An Assessment of the Crisis Resolution Mechanisms Employed in the Context of the Greek Sovereign Debt Crisis

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Abstract

This paper examines the institutional response to the Greek sovereign debt crisis, focusing on the three Economic Adjustment Programmes for Greece between 2010 - 2018, as well as the 2012 debt restructuring operation. It provides a detailed analysis of the design and execution of the March 2012 debt exchange and the December debt buyback, evaluating their role within the broader crisis management framework. Using vector autoregression models, the study assesses the impact of the adjustment programmes on Greek market indicators and the extent of financial contagion within the Eurozone. The results provide insight into the functioning of crisis resolution mechanisms within a monetary union.

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1. Introduction

The Greek sovereign debt crisis stands out as one of the most complex and consequential economic events in the history of the Eurozone. While it was brought to the surface in the wake of the 2008 global financial crisis, Greece's underlying vulnerabilities had been building for years—rising debt levels, persistent fiscal imbalances, and a reliance on external borrowing all played a role. Once markets lost confidence in the country's ability to meet its obligations, the fallout was fast and severe, both for Greece and for the stability of the European monetary union.

In response, a series of interventions were launched, beginning with the first bailout in mid-2010. Over the next several years, Greece entered three separate fiscal adjustment programmes, which combined financial assistance with austerity measures and sweeping reforms. Yet, their effectiveness, both in terms of restoring Greece's access to financial markets and containing spillovers to other peripheral Eurozone economies, remains a subject of ongoing debate.

A crucial part of the crisis response came in 2012, when Greece underwent a major restructuring of its debt. This included a private sector bond exchange in March and a debt buyback operation in December. These two events marked a shift in the crisis strategy, moving beyond liquidity support to a more direct attempt at improving debt sustainability through write-downs and market-based incentives. The scale of the restructuring was unprecedented in the historical context of sovereign debt crises.

This paper examines the evolution of the Greek debt crisis and the mechanisms employed to address it. It pays particular attention to the three bailout programmes and the 2012 restructuring operation, exploring how they were designed and what they achieved in practical terms. Using both historical analysis and empirical tools, the study investigates the extent to which the implemented crisis resolution mechanisms prevented financial contagion in the Eurozone and helped Greece regain investor confidence. By combining qualitative insights with quantitative analysis, this research aims to offer a clearer picture of what worked, what did not, and what lessons can be drawn from the handling of the Greek case.

2. Causes of the Greek Debt Crisis

The Greek debt crisis was the outcome of deep-rooted structural issues, macroeconomic imbalances and policy inefficiencies, further exacerbated by external factors. The combination of high government spending, cheap credit and high public debt growth, among other factors, led to a fiscal and banking crisis which spilled over to the nation's real economy. While the 2008 global financial crisis did not directly trigger Greece's crisis, this investigation maintains that it was a decisive parameter in i) exposing underlying structural vulnerabilities in late 2008, and ii) contributing to Greece's exclusion from capital markets in mid-2010.

The Greek crisis is attributed to a synthesis of domestic and external shocks. Analysis of those key factors ensues in this section.

2.1 Macroeconomic Imbalances

Following its adoption of the euro in 2001, Greece exhibited a track record of primary deficits, indicating a pattern where government spending (excluding interest payments on debt) systematically exceeded government revenue. Figure 1 presents a time series of government primary balance as percent of GDP. It compares Greece to Italy (whose size of sovereign debt was similar to Greece in the run-up to the crisis), as well as to the Eurozone (EZ) average. As seen, the Greek primary balance diverged significantly post-2006. Greece's inflated government spending was predominantly allocated toward public sector salaries, pensions and social benefits; public expenditure decisions were largely driven by political considerations rather than economic merit and the creation of long-term economic benefits (Papanikos, 2016).

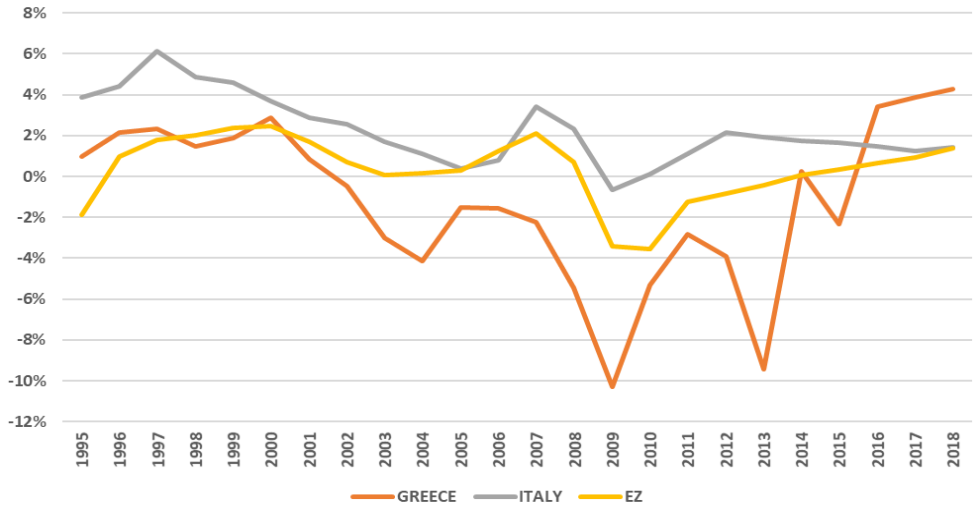

Figure 1: Government primary balance in Greece, Italy and the EZ average (% of GDP), 1995 - 2018. *Data from the ECB's Data Portal.*

Simultaneously, the Greek economy exhibited dependence on domestic consumption and limited prospects of export-driven growth, resulting in weak competitiveness and imports systematically surpassing exports. Notably, exports ranged between a mere 30% - 35% of imports for the years 2002-2009, as shown in Figure 2. Consequently, by the early 2000s, Greece had twin deficits - concurrently running both a budget and a current account deficit.

