Greek Debt Crisis: A Complete Story*

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Abstract

The Greek debt crisis stands out as a compelling case study of a severe financial crisis in a developed country within a currency zone. Despite the abundance of literature on the subject, the significance of debt accumulation in the 1980s is often overlooked, and details are frequently omitted. Through an analysis of data gathered from Greece's public finance statistical yearbooks spanning from 1962 to 2008, it is observed that the Greek government utilized both domestic and foreign loans to fund investment programs starting in 1957. Additionally, loans were employed to finance a significant increase in current expenditure from 1981 onward. Both the cointegration test and fiscal reaction function test not only confirm that the Greek government debt deviates from the ad hoc sustainability requirement between 1957 and 2008 but also indicate that this deviation was evident since 1974.

Keywords: debt sustainability, primary deficit, cointegration test, fiscal policy
JEL Codes: E20, E58, E60

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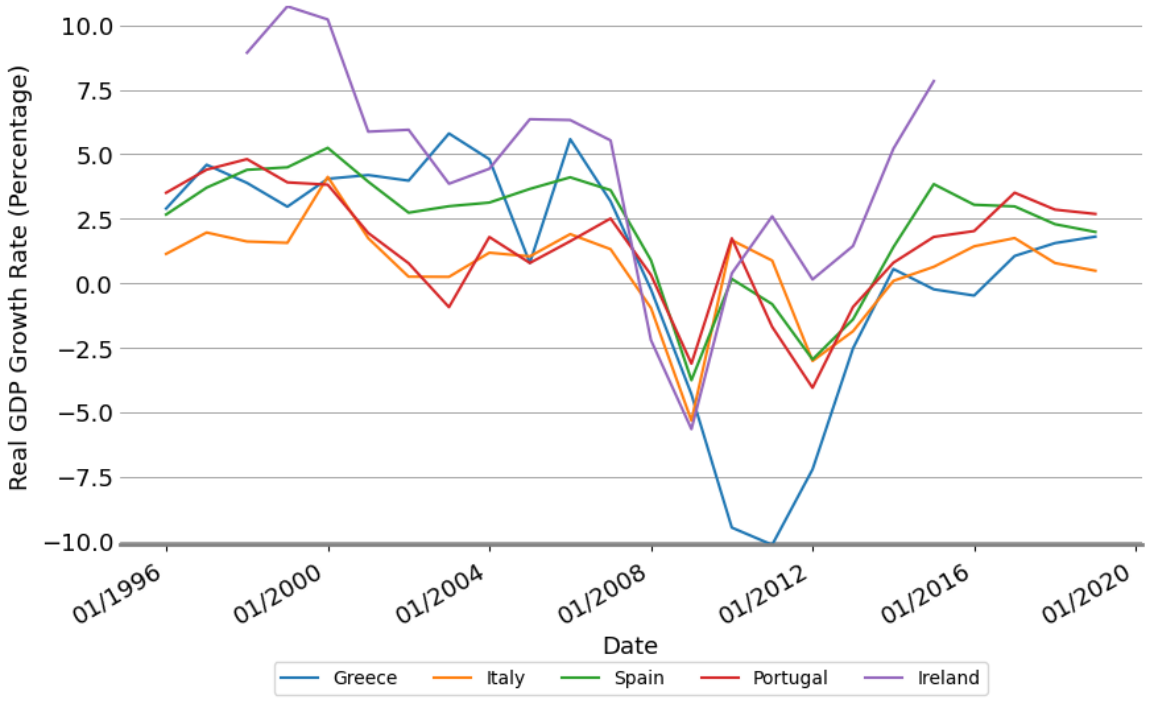
1 Introduction

The initial two decades of the twenty-first century have posed significant challenges to public finance. Governments faced a daunting task of stabilizing economies during the 2007-08 financial crisis, resulting in historically high levels of government debt. Even before a full recovery from this crisis, the global economy was challenged once again by the COVID-19 pandemic. As a consequence, many governments now teeter on the brink of bankruptcy, making a series of government debt crises seemingly inevitable. To examine the pertinent issue of government debt crises, delving into historical cases becomes imperative. This paper intends to revisit a crisis that remains vivid in the memories of many: the Greek debt crisis.

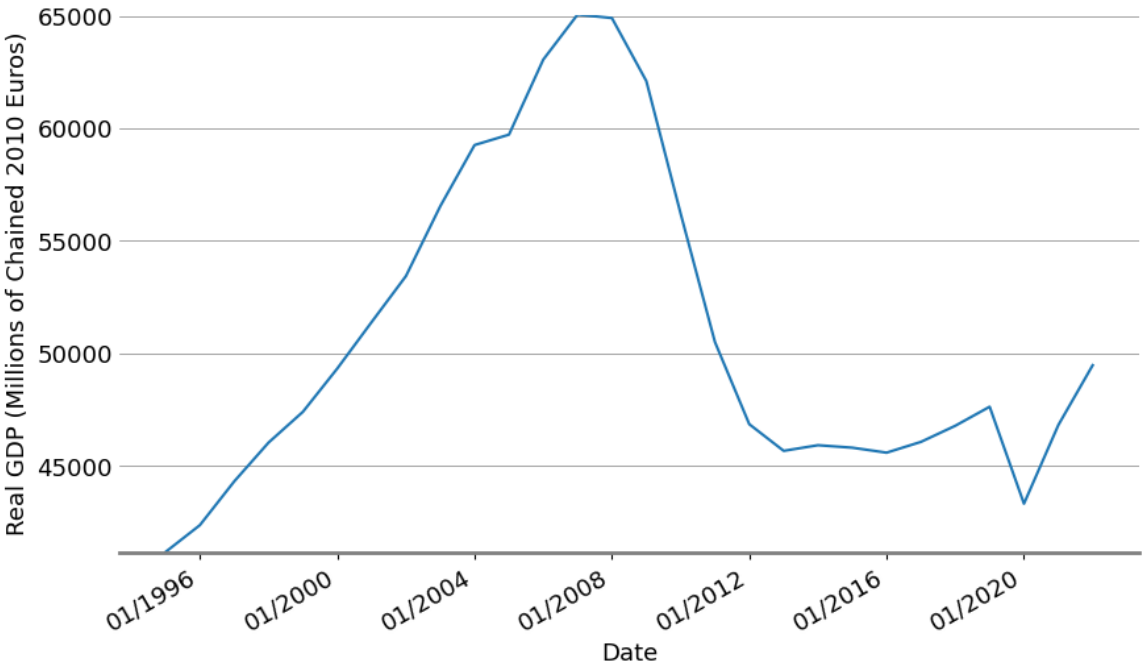
Figure 1: Real GDP Growth for Greece, Ireland, Italy, Portugal, and Spain



The Greek debt crisis emerged subsequent to the 2007-08 financial turmoil when the newly elected Prime Minister George Papandreou disclosed that Greece's budget deficit far surpassed previous estimates. This crisis acted as a catalyst, sparking a larger debt crisis across the Eurozone. The Greek debt crisis stands out as an interesting case study for several reasons:

Debt crisis In A Developed Country: Most previous sovereign debt crises happened in developing countries. When Greek debt was on the edge of default in 2010, many economists still believed that default in advanced economies was unlikely (Cottarelli

Figure 2: The Real GDP of Greece



et al. [2010]).

Financial Contagion: The Greek debt crisis had a contagious effect, spreading to other financially vulnerable countries in the Eurozone, such as Portugal, Ireland, Italy, and Spain.

Severe Economic Impact: Greece's debt crisis was one of the most severe economic crises in the EU's history, leading to a deep recession, high unemployment, and a significant decline in Greece's GDP. Figure 1 shows that among the euro area member states that experienced debt crises, Greek economy suffered the deepest and longest recession. Greece's real GDP plunged from the peak of 65 billion (2010 euro) before 2008 to 45 billion (2010 euro) in 2013 (Figure 2).

