public debt. Again, we note that the expectation of the GVAR variable being negative and significant holds true. The YVAR coefficient is positive and significant in both periods, showing that Portugal's revenues above the trend prove to be a decent predictor for fluctuations in the primary balance. Lastly, the chow test is insignificant with a p-value of 0.1127, suggesting there is no evidence for a structural break in 2020.

9.1.5 Japan

Japan is potentially the most renowned case of extreme fiscal policy resulting in extremely high public debt. This extraordinarily high debt of 256,217% of GDP in 2020 undoubtedly evokes surprise that this country is part of the 1-1 countries. Back in the results section, the case of the USA showed that despite having an increasing debt and a visually seemingly unhealthy primary surplus development, a country can still prove to have a sustainable debt. Without a doubt, Japan is a more extreme case than the USA, with their public debt-to-GDP following an ever increasing rising trend, only showing little decreases in 2006, 2007, 2015, and 2017, and with their primary surplus only showing a positive value once in 1992. There is not much more to say other than that these figures are the most unhealthy looking out of all countries. The debt giant and its unprecedented debt accumulation tips the scales, leading many researchers to be concerned about a possible sovereign debt crisis in Japan.

One of the earlier discussed potential weaker points of the Bohn (1998) fiscal reaction function test is best illustrated by the case of Japan. Figure 4 manifests that the primary surplus has been negative for the past 27 years, while the public debt has basically always been increasing. However, Japan still shows a significant mean reversion, which is reflected by the high significance for the b(t-1)

coefficients for both time periods (figure 5). For the reason why Japan's debt proves to be sustainable, despite having unhealthy looking economic conditions, I refer back to the methodology section, or the case of the United States of America in the results section. The cause for bringing the topic back up is simply because Japan is the most extreme case where the Bohn (1998) fiscal reaction function test might show its cracks. The assumption of the model is that a significant positive response of the primary surplus to the lagged debt ratio will suffice for debt sustainability, which is grounded by plenty of economic theory and government debt research. However, the main discussion should revolve around this earlier mentioned question: 'is making the primary surplus less negative really a sufficient response for debt sustainability?' Bohn's (1998) model would un-hesitantly answer this question with 'yes'. Discussions about questions like these can only be answered by time, which makes the discussion unsolvable for now. Nevertheless, it's important to show different points of view, especially as the case of Japan is the 'perfect' practical example that could prove the fiscal reaction function of Bohn (1998) wrong. There is a significant response, but the b(t-1) coefficients are low (0.189 and 0.210), meaning the fiscal response is relatively weak. On top of that, a consistent marginal less-negative primary surplus as a response to an increase in debt could be an oversight of Bohn (1998), or an exception to the general rationale behind the model. Theoretically, a country could have followed such a path where it mainly experienced enormous increases in debt, while it also consistently had primary deficits, fluctuating around -80% of GDP. This country can still come out as having a sustainable debt according to the Bohn (1998) test, by making sure the primary balance becomes less negative when debt increases. In practise, we would know this country wouldn't last long, but the Bohn test would suggest the country has sustainable debt. This gives rise to the thought that the actual levels of debt should be included in the model, but this foregoes the fact that these extreme cases rarely occur. However, when debt is very high, and the primary surplus is structurally deeply negative, but does respond appropriately to rising debt, there are concerns around the Bohn (1998) test holding up. Needless to say, it's important to note that there aren't any statements made concerning the test, but one should know that there could be discussion about the feasibility of the fiscal reaction test for countries that experience the earlier mentioned characteristics.

Carrying on with the results, the GVAR variable is negative and significant, which was predicted. The YVAR variable is only significant at the 10% level for the shorter time interval. The chow-test statistic shows to be significant, meaning there is a structural break in 2020 regarding the coefficients. However, when comparing the coefficient, we see that there barely is a difference between the values. Although, more evidence is stacking up against the hypothesis that the COVID-19 period and its aftermath could weaken the mean reversion. In the case of Spain, as well as Japan, the mean reversion has been significantly strengthened. This interesting finding will be elaborated on further in the section with the 0-1 countries, as this is the section where a significant break will show most of its impact.

9.1.6 Germany

Germany used to be nicknamed 'the sick man of Europe', but has transformed in rapid succession into the front runner of the European Union (Dustmann, et. al., 2014). Germany's economy is now widely seen as one of the most progressive and healthy economies of the world, which makes it no surprise that Germany is part of the 1-1 countries. Something which immediately stands out of figure 3 is that, opposed to the previous 5 countries, the debt ratio has barely increased over the 28 year time interval. From 41.45% in 1992 to 68.93% in 2020, with the highest peak being 82.32% in 2010. More surprising is the primary surplus graph, which shows a hesitant loop around the 0% mark, averaging a yearly primary surplus of 0.266%. One could argue this seems quite low for a country depicted as the wonder child of Europe, but is actually quite fitting when looking at the moderate debt increase in figure 3.

Germany distinguishes itself from the previous 1-1 countries, as it's the only country up till now that has the YVAR variable significant at the 1% level in both periods. In fact, all variables are significant at the 1% level, proving that Germany perfectly fits the model. On top of that, the R-squared values of 0.706 and 0.639 are the highest up till now, proving that the goodness of fit is exceptionally high. There is strong evidence for both periods that Germany has sustainable debt. The chow test statistic is 2.1, with a significance of 0.1085, meaning there isn't enough evidence in favour of a structural break.

9.2 The 0-1 Countries

As a reminder, the countries are divided up into different groups, all based on similar results the countries experience. The '0' means the b(t-1) variable for the period from 1992-2019 is not significant, and the '1' means the b(t-1) variable for the period from 1992-2026 is significant. This indicates that the short time period would provide evidence for sustainability according to the fiscal reaction function test, while the long time horizon shows evidence for unsustainable fiscal policy. First, the second group of countries will be analysed, and this group consists out of Italy, Belgium, and France. In addition to the standard functional form, a simple adjustment has been made to include additional testing for mean reversion. Sometimes, countries are embedded in a political system which doesn't allow for swift fiscal responses to changing macroeconomic circumstances. Consequently, countries could go through a slow fiscal response when facing an increasing public debt. It makes sense to test this for the 0-1 countries, as it's important to find out whether the insignificant b(t-1) for the short time horizon might be due to a slow fiscal response. To test for this, an additional functional form has been composed.

$$s_t = \beta_0 + \beta_1 * b_{(t-1)} + \beta_2 * GVAR_t + \beta_3 * YVAR_t + \beta_4 * b_{(t-2)} + \varepsilon_t \qquad (3)$$

Where the parameters of the formula are exactly the same as in functional form '1' from the methodology section, apart from the b(t-2) coefficient, which is now added. It is the marginal two-year

lagged debt-income ratio. It's vital to note that this estimation was not used in Bohn (1998), so it only serves for the purpose of additional testing. Functional form 1 will still provide the leading evidence. The estimation will be performed over both the time periods and will be represented in the third and fourth column of the regression output.

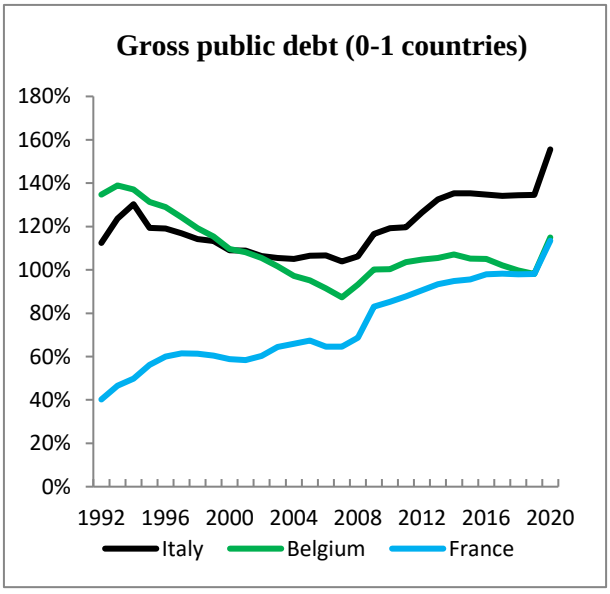
As already touched upon before, the fact that some countries experience stronger mean reversion when the predicted values from the IMF (2021) for 2020 to 2026 are included contradicts the logical expectation of a crisis weakening the mean reversion. Because of this, an analysis of the historical accurateness of the predictions from the IMF will be included for each country, to find out whether the IMF might be too optimistic when predicting future macroeconomic factors. It's essential to note that there is no value judgement made regarding the accuracy of the IMF predictions, meaning there is zero intention to speculate about the reason why the IMF predictions could be different than the actual values. In other words, it's not important for this research to speculate whether the potential deviations are due to the methodology used by the IMF, the countries deviating from recommended/intended behaviour, or any other reason, meaning that no judgement will be made about this. So, when statements are made about the 'overestimation' or 'underestimation' of the IMF, there is no blame intended, it's merely an observation. The fact that this suspicion has occurred, is only due to the observation that almost all countries show, whether backed up by the chow test or not, a higher b(t-1) coefficient for the longer time period than the short time period. To investigate whether the estimations of the IMF are deviating from the country's behaviour regarding controlling debt levels and increasing their primary surplus, a time series trend of the estimated variables will be compared with the actual values. The estimated time series path will be simulated using the published WEO's from the past of the IMF (2021). Every time the IMF (2021) releases their WEO report with values of macroeconomic variables, an additional two to seven years of estimations by the IMF are also released.