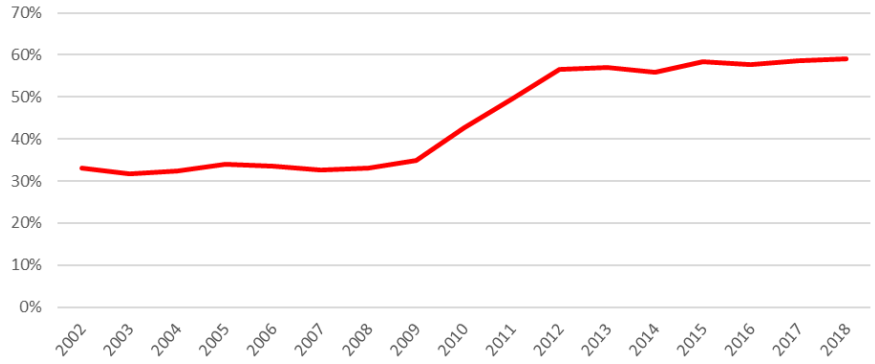

***Figure 2: Greek exports as percent of imports, 2002 - 2018**. Data from the Bank of Greece (BoG).*

The accumulation of these imbalances suggests that when Greece joined the EZ in 2001, it did so with alarming macroeconomic weaknesses.[1] These weaknesses were masked by a period of growth in nominal GDP (10.2% average annual GDP growth between 1995-2007), and stability - though no decline - in the debt-to-GDP ratio. Figure 3 plots sovereign debt as percent of GDP for Greece, Germany, and other distressed EZ economies.

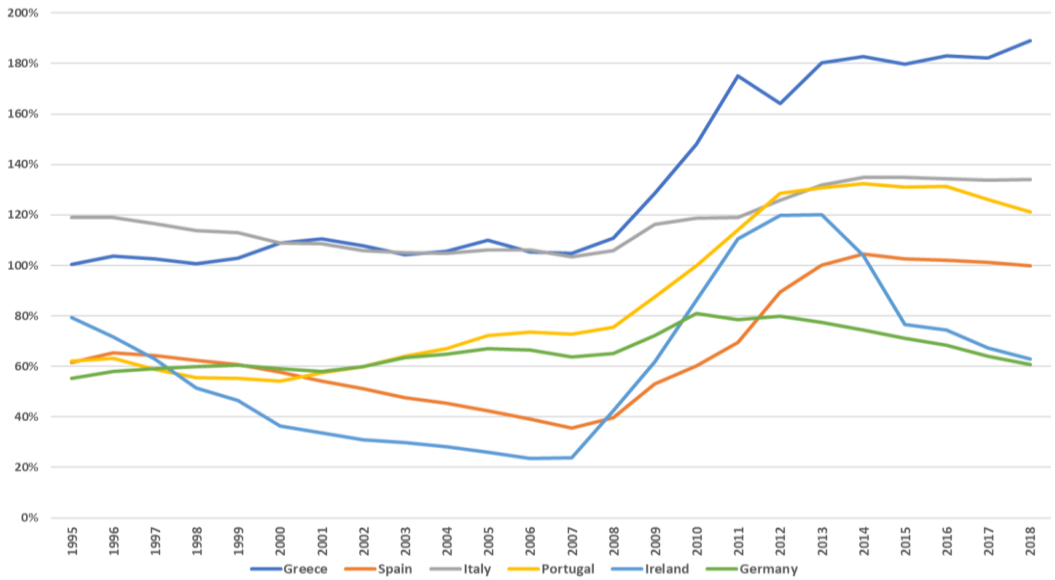

***Figure 3: Sovereign debt (consolidated, % of GDP) in Greece, Germany and other EZ distressed economies, 1995-2018.** Data from the ECB's Data Portal.*

[1] The existence of large current account deficits among poorer EZ members (e.g. Greece), both before and immediately after EZ entry, is expected to some degree. Economic theory predicts such imbalances as part of the 'catch-up and convergence' process. This is supported by Blanchard and Giavazzi (2002) in a paper that examined the experience of Portugal and Greece.

Greece's debt-to-GDP rose only slightly from 1995 (100.4%) to 2007 (104.6%). Nonetheless, budget discipline - which was already problematic - became even looser after 2007 (Gourinchas, Philippon & Vayanos, 2016). This yielded a sharp increase in the variable; debt-to-GDP surged to 110.9% in 2008 and 128.5% in 2009. Thus, by early 2009, Greece found itself in 'uncharted territory' - far beyond the 60% debt-to-GDP prudential limit set by the EZ and well above the debt-to-GDP ratio of other distressed EZ economies.

It can be argued that Greece's increase in nominal GDP and stability in debt-to-GDP between 1995 - 2007 were not the outcome of macroeconomic improvements or strengthening of domestic productivity. Rather, they were the consequence of a surge in foreign credit following 2001 (EZ entry). Validity to this argument is given by Figure 4, which plots gross government external debt and net foreign asset (NFA) deficit for Greece as percent of GDP, comparing it with the corresponding data for Spain and Portugal.[2]

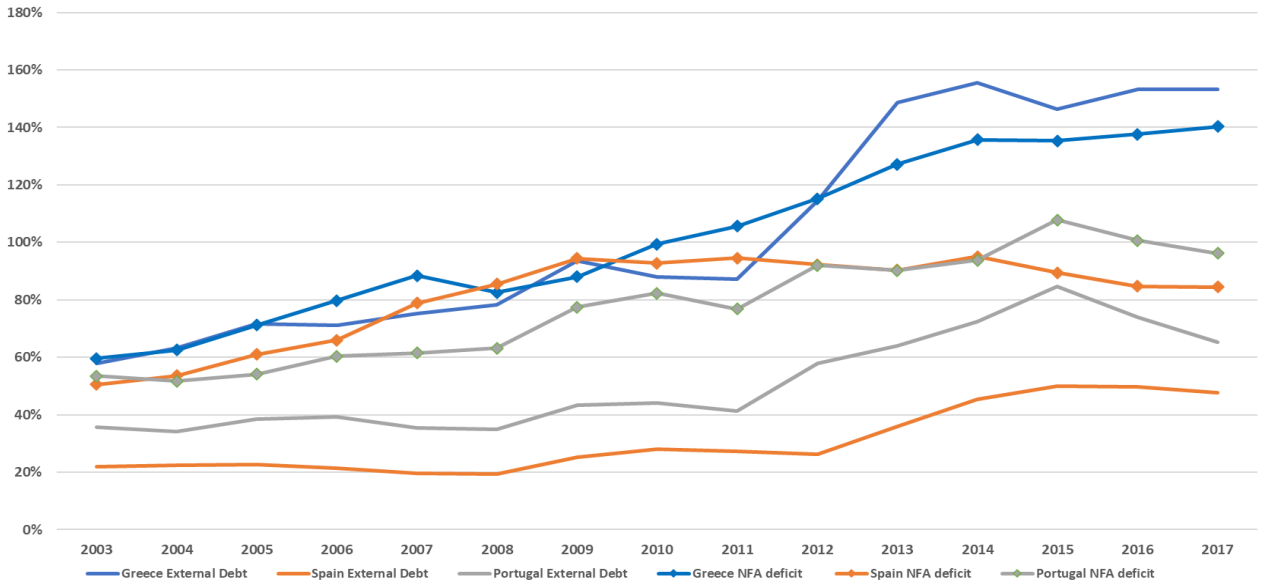

Figure 4: Gross government external debt & NFA deficit for Greece, Spain and Portugal, 2003-2017 (% of GDP). *Data from Bank of Greece, Bank of Spain and Bank of Portugal. The data is quoted quarterly, and the annual average is reported. Data before 2003 was not available or accurate enough for all countries.*