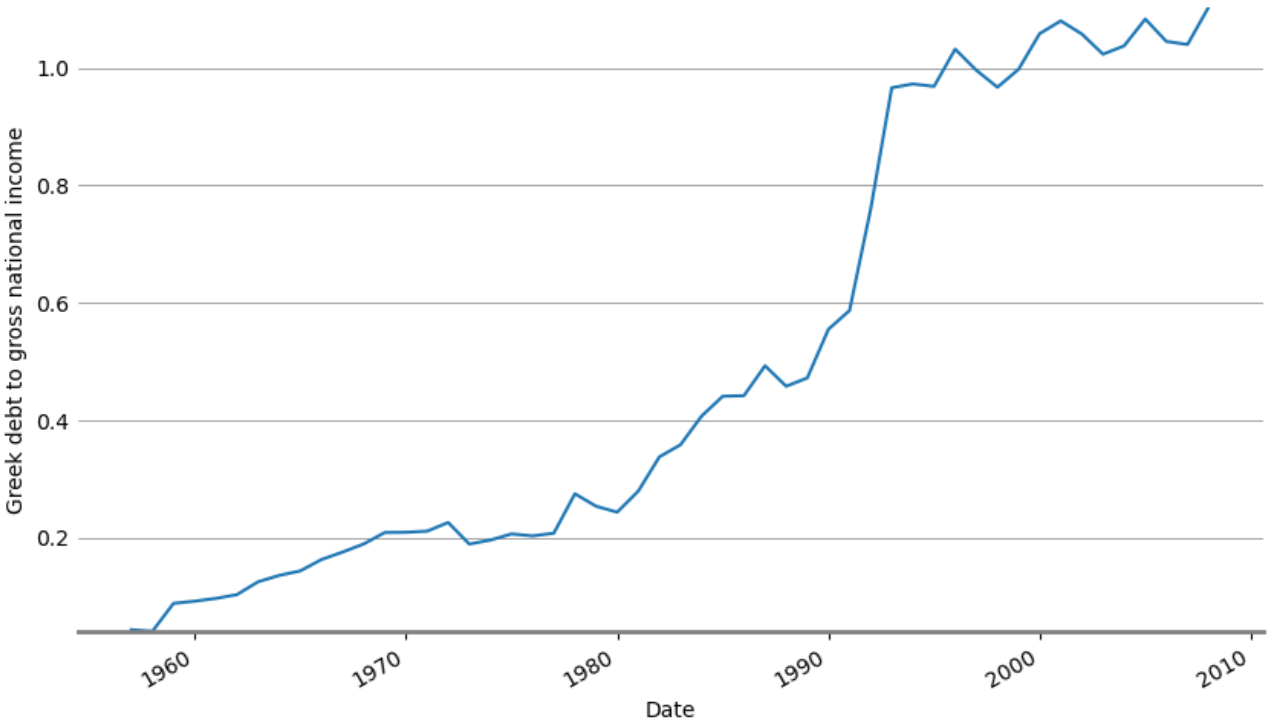
Complex Eurozone Dynamics : The crisis exposed structural issues within the Eurozone, as a single currency was used by countries with vastly different economic strengths and weaknesses. The inability to devalue its currency, a tool often used by countries facing economic difficulties, further complicated Greek economy's recovery.

Austerity Measures: To secure bailout packages from international institutions like the International Monetary Fund (IMF) and the European Central Bank (ECB), Greece had

to implement harsh austerity measures, including tax hikes, spending cuts, and structural reforms. These measures had severe social and political consequences and sparked widespread protests and political unrest.

The Greek debt crisis, along with the broader euro area debt crisis, has garnered considerable attention from the outset, leading to a substantial body of literature that approaches the Greek debt crisis from various perspectives. Noteworthy contributions include Alogoskoufis [2012b], Arghyrou and Tsoukalas [2011], Nelson et al. [2010], Rady [2012], which delve into the root causes and propose rescue plans for addressing the Greek debt crisis. Mink and De Haan [2013] focus on scrutinizing the contagion effects, while Featherstone [2011] and Featherstone [2015] direct their attention to exploring Greece's relationship with the EU and the potential for political reform. Zettelmeyer et al. [2013] provide a comprehensive insight into Greek debt restructuring, and Hawkesworth et al. [2009] investigate the budgeting reform efforts initiated in Greece in 2008. Collectively, these works contribute to a nuanced understanding of the multifaceted issues surrounding the Greek debt crisis.

Figure 3: Greece's debt/GNI ratio



Despite the abundance of literature on the Greek debt crisis, several lingering questions remain without detailed answers. Notably, Figure 3 illustrates that Greece's debt/GNI ratio

was mere 25 percent in 1981 but skyrocketed to 100 percent by 1993. The factors contributing to such a dramatic increase in government debt as a percentage of GNI during that period are not clearly elucidated. Alogoskoufis [2012b]], Alogoskoufis [2021] posit that the surge in government spending played a pivotal role in the accumulation of Greece's government debt throughout the 1980s. However, a more in-depth analysis supported by detailed data would undoubtedly enhance our understanding of this historical period.

Moreover, empirical test methods for evaluating the sustainability of government debt have emerged since the late 1980s. Despite the European Union's rigorous convergence criteria for nations aspiring to embrace the euro and the fiscal oversight applied to countries within the euro area, there is a notable scarcity of research employing these empirical test methods on Greek data[1]. Can these testing approaches ascertain the sustainability of Greece's government debt? If applied to Greece's public finance data, could they have offered adequate early warning signals of the impending crisis? These pivotal inquiries necessitate exploration to gauge the efficacy of existing empirical test methods in predicting and averting crises of this nature.

This paper aims to address two pivotal questions regarding the Greek government debt. Firstly, in order to understand the factors contributing to the rapid accumulation of Greek government debt during the 1980s and 1990s, a meticulous examination of Greece's historical public finance data is essential. Through a detailed analysis of Greece's statistical yearbooks of public finance spanning from 1962 to 2008[2], I have constructed data series encompassing government revenue, expenditure, and debt.

Secondly, I employ two commonly utilized empirical tests to assess government debt sustainability using Greece's public finance data. Specifically, I apply Trehan and Walsh's (Trehan and Walsh [1991]) cointegration test in conjunction with Bohn's (Bohn [2007]) fiscal reaction function test. These tests are employed to scrutinize and evaluate the sustainability of Greece's government debt across different time periods, providing insights into its long-term fiscal viability.

This paper presents several intriguing findings. Firstly, an examination of Greece's histor-

[1] Makrydakis et al. [1999] applied unit roots tests to Greek government debt. The details are in the literature review section

[2] These statistical yearbooks of Greece's public finance are available in the Hellenic Statistical Authority Digital Library

ical public finance data reveals that the Greek government has been relying on loans to fund its investments since 1958, while domestic revenues were initially sufficient to cover current expenditures. However, a significant surge in current expenditure since 1981 necessitated loans to finance a substantial portion of these expenditures.

Secondly, a noteworthy discovery emerges regarding the substantial inclusion of loans as revenue in Greece's budget tables from 1981 onwards[3]. This accounting practice significantly understated the official deficit figures. Importantly, this misleading financial approach persisted even after Greece became a member of the euro-zone. If these loans are excluded from the revenue calculations, the corresponding budget deficits appear considerably larger than the deficit figures reported by various other sources, including the revised data reported by OECD[4].

Thirdly, both the applied empirical test methods confirm the violation of the ad hoc sustainability condition[5] for the period spanning from 1958 to 2008. Furthermore, the results of tests conducted on sub-sample periods suggest that Greece's public finance data fails to meet the ad hoc sustainability condition, even within the time frame of 1958 to 1974. Despite the fiscal consolidation measures implemented from 1994 to 2000, which led to an improvement in Greece's public finance status, the test results indicate that these measures alone are insufficient to meet the requirements of the ad hoc sustainability condition.

This paper contributes to the existing literature from various perspectives. Firstly, it serves as evidence that establishing a robust and transparent system for managing public finance data is not only the initial but also a crucial step in ensuring the sustainability of a government's budget. The crisis in Greece was exacerbated by a lack of transparency and accountability in the budgetary processes.

Secondly, this paper delves into the roots of Greece's debt, tracing it back as early as the 1970s. Through a detailed examination of Greece's public finance data, it becomes evident that a lack of budgetary discipline and excessive spending, particularly during the period from 1981 to 1993, played a significant role in contributing to the crisis.

Thirdly, the paper highlights the effectiveness of empirical test methods in assessing debt sustainability. While these methods can only offer indicative results, their insights prove in-

[3]See Table 6
[4]See Figure 6
[5]The definition is introduced in methodology section.

valuable for the monitoring of fiscal policies and effective budget management.

The paper unfolds as follows: Section 2 will commence with a concise review of the literature pertaining to government debt sustainability, followed by a comprehensive exploration of empirical tests applied in evaluating the sustainability of government debt. Additionally, a summary of prior research on the Greek debt crisis will be presented. Section 3 delves into an examination of Greece's political landscape and fiscal policies post-World War II. Section 4 will analyze data related to various government spending categories and revenue streams, elucidating the trajectory of Greek government budget deficits. Methodological details will be expounded upon in Section 5. Section 6 will unveil the results obtained from empirical tests conducted. Subsequently, Section 7 will delve into an in-depth discussion of the policy implications derived from the findings. Section 8 will conclude.

2 Literature Review

In this section we summarize the literature on the Greek debt crisis, then we give a review of empirical tests of government debt sustainability.

2.1 Literature on the Greek debt crisis

The Greek debt crisis, which began to unfold in the late 2000s, stands as a pivotal case study in modern economics and finance. The crisis raised critical questions about Greece's fiscal sustainability, budget transparency and accountability, the euro zone's effective fiscal surveillance and oversight, and the implications of austerity measures. This subsection summarize the literature on key aspects of the Greek debt crisis.

On the causes of the crisis, a consensus in the literature attributes the immediate cause of Greece's debt crisis to the "sudden stop" of capital inflows due to the 2008 financial crisis. Merler and Pisani-Ferry [2012], Gourinchas et al. [2017], Bordo and James [2014], Lane [2012] all explored the impact of the global financial crisis of 2008 as a catalyst for the escalation of the Greek crisis. The economic downturn created unfavorable conditions, exposing vulnerabilities in Greece's financial system and exacerbating pre-existing issues. However, numerous studies highlight Greece's fiscal mismanagement and structural weaknesses such as a bloated public

sector, a rigid labor market, and inefficient state-owned enterprises, as primary contributors to the crisis. The literature consistently points to the accumulation of public debt as a central element in the crisis. Unsustainable borrowing practices, often masked by creative accounting methods, led to an explosion of government debt, reaching levels that were ultimately unsustainable (Kouretas and Vlamis [2010], Alogoskoufis [2012a], Nelson et al. [2010]). Besides, some economists argues that the euro crisis was not just a fiscal crisis, but also a balance-of-payments crisis (Merler and Pisani-Ferry [2012], Tornell and Westermann [2012], Febrero et al. [2018], Micossi [2016]).