For the primary surplus ratio we can simply take the values from the different WEO's throughout the years and study them, as the predicted values are not heavily influenced by the previous period's value. However, for the debt-to-GDP ratio this is not the case, because the value of the debt-to-GDP ratio of the relevant period will be a result of the previous period, with an incremental increase or decrease. As the predictions are performed on an incremental basis, it's impossible to simply take the estimated values and add them together as one uninterrupted observation of values. The reason for this is that the estimations have to be taken from different WEO reports throughout the years, which all assumed a different base value from which they calculated their predictions forward, namely the actual value of the debt-to-GDP at that moment. Also, the actual values within the IMF databases often tend to have very small adjustments. For example, the WEO from April 2021 might say the gross debt-to-GDP in 2010 was 51,510% for country X, while the WEO from April 2014 might state the gross-debt-

to-GDP in 2010 was 50,434% for country X. Both these problems result in the fact that the values should be corrected, as the detached values will be incomparable. As solution, one fluent time series flow of values will be simulated by starting with a base year. This base year will be the actual value of the debt from the year in which the path starts, while the time series will be expanded with the predicted percentage increase of that year. With this method, we create the predicted debt-to-GDP ratio path by the IMF, which we can compare with the actual development of the debt-to-GDP ratio over the years.

In short, the predicted debt levels of the IMF database will be converted to percentage changes, and these will be used to simulate the predicted path. Logically, the real path and the simulated predicted path both start from the same base year, being the actual debt level in both cases. Of course, this methodology is still open to error, as the predicted percentage changes of the IMF could have been different if the concrete debt level would have been different in that year. This entails that the predictions of the IMF could have been different to the slightest extend. However, the debt values on which the IMF based their predictions are always very close to the values used to calculate the percentage changes of the simulated path. Hence, using the predicted percentage differences to simulate the predicted debt path by the IMF is the most logical way to find out whether the predictions of the IMF proved to be historically accurate, without running into the two aforementioned problems.

First, the gross public debt-to-GDP ratio and the primary surplus to GDP ratio are provided for the 0-1 countries in figures 6 and 7, as well as the regression output in figure 8. Figure 8 contains four regressions per country, with the first two being the output for functional form 1, and the last two being the regression output for functional form 3.



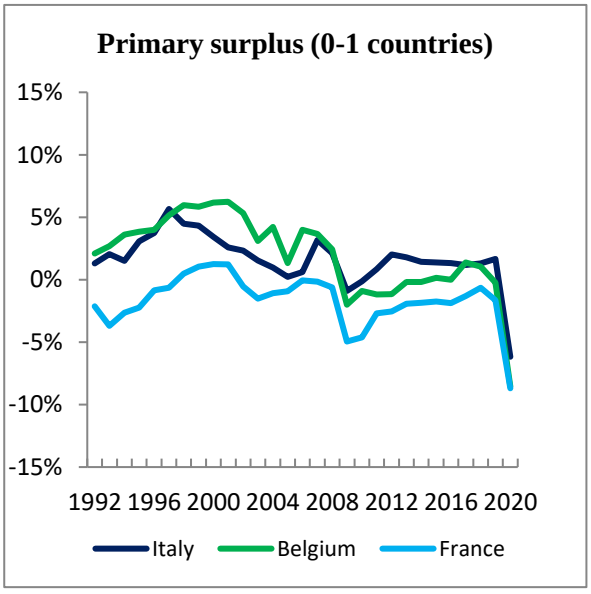


Figure 6: Gross public debt to GDP ratio of the 0-1 countries from 1992-2020.
Figure 7: Primary surplus to GDP ratio of the 0-1 countries from 1992-2020.

	Italy (1992-2019) S(t)	Italy (2019-2026) S(t)	Italy (1992-2019) S(t)	Italy (1992-2026) S(t)	Belgium (1992-2019) S(t)	Belgium (1992-2026) S(t)
b(t-1)	0.070	0.130**	0.052	0.116**	0.079	0.220***
	(0.052)	(0.055)	(0.055)	(0.051)	(0.089)	(0.070)
GVAR	-0.121	-0.201	-0.141	-0.303	-0.712**	-0.985**
	(0.273)	(0.291)	(0.272)	(0.276)	(0.339)	(0.374)
YVAR	0.519	1.330***	0.537	1.318***	-0.309	0.795
	(0.315)	(0.313)	(0.314)	(0.293)	(0.571)	(0.525)
b(t-2)			0.056	0.105**		
			(0.050)	(0.045)		
Constant	-0.069	-0.155	-0.124	-0.303	-0.064	-0.143
	(0.235)	(0.260)	(0.239)	(0.252)	(0.276)	(0.273)
Observations	28	35	28	35	28	35
DW-Stat	1.524	1.175	1.758	1.471	1.892	1.270
R-squared	0.123	0.401	0.168	0.492	0.159	0.392
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						
Chow test - b(t-1)	1992-2026				1992-2026	
F(4,27)	6.86				5.14	
Prob > F	0.0006				0.0033	

	Belgium (1992-2019) S(t)	Belgium (1992-2026) S(t)	France (1992-2019) S(t)	France (1992-2026) S(t)	France (1992-2019) S(t)	France (1992-2026) S(t)
b(t-1)	0.007	0.190**	0.164	0.344***	0.125	0.319***
	(0.096)	(0.071)	(0.102)	(0.077)	(0.079)	(0.062)
GVAR	-0.810**	-1.045***	-1.696*	-1.773*	-1.879**	-1.914**
	(0.332)	(0.368)	(0.938)	(0.954)	(0.726)	(0.761)
YVAR	-0.395	0.721	0.116	1.118***	0.371	1.090***
	(0.553)	(0.515)	(0.532)	(0.389)	(0.416)	(0.311)
b(t-2)	0.144*	0.101			0.249***	0.206***
	(0.086)	(0.065)			(0.060)	(0.048)
Constant	-0.018	-0.130	-0.449	-0.853***	-0.955***	-1.274***
	(0.267)	(0.267)	(0.342)	(0.279)	(0.291)	(0.243)
Observations	28	35	28	35	28	35
DW-Stat	2.049	1.337	1.213	1.081	1.542	1.218
R-squared	0.249	0.438	0.152	0.510	0.516	0.698
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						

Chow test - b(t-1)	1992-2026
F(4,27)	2.35
Prob > F	0.0798

Figure 8: Regression output, DW-stat and Chow test results for the 0-1 countries.

9.2.1 Italy

Italy has been steadily increasing its debt up till 1994, where it peaked at 130.28% of GDP. However, as depicted in figure 6, Italy seems to be the first country in the analysis (or arguably the second, after Spain), which shows lasting behaviour as expected by the Maastricht Treaty in 1992. Since 1994, the debt level only increased from 130.276% in 1994 to 134.56% in 2019. Evidence around this topic comes from Galli and Padovano (2008), which show that fiscal policy around public debt management has been significantly influenced by institutional aspects, in particular the Maastricht treaty. Despite the right-minded acting over the last 27 years, Italy took a big hit from the COVID-19 pandemic, which boosted public debt upwards to 155.56% of GDP in 2020.

As opposed to the previous countries, a third and fourth column have been included, which reflect the 2-year lagged marginal debt ratio in addition to the 1-year lagged marginal debt ratio. The reason to include this regression is because Italy shows no significant mean reversion in the pre-COVID period. The b(t-1) variable for the period from 1992 to 2019 shows as 0.07, but isn't significant. Nevertheless, the coefficient which includes the COVID-19 period does show a slight significant mean reversion of 0.130, meaning that including the pandemic period and its aftermath proves that the Italian public debt is in fact sustainable. Most interesting is the fact that the pre-pandemic period shows no significance in any variable, while also exhibiting a relatively weak R-squared of 0.123. The combinations of these results suggests that only using the b(t-1) variable could not be suitable for assessing Italy's debt sustainability.

One possibility is that the Italian government could appear to have a slow fiscal response. For this reason, the two-year lagged debt ratio has been included. The output for this estimation provides enough evidence that a slow fiscal response is not the case, as the variable coefficients of column 3 are all insignificant, whilst the R-squared (0.168) is still low. The longer time horizons for functional form 1 (2^{nd} column) and 3 (4^{th} column) both show significant b(t-1) coefficients, while functional form 3 also shows a significant b(t-2) coefficient. This means that including a crisis period could result in mean reversion, while the pre-pandemic period doesn't, which is quite counterintuitive. A possible explanation can be that the IMF forecasts could be structurally higher than the actual primary surplus height, while the IMF predictions for the debt-GDP ratio are lower than the actual values. For this reason, figures 14 and 15 have been included in the appendix. Lastly, the chow test statistic is 6.86 and very significant, indicating that the estimated linear model from the post-break is significantly

different than the pre-break linear model. This finding gives even more reason to question the possible discrepancies between the actual values and the forecasts.