The figure shows that there is a sharp uptrend in Greek external debt post-2001 (+65% from 2001 to 2009). This coincides with the timing of Greece's accession to the (EZ), an event which substantially reduced borrowing costs and enhanced creditworthiness due to lower sovereign risk perception. The result was a surge in foreign capital inflows which, rather than being

[2] Although Figure 4 plots gross instead of net government external debt, the Greek sovereign's gross foreign assets were non-significant, as mentioned by Hyppolite (2016).

channeled into productive domestic investments, predominantly financed real estate and public sector expansion, payments on sovereign debt, and expenses for the 2004 Olympics (Pagoulatos, 2018). Between 2003 - 2009, Greece's gross external debt as percent of GDP and NFA deficit as percent of GDP were highly correlated (0.85) and nearly mirroring each other's values. This suggests that i) economic expansion was largely debt-financed, and (ii) the Greek government was covering its current account deficit by borrowing foreign capital but not acquiring an offsetting amount of foreign assets. The argument that Greece was dependent on foreign capital inflows to sustain government spending is also backed by Greece's borrowing requirement as percent of GDP: the variable rose from a mean 7.04% in 2001 to a mean 16.6% in 2009. On the other hand, Figure 4 shows that between 2001 - 2009, Spain and Portugal exhibit NFA deficits similar to Greece's but substantially more controlled gross government foreign debt.

Greece's rise in foreign capital inflows did not translate to the real economy. In absolute terms, between Q1 2001 - Q1 2009, net financial wealth of the Greek private sector excluding businesses decreased by €47.5bn (Figure 5), whereas net financial wealth of the Greek private sector including non-financial businesses fell by a larger €59.4bn (Figure 6).

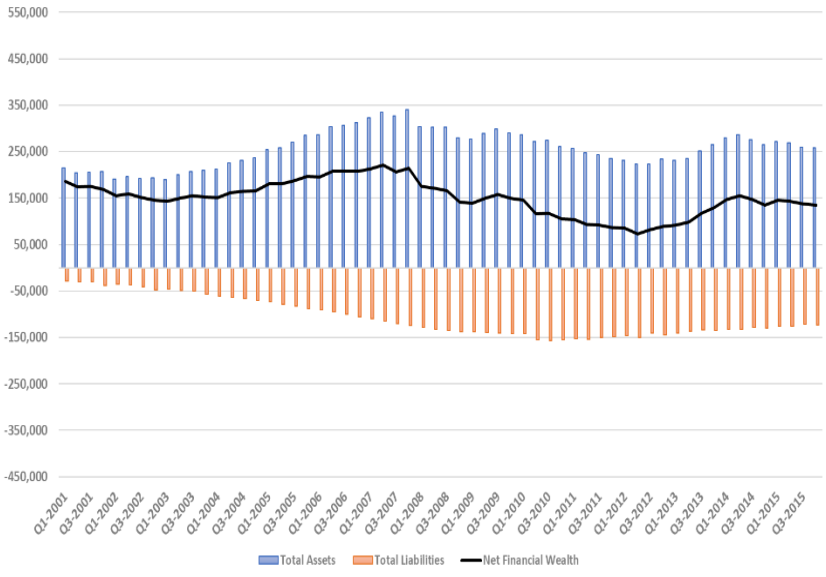

Figure 5: Financial account of Greek private sector (excluding non-financial businesses, EUR million), Q1 2001 - Q4 2015. *Data from Bank of Greece, end of period stocks.*

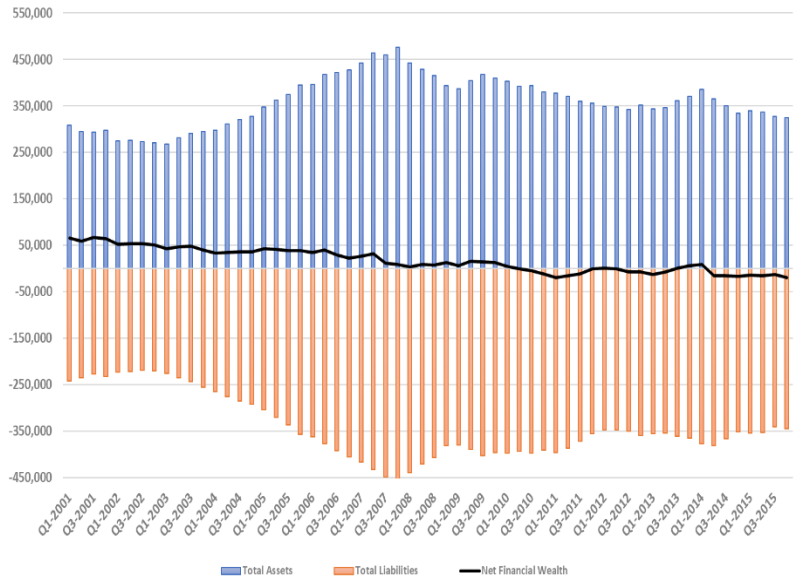

Figure 6: Financial account of Greek private sector (including non-financial businesses, EUR million), Q1 2001 - Q4 2015. *Data from Bank of Greece, end of period stocks.*

By early 2008, Greece's debt-heavy model and consistent deficits had set up a fragile macro-stability structure, leaving the Greek sovereign and banking sector severely exposed to internal and external shocks.

2.2 The 2008 Global Financial Crisis and Financial Liberalization

The global financial crisis was set off in August 2007; BNP Paribas froze the accounts of three hedge funds due to their exposure to US subprime mortgage loans, citing a 'complete evaporation of liquidity' (BNP Paribas, 2007). The crisis escalated thereafter, reaching its climax in September 2008 with the bankruptcy of Lehman Brothers. Figure 7 presents a monthly time series of a Greek, European and U.S. bank-composed equity index. All indices are normalized to 100 on August 2004 (base value).