As the largest sovereign debt restructuring in history and the first one in the euro area, Greece's debt restructuring is a complex and multifaceted topic that has garnered significant attention from scholars, economists, policymakers, and international organizations. The restructuring, primarily occurring in 2012, aimed to address the country's unsustainable debt levels and stabilize its economy. Zettelmeyer et al. [2013] provide a thorough account of the context, process and outcome of Greek debt restructuring.

After the broke out of the debt crisis, austerity measures were introduced in Greece as part of the conditions attached to the financial assistance packages provided by international institutions, including the International Monetary Fund (IMF), the European Central Bank (ECB), and the European Commission (EC). The overarching goal was to address Greece's fiscal imbalances, stabilize its economy, and restore investor confidence. While these measures aimed to address fiscal imbalances, their social and economic consequences have been a subject of ongoing debate and analysis (Ifanti et al. [2013], Granados and Rodriguez [2015], Monastiriotis et al. [2013]).

2.2 Literature on government debt sustainability

The government, like households, faces two borrowing constraints, the short run budget constraint and the long run budget constraint. The short run budget constraint can be expressed as

$$T_t + D_t \geq G_t + (1 + i_t) * D_{t-1} \tag{1}$$

where T_t is the nominal tax revenue collected during time period t, D_t is the nominal value of government debt at the end of period t, G_t is government spending, and i_t is the interest rate for one-period government debt issued in period $t-1$. We assume the government only issues one-period bonds.

The short run budget constraint just says that for the government not to default, the sum of tax revenue and newly issued debt should be enough to cover government spending and repayments of outstanding debt.

If the equality is always satisfied in equation (1), then it can be rearranged as

$$D_{t-1} = \frac{T_t - G_t}{1 + i_t} + \frac{D_t}{1 + i_t}. \tag{2}$$

By iterating equation (2) forward, we can get

$$D_{t-1} = \sum_{i=1}^{\infty} \frac{T_{t+i} - G_{t+i}}{(1 + i_{t+i})^i} + \lim_{i \to \infty} \frac{D_{t+i}}{(1 + i_{t+i})^i} \tag{3}$$

If we assume the government can't run Ponzi game, then we have

$$\lim_{i \to \infty} \frac{D_{t+i}}{(1 + i_{t+i})^i} = 0 \tag{4}$$

. Assuming Equation (4) holds, equation (3) becomes the following government's long run budget constraint

$$D_{t-1} = \sum_{i=1}^{\infty} \frac{T_{t+i} - G_{t+i}}{(1 + i_{t+i})^i} \tag{5}$$

There are two categories of literature on the sustainability of government debt focusing separately on the two constraints mentioned above. The first category focuses on the government's debt ceiling, which is the government's borrowing limit. One question it tries to answer is the government's optimal debt policy given the threat of a debt crisis and the trade-off between default and not default. Eaton and Gersovitz [1981] show that, assuming government borrowers who default will face permanent exclusion from capital markets, there will be a credit ceiling that lenders are willing to provide to borrowers. The lenders decide the credit ceiling based on their perception of borrowers' disutility from exclusion from capital markets.

Cole and Kehoe [2000] point out the importance of lenders' confidence in the government. If lenders lose confidence in the government, they will stop buying new government debt. The government will suffer from a liquidity shortage. The government will violate the contemporary budget constraint and default, even if the fundamentals still satisfy the intertemporal budget constraint.

The second category of literature focus on the implications of the government's long run budget constraint, assuming the long run constraint holds. D'Erasmo et al. [2016] review this category of research on government debt sustainability. For this literature, there are two different approaches. In the The first approach, the empirical test of government debt sustainability, uses time series econometrics tools to examine whether equation (4) and (5) hold given the series of government debt, primary deficit, or other government public finance data. They are the tools we use in this paper. We will give a detailed literature review later. The second approach uses dynamic stochastic general equilibrium (DSGE) models. The DSGE approach can be used to analyze the trade-off of alternative measures to restore fiscal solvency.

2.3 Literature on empirical tests of government debt sustainability

When the U.S. federal government continually ran budget deficits in the 1980s, economists started to question the sustainability of U.S. debt. The progress in time series econometrics provided tools to empirically test the sustainability of government debt. Hamilton and Flavin [1986] provide the first empirical test of the U.S. government debt sustainability. They use the Dickey-Fuller unit root test to test the stationarity of U.S. federal debt and primary surplus between 1960 and 1984. The results reject the null hypothesis of non-stationarity. Thus, they conclude that the postwar U.S. public finance data is consistent with government's long run budget constraint. Different from Hamilton and Flavin's findings, Wilcox [1989] finds that for the period from 1960 to 1984 there is a structural shift of fiscal policy after 1974. For the period between 1960 and 1974, the test result shows that the long run budget constraint is satisfied. But for the period after 1974, the result is different. Therefore, he concludes that the U.S. fiscal policy after 1974 is not sustainable.

The first wave of research on empirical test of government debt sustainability ends with

Trehan and Walsh's (Trehan and Walsh [1988] Trehan and Walsh [1991]) cointegration test. The details of this test method will be shown in the methodology part. They find that the level of both the surplus and government debt between 1960Q1 and 1987Q4 are not stationary, but the first difference of the two variables are stationary. The cointegration test shows that the surplus and government are cointegrated which is evidence that the long run budget constraint is satisfied.

Bohn [2007] starts the second wave of research first by showing that stationarity or cointegration is not necessary for the transversality condition (equation (4)) to be satisfied. He proves that if a debt series is integrated of arbitrarily finite order, then the transversality condition (equation (4)) is satisfied. This doesn't mean Trehan and Walsh's cointegration test is wrong, because Trehan and Walsh's cointegration test has a prerequisite that the level or first difference of government primary surplus are stationary. That is to say, Trehan and Walsh's cointegration test is valid only when the level or first difference of government primary surplus are stationary. Considering that it is rare for macroeconomic variables to be integrated of order two or higher, Trehan and Walsh's cointegration test is still useful for most cases.

Bohn [2007] proposes a more general test method of government debt sustainability, the fiscal reaction function test. The details of this test will be presented in the methodology section. D'Erasmo et al. [2016] estimate the fiscal reaction function for the U.S. using the data from 1791 to 2014. They find a positive conditional response of primary balance to government debt, which is evidence to support fiscal solvency. However, their predicted primary balances according to the estimated fiscal reaction function for the period from 2008 to 2014 are much larger than the actual ones, which is evidence of a structural shift in the fiscal policy after the 2008 financial crisis.

The above literature all focus on the sustainability of U.S. government debt. Now we turn to the research on other countries. De Mello [2008] estimates the fiscal reaction functions for different levels of Brazilian government using monthly data from 1995 to 2004. His results show that for all levels of Brazil government, the primary budget surplus has a strong positive response to the changes in indebtedness. Jooste et al. [2011] estimate the fiscal reaction function for South Africa and the results suggest that South Africa's fiscal policies since 1946 are sustainable. For the case of Greece, **?** examine the sustainability of Greece's fiscal policy

using data from 1958 to 1995 and find strong evidences against the sustainability of Greek government debt. However, their results also show that the fiscal consolidation policies that was started in 1992 began to set Greece on the right track to fiscal solvency.

3 A summary of Greek politics, fiscal policies and economic performances from 1950 to 2008

In this section, we go through the politico-economic context that was fundamental in shaping the evolution of sovereign debt in Greece from 1950 to 2008. We discern five phases, and in following part we describe the main political events, fiscal policies, and economic outcomes which make each phase a distinct era.

The first phase was from 1950, the end of Greece's civil war, to 1974, Greece's return to democracy. Even though communist or socialist parties were banned from politics during this period, the fierce competition among right wing parties led to frequent elections and changeovers of governments. There were eight general elections held in 1950, 1951, 1952, 1956, 1958, 1961, 1963, and 1964. At the same time more than twenty cabinets were organized. More than half of the cabinets lasted for less than one year. The shortest lasted for less than one month. The military took over power in 1967 through a coup. The military regime lasted seven years until the Cyprus crisis in 1974. Despite the frequent elections and changeovers of governments, this period was viewed as a regime providing coordination and credible commitments to sustain high returns for investments (**?**). Greece enjoyed fast economic growth, low inflation and high investment for twenty years until 1974. From 1954 to 1973 the average annual GDP growth rate was 7 percent while the annual inflation rate was only 4 percent (Table). The result was a rapid convergence to the advanced EU countries. Using GDP per capita as the benchmark, Greece grew from less than 50 percent of the EU15 average in the beginning of 1960s to 80 percent in 1973. The Greek economic miracle ended in 1974 due to high oil prices and the Cyprus crisis.