Figure 14 in the appendix shows the actual gross public debt-to-GDP path of Italy since 2005, as well as the simulated predicted debt path constructed with the historical predictions of the IMF WEO database. Both the actual debt path and the predicted debt path (simulated) start at the actual gross debt value of 106.56% in 2005, meaning the first predicted value of the predicted debt path is in 2006. The yearly changes of the simulated price path are calculated through taking the percentage change which the IMF predicted for the respective year. For a more detailed explanation, I refer back to the '0-1 countries' section. The time interval is from 2005 up till 2019. From 2005, the IMF started to add forecasted years to the WEO's they released, which is why 2006 will be the first predicted value in the graph. The last year is 2019, as this is the last year for which actual/real data is available. Looking at the path, we see that the predicted debt ends at a much lower point than the actual debt. The predicted price path ends at 117.86%, 11.23% higher than in 2005. The actual price path ends at 134,56%, which is 28.003% higher than in 2005. The actual debt ended 2.5 times higher than the predicted path, leading to the belief that the IMF has structurally underestimated the rise in debt of Italy.

Figure 15 in the appendix graphs the actual primary surplus and the predicted primary surplus from 2010 up till 2019. The IMF only started forecasting the primary balance since 2009 and further, which is why the graph starts at 2010. It's hard to find any visual evidence from this graph, as the actual and predicted values seem to be quite close to each other.

Taking the average from the primary surplus offers an opportunity to get a better insight into the possible overestimation. The average of the actual values is 1.28%, while the average of the predicted values comes down to 1.56%. Although it does show the IMF has over-predicted the primary surplus, this is quite a small difference for a ten-year time horizon. However, when combining the decently sized under-prediction of the debt-to-GDP path, with the overestimation of the primary surplus, we could say that there has been a historical discrepancy for Italy. This visual test is in no way shape or form a test which can deliver significant evidence. However, when countries showed behaviour in the past that resulted in a more negative outcome than the IMF predicted, there is an argument to be made that this will potentially also happen in the future. Therefore, we could argue that taking the 1992-2026 models as evidence would be less reliable, as there are historical indications that the IMF predictions for the coming years could also be under/overestimations. Hence, there is a higher tendency to use the 1992-2019 model as leading evidence, because this time period does not contain predictions. We already established that Italy does not show a slow fiscal response, meaning we can confidently see the evidence from functional form 1 for time horizon 1992-2019 as most reliable. Hence, an argument can be made that this inquiry comes with stronger evidence against public debt sustainability of Italy, as the b(t-1) variable is not significant for functional form 1 from 1992 to 2019.

9.2.2 Belgium

Belgium is a special case within this section, as it is one of the only countries that exhibited a downwards spiral in their public debt ratio (figure 6), arguably fuelled by the Maastricht treaty in 1992. Unfortunately, the primary surplus (figure 7) seems to be in a similar declining trend. This combination of these two downwards trends could point towards investment issues where excess money was used to pay off debt, instead of investing to boost the primary surplus.

The b(t-1) coefficient (0.079) for the first time period is quite small and not significant, suggesting an unsustainable debt. Just like in the case of Italy, the marginal 1-year lagged debt ratio (0.220) for the longer time period is highly significant and considerably higher than 0.079. The R-Squared of the first column is quite low (0.159), while the R-squared rapidly rises when the last 7 years are included, to 0.392. The estimation with the IMF predictions seems to be a better model of fit than the 1992-2019 estimation, due to the significant b(t-1) coefficient and the higher R-squared. Just as for Italy, the chow test statistic is highly significant at the 1% level, meaning there is a structural break in 2020. This result is in line with the difference in the regression output between the short and long time periods. Again, this raises the suspicion that the forecasts of the IMF could historically be deviating from the actual values.

Figure 16 in the appendix shows the actual and predicted gross debt-to-GDP path, which now commences from 2009 instead of 2005, as 2009 was the first year with available data for Belgium. The predicted debt path is in fact higher than the actual debt path, mainly due to one big estimation error in 2010. Other than that, the predicted path has almost followed the same path as the actual path. The average actual primary surplus was 1.28%, and the predicted primary surplus was 1.57%, summing up to a slight overestimation of 0.29%. We can conclude that there is no historical evidence for underestimation of the debt ratio, as well as that there is only a slight over-prediction of the primary balance. Hence, the longer time horizon with the IMF predictions could be seen as a plausible prediction. The estimation for Belgium with both the b(t-1) and the b(t-2) coefficients for the two time periods show that Belgium does not have a slow fiscal policy response, as both the b(t-2) variables are insignificant. As the IMF predictions are seen as plausible, while there is no evidence for a slow fiscal reaction, we can conclude that the estimation of functional form 1 for both the time periods provides leading, but contradicting evidence. Hence, there is no lasting evidence in favour or against a sustainable debt, as both the time periods show reliable contradicting evidence in the form of an insignificant and a significant b(t-1) coefficient.

9.2.3 France

Figure 8 suggest that there is no mean reversion when looking at the 1992-2019 time horizon, while there is mean reversion when the last 7 years are added to this period, reflected by the insignificant b(t-

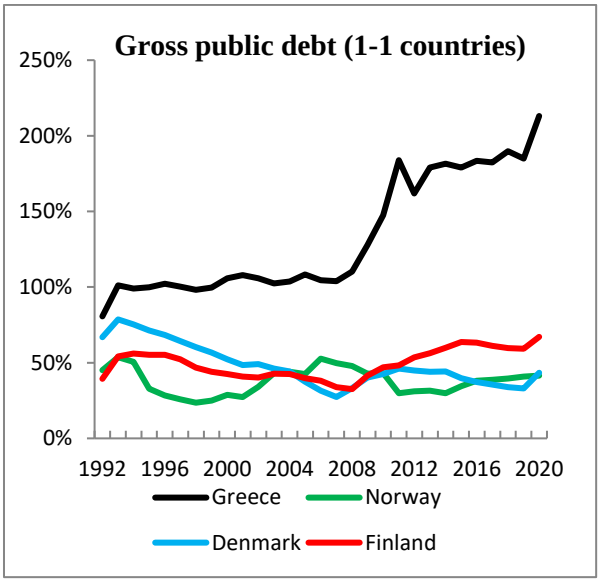
1) coefficient (0.164) and the highly significant b (t-1) coefficient (0.344) of respectively the first and second column of France. The longer time horizon has a high goodness of fit (0.510), significant b(t-1), YVAR and GVAR coefficients, while the short timespan has a low goodness of fit (0.152), with insignificant variables. The chow test tends to frequently have a low P-value, meaning the 5% confidence level will be assumed as a hard breaking point, indicating that there is only a weak to moderate structural break (0.0798) in this model.

To test for a possible slow policy response, the two-year lagged estimation is included in column 3 and 4 for France. Both the time periods show a highly significant b(t-2) coefficient, really pointing towards a slow policy response. Also, for the long time period, the b(t-1) coefficient is highly significant. As opposed to the single b(t-1) estimation, the R-squared (0.152 to 0.516) has significantly increased for the short time period. Including the 2 year lagged marginal debt ratio structurally enhances the performance of the model for both time periods, meaning that there is convincing evidence in favour of a (slow) policy response. The simulated debt path in figure 18 of the appendix starts at 67.38% in 2005 and ends at 88.31% in 2019, which is an increase of 20.93. The actual debt path commences at 67.38% and ends at 98.07%, which accounts for an increase of 30.69. Thus, the IMF has historically underestimated the debt-to-GDP ratio increase by 1.5 times. The average actual primary surplus was -2,08%, while the average estimated primary surplus amounted to -1,95%. The difference is neglectable. The visual proof from the historical comparison is in no way shape or form significant evidence, while the estimation with the 2-year lagged debt ratio shows strong signs in favour of a sustainable debt for both the short and long time horizon. Therefore, the evidence in favour of a sufficient (but slow) fiscal response is convincing, suggesting France is assumed to have a sustainable government debt.

9.3 The 0-0 Countries

Lastly, the 0-0 countries will be analysed. The 0-0 countries are the cases in which there is no significant evidence in favour of a sustainable debt policy according to the fiscal reaction function test. The functional form with the one-year and the two-year lagged debt variable has been examined for the 0-0 countries. However, the deliberate choice has been made to not report this estimation, as all countries were exposed to a terrible goodness of fit in this estimation, while showing barely any, or no improvement as opposed to estimation with only the b(t-1) variable. On top of that, the results for both the b(t-1) and the b(t-2) coefficient were insignificant for all countries, indicating that no country experiences a slow fiscal response of the 0-0 countries. Also, the chow test statistic will be excluded, as there is no reason to test for a structural break when both the time intervals are insignificant. The 0-0 countries are Greece, Denmark, Norway, and Finland. The last three countries might be surprising, but the individual sections prove why it's not as strange that these countries show no immediate fiscal

response. The first country that will be analysed is Greece, but first, the important figures will be presented.