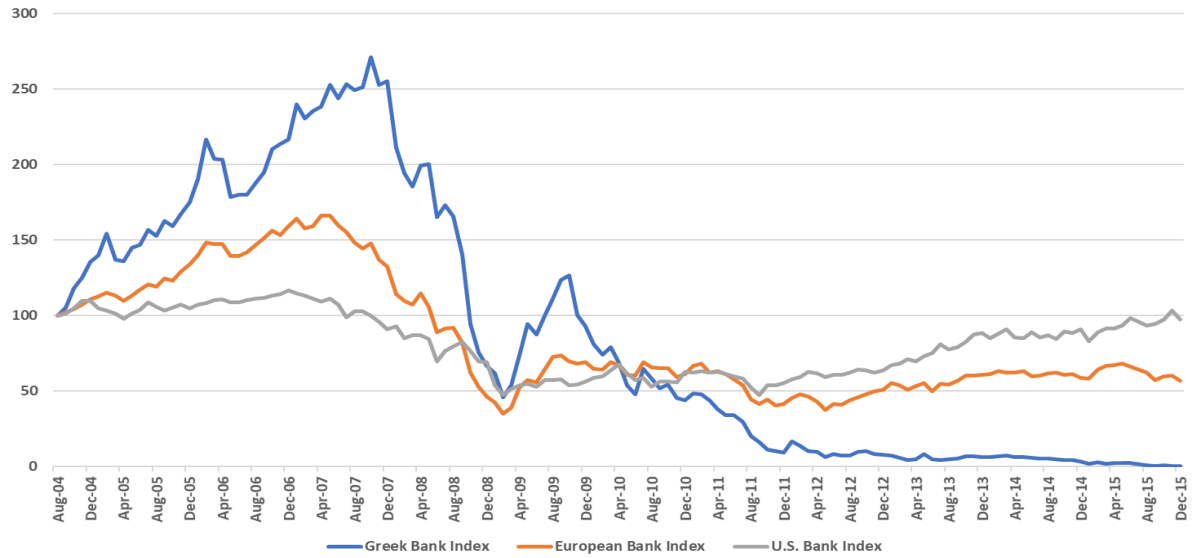

Figure 7: Performance of Greek, European and U.S. banking sector index, Aug 2004 - Dec 2015. *Greek index: FTSE Greek Banks, European index: STOXX Europe 600 Banks, U.S. index: NASDAQ Bank Index. Indices normalized to 100 on August 2004. Data from Bank of Greece and Investing.com.*

From August 2007 to September 2009, the global financial crisis affected banks severely across the three examined regions: the Greek and European index each fell by 50.3%, while the U.S. index dropped by 44%. Nonetheless, Greek banks exhibited greater sensitivity to fluctuations during the crisis: the Greek index dipped almost equally to the European and more than the U.S. index between August 2007 and the Lehman Brothers collapse, followed by the largest rise leading up to September 2009. Higher observed volatility by Greek banks implies that they were more exposed to a worldwide financial downturn than the mean EU/U.S. bank.

Between August 2007 - December 2007, the Greek index increased by 2.5%, whereas the European and U.S. indexes fell by 10.7% and 11.7% respectively. At this early phase of the crisis, concerns were centered on solvency problems stemming from exposure to toxic U.S. mortgage-backed securities (Gerardi et al., 2008). The increase in the Greek index implies that Greek banks were not long in such toxic assets. This argument aligns with anecdotal reports as well as balance sheet insights: foreign non-EZ debt securities amounted to only 3.93% of Greek banks' total assets in August 2007. Evidently, the global financial crisis impacted Greek banks via liquidity constraints, i.e., rollover issues.

Figure 8 presents the monthly composition of Greek banks' total liabilities between 2001-2016. The quality of Greek banks' liability structure can be seen deteriorating noticeably in the run-up to the Lehman Brothers bankruptcy. From August 2007 to September 2008, as percent of total liabilities, customer deposits decreased by 4.8% (66.8% to 62%), interbank debt increased by 4% (15.1% to 19.1%), and central bank liabilities rose by 2.3% (1.1% to 3.4%). On the other hand, from September 2008 to September 2009, customer deposits fell by 3.4%, interbank debt decreased by 0.2%, while central bank liabilities increased by 4.5%. Evidently, the Lehman Brothers shock in September 2008 deepened the liquidity crunch: it boosted the trend of deposit outflows and dried up the supply of liquidity to Greek financial institutions via interbank markets. The result was a surge in borrowing from the European Central Bank (ECB - see the rise of central bank loans starting in 2008 in Figure 8).

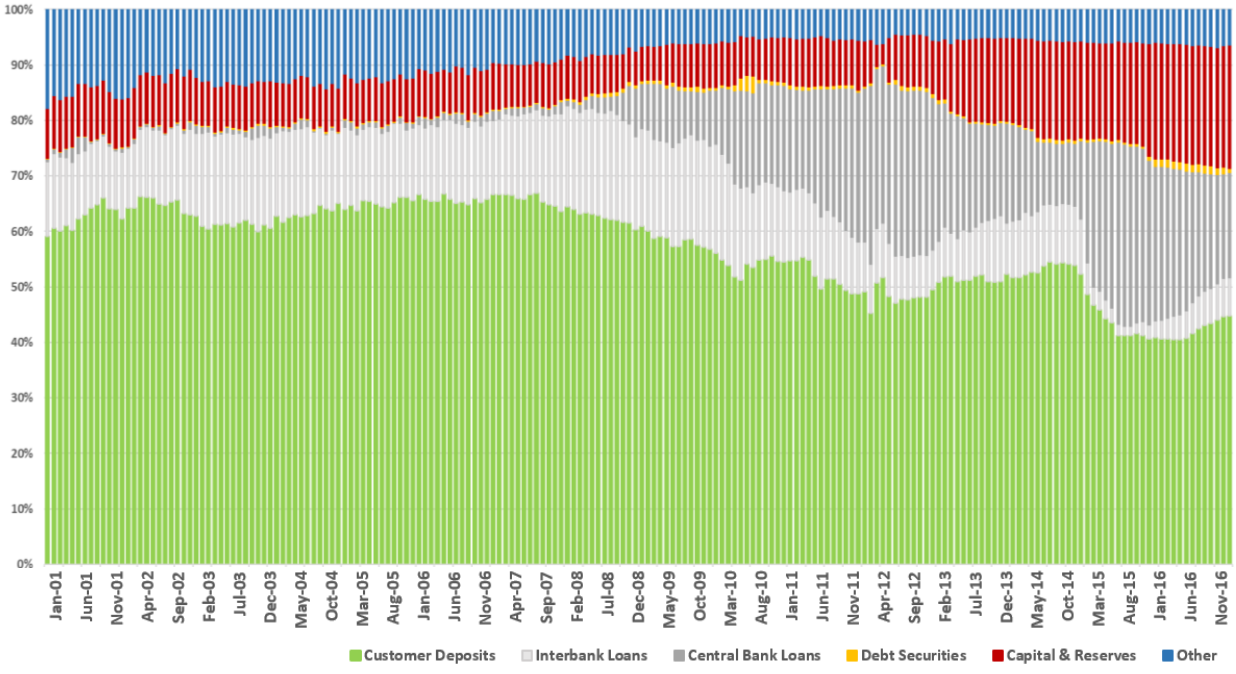

Figure 8: Monthly liability composition of Greek banks, Jan 2001 - Dec 2016. *Data from Bank of Greece, end of period.*