The second phase, from 1974 to 1981, features the democratic transition and the beginning of a turnaround in economic regimes, from the pre-1974 regime to the post-1974 regime.

Konstantinos Karamanlis was the prime minister for almost six years and was succeeded by Georgios Rallis who was in power for one and a half years. After Greece returned to democracy, the ban on socialist parties were removed. In the 1974 elections the newly founded socialist party, the Panhellenic Socialist Movement (PASOK), received 13.5 percent of the vote and became the main opposition party, which signaled dramatic changes in Greek politics for the future. Greek economy soon recovered from the oil shocks and the Cyprus crisis. By the end of the 1970s, GDP per capita in Greece reached more than 80 percent of the EU15 average.

The third phase was from 1981 to 1993. Politically, PASOK led Greece in the first half of the third phase and other democratic parties led the second half. The PASOK won the 1981 elections with a landslide victory. Andreas Papandreou, the son of former Prime Minister Georgios Papandreou in 1960s, became the Prime Minister of the first socialist government in Greece after the end of civil war. Andreas Papandreou was the Prime Minister for two consecutive terms until PASOK lost the 1989 elections. Within one year after the 1989 elections three cabinets were organized. In the first term the Papandreou government achieved considerable improvements in social justice and national reconciliation. In terms of the economy the socialist government focused more on nationalization ,income distribution and extending social welfare protections. The government initially raised incomes of low and middle income classes, indexed wages, strengthened price controls, and engaged in selective socialization of key means of production. However, these policies caused severe damage to the Greek economy and tax revenue was not enough to support these social policies. As a result, government deficits increased dramatically and the Greek economy stagnated. Konstantinos Mitsotakis led the New Democracy to win the 1990 elections and his term lasted three and half years. From 1990 to 1993 Greece governments pledged to reduce the budget deficits and bolster the economy. However, structural adjustments such as privatization of state-owned firms and liberalization of prices were only partially successful.

The fourth phase was from 1993 to 2000, featuring Greece's fiscal consolidation to meet the convergence criteria for joining the euro zone. The Papandreou government came back after PASOK won the 1993 elections. After Andreas Papandreou resigned due to health issues, Konstantinos Simitis succeeded and served for two consecutive terms until 2004. The European Council decided to form an Economic and Monetary Union (EMU) in December 1991. The

decision was later enshrined in the Maastricht Treaty. To join the EMU, a country needs to meet the convergence criteria consisting of requirements on inflation, government deficits, exchange rates, long-term interest rate, etc. Compared to other EU member countries, Greece faced much more severe adjustment problems (Herz and Kotios [2000]). The inflation rate was 10.8 percent in 1993. The budget deficit of 1994 was 13.2 percent of GDP and the outstanding public debt was 112 percent of GDP. The long-term interest rate was 19.5 percent in 1994. After the Papandreou government came back into office in 1993, it pledged to lower the inflation rate to 3.3 percent, reduce the budget deficit to 2.1 percent and the public debt to 103 percent of Greek GDP and lower long-term interest rates to 2.1 percent by 1999, and meet the exchange rate criteria by 1997 (Herz and Kotios [2000]). The first phase of the convergence policy from 1994 to 1997 proved to be unsuccessful and it was clear that Greece would not be among the first wave of entrants into EMU. Then the goal was changed to join the EMU in 2001. During the second phase of convergence, due to the further improvements in monetary and fiscal policies and the confidence and hope brought about by the adoption of the euro, Greek economy improved considerably. In 1999, Greece's inflation rate was only 2 percent. The long-term interest rate was 6.4 percent. The fiscal deficit was 1.6 percent of GDP. The public debt was 104.4 percent of GDP.

The fifth phase was from 2000 to 2008, featuring the enthusiasm and hope brought about by the adoption of the euro, the expansion of demand due to the fall in interest rates, but then the sudden stop of the honeymoon phase because of the financial crisis. Konstantinos Simitis led the PASOK to win the 2000 elections and started his second term. The New Democracy party defeated PASOK in the 2004 and 2007 elections. Konstantinos Karamanlis served as the Prime Minister for two consecutive terms from 2004 to 2009. The EU Commission and the European Central Bank concluded that Greece had satisfied the convergence criteria by spring 2000 and Greece became an euro area member on 1 January 2001. Unfortunately, the consolidation policies in the late 1990s were reversed after Greece joined the euro zone. In 2004, primary expenditures of the ordinary budget, including central government employee compensation, pensions and grants, increased by 15.1 percent and the budget deficit rose to 6.1 percent (Psalidopoulos). Instead of using the cheap international credit to support productive investments and increase economic competitiveness, the Greek government borrowed from

international markets to finance their ballooned budget deficits. At the same time, the current account deteriorated. The trade deficits rose from 7 percent in 2001 to around 15 percent in 2008.

4 The evolution of Greece's public finance

In last section we summarized Greece's politics, fiscal policies and economic performances in the five phases from 1950 to 2008. Now we dive into Greece's public finance data to examine the evolution of Greece's government spending, revenue, deficits and debt.

First we provide a summary table of Greece's government expenditures and revenues from 1968 to 1971 from Greek's statistical yearbook of public finance. The Hellenic Statistical Authority Digital Library (ELSTAT) provides the digital statistical yearbook of public finance for the period from 1960 to 2008. Table 1 is a replication of the table *Cash transaction of the State Fiscal years 1966 through 1971*. Some simplifications and adjustments are made.

On the spending side, the Greek central government expenditure consists of three main categories: ordinary budget, investment budget, and NATO expenditures. The NATO expenditure is too small relative to the other two categories and can be neglected. The ordinary budget is divided into two subcategory, current expenditure and investment expenditure.

Table 1: Expenditures from 1968 to 1971 (Million drachmae)

	1968	1969	1970	1971
Total expenditures	52,109	65,544	65,126	73,875
1. Ordinary budget	43,201	55,208	52,843	60,654
a) Current expenditures	42,228	54,023	51,578	58,212
b) Investment expenditures	974	1,185	1,265	2,442
2. Investment budget	8,669	10,144	12,101	13,035
3. NATO expenditures	239	193	182	187

On the revenue side, the financing of the ordinary budget depends on the taxes, other current revenue and special investment revenue. For the the investments, the financing consists of domestic sources and foreign sources. The domestic sources include special investment revenue, state loans, and contribution of ordinary state budget. From Table 3, we can find that the

Table 2: Financing of ordinary budget from 1968 to 1971 (Million drachmae)

	1968	1969	1970	1971
Ordinary budget	43,201	55,208	52,843	60,654
Revenue for ordinary budget	45,196	50,716	56,160	61,862
a) Direct taxes	8,248	9,523	10,847	13,222
b) Indirect taxes	31,767	35,711	39,292	42,807
c) Revenue from state invest.	842	796	881	636
d) Other current revenue	4,340	4,686	5,140	5,197

Table 3: Financing of State investments 1968 to 1971 (Million drachmae)

	1968	1969	1970	1971
I. Expenditures	9,264	10,837	12,939	14,995
II. Financing	9,264	10,837	12,939	14,995
A. Domestic sources	7,349	8,661	10,181	12,266
1. Special investment revenue	842	796	881	636
2. State loans	4,300	5,000	5,600	7,325
3. Contribution of ordinary Sate budget	2,207	2,866	3,700	4, 305
B. Foreign sources	1,915	2,176	2,759	2,730
a) Aid	32	39	30	26
b) Loans	1,883	2,137	2,729	2,703

[6]

financing of investments depends heavily on domestic and foreign loans. This is a typical feature of Greece's public finance for the pre-1974 regime: the ordinary budget is covered by domestic revenues and the investment is mainly financed through loans.

Now let's turn to the data of post-1974 regime. Table 4 tells us Greece's government expenditures under state budget from 1979 to 1982. The categories are exactly the same as in Table 1. The main parts are still the ordinary budget and the investment budget. The numbers show that there was a dramatic increase in total expenditure from 1980 to 1981, mainly because of the increase in current expenditure. Table 6 shows the financing sources for the ordinary budget from 1979 to 1982. Two new items appear in Table 6, starting in 1981, credit revenue and transfers from the EEC (the European Economic Community). From 1980 to 1981, the tax revenues only increased mildly compared to the increase in total expenditure. Credit revenue,

which is loans from the Bank of Greece, was the tool the government used to finance the huge gap between total expenditure and tax revenues. Using loans from domestic and foreign banks to finance their large government deficits is an important feature in Greece's public finance since 1981. The result is the surge in Greece's sovereign debt.