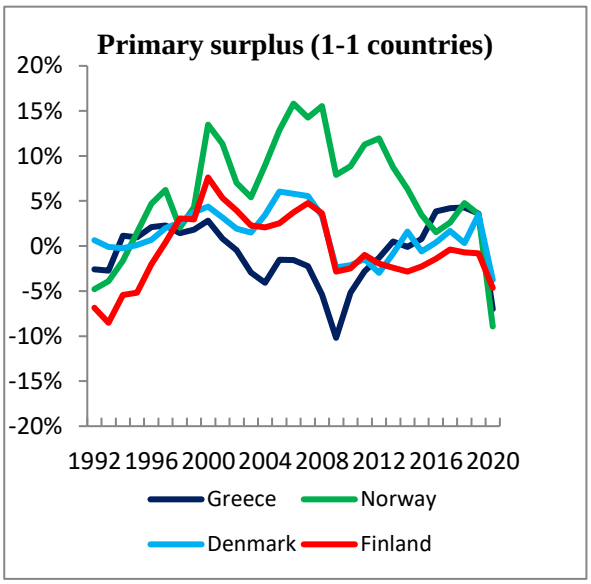


Figure 9: Gross public debt to GDP ratio of the 0-0 countries from 1992-2020.
Figure 10: Primary surplus to GDP ratio of the 0-0 countries from 1992-2020.

	Greece (1992-2019) S(t)	Greece (1992-2026) S(t)	Denmark (1992-2019) S(t)	Denmark (1992-2026) S(t)	Norway (1992-2019) S(t)	Norway (1992-2026) S(t)
b(t-1)	0.042	0.060	-0.108	0.017	0.001	0.016
	(0.035)	(0.043)	(0.106)	(0.101)	(0.095)	(0.099)
GVAR	-0.236	-0.423**	0.033	-0.511	-1.030**	-1.378***
	(0.172)	(0.207)	(0.501)	(0.531)	(0.382)	(0.368)
YVAR	-0.167	0.205	0.156	0.437	0.488	0.783
	(0.221)	(0.275)	(0.650)	(0.707)	(1.068)	(1.005)
Constant	-0.005	-0.055	-0.026	-0.037	0.170	0.148
	(0.393)	(0.480)	(0.358)	(0.349)	(0.581)	(0.542)
Observations	28	35	28	35	28	35
DW-Stat	2.062	1.709	1.709	1.954	1.299	1.535
R-squared	0.253	0.160	0.090	0.106	0.257	0.378
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

	Finland (1992-2019) S(t)	Finland (1992-2026) S(t)
b(t-1)	-0.032	-0.009
	(0.102)	(0.093)
GVAR	0.214	0.219

	(0.648)	(0.597)
YVAR	0.157	0.324
	(0.504)	(0.457)
Constant	0.087	0.023
	(0.496)	(0.413)
Observations	28	35
DW-Stat	1.559	1.490
R-squared	0.011	0.018

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 11: Regression output, DW-stat and Chow test results for the 0-0 countries.

9.3.1 Greece

Greece mainly holds two reputations: the holiday resort of Europe, and the financial disaster of the European Union, of which one of the two will play a vital role in determining the sustainability of their liabilities. The country is known for having the highest debt in Europe, mainly building up since the 1980s, when Greece entered the European Economic Community. Although all countries witnessed a substantial increase in their sovereign debt as a result of the credit crisis in 2008, Greece is the country which was hit the hardest. It's debt accounted to 103,98% in 2007, and skyrocketed to 183,87% in 2011 (IMF, 2021). This huge climb was mainly fuelled by high uncertainty regarding the solvability of the Greece government, causing the GDP to drop and the debt to rise. The combination of structural weaknesses of the Greece economy and the lack of monetary flexibility as a member of the Eurozone caused bond yields to explode, from about 5.2% in August 2009 to a peak of 36.8 % in February 2012. Bailout loans from the IMF, the Eurogroup, and the ECB were required in 2010, 2012, and 2015 respectively. The event that Greece failed to fulfil payment obligations of 1.6 billion euros to the IMF in time in 2015 could be seen as the first time a European country officially partially defaulted (Baltas, 2013).

From figure 11 we can make up that Greece is the second country which fails to adhere to the intertemporal budget constraint. The insignificant b(t-1) coefficient (0.042 & 0.06) in both time horizons indicate an unsustainable sovereign debt. When the marginal debt ratio is positive, Greece fails to take corrective measures through the primary balance the next year. The fact that the GVAR and YVAR variables are not significant gives some sort of indication that important macroeconomic indicators barely play a role in Greek fiscal policy. Decisively, there is no evidence to suggest that Greece has a sustainable public debt.

9.3.2 Denmark

The last three cases of the 0-0 countries are Denmark, Norway, and Finland. These countries all show similar characteristics, of which Finland could be a potential exception. Denmark is part of the North-European region, and currently has a GDP of 352.24 billion USD. When identifying figure 9, it becomes clear that Denmark has experienced a downwards trend regarding their public debt over the 29 year time period. In fact, the debt decreased from 78,63% in 1993 to 43,42% in 2020, adding up to a decrease of 35.21%. This is the first indication that Denmark seems to be financially healthy. Denmark has had a predominantly positive primary surplus (figure 10), which is a second indicator of satisfactory financial circumstances. These two figures lead to believe that Denmark should have a sustainable sovereign debt, but the country is still part of the 0-0 countries, which is quite remarkable.

The overall conclusion that can be made based on figure 11 is that Denmark has no sustainable debt in both time periods, while the other explanatory variables are insignificant and the R-squared is also too low. This is an extremely contradicting result to the healthy looking debt ratio and primary surplus. On top of this, several previous inquiries show that Denmark does indeed prove to have sustainable debt, according to the Denmark country report of the Sustainable Governance Indicators (SGI) (Laursen & Andersen, 2018).

The question arises how a country with such healthy looking conditions can still show no signs of a sustainable debt according to the fiscal reaction function test. The answer to this question is quite simple and straightforward, Denmark simply does not have to care. One could question why a country like Denmark could be labelled as a country that simply doesn't have to care about its direct fiscal response, while Belgium, a country with decreasing sovereign debt, should. The first argument behind this is based on the substantial difference between the high current debt of Belgium (114,99%), and the lower current debt of Denmark (43,42%). Denmark has proven to be able to adequately manage their debt to remain around a low concrete value, partly due to their positive primary balance surpluses, which average to 1.314%. Of course, this is open to debate, it's unclear at which point a country should start to 'care' about its direct fiscal response to marginal debt increases. One of the only formal critical values of debt sustainability was proposed in the Maastricht treaty. The founders explicitly stated that any debt-to-GDP above 60% should impose concern regarding debt sustainability (Council of the European communities, 1992). It is therefore more than logical to assume this value as the moment at which countries should 'care' about their fiscal response to debt accumulation. Especially because this limit is imposed as a formal standard, as it is heavily backed up by research. The current debt of Denmark is 43,42% of GDP, which is quite a bit lower than 60%. Also, the debt ratio has only been slightly above this critical value for 7 out of 28 years. According to this logic and the foregoing analysis, we can conclude that Denmark has a sustainable debt.

Anyhow, it's clear that a second flaw of the Bohn (1998) test has been found, but it comes down to the same problem which was discovered earlier. The model simply does not take current debt and primary surplus levels into account. Just like the extreme theoretical example which was constructed in the section of Japan, one can be created here as well. Imagine a country that has a steadily decreasing debt, from 5% of GDP to 0%. This country wouldn't have to care about any appropriate fiscal response, as the debt is already that low. Therefore, the country would probably also come out as unsustainable, due to the non-responsive primary surplus. The Bohn (1998) test seems to run into two flaws. The first flaw is when countries can still prove to be sustainable, despite having extremely high debt and a structural negative primary surplus. The second problem is that countries with seemingly healthy economies can still come out as unsustainable. Both problems come down to one drawback, which entails that the model does not account for actual debt and primary surplus levels, and only looks at the changes as opposed to the previous year. In the end, it's important to note that these cases are quite rare, meaning that the Bohn (1998) fiscal reaction function still is a good estimator of fiscal sustainability. Though, it's an interesting topic for further research. The way in which Bohn addressed these problems will be discussed in the 'discussion' section, at the end of the paper. Lastly, an even more extreme case of a country that likely does not have to 'care' about their fiscal reaction is Norway, which is the next country of analysis.