The liquidity crunch coincided with concerns over the quality of bank assets, as Greek banks had significantly expanded household and corporate lending in the pre-crisis years. Figure 9 illustrates bank credit allocated to the Greek government and private sector (i.e., households and non-financial businesses), expressed as percent of GDP.[3] The plunge in bank credit to the sovereign - from 33% of GDP in 2001 to 14.7% in 2008 - was more than offset by a surge in credit to the private sector; the variable rose from 45.3% of GDP in 2001 to 82.4% in 2008. At the same time, domestic savings were falling. Between 2001 - 2009: i) Greek gross domestic savings decreased from 14.61% of GDP to 10% of GDP, and ii) gross domestic savings as percent of GDP and bank credit to the private sector as percent of GDP exhibited a correlation of -0.57.

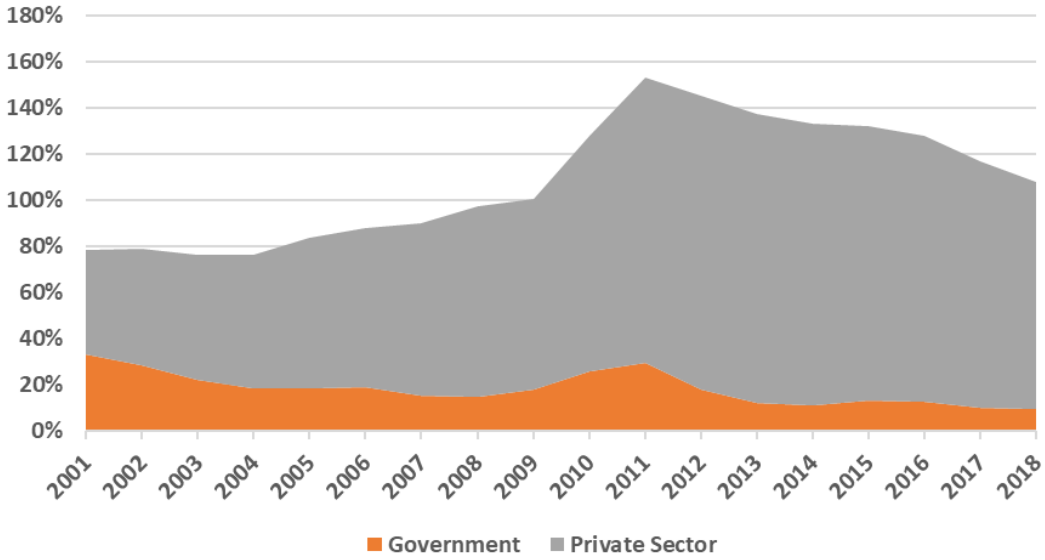

Figure 9: Bank credit in Greece (% of GDP), 2001-2018. *Data from Bank of Greece, end of period. The data is quoted quarterly, and the annual average is reported.*

Declining economic activity as a result of tighter bank credit is: i) a common way by which banking sector problems spill over to the state, and ii) a means for the bank-sovereign loop to manifest itself (Hardouvelis & Vayanos, 2023). Greek banks' liquidity crisis seems to have spilled over to the nation's real economy by early to mid-2009. Evidence of this can be found in the "Access to Finance" survey organized by the ECB and European Commission (EC).[4] In its 2005 version, 66% of Greek SMEs stated that access to loans granted by banks was easy, a ratio that was 20% above the European Union (EU) average.[5] Contrarily, in the 2009 version of the survey,

[3] The bank credit aggregate comprises loans granted and debt securities purchased.
[4] This periodic survey assesses the financial conditions and financing constraints faced by SME's across Europe.
[5] Page 24, https://europa.eu/eurobarometer/surveys/detail/1240

39% of Greek SME's stated that access to finance was 'the most pressing problem', a ratio which was the highest in Europe and 26% above the EU average.[6]

To conclude: i) Greek banks were more sensitive to financing disruptions than the average U.S. / E.U. bank, i) the 2008 global financial crisis affected Greek banks through restricted access to funds, and iii) Greek banks' liquidity crisis and perils associated with the Greek credit boom spilled over to the real economy in mid-2009 and exacerbated the threat of a bank-sovereign 'doom loop.'

2.3 The 2009 Government Budget Deficit Revision

On October 20, 2009, two weeks following the Greek parliamentary election, the newly elected government updated the projection for the 2009 government budget deficit. The forecast for Greece's budget deficit as percent of GDP was raised to 12.5%, a figure substantially higher than the previous government's stated forecast of 6%.[7] This revision triggered a sharp decline in investor confidence and acted as a negative financial shock. Markets set off a chain reaction that rendered Greece's debt servicing costs unsustainable and forced the country to request a rescue package on April 23, 2010.

Figure 10 plots the yield spreads of Greek and other EZ distressed countries' 10Y debt versus the benchmark German 10Y debt, ranging from the onset of the global financial crisis in August 2007 to the rescue package request by Greece in late April 2010.