Table 4: Expenditure Under State Budget, 1979 to 1982 (million drachmae)

	1979	1980	1981	1982
Total expenditure	376,746	423,115	733,076	794,295
1. Ordinary budget	326,775	372,784	668,014	708,747
a) Current expenditure	310,896	357,879	633,778	673,583
b) Investment expenditures	15,879	14,925	34,236	35,164
2. Investment budget	49,682	50,285	63,689	83,726
3. NATO expenditure	289	45	1,373	1,822

Table 5: Categories of expenditures, 1979 to 1982 (million drachmae)

	1979	1980	1981	1982
Total expenditure	376,746	423,115	73,076	794,295
1. Current expenditure	311,584	357,879	633,778	673,583
2. Investment expenditure	64,992	65,210	97,926	118,890
a) Investment expenditure under ordinary budget	15,789	14,925	34,236	35,164
b) Investment expenditure under investment budget	49,682	50,285	63,689	83,726
3. Expenditure for NATO common interests	170	46	1,373	1,822

Figure 4 shows us the different categories of government expenditures and financing sources relative to Greek gross national income. For the 1957 to 1974 period, the main features are: the ratio of current expenditures to gross national income increased mildly; the ratio of investment to gross national income was very stable; the domestic revenue was enough to cover the current expenditures; the investment was financed by borrowing, foreign aid, and the domestic revenue together. From 1974 to 1980, the current expenditures and investment were very stable and very similar to the pre-1974 period. However, the current expenditure increased dramatically starting in 1981. This was due to the policies for redistribution issued by the PASOK gov-

Table 6: Financing of ordinary budget, 1979 to 1982 (million drachmae)

	1979	1980	1981	1982
Total revenue	376,810	423,117	733,078	722,734
Revenue for ordinary budget	312,360	358,216	633,634	601,804
a) Direct taxes	80,684	104,439	123,692	175,001
b) Indirect taxes	206,504	220,797	257,223	362,080
c) Credit revenue	-	-	211,092	12,656
d) Other revenue	25,174	32,980	32,137	36,655
e) Transfer from EEC	-	-	9,490	15,411

Table 7: Financing of investment, 1979 to 1982 (million drachmae)

	1979	1980	1981	1982
Revenue for investment budget	64,086	64,306	97,080	117,855
a) Revenue from state investment	2,096	862	2,304	1,299
b) EEC receipts	-	-	5,823	4,529
c) Foreign aid	79	91	98	86
d) Loans	61,911	63,354	89,955	111,942
Domestic	41,450	37,276	47,010	64,299
Foreign	20,461	26,078	42,945	47,643

ernment. The rapid increase in current expenditure didn't stop after PASOK lost power in 1989. The decrease in current expenditure started in 1994 when the Greek government started reforms to satisfy the convergence criteria.

How did the Greek government finance the dramatic increase in current expenditure? The answer was loans from the Bank of Greece. Figure 4 shows the rapid increase of borrowing parallel to the increase of current expenditure. Before 1974, the borrowing was only used to finance the investment. Starting in 1981, huge amounts of loans from the Bank of Greece were used to finance current expenditures.

In figure 5 we show Greece's budget deficit and primary deficit in terms of gross national income from 1957 to 2008. The primary deficit is calculated as the difference between Greece's domestic revenue and total expenditure excluding payments related to government debt. The domestic revenue includes tax revenues, foreign aid, and other current revenue. No types of borrowing, including credit revenue for the ordinary budget, the domestic and foreign loans for

Figure 4: Expenditures and revenues

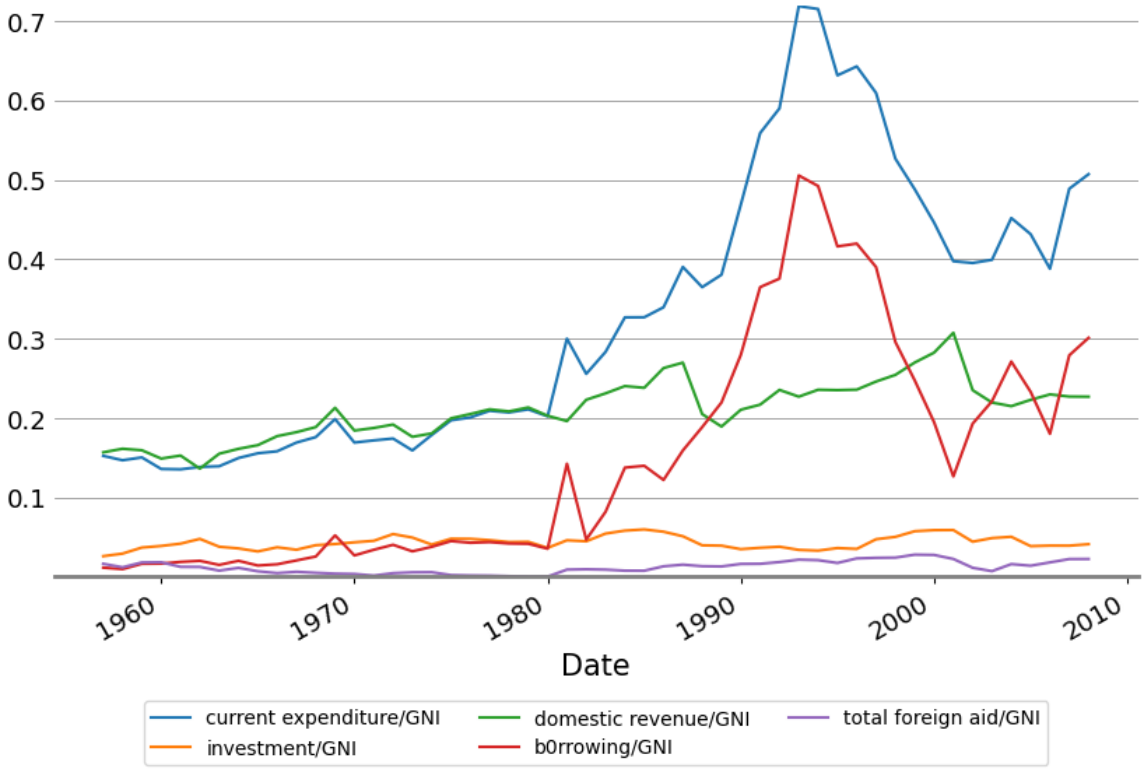
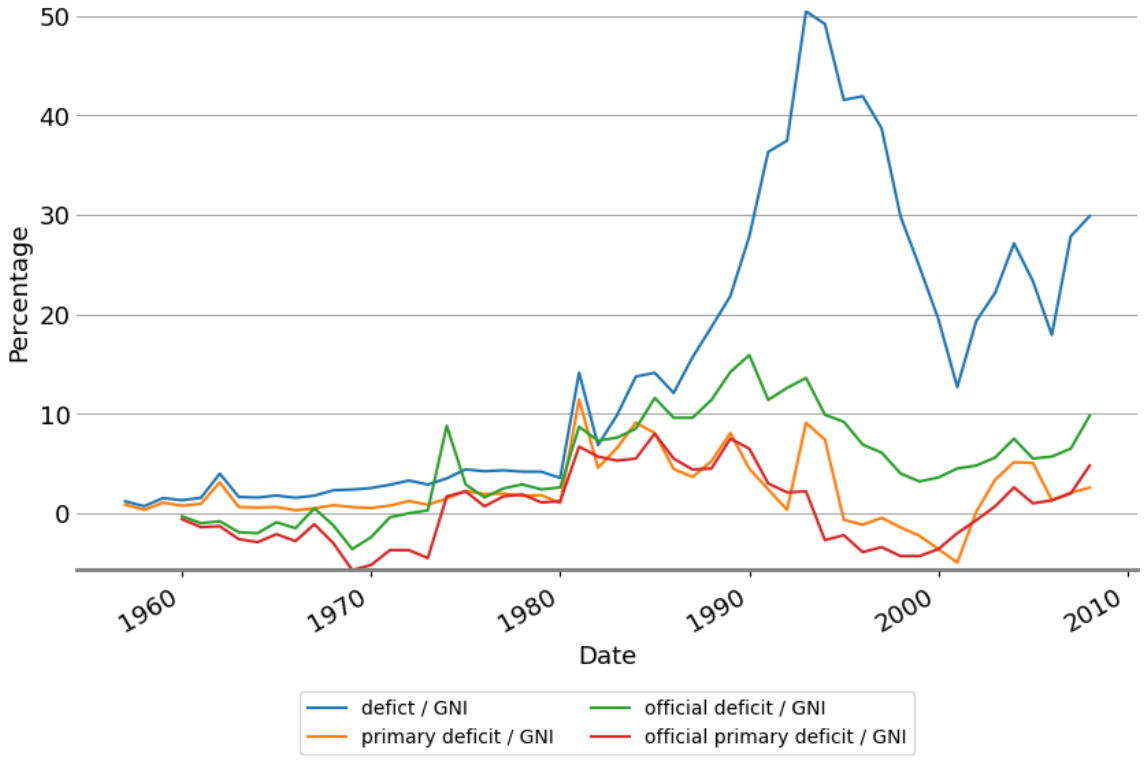
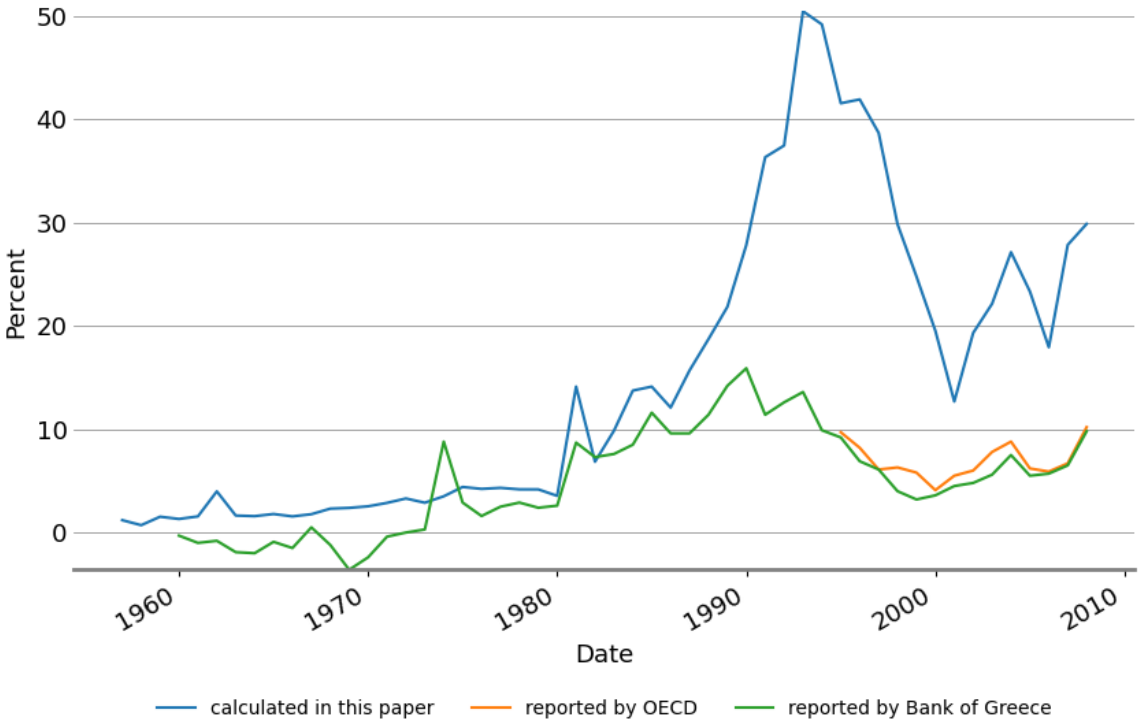