9.3.3 Norway

Norway has a high standard of living when compared to other European countries, which is partly due to the exploitation of natural resources, such as oil and gas (Bjornland, 1998). Norway has the highest average primary surplus of all 13 countries (6.04%), meanwhile being the only country that exceeded a primary surplus of 15% of GDP, reflected in figure 10. Norway is an even more extreme example than Denmark. The country ends with approximately the same debt-to-GDP in 2020 of 41.4%, but shows more balanced management. One of the most outstanding facts is that Norway had a decrease of debt in the years around the credit crisis of 2008. This shows their ability to cope with times of economic contraction. Also, note that the debt in 2019 has barely increased as a result of the COVID-19 pandemic. Norway seems to have the healthiest economic conditions for sustainable debt, but the country is still part of the 0-0 countries.

Again, the complete estimation does not make much sense. Norwegian debt comes out as completely unsustainable, while figures 9 and 10 prove that Norway has one of the best debt and primary surplus scores out of all countries. The b(t-1) p-value was 0.995 for 1992 to 2019, and 0.869 for 1992-2026, showing how insignificant the results actually were. Norway is another country, just like Denmark, which simply proves to not 'care' about the fiscal reaction to debt accumulation. This statement is heavily backed up by the fact that the Norwegian government currently holds more assets than liabilities, represented by a negative net debt (IMF, 2021). Whether this behaviour is justified can be

determined with the same criterion as used for Denmark. The debt-to-GDP is, and has been, far under the imposed 60% of the Maastricht treaty, namely 41,4% in 2020. This means we conclude that Norway's sovereign debt is sustainable.

9.3.4 Finland

The last country which will be analysed is Finland, proving to be one of the most complicated cases out of the 0-0 countries. The debt accumulated (figure 9) from 39.29% in 1992 to 67.1% in 2020, sums up to a moderate increase of 27.81. Just like the other North-European countries, the estimation for Finland shows extremely insignificant results. The extremely low R-squared and the insignificant variables prove that the model does not fit the case of Finland. Even though Finland has been under the 60% benchmark for a big portion of the time, its current debt-to-GDP ratio is 67,1%. Considering that the IMF (2021) expects that this will rise to 71.17% in 2026, we can convincingly say that Finland should be concerned about its fiscal response in the future. However, the regression was estimated for the complete samples of 28 and 35 years. Finnish debt has only been above the critical value for 4 out of 28 years. Taking into consideration that a country should only start to be concerned at the moment when the debt exceeds 60%, we can only essentially analyse those four years. The IMF predicts that the debt ratio will be above 60% for all the years from 2020 up till 2026. So if the forecasted years are included, the analysis can be done over 11 years. However, time windows as such are too short to get reliable results. Hence, there can't be enough evidence collected to determine whether the Finnish debt is sustainable. Although, what we do know is that the following years will be important for Finland, because when the debt ratio keeps increasing, while the country does not take corrective actions through the primary balance, the country could be heading in a direction with an unsustainable debt policy.

9.4 Panel data estimation

To provide additional evidence on whether the shifting paradigm towards high debt ratios is justified, a panel data test will be performed. The goal of the estimation is to test whether an estimation over the complete sample of 13 countries will show a significant sufficient fiscal reaction. At this point, an aggregated sustainable public debt is expected, because most individual countries demonstrated to have sustainable fiscal policy. The test is performed using functional form 2 from the methodology section. First, the Hausman test will be performed to judge whether a random effects or fixed effects model should be used. The Hausman test statistic for the 1992-2019 period is 3.39 with a p-value of 0.3352, and the 1992-2026 model has a statistic of 4.72 with the p-value being 0.1936, meaning that at a 10% confidence level we can assume that the random effects model is not biased in both cases. Therefore, the random effects model is used to estimate the regression. The output can be found in figure 12.

Panel data estimation	(1992-2019)	(1992-2026)
All countries	S(t)	S(t)
b(t-1)	0.070***	0.144***
	(0.020)	(0.019)
GVAR	-0.592***	-0.757***
	(0.073)	(0.070)
YVAR	0.127	0.643***
	(0.110)	(0.109)
Constant	-0.182*	-0.265**
	(0.107)	(0.107)
Observations	364	455
Number of countries	13	13
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Figure 12: Panel data regression output for all countries

The panel data estimation shows compelling results. The GVAR variable shows negative and highly significant in both cases, while the YVAR variable is positive and only significant for the 1992-2026 sample. The most important part is represented by the b(t-1) coefficient, which is significant at the 1% level for both countries. The coefficient values are 0.07 and 0.144. These relatively small coefficients indicate a light, but sufficient, form of mean reversion. The aggregated sample of the 13 countries proves that sustainable fiscal policy is still highly present within these advanced countries. With focus on the recent concerns regarding the consistent accumulation of debt by most advanced countries, this finding should be somewhat comforting.

9.5 Evaluation

The results are summarized in figure 13 below. The Bohn (1998) fiscal reaction function test results are in the first and second column. The notation ‘x’ means that the b(t-1) coefficient was significant on at least the 10% level, and the notation ‘-‘ means that the b(t-1) coefficient for the fiscal reaction function test was not significant for that time period. The final judgement has been made primarily based on the fiscal reaction function test, as well as on additional analysis whenever the first results indicated no conclusive evidence. The judgement ‘yes’ means that a convincing majority of the evidence was in favour of sustainability, while ‘no’ means that a convincing majority of the evidence was against sustainability. Finland and Belgium show as inconclusive, as those were the only countries without convincing evidence in favour or against sustainable government debt. Though, something which has become clear is that the coming years will be vital for Finland to determine whether its debt is sustainable or not. The countries for which the final judgement solely has been made on the original

Bohn (1998) test are Germany, Greece, Japan, Portugal, Spain, the UK, and the USA. Additional analysis and testing was required for Belgium (Inconclusive), Denmark, Finland (inconclusive), France, Italy, and Norway.

	1992-2019	1992-2026	Final judgement
Belgium	-	x	Inconclusive
Denmark	-	-	Yes
Finland	-	-	Inconclusive
France	-	x	Yes
Germany	x	x	Yes
Greece	-	-	No
Italy	-	x	No
Japan	x	x	Yes
Norway	-	-	Yes
Portugal	x	x	Yes
Spain	x	x	Yes
UK	x	x	Yes
USA	x	x	Yes
All countries	x	x	Yes

Figure 13: Summary of test estimations for the two time horizons and final judgement.

Despite the high rise of sovereign debt for most advanced countries, only 2 out of 13 countries show significant signs of unsustainable debt, mostly based on the evidence coming from the fiscal reaction function test of Bohn (1998). This strengthens the claim that countries are exceeding the imposed debt limits while still maintaining sustainable fiscal policy. Based on these results, it's hard to make any statements regarding the differences between non-, North-, Central, and South-European countries. The only two countries with unsustainable debts are South-European countries, which could indicate a discrepancy. However, this doesn't indicate that there are any fundamental differences among the regions only looking at debt sustainability itself. Nevertheless, detailed analysis of the individual countries proved that North-European countries tend to show more healthy debt levels and higher primary surpluses than Central-, South, and Non-European countries.

As a final note, it's challenging to compare the results of this inquiry with previous research. As mentioned, different research methods and different time horizons lead to a broad base of contradicting results for a decent amount of countries. Anyhow, to get a general impression, the final judgements are mostly in line with previous literature for Denmark, Germany, Greece, Italy, Norway, Spain, the UK, and the USA. Belgium and Finland cannot be compared due to inconclusive results.

The results from this paper for Portugal show contradicting results to previous literature (e.g. Mendoza et. al., 2011). Lastly, previous literature for Japan and France is quite equally divided (e.g. Payne, 1997; Corsetti and Roubini, 1991; Mendoza et. al., 2011). For Japan, this can be explained by the fact that research that is based on the fiscal reaction often finds mean reversion, while research based on co-integration and unit root tests often finds no sustainability. France could be seen as a relatively doubtful case, which was also experienced in this inquiry. However, due to the highly significant slow fiscal response of France, convincing evidence was acquired to prove that France does have a sustainable fiscal policy.

10. Conclusion

What can we say about public debt sustainability in 13 selected OECD countries in view of the unprecedented rise in debt levels, partly as a result of the COVID-19 crisis, and the possibly shifting theoretical paradigm on sustainable debt levels?