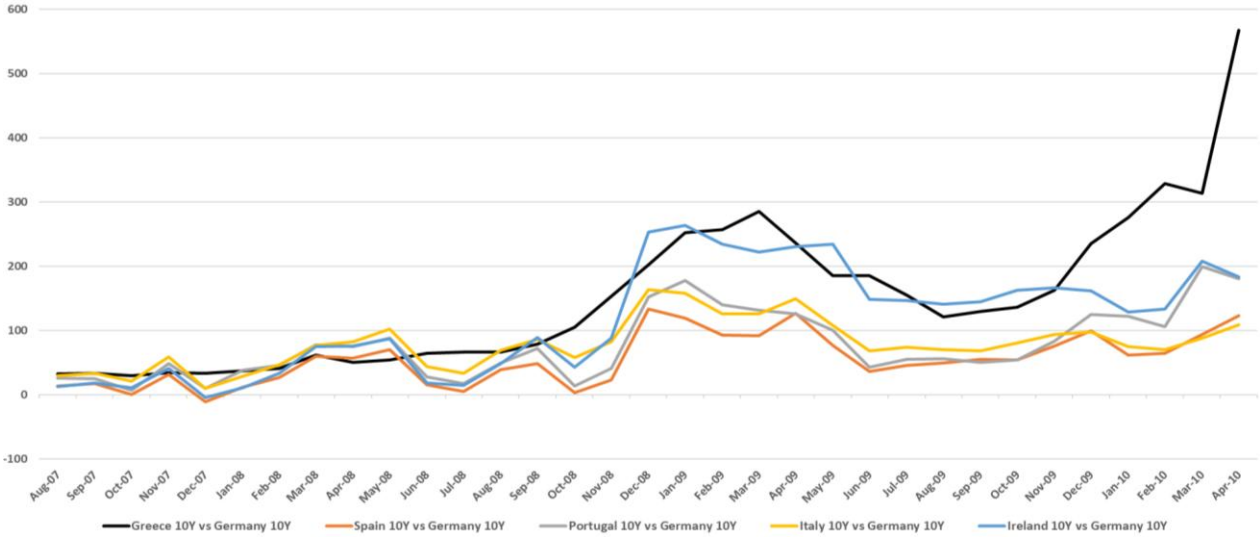

Figure 10: 10Y sovereign yield spread of Greece and other EZ distressed countries vs Germany, basis points, Aug 2007 - Apr 23, 2010. *The data is monthly, except for Apr 2010 which takes the value of Apr 23. Data from Investing.com.*

[6] Page 28, https://europa.eu/eurobarometer/surveys/detail/756

[7] After a Eurostat audit in November 2010, the actual figure was readjusted to 15.4% of GDP.

Between August 2007 - September 2008, the Greek 10Y spread was maintained at low, stable levels similar to the spreads of other distressed EZ economies. Signs of financial distress were not widespread and the liquidity crunch had not yet spilled over to the EZ sovereign debt market (Arghyrou & Kontonikas, 2012). By contrast, the Lehman Brothers bankruptcy in mid-September 2008 triggered a notable spike in yield spreads that was the result of generalized market distress and flight to safety. Investors' 'risk-off' behavior post-Lehman was more pronounced toward Greek sovereign debt, i.e., the selloff in Greek debt after September 15th was comparatively deeper, longer, and lacked the delayed component of other EZ distressed countries' debt selloff. This observation is possibly attributed to markets' rapid pricing-in of the Greek macroeconomic imbalances and liquidity constraints analyzed in sections 2.1. and 2.2 respectively.

Between March 2009 - October 2009, all spreads in Figure 10 reverted to lower levels. This might have occurred because: i) markets regained some confidence in EZ peripheral economies, and ii) several coordinated interventions were made by the ECB to restore stability in sovereign debt markets (e.g. Covered Bond Purchase Programme, Long-Term Refinancing Operations). Overall, the homogeneity in spread fluctuations between August 2007 - late October 2009 suggests that, during that period, markets had a similar perception of sovereign risk for the aggregate of EZ distressed economies.

The 2009 budget deficit revision is identified as a fundamental structural break for Greece in that it triggered an alarming spread spike and a clear decoupling from the spreads of other EZ distressed economies. Post-October 20, 2009, the Greek spread can be seen widening alarmingly as the spreads of all other EZ distressed economies remained below 200 basis points. By early March 2010, Greece's spread reflected extreme default risk pricing and market capitulation, culminating in the government's rescue package request on April 23.

The crisis effect of the 2009 budget deficit revision is further reflected in Figure 11, which plots the premium on 5-year Greek Credit Default Swaps (CDS). The chart also comprises the instrument's 20-day simple moving average (20 SMA), an upper band (20 SMA + 2σ), and a lower band (20 SMA - 2σ). The time series ranges from August 24, 2009 to April 23, 2010.

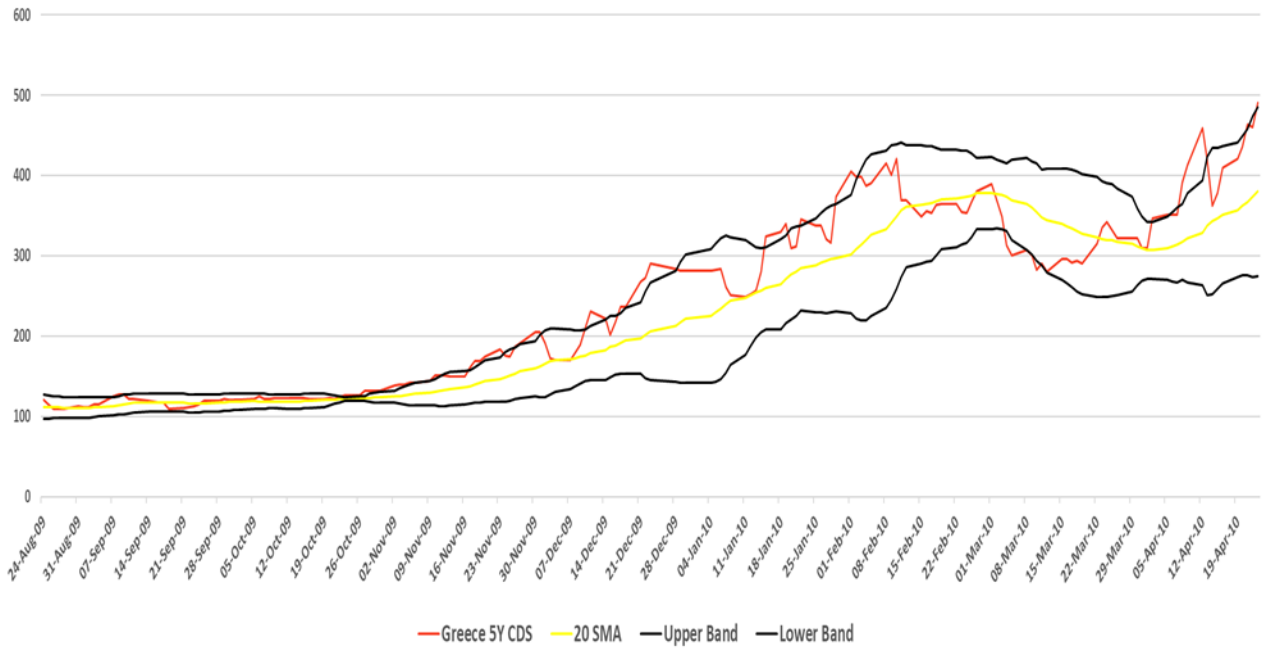

Figure 11: Greek 5Y CDS premium, 20 SMA and boundaries (20 SMA ± 2σ), in basis points, Aug 24, 2009 - Apr 23, 2010. *Data from Investing.com.*

From late August 2009 until the government budget deficit revision on October 20, 2009, the CDS premium remained stable, fluctuating minimally and showing negligible deviation from the 20 SMA. The CDS premium increased significantly post-budget deficit revision. The widening of the distance between the upper and lower band until April 23, 2010 underscores the sharp increase in volatility as markets reassessed Greece's sovereign credit risk. With a brief exception between February 2010 - early March 2010, the CDS premium traded persistently above its 20 SMA and close to its upper band. The CDS premium surged beyond 400 basis points and broke above the upper band in early April 2010, effectively trading above the 97.7th percentile of expected returns. This reflected: i) a period of extreme market distress, and ii) a signal by markets that Greek default was a near-certain event in the absence of external assistance.