Figure 5: Deficit and Primary Deficit



investment are counted as domestic revenue.

Figure 6: Greece's deficit/GNI ratio from different sources



5 Methodology

In this paper we will use two empirical test methods to check the sustainability of Greece debt, cointegration test (Trehan and Walsh [1991]) and fiscal reaction function test (Bohn [2007]).

We start with the definition of nominal budget deficit at the end of time period t, DEF_t, which is

$$DEF_t = G_t - T_t + i_t D_{t-1} = PDEF_t + i_t D_{t-1} \tag{6}$$

where G_t is the nominal value of government expenditures for period t excluding interest payments, T_t is the nominal value of taxes net of transfer for period t, i_t is the nominal interest rate during period t, D_t is the nominal value of government debt at the end of period t, and $PDEF_t$ is the nominal value of primary budget deficit for period t.

The change in the value of government debt during period t can be expressed as

$$D_t - D_{t-1} = DEF_t = PDEF_t + i_t * D_{t-1} \tag{7}$$

Then we can express D_{t-1} as

$$D_{t-1} = \frac{-PDEF_t + D_t}{1 + i_t} \tag{8}$$

Suppose private agents have information set I_{t-1} at the beginning of period t. If we assume $E(i_{t+k}|I_{t-1}) = i$, for all $k \geq 0$, we can take the expectation of equation (8) conditional on the information set I_{t-1} and iterate forward to get the government's intertemporal budget constraint:

$$D_{t-1} = -\sum_{j=1}^{\infty} R^{-(t+j)} E(PDEF_{t+j}|I_{t-1}) + \lim_{j\to\infty} R^{-(t+j)} E(D_{t+j}|I_{t-1}) \tag{9}$$

where $R = 1 + i$.

Bohn defines ad hoc sustainability as:

Ad hoc sustainability: A fiscal policy satisfies ad hoc sustainability, if it is on a trajectory such that the present value of expected future primary surpluses equals the initial debt.

Given the above definition, equation (9) tells us that the ad hoc sustainability holds if and only if the present value of future debt converges to zero. That is to say, we have the transversality condition mentioned before

$$\lim_{j\to\infty} R^{-(t+j)} E(D_{t+j}|I_{t-1}) = 0 \tag{10}$$

which leads to the government's intertemporal budget constraint

$$D_{t-1} = -\sum_{j=1}^{\infty} R^{-(t+j)} E(PDEF_{t+j}|I_{t-1}) \tag{11}$$

Equation (10) just rules out the possibility of Ponzi schemes in which government can roll over the public debt continually. Otherwise, the government can increase current expenditure, while leaving current taxes as well as future taxes and expenditures unchanged.

5.1 Trehan and Walsh's Cointegration test

Trehan and Walsh's Cointegration Test: If the evolution of D_t is given by equation (7) with $E(i_{t+j}) = i$ for all $j \geq 0$, and $(1 - \lambda L)PDEF_t$ is a mean zero stationary stochastic process

with $0 \leq \lambda < 1 + i$, then equation (15) holds if and only if there exists a linear combination of D_{t-1} and $PDEF_t$, $D_{t-1} + \mu PDEF_t$, which is stationary with $\mu > 0$.

Trehan and Walsh [1991] test method generalizes some special cases discussed before. The first case is the situation when $\lambda = 0$. It is discussed by Hamilton and Flavin [1986]. When $\lambda = 0$, it means the process of primary deficit is stationary. Then the intertemporal bughet constraints implies that the series of government debt should be stationary too. One special example under this case is like: assume debt stock at period 0, D_0, is equal to $\bar{D}$ and $PDEF_t = -i * \bar{D}$ for $t = 1, 2, 3, ...$ Then we have $D_t = \bar{D}$ for $t = 1, 2, 3, ...$ Equation (6) can be expressed as

$$\lim_{j \to \infty} R^{-(t+j)} E(D_{t+j} | I_{t-1}) = \lim_{j \to \infty} R^{-(t+j)} \bar{D} = 0. \tag{12}$$

The present value of future debt converges to when time goes to infinity. And the cointegration relationship between D_{t-1} and $PDEF_t$ is $D_{t-1} + \frac{1}{i} * PDEF_t = 0$. The government debt is just a perpetual bond.

The other interesting case happens when the primary budget deficit can cover only part of the debt interest. **?** considers a stochastic version of this. We can give a simpler example here. Suppose that the primary budget deficit only covers half of the interest payments, which gives us

$$PDEF_t = -\tfrac{1}{2} i * D_{t-1},$$
$$D_t = (1 + i) D_{t-1} - \tfrac{1}{2} i * D_{t-1} = (1 + \tfrac{1}{2} i) D_{t-1}.$$

Given the initial government debt D_0, D_t can be expressed as

$$D_t = (1 + \tfrac{1}{2} i)^t D_0.$$

The present value of D_t when t goes to infinity is

$$\lim_{t \to \infty} R^{-t} D_t = \lim_{j \to \infty} (1 + i)^{-t} (1 + 1/2i)^t D_0 = 0. \tag{13}$$

We can generalize the above case as : suppose government primary budget surplus can only cover α of the interest payment, $0 < \alpha < 1$. Then we have

$$PDEF_t = -\alpha i D_{t-1},$$

$$D_t = (1+i)D_{t-1} - \alpha * i * D_{t-1} = (1+i-\alpha * i)D_{t-1}.$$

Given the initial government debt D_0, D_t can be expressed as

$$D_t = (1+i-\alpha * i)^t D_0.$$

The present value of D_t when time goes to infinity is

$$\lim_{t\to\infty} R^{-t} D_t = \lim_{j\to\infty} \frac{(1+i-\alpha * i)^t D_0}{(1+i)^t} = \lim_{j\to\infty} (\frac{1+i-\alpha * i}{1+i})^t D_0 = 0. \tag{14}$$

5.2 Fiscal reaction function test

Bohn [2007] shows that if D_t is integrated of finite order m for any $m > 0$, then the transversality condition (10) is satisfied and the intertemporal budget constraint (11) holds. The reason why the transversdality condition holds is that if D_t is integrated of finite order m, $E(D_{t+j})$ is at most a polynomial of order m. When $E(D_{t+j})$ is discounted by $(1+i)^j$, the exponential growth of discount factor dominates the polynomial growth of $E(D_{t+j})$ (D'Erasmo et al. [2016]).

Bohn's fiscal reaction function test: If the primary surplus S_t is an increasing linear function of D_{t-1},

$$s_t = \mu_t + \rho D_{t-1} + \epsilon_t \tag{15}$$

for all t, where $\rho > 0$, μ_t is a composite of other determinants, and ϵ_t is i.i.d, then the government's intertemporal budget constraint is satisfied.

The cointegration test in fact is a special case of fiscal reaction function test. If the primary deficit series is stationary or first-difference stationary, then the debt and primary deficit need to be cointegrated, which means the debt and primary surplus must have parallel trends. Thus, the debt series must be stationary or first difference stationary correspondingly. If the debt and primary deficit series are integrated of higher orders, the primary deficit (primary surplus) needs to respond negatively (positively) to the debt to make the government debt sustainable.