This paper commenced with insights into the historical development of public debt theory and showed that recent trends are not in line with what we assumed to be sustainable debt levels. There has been a growing acceptance for debt accumulation through the years. From denying the effectivity of public debt within classical economics, to promoting debt acquisition when used correctly by Keynesian economics, and ending at seeing debt levels as conditionally irrelevant by modern monetary theory. The interest rate drop has made the governments realise that this is the time to invest, reflected by significant gross debt increases. This paper has attempted to analyse and provoke a new theoretical paradigm regarding debt policy. This paradigm has subsequently found substantial evidence in the empirical section. The results show that elevated sovereign debts don't necessarily have to indicate unsustainable fiscal policies. The fiscal reaction function test proves that adequate fiscal policy can secure long-term solvability. Countries showing adherence to the intertemporal budget constraint are not exposed to budgetary mismanagement, suggesting that exploitation of the historically low interest rates is justified. According to the fiscal reaction function and additional analysis, 9 out of the 13 countries have sustainable debt, while 2 countries show an unsustainable debt, and 2 countries have inconclusive results. The panel data estimation adds additional proof that governments are jointly complying with the imposed requirement of a sustainable debt. The fact that a high majority of the countries show sustainable debt policy implicates that there is sufficient justification for the debt sustainability necessity within the new paradigm. This inquiry also attempted to assess what the effect of the COVID-19 outbreak will be on the sustainability of gross national debt. Surprisingly, the complete opposite of what was expected occurred, taking this research in a totally different direction. The inclusion of the pandemic period and its aftermath gave rise to a stronger mean reversion process for 11 out of 13 countries, while 4 out of 9 countries disclosed a significant structural break. The IMF forecasts heavily indicate that countries will recuperate, which is why most countries showed a

stronger fiscal reaction. Whether this finding is justified has to be proven by the way in which countries recover the coming years. In summary, it has become evident that a shift of the conventional paradigm is taking place, represented by the situational changes and the evolution of thought regarding sustainable public debt.

11. Discussion

Gross debt vs net debt and intragovernmental holdings

The deliberate choice has been made to use gross public debt instead of net public debt. Despite the fact that most arguments were in favour of this choice, net public debt also has its advantages. Including government holdings can give a better representation of the financial state of governments. As an example, Norway currently has a substantial negative debt when looking at net government debt, while Italy is still far into the positives (IMF, 2021). Countries could have a high degree of financial assets, essentially counteracting the debt the country is in. When omitting financial assets, the risk could arise that the complete oversight is ignored. On top of this, central banks and other parts of the government are often big holders of government debt. Due to the extensive QE policies of the central banks, the amount of debt holdings by central banks has only increased over the last years. This could potentially also fit into the new paradigm, as this change has simultaneously happened during the paradigm shift of the last decades. Therefore, it could be interesting to study the sustainability of net public debt, while taking out intragovernmental holdings. This could show interesting results, especially with an eye on the shifting paradigm, which is why this research suggests this topic for future research.

YVAR variable

The YVAR variable has proven to not be the best non-debt determinant of the primary surplus. Most countries had an insignificant YVAR variable, which shouldn't have a big impact on the reliability of the results. However, it could have been better if a different variable was included, chosen through literature research. The main goal of the inquiry was to stay as close to the Bohn (1998) test as possible, which is why the same non-debt determinants were used. Though, the most interesting finding is that the YVAR variable was insignificant for both time periods for the USA, which is the same country as studied in Bohn (1998). Potentially, recent developments could indicate that the determinants of the primary surplus have changed as opposed to the years before 1998. Future research should include a different non-debt determinant instead of the YVAR variable.

Limitations of the fiscal reaction function

To recall, this paper stumbled upon two problems when examining the fiscal response of governments through the Bohn (1998) fiscal reaction function test. The first problem was that countries can prove to

have sustainable debt while having structural primary surplus deficits and a highly increasing debt. The second problem is when countries have the combination of a very low sovereign debt and a really healthy primary balance. These countries are structurally below the imposed 60% limit of the IMF, meaning it simply doesn't matter whether countries show a direct fiscal response. The Bohn test will potentially not show a significant fiscal response. Those countries have healthy fiscal policies, meaning they don't have to exhibit a significant direct fiscal response. Both these problems come down to one flaw of the fiscal reaction function test, namely that actual debt and primary balance levels aren't in the analysis.

Bohn specifically stressed that this test can be interpreted as a new and good test for testing the sustainability of fiscal policy. 'Finally, I show that an estimated positive response of primary surpluses to the debt-GDP ratio can be interpreted as a new test for the sustainability of U. S. fiscal policy' (Bohn, 1998, p. 962). Before 1998, unit root tests were often used on actual debt levels to test whether actual debt levels were stationary. These tests account for the earlier mentioned problems by definition, as they test the time series of sovereign debts themselves. However, Bohn refutes these tests, for example with the following statement: 'The paper shows that the unit root tests are inconsistent and misleading because they do not properly adjust for fluctuations in GDP and in government spending' (Bohn, 1998, p.962). Bohn showed that standard unit root tests are weak when assessing public debt sustainability (Berti et. al., 2016). Later, Bohn recognizes that simply refuting stationarity tests is unjustified, for example in Bohn (2005) and Bohn (2007). However, he still mentions that tests on the intertemporal budget constraint are preferred, as rejections of sustainability based on non-stationary debts, deficits, revenues or spending are not valid (Bohn, 2007).

Anyhow, this paper has found a solution to the question of when countries should start to show a direct fiscal response. A highly grounded and formal limit of the Maastricht treaty was used to determine when countries should show concern about their rising debt, imposing a lower debt limit of 60% of GDP. The fiscal reaction function was used to determine how this concern should be expressed. Regarding the upper limit, this paper has not found a solution at which point a direct fiscal response is not enough anymore. As the fictional example in the section of Japan showed, countries with extremely unhealthy looking debts and primary deficits will at some point go into default, despite potentially coming out as sustainable when the Bohn test is used. However, in this research, it's assumed that the most extreme practical case of Japan itself will not be exposed to this problem yet, as the actual underlying macroeconomic variables are seemingly not drastically unhealthy. It's hard to set this upper limit, as it's a whole research in itself. Therefore, this is suggested as a topic for future research. Although, a more challenging topic would be to adjust the fiscal reaction function in order to take actual debt and primary surplus figures into account, such that both the direct fiscal response and the real macroeconomic variables can be studied within one model.

References

Aldama, P., Creel, J. (2019). Fiscal policy in the US: Sustainable after all? Economic modelling, Vol. 81: 471-479.

Arner, D.W. (2009). The Global Credit Crisis of 2008: Causes and Consequences. International Lawyer. Vol. 43(1): 91-136.

Baltas, N. (2013). The Greek financial crisis and the outlook of the Greek economy. Journal of Economic Asymmetries. Vol. 10(1): 32-37.

Bank of England. (2021). What is quantitative easing an how does it work? Retrieved on 10-07-2021, from: https://www.bankofengland.co.uk/faq/inflation-and-interest-rates

Bank of Japan. (2021). The Bank of Japan's Policy Measures during the Financial Crisis. Retrieved on 21-03-2021, from: https://www.boj.or.jp/en/mopo/outline/cfc.htm/

Barro, R J. (1979). On the Determination of Public Debt. Journal of Political Economy, Vol. 87(5): 940-971.

Berti, K., Colesnic, E. Desponts, C., Pamies, S., Sail, E. (2016). Fiscal Reaction Functions for European Union Countries. European commission, discussion paper 028. Retrieved on 12-08-2021, from: https://ec.europa.eu/info/sites/default/files/dp028_en.pdf

Bilan, I. (2016). Overview of the main theories on the economic effects of public indebtedness. EIRP Proceedings, Vol. 11, retrieved on 28-03-2021, from http://www.proceedings.univ-danubius.ro/index.php/eirp/article/view/1735/1844

Bjornland, H.C. (1998) The economic effects of North Sea oil on the manufacturing sector. Scottish Journal of Political Economy. Vol. 45(5): 553-583.

Bloomberg. (2021). Government Bond Yields. Retrieved on: 21-03-2021, from: https://www.bloomberg.com/markets/rates-bonds/government-bonds/japan

Bohn, H. (1995). The sustainability of budget deficits in a stochastic economy. Journal of Money, Credit and Banking, Vol. 27(1): 257-271.

Bohn, H. (1998). The behaviour of US public debt and deficits. The Quarterly Journal of Economics. Vol. 113(3): 949-963.

Bohn, H. (2005). The sustainability of Fiscal Policy in the United States. CESIFO Working Paper No. 1446.

Bohn, H. (2007). Are stationarity and cointegration restrictions really necessary for the intertemporal budget constraint? Journal of Monetary Economics. Vol. 54(7): 1837-1847.

Born, B., Müller, G., Schularick, M., Sedláček, P. (2019). £350 million a week: The output cost of the Brexit vote. Centre for Economic Policy Research. Retrieved on 24-07-2021, from https://voxeu.org/article/300-million-week-output-cost-brexit-vote

Brady, G.L. (2020). Modern Monetary Theory: Some Additional Dimensions. Athlantic Economic Journal. Vol. 48(1): 1-9.

Briceno, H.R., Perote, J. (2020). Determinants of the Public Debt in the Eurozone and Its Sustainability Amid the Covid-19 Pandemic. Sustainability. Vol. 12(16).