Another indicator that depicts the crisis shock of the budget deficit revision is the Greek sovereign yield curve. Figure 12 plots the Greek yield curve on four significant dates: the day of BNP Paribas' shutting down of the three hedge funds' accounts, the day of the Lehman Brothers bankruptcy, the day of the Greek government's budget deficit revision, and the day of Greece's official request for a rescue package.

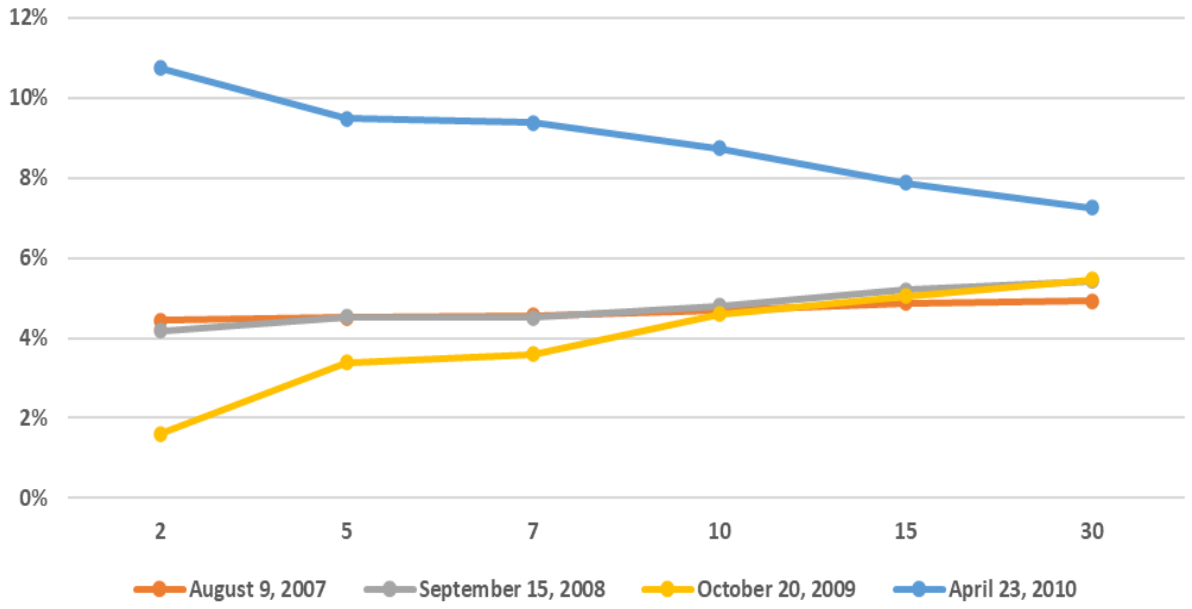

Figure 12: Greek yield curve, Aug 2007 - Apr 2010. *Data from Bank of Greece.*

The yield curve was flat on August 9, 2007, exhibiting a tight spread of 48 basis points between the long end and the front end of the curve (30Y - 2Y). Borrowing costs of the Greek sovereign remained relatively stable until the Lehman Brothers bankruptcy, on which day the 30Y-2Y spread was at 123 basis points. From the Lehman event to the date of the budget deficit revision, a steepening of the curve is observed; the 2Y yield fell from 4.19% to 1.61%, while the 30Y yield changed negligibly from 5.42% to 5.46%. The 258 basis point fall in the 2Y yield suggests that, until October 20, 2009, markets did not anticipate near-term distress in Greece's ability to meet its short-term debt obligations.

The budget deficit revision caused a financial shock that severely stressed the country's ability to service its debt. Figure 13 presents the basis point increase in Greece's sovereign borrowing costs across the curve, from October 20, 2009 to April 23, 2010.

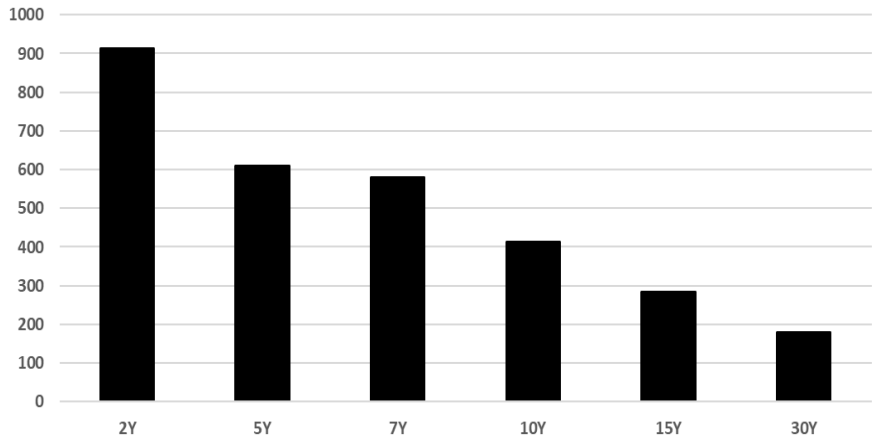

Figure 13: Increase in Greece's sovereign borrowing costs across various maturities, basis points, Oct 20, 2009 - Apr 23, 2010.

The rise in borrowing costs between October 20, 2009 - April 23, 2010 followed a distinct pattern, with yields increasing incrementally from the long end toward the front end of the curve. Notably, the yield on 30Y debt rose by 179 basis points, while the 2Y yield surged by a startling 913 basis points. Greece's inverted curve on April 23, 2010 (i.e., the day of Greece's request for a rescue package) reinforces the view that markets saw extreme near-term sovereign default risk, expecting Greece to be unable to roll over its short-term obligations without financial intervention. Yields in the long end of the curve were also alarmingly high, but lower than yields in the front end; this suggests that investors priced in a potential crisis resolution mechanism in the long-term and overall improvement in the state of Greek financial affairs.