In our empirical test, we will focus on the level of economic variables, but their ratios to nominal GDP. Dividing both sides of equation (8) by GDP_{t-1}, the nominal GDP of period

$t-1$, we get

$$\frac{D_{t-1}}{GDP_{t-1}} = \frac{1}{1+i_t}(\frac{PDEF_t}{GDP_t} * \frac{GDP_t}{GDP_{t-1}} + \frac{D_t}{GDP_t} * \frac{GDP_t}{GDP_{t-1}}) \tag{16}$$

Equation (12) can be rewrite as

$$d_{t-1} = \frac{1+g_t}{1+i_t}(pdef_t + d_t) \tag{17}$$

where d_t is the ratio of D_t to GDP_t, $pedf_t$ is the ratio of $PDEF_t$ to GDP_t, and g_t is the growth rate of nominal GDP.

In next two subsections we will use this two empirical tests to examine Greece government's debt sustainability in five different time periods, 1957 to 1974, 1957 to 1981, 1957 to 1993, 1957 to 2000, and 1957 to 2008. There is no doubt that the test results should reject the debt sustainability for period from 1957 to 2008. Otherwise, the validity of these tests are questionable. Furthermore, we want to find out the time point when Greece government debt became unsustainable. We choose 1981, 1993, and 2000 as separating points, because there were dramatic changes of fiscal policies due to changes of governments or the adoption of euro. The period 1957 to 1974 is chosen because the test results are surprising and we need to trace the Greece public finance problem to the point much earlier than our initial guess.

6 Empirical Test Results

In this section we first apply the two test methods to the whole sample period, which is from 1957 to 2008. We expect that both two methods should confirm that Greek public finance was not sustainable for the whole sample period. Otherwise, the usefulness of these two methods would be questionable. Then we apply these two methods to four sub-sample periods, 1957 to 1974, 1957 to 1981, 1957 to 1993, and 1957 to 2000. Reasons to choose 1974 as a separating point include: there was a fiscal policy regime change in 1974, as suggested by **?**, from the pre-1974 regime to the post-1974 regime; Greece returned to democracy in 1974 and the political change may have had an impact on the Greek public finance. The year 1981 is a dividing point because the communist party PASOK won the elections in 1981 and initiated many welfare-oriented programs which symbolized the post-1974 fiscal policy regime. In addition, Greece joined the

EEC in 1981. The entry into the EEC had a significant impact on tariffs collected and the current account, and may have affected the Greek government's public finance. Greece also received plentiful subsidies and transfers from the EEC, which were helpful to the government budget. The year 1993 was a crossroads for Greece because a new government came into office and more importantly, it introduced a convergence program for the period 1994 to 1999 and started the fiscal consolidation procedures. The year 2000 is doubtlessly a milestone for Greece because of the admission into the eurozone.

6.1 Empirical test results for 1957 to 2008

We first apply the cointegration test method to the period from 1957 to 2008. To apply the conintegration test, we need to make sure the series of primary deficit or its first difference is mean zero stationary. The primary deficit is the difference of government expenditures excluding interest payments and revenue. For the government expenditures, we use the figure of total expenditures in Table 1 and Table 4, which is the sum of ordinary budget, investment budget and NATO expenditures. However, when it comes to the revenue, we should be wary of the fact that Greek government has been using loans to finance the investment since 1957 and started to use loans to finance ordinary budget since 1981. To more accurately reflect Greek government's ability to raise revenues, we exclude the figures of loans, both domestic and foreign, from revenue. However, all forms of foreign aids and transfers are counted as revenue. Greece government revenue is the sum of domestic revenue and foreign transfer. The borrowing is not counted as revenue. Thus our calculated total revenue include direct taxes, indirect taxes, other current revenue, revenue from state investment programs, and all types of foreign aid and transfer. For the interest rate payments, we use the figure of public debt related payments in the public finance statistic yearbook. It includes interest payments, public debt amortizations, public dent expenses, and payments relating with state guarantees in favor of third parties.

To test the stationarity, we use the augmented Dicky-Fuller (ADF) test. The regression

equation for an ADF test is

$$\Delta Y_t = \beta_0 + \gamma Y_{t-1} + \sum_{i=1}^{k} c_i \Delta Y_{t-i} + \epsilon_t. \tag{18}$$

The null hypothesis is $\gamma = 0$ which means the Y_t series is a unit root. If the statistics is negative enough to reject the null hypothesis, the Y_t series is stationary. We use the Akaike and Schwartz Information Criteria (AIC) to choose the number of lags. which is k.

Table 8 shows that the estimate of γ is significantly negative, which implies the level of primary deficit for sample period from 1957 to 2008 is stationary. However, the estimate of constant is 0.010 and significant, which means on average the Greek government run a primary deficit worth of one percent of GDP. Because the level of primary deficit is not mean zero stationary, we need to further test the stationarity of the first difference of primary deficit. Table 9 shows that the estimate of γ is significantly negative and the constant is zero and significant. Therefore, the first difference of the primary deficit for sample period from 1957 to 2008 is stationary and the mean is zero. The prerequisite to apply the cointegration test is satisfied.

Table 8: Unit root test of primary deficit for 1957 to 2008

Sample period	constant	P-value	γ	P-value	Number of lags
1957 to 2008	0.010	0.042	-0.409	0.007	0

The regression equation for the cointegration test between the Greek government debt D_{t-1} and primary deficit $PDEF_t$ is

$$D_{t-1} = -\mu * PDEF_t + \epsilon_t \tag{19}$$

If μ is significantly positive and the residual ϵ_t is stationary, D_{t-1} and $PDEF_t$ are said to

Table 9: Unit root test of the first difference of primary deficit for 1957 to 2008

Sample period	constant	P-value	γ	P-value	Number of lags
1957 to 2008	0.001	0.863	-1.915	0.000	2

be cointegrated and the Greece government debt is stationary.

Table 10: Cointegration test results for period 1957 to 2008

Sample period	μ	P-value	Stationarity of ϵ_t
1957 - 2008	-6.383	0.003	Non-stationary

The cointegration test results for time period 1957 to 2008 are shown in Table 10. The residuals ϵ_t are not stationary, which implies that the Greek government debt D_{t-1} and primary deficit $PDEF_t$ are not cointegrated. In addition, the estimate of μ is negative and significant. This means the government debt and primary surplus don't have a parallel trend, which violates the implication of cointegration test.

To visualize the relationship of government debt and the primary deficit, we draw the government debt and primary surplus together in Figure 7. From Figure 7, it is clear that the government debt has a positive trend on average from 1957 to 2008, while the primary surplus fluctuates below zero most of the time. The parallel trend of government debt and primary surplus for the whole sample period from 1957 to 2008 apparently doesn't exisit here.

Figure 7: Debt and Primary Surplus

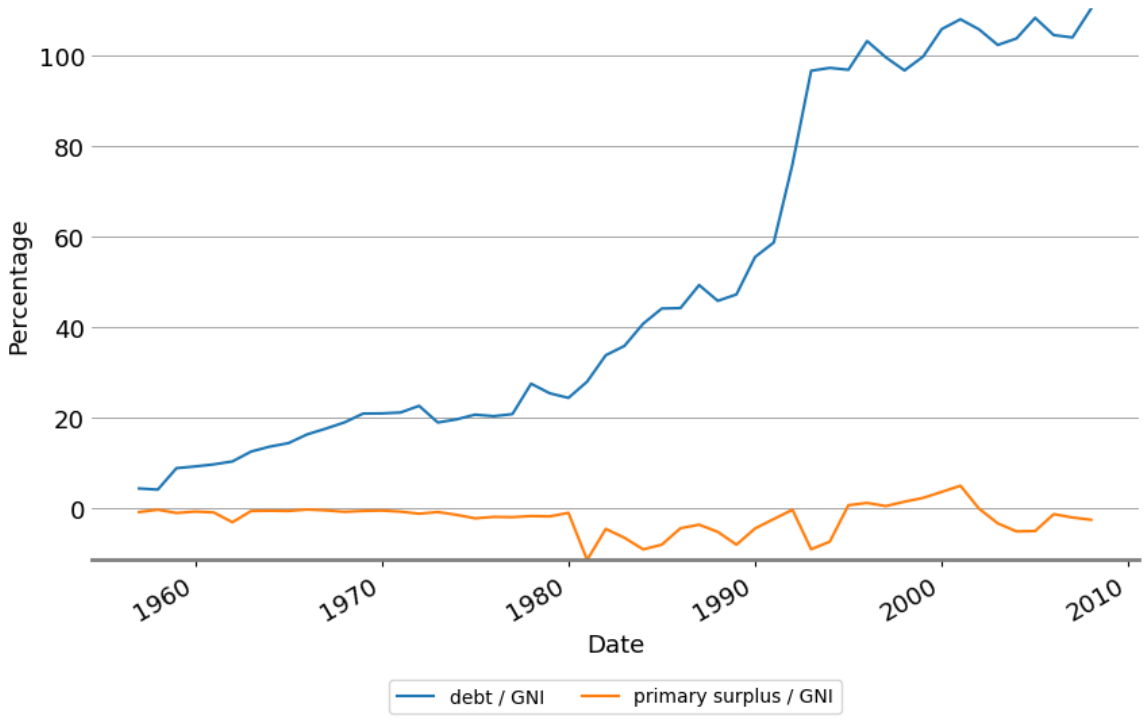


Table 10 tells us that the estimates of μ are all negative for the five periods, which should

be positive if the Greece debt is sustainable. The results are not surprising after our visual check of the data. The Greece debt is not sustainable since the 1970s.