Cecchetti, S.G., Mohanty, M.S., Zampolli, F. (2011). The real effects of debt. BIS working papers, no 352. Retrieved on 30-07-2021, from: https://www.bis.org/publ/othp16.pdf

Chouraqui, J-C., Jones, B., Montador, R.B. (1986). Public debt in a medium-term context and its implications for fiscal policy. OECD working paper No. 30, retrieved on: 02-04-2021, from: https://www.oecdilibrary.org/docserver/628367225815.pdf?expires=1617294388&id=id&accname= uest&checksum=4DC8B668823B45DEE71641FF8BD0319F

Chu. T.T., Holscher, J., McCarthy, M. (2020). The impact of productive and non-productive government expenditure on economic growth: an empirical analysis in high-income versus low- to middle-income economies. Empirical Economics. Vol. 58(5): 2403-2430.

Congressional Budget Office (2021). The 2021 long-term budget outlook, at a glance. Retrieved on 26-03-2021, from: https://www.cbo.gov/publication/57038

Corsetti, G., Roubini, N. (1991). Fiscal Deficits, Public Debt, and Government Solvency: Evidence from OECD Countries. NBER Working Paper: No. 3658.

Council of the European communities (1992). Treaty of European Union. Luxembourg: Office for Official Publications of the European Communities. Retrieved on 21-03-2021, from: https://europa.eu/european-union/sites/europaeu/files/docs/body/treaty_on_european_union_en.pdf

Cruces, J. J., Trebesch, C. (2013). Sovereign Defaults: The Price of Haircuts. American Economic Journal: Macroeconomics, Vol. 5 (3): 85-117.

Debrun, X., Ostry, J. D., Willems, T. & Wyplosz, C. (2018). “Sovereign Debt: A Guide for Economists and Practitioners”. Chapter 4. Public debt sustainability. Retrieved on 02-04-2021, from: https://www.imf.org/~/media/Files/News/Seminars/2018/091318SovDebt-conference/chapter-4-debt-sustainability.ashx

Debrun, X., Ostry, J. D., Willems, T. & Wyplosz, C. (2019a). Public Debt Sustainability, CEPR Discussion Papers 14010, C.E.P.R. Discussion Papers.

Debrun, X., Ostry, J. D., Willems, T. & Wyplosz, C. (2019b). The art of assessing public debt sustainability: Relevance, simplicity, transparency. Retrieved on: 26-03-2012, from: https://voxeu.org/article/art-assessing-public-debt-sustainability

Dietz, S. (2021). Handbook of Financial Risk Management. Journal of the Royal Statistical Society: Series A (Statistics in Society), Vol. 184 (1): 402-403.

Dustmann, C., Fitzenberger, B., Schönberg, U., Spitz-Oener, A. (2014). From Sick Man of Europe to Economic Superstar: Germany's Resurgent Economy. Journal of Economic perspectives. Vol. 28(1): 167-188.

Elmendorf., W., Mankiw, G. (1998). Government debt. NBER working paper series. Working paper 6470. Retrieved on 28-07-2021, from https://www.nber.org/system/files/working_papers/w6470/w6470.pdf

Eulerhermes. (2021) France, country rating. Retrieved on 26-07-2021, from: https://www.eulerhermes.com/en_global/economic-research/country-reports/France.html

European Commission (2020). Debt sustainability monitor 2020. Institutional Paper 143. Retrieved on 12-07-2021, from: https://ec.europa.eu/info/sites/default/files/economy-finance/ip143_en.pdf

European commission. (2021). Post-Programme Surveillance Report Portugal, Spring 2021. Institutional paper 152. Retrieved on 16-07-2021, from: https://ec.europa.eu/info/sites/default/files/economy-finance/ip152_en.pdf

Filip, B.F. (2019). Determinants of public debt. The case of the European Union countries. Theoretical and Applied Economics, Vol. 0 (special): 61-70.

Forbes. (2020). What Does The U.K. Government Think About Its Financial Sustainability? Retrieved on 24-07-2021, from https://www.forbes.com/sites/robwhiteman/2020/08/04/what-does-the-uk-government-think-about-its-financial-sustainability/?sh=7f3bc28a3eb3

Fortre, F., Fedeli. S., Beqiraj. El. (2018). Public debt sustainability: an empirical study on OECD countries. Journal of macroeconomics, Vol. 59: 238-248.

Galli, E., F. Padovano (2008). Sustainability and Determinants of Italian Public Deficits before and after Maastricht. CESifo Working paper series 1391.

Górniewicz, G. (2013). The problem of public debt (the case of Spain). Toruńskie Studia Międzynarodowe. Retrieved on 12-07-2021, from: https://www.researchgate.net/publication/269629284_The_problem_of_public_debt_the_case_of_Spain

Grant, R. Brue, S. (2012). The Evolution of Economic Thought. Cengage Learning Inc.

Greimer, A. Kauermann, G. (2008). Debt policy in euro area countries: Evidence for Germany and Italy using penalized spline smoothing. Economic Modelling, Vol. 25 (6): 1144-1154.

Greiner, A., Semmler, W. (1999). An Inquiry into the Sustainability of German Fiscal Policy: Some Time-Series Tests. Public Finance Review, Vol. 27 (2): 220-236.

Eurostat. (2018). Net government debt. European commission, Eurostat statistical working paper, retrieved on 02-04-2021, from: https://ec.europa.eu/eurostat/documents/3888793/5858885/KS-TC-14-005-EN.PDF/dc48be06-9e44-4cb9-b544-876457437955

Hakura, D. (2020). What is debt sustainability? International Monetary Fund. Retrieved on 26-03-2021, from https://www.imf.org/external/pubs/ft/fandd/2020/09/what-is-debt-sustainability-basics.htm

Harrison, V. Lakios, C. (2015). Greece defaults on $1.7 billion IMF payment. CNNMoney. Retrieved on 01-04-2021, from: https://money.cnn.com/2015/06/30/news/economy/greece-imf-default/index.html

Huston, J.H., Spencer, R.W. (2016). The Wealth Effects of Quantitative Easing. Atlantic Economic Journal. Vol. 44(4): 471-486.

IMF. (2020). General government gross debt, Percent of GDP. Retrieved on 26-03-2021, from: https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/USA?year=2020

IMF. (2021). World Economic Outlook Database, April 2021. Retrieved on 27-07-2021, from: https://www.imf.org/en/Publications/WEO/weo-database/2021/April

Kahn, J.A. (2011). Can We Determine the Optimal Size of Government? Center for global liberty & prosperity, development policy briefing paper no7.

Keynes, J.M., (1923). A Tract on Monetary Reform. The Collected Writings of John Maynard Keynes, Macmillan, Vol. 4 (1971).

Krugman, P. (2009). How did economists get it so wrong? New York Times. Retrieved on 28-07-2021, from: https://www.nytimes.com/2009/09/06/magazine/06Economic-t.html

Krugman, P. (2015). Debt Is Good. The New York Times. Retrieved on 12-07-2021, from: https://www.nytimes.com/2015/08/21/opinion/paul-krugman-debt-is-good-for-the-economy.html

Laursen, F., Andersen, T. (2018). Denmark country report. Sustainable Governance Indicators 2018. Retrieved on 27-07-2021, from https://www.sginetwork.org/docs/2018/country/SGI2018_Denmark.pdf

Lennkh, A., Bartels, B., Vasse, T. (2019). The rise of central banks as sovereign debt holders: Implications for investor bases. SUERF Policy Note, no 109. Retrieved on 13-08-2021, from https://www.suerf.org/policynotes/8431/the-rise-of-central-banks-as-sovereign-debt-holders-implications-for-investor-bases

Lukkezen, J., Rojas-Romagosa. (2013). Stochastic debt sustainability indicators. Revue de l'OFCE, 1(1): 97-121. Retrieved on 27-03, from: https://doi.org/10.3917/reof.127.0097

Macdonald, R. (1992). Some tests of the government's intertemporal budget constraint using US data. Applied economics, Vol. 24 (12): 1287-1292.

Makrydakis, S., Tzavalis, E., Athanassios, B. Policy regime changes and the long-run sustainability of fiscal policy: an application to Greece. Economic modelling, Vol. 16 (1): 71-86.

Mendoza, E.G., Ghosh, A., Kim, J.I.,Ostry, D., Qureshi, M.S. (2011). Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies. NBER Working Paper, No: 16782.

OECD. (2013). OECD work on statistics. Retrieved on 27-03-2021, from: http://www.oecd.org/sdd/OECD-Work-on-Statistics-brochure2013.pdf

OECD (2021a). General government debt. Retrieved on 26-03-2021, from: https://data.oecd.org/gga/general-government-debt.htm

OECD. (2021b). Long-term interest rates (indicator). Retrieved on 30-07-2021, from: https://data.oecd.org/interest/long-term-interest-rates.htm#indicator-chart

Palley, T. (2015). Money, Fiscal Policy, and Interest Rates: A Critique of Modern Monetary Theory. Review of Political Economy. Vol. 27 (1).

Paola, C., Giancarlo, M. Alessandro, P. (2020). Financial Crisis and Sustainability of US Fiscal Deficit: Indicators or Tests? Journal of Policy Modelling, Vol. 42 (1): 192-204.