Having finished the cointegration test, now we turn to the fiscal reaction function test. The fiscal reaction function test is easier and more straightforward than the cointegration test. The regression equation for the fiscal reaction function test is

$$PDEF_t = \alpha + \beta * D_{t-1} + \epsilon_t \tag{20}$$

If the coefficient β is negative and significant, it means the primary deficit (primary surplus) responds negatively (positively) to the change of government debt and the government debt is sustainable.

The fiscal reaction function test results for the time period 1957 to 2008 are shown in Table 11. The estimate of β is negative, which means that on average the government didn't take effective measures to reduce the primary deficit in responding to the growing government debt. The unresponsive government budget policies violate the requirement for the debt to be sustainable.

Table 11: Fiscal reaction function test results

Sample period	α	P-value	β	P-value
1957 - 2008	0.026	0.000	-0.009	0.493

6.2 Empirical test results for subsample periods

In last subsection, we apply the cointegration test and fiscal reaction test to the whole sample period from 1957 to 2008. Both this two tests verify the fact that the Greek government debt was not sustainable for period from 1957 to 2008. A natural question following is when the Greek government debt started to be unsustainable. The first method to approach this question is to drop year 2008 from the data and apply the two tests to period from 1957 to 2007. Next we apply the two tests to period from 1957 to 2006. This method is tedious, and doesn't provide much economic insights to our understanding of how the pattern of debt sustainability was affected by fiscal and political regimes. Therefore, we choose four sub-sample

periods, 1957 to 1974, 1957 to 1981, 1957 to 1993, 1957 to 2000 and apply the two two test methods to each of the subsamples. Reasons to choose 1974 as a separating point include: there is a fiscal policy regime change in 1974 suggested by **?**, from pre-1974 regime to post-1974 regime; Greece returned to democracy in 1974 and the political change may have impact on the public finance. The year 1981 is a dividing point because the communist party PASOK won the elections in 1981 and initiated many welfare-oriented programs which symbolized the post-1974 fiscal policy regime. In addition, Greece joined the EEC in 1981. The entry to EEC had a significant impact on the tariff collected and the current account and could affect Greek government's public finance. Greece also received plentiful subsidy and transfer from the EEC, which were helpful to the government budget. The year 1993 was an crossroads for Greece because a new government came into office and more importantly, it introduced a convergence program for the period 1994 to 1999 and started the fiscal consolidation procedures. The year 2000 is doubtlessly a milestone for Greece because of the admission to eurozone. The adoption of euro dramatically lower the borrowing costs for Greek citizens, firms, financial institutions, and Greek government, which has a significant impact on domestic consumption, investment, trade balance and public finance.

We first apply the cointegration test to the four subsamples. Same as before we need to make sure the series of primary deficit or its first difference is mean zero stationary. Table 12 shows the unit root test results for the level of primary deficit for the four subsamples. Only the primary deficit for period from 1957 to 2000 is barely mean zero stationary. The P-value for the constant is 0.101. The primary deficit for period from 1957 to 1974 is stationary, but not mean zero. The primary deficit for periods from 1957 to 1981 and from 1957 to 1993 are neither stationary nor mean zero.

Table 12: Unit root test of primary deficit for the subsamples

Sample period	constant	P-value	γ	P-value	Number of lags
1957 to 1974	0.009	0.007	-0.981	0.004	0
1957 to 1981	0.007	0.525	-0.160	0.937	1
1957 to 1993	0.009	0.201	-0.214	0.720	3
1957 to 2000	0.009	0.101	-0.404	0.032	0

Table 13: Unit root test of the first difference of primary deficit for 1957 to 2008

Sample period	constant	P-value	γ	P-value	Number of lags
1957 to 1974	0.001	0.740	-1.468	0.000	0
1957 to 1981	0.005	0.301	-1.987	0.012	0
1957 to 1993	0.003	0.490	-2.689	0.000	2
1957 to 2000	-0.002	0.686	-2.231	0.000	2

Table 13 shows the unit root test results for the first-difference of primary deficit for the four subsamples. The first-difference of primary deficit for all the four subsamples are mean zero stationary. Thus the prerequisite for using the cointegration test is satisfied.

The cointegration test results for the four subsamples are shown in Table 14. The estimates of μ for all the four subsamples are negative and significant, which violate the requirement that μ must be positive. This is clear evidence that the Greek government debt was not sustainable even for the period from 1957 to 1974. This is a surprising result, because even our boldest guess is that the Greek public finance was in trouble since 1980s.

Table 14: Cointegration test results

Sample period	μ	P-value	Stationarity of ϵ_t
1957 - 1974	-10.506	0.001	Non-stationary
1957 - 1981	-4.254	0.001	Non-stationary
1957 - 1993	-6.111	0.000	Stationary
1957 - 2000	-5.112	0.004	Non-stationary

To verify our findings with cointegration test, we apply the fiscal function test to the four subsamples. The results are shown in table 15. The estimates of μ for all the four subsamples are not significantly negative, which are evidences that Greek government debt were not sustainable for all the four time periods. If we dive into the results for each time periods, we can find more interesting information other than the general conclusion. For the period from 1957 and 1974, the estimate of μ is negative, even though not significant. Though the results show that the Greek government debt was not sustainable, the negative sign of the estimate of μ also indicates that it was not very difficult for the Greek government to guide their public finance back to the sustainable path. However, the estimates of μ for periods from 1957 to 1981 and from 1957

to 1993 are both positive. These are evidences that the fiscal policies in the late 1970s and 1980s made the Greece's public finance much worse. The estimate of μ becomes negative again for period from 1957 to 2000, but still not significant. It implies that the fiscal consolidation measures carried out to meet the convergence criteria was leading Greece's public finance into the right direction, even though not enough.

Table 15: Fiscal reaction function test results

Sample period	α	P-value	β	P-value
1957 - 1974	0.010	0.033	-0.009	0.748
1957 - 1981	-0.002	0.865	0.106	0.144
1957 - 1993	0.001	0.874	0.103	0.000
1957 - 2000	0.029	0.002	-0..009	0.610

7 Policy Implications

The Greek debt crisis, which began in the late 2000s and persisted for several years, had significant policy implications for Greece, the European Union (EU), and the broader global economy. Here are some of the key policy implications of the Greek debt crisis:

1. Public sector budget management: Greece's fiscal management came under close international supervision and monitoring, primarily by the Troika (the European Commission, the European Central Bank, and the International Monetary Fund). These institutions imposed strict conditions and provided financial assistance in exchange for Greece implementing specific budgetary and structural reforms. This oversight influenced Greece's budgetary decisions.

2. Strengthened accounting standards: Greece's austerity measures led to significant changes in public sector accounting. The government implemented reforms to improve the accuracy and transparency of its financial reporting. This included measures to track and control public spending more effectively. To address issues like off-balance-sheet financing and excessive government debt, there was a push for stronger and more transparent accounting standards. The adoption of International Financial Reporting Standards

(IFRS) by Greece and other EU countries was promoted to enhance transparency and comparability of financial statements.

3. Increased regulatory oversight: The crisis exposed weaknesses in financial reporting and accounting practices, leading to a heightened focus on regulatory oversight of financial institutions and government accounting. In Greece, this resulted in the establishment of the Hellenic Accounting and Auditing Standards Oversight Board (HAASOB) to improve financial reporting standards and enforcement.

4. Risk assessment and stress testing: Financial regulators and accounting bodies started emphasizing risk assessment and stress testing as essential tools to identify vulnerabilities in the financial system. Banks were required to undergo regular stress tests to evaluate their ability to withstand adverse economic conditions, which has implications for their accounting and capital adequacy.

8 Conclusion

The challenge of accessing reliable public finance data has been a hurdle for research on Greek sovereign debt sustainability. However, we have gathered detailed data from the statistical yearbooks of public finance spanning 1962 to 2008, accessible on the Hellenic Statistical Authority website. While we cannot independently verify the data's accuracy, we consider it more credible compared to other sources available. Our hand-collected data reveals Greece's consistent use of domestic and foreign loans to fund investment programs since 1957. Notably, after the election victory of PASOK in 1981, a significant surge in current expenditures occurred, predominantly financed through loans.

Employing the cointegration test and fiscal reaction function test on the collected dataset, both methods reinforce the conclusion that Greek government debt was unsustainable between 1957 and 2008. Surprisingly, even as early as 1974, the government debt exhibited signs of unsustainability. Our findings underscore that fiscal policies in the late 1970s and 1980s exacerbated the situation, while the fiscal consolidation efforts in the 1990s yielded positive yet insufficient outcomes for Greece's public finance.

Our study unequivocally establishes that mismanagement of government spending stands as the primary driver behind the Greek debt crisis. Furthermore, we aim to rekindle economists' interest in empirical testing of government debt sustainability. Despite the simplicity of the two test methods we employed, they emerge as crucial tools in scrutinizing government public finance conditions and comprehending how specific fiscal policies can impact sovereign debt sustainability..

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