Payne, J., 1997. International Evidence on the Sustainability of Budget Deficits. Applied Economic Letters, No.12.

Petrovic, P., Milojko, A., Nojkovic, A. (2021). Increasing Public investment can be an effective policy in bad times: evidence from emerging EU economies. Economic modelling, Vol. 94: 580-597.

Rogoff, K.S., Reinhart, C.M. (2010). Growth in a time of debt. American Economic Review: Papers & proceedings, Vol. 100(2): 573-578.

Rosen, H. Gayer, T. (2014). Public finance. 10th edition. New York, Mcgraw-Hill Education.

Statista. (2021). Japan: National debt from 2015 to 2025 in relation to gross domestic product. Retrieved on 21-03-2021, from: https://www.statista.com/statistics/267226/japans-national-debt-in-relation-to-gross-domestic-product-gdp/

Statistics Finland. (2020). Structural change of the economy. Retrieved on 27-07-2021, from https://www.stat.fi/tup/suoluk/suoluk_kansantalous_en.html

United Nations Conference on Trade and Development (UNCTAD). (2008). Domestic and External Public Debt in Developing Countries. Discussion paper No. 188. Retrieved on 02-04-2021, from: https://unctad.org/system/files/official-document/osgdp20083_en.pdf

United States Department of the Treasury. (2021). The debt to the penny. Retrieved on 02-04-2021, from: https://fiscaldata.treasury.gov/datasets/debt-to-the-penny/debt-to-the-penny

Wray, R.L., Nersisyan, Y. (2021). Has Japan Been Following Modern Money Theory Without Recognizing It? No! And Yes. Levy Economics Institute, working paper no 985. Retrieved on 30-07-2021, from: http://www.levyinstitute.org/pubs/wp_985.pdf

Appendix

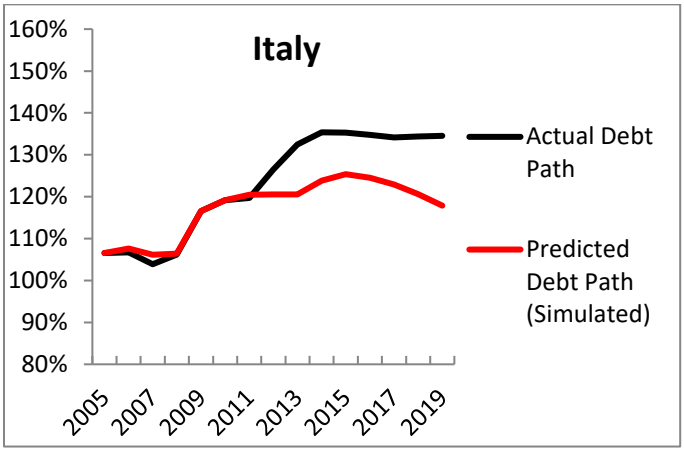


Figure 14: Actual and predicted gross debt-to-GDP path from 2005-2019 for Italy.

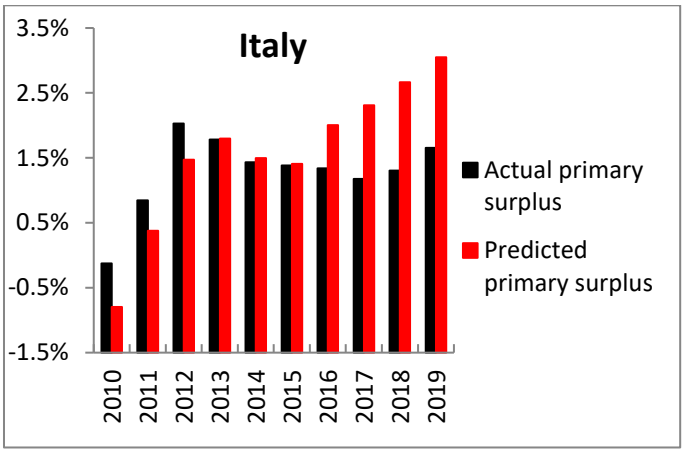


Figure 15: Actual and predicted Primary Surplus-to-GDP from 2010-2019 for Italy.

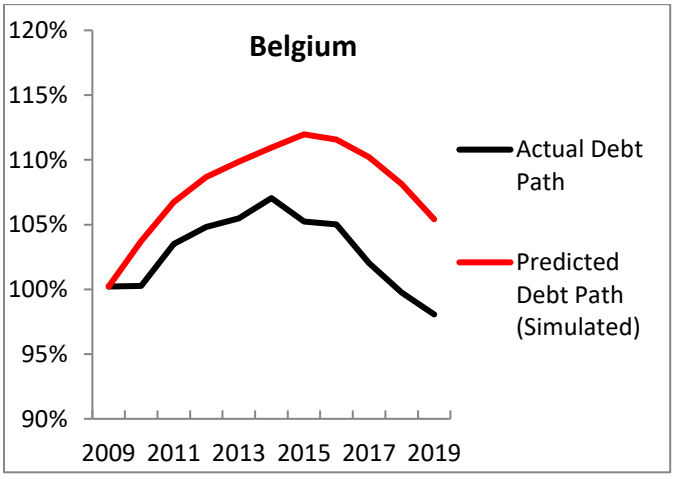


Figure 16: Actual and predicted gross debt-to-GDP path from 2009-2019 for Belgium.

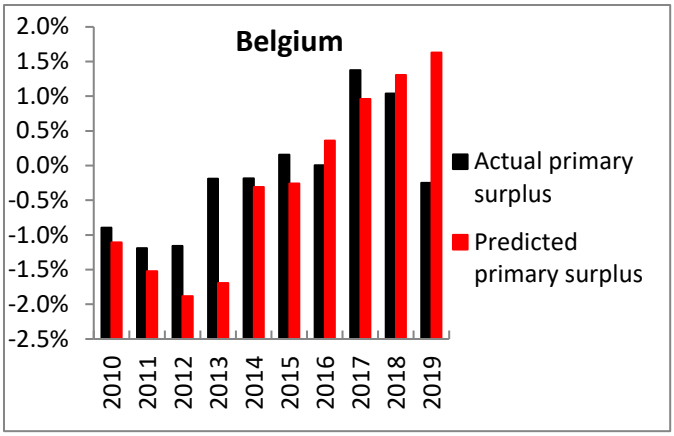


Figure 17: Actual and predicted Primary Surplus-to-GDP from 2010-2019 for Belgium.

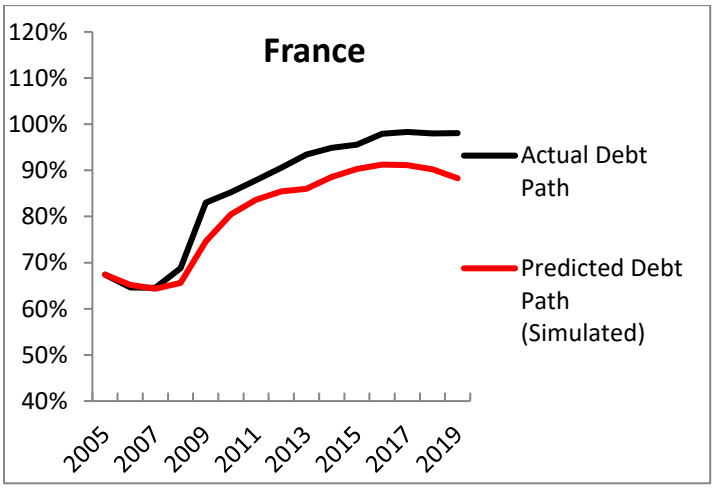


Figure 18: Actual and predicted gross debt-to-GDP path from 2005-2019 for France.

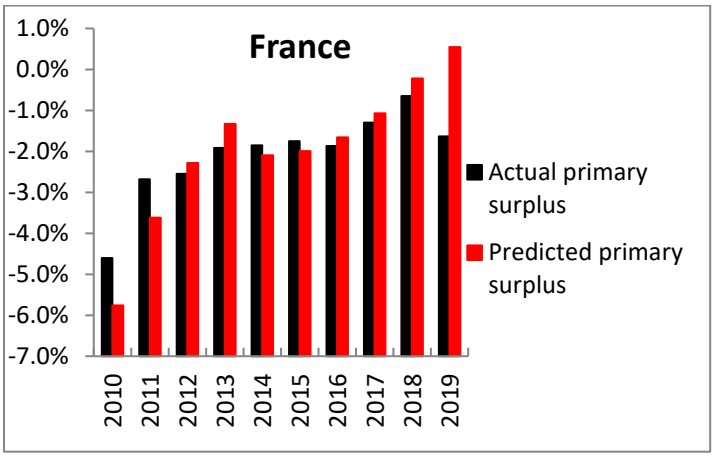


Figure 19: Actual and predicted Primary Surplus-to-GDP from 2010-2019 for France.