Lastly, Table 1 provides a timeline of credit rating downgrades that took place after the government budget deficit revision and up to late April, 2010. The listed downgrades underscore the rapid erosion of the sovereign's creditworthiness and provide context to the government's request for external intervention on April 23, 2010.

Date	Rating Agency	Previous Rating	New Rating	Comments
October 22, 2009	Fitch	A	A-	Downgrade after the government's budget deficit revelation, citing a 'negative outlook'.
December 8, 2009	Fitch	A-	BBB+	Downgrade based on negative medium-term prospects, as well as vulnerability toward future adverse shocks.
December 16, 2009	Standard & Poor's	A-	BBB+	Downgrade due to concerns that Greece's announced fiscal measures were not sufficient to yield public debt sustainability.
December 22, 2009	Moody's	A1	A2	Downgrade based on Greece's deteriorating public finances.
April 9, 2010	Fitch	BBB+	BBB-	Further downgrade amid increasing fears of sovereign default.
April 27, 2010	Standard & Poor's	BBB+	BB+	Downgrade to junk status amid escalating fears of default.

Table 1: Timeline of Greece's credit rating downgrades, Oct 2009 - Apr 2010.

3. The Greek Debt Crisis

Following Greece's formal request for external assistance on April 23, 2010, its financial crisis could be addressed with intervention either through: (i) disbursement of bailout loans, or (ii) debt restructuring (IMF, 2013). Naturally, these two approaches encompass fundamentally different diagnoses of the structure of a crisis. Typically, the choice of a bailout loan is designed to mitigate short-term problems in a country's liquidity channel (Hur et al., 2021). In contrast, debt restructuring is typically associated with medium- to long- term solvency issues, i.e., a country's level of debt is rendered unsustainable and calls for a restructuring or, at least, a mild reprofiling. Depending on the magnitude of the debt adjustment, this can occur through haircuts, coupon rate reductions, or maturity extensions (Schroeder, 2014). Unlike haircuts, which necessitate the outright reduction in the face value of debt, coupon rate reductions and maturity extensions aim to reduce the Net Present Value (NPV) of debt, which is defined as:

$$NPV_{debt} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + \frac{FV_t}{(1+r)^t}$$

A reduction in the coupon rate C_t decreases the periodic outflows, whereas a maturity extension increases the discounting effect through the variable t. The term $\frac{FV_t}{(1+r)^t}$, which estimates the present value of the principal, decreases the further the principal's repayment is deferred into the future. Thus, the aim of restructuring is to construct a debt profile that is deemed credible and sustainable by capital markets, thereby helping a country restore its access to those markets.

At the onset of the Greek crisis in April 2010, the "Troika" - an ad hoc decision group established by the EC, ECB, and International Monetary Fund (IMF) to oversee the crisis - recognized Greece's debt problem as one of illiquidity rather than insolvency. An admission that Greece was facing solvency issues would have necessitated a Greek debt restructuring, an event which, the Troika deemed, had the capacity to trigger a systemic spillover, i.e., contagion to other EZ distressed economies (European Stability Mechanism [ESM], 2020; Nordström & Laiho, 2023). Debt restructuring does indeed have the capacity to trigger contagion, particularly within monetary unions, as per findings by Brooks & Lombardi (2015) and Claessens & Forbes (2004).

Systemic risk is heightened in that financial markets hold large amounts of advanced countries' debt as a perceived risk-free asset, and thus sovereign bonds are an integral component of global financial markets (Schwarcz, 2011).

Moreover, it is hypothesized that the decision to avoid any form of restructuring or reprofiling in 2010 was further driven by the significant exposure of foreign banks to Greek sovereign bonds, and in particular French and German banks. In March 2010, French banks' total exposure to Greek government bonds (GGBs) stood at €52 billion, while German banks' total exposure stood at €32.5 billion (CFR, 2015). Combined, French and German banks' claims on Greece accounted for 38.4% of Greece's gross external debt as of the first quarter of 2010.

Notwithstanding initial objections by Germany, the Troika's ultimate decision in May 2010 was to offer Greece a traditional bailout loan.

3.1 Overview of Economic Adjustment Programmes for Greece

3.1.1 1st Economic Adjustment Programme

Greece's first bailout loan stood at €110 billion, comprising €80 billion in bilateral loans from EZ countries pooled through the Greek Loan Facility (GLF), and €30 billion from the IMF (IMF, 2010). The primary objective of this 1st bailout programme was the rapid reduction of Greece's budget deficit and the restoration of Greece's credibility for capital markets. In exchange for the bailout, a wide range of front-loaded fiscal austerity measures were imposed on Greece, which ultimately aimed for the country's return to a budget surplus by 2013. The programme was thus expected to conclude in 3 years, as opposed to the 5-6 years suggested by the IMF (Pagoulatos, 2018). The bailout funds were to be disbursed in tranches until 2012, with each disbursement conditional on: (i) Greece's effective execution of a 3-year fiscal adjustment plan that amounted to a minimum of 10% of its GDP as of Q1 2010, and (ii) the implementation of structural reforms targeting growth and international competitiveness (Zettelmeyer, Trebesch, & Gulati, 2013).

Although markets exhibited a short period of stability during the first months of programme implementation, Greece's debt servicing costs continued their upward trajectory following October 18th, 2010. On that date, it was announced that the private sector would participate in the costs of future EZ sovereign crises, i.e., private investors would be bailed in via haircuts on their exposure. This led to a selloff in Greek debt by private investors, who began pricing in a

possibility of near-term sovereign debt restructuring for Greece. In this context, the likelihood of Greece making a comeback to capital markets by early 2012 - as originally envisioned by the Troika in May 2010 - worsened substantially.

Greece's fiscal consolidation in 2010 translated to a significant 5% reduction in its primary deficit as percent of GDP. This sizeable correction aligns with the EC's first review of the May 2010 economic adjustment programme, in which it recognized that "the programme is frontloaded and more than half of the required budgetary consolidation measures up to 2014 have already been adopted by Parliament and are being implemented" (EC, 2010). Between May 2010 - May 2011, the unemployment rate increased from 12.6% to 17.4%. Given a larger-than-anticipated economic contraction, nonetheless, reform implementation lagged and fiscal adjustment was halted in the first semester of 2011, during a period when Greece's debt-to-GDP ratio was still above 150%, and its primary deficit as percent of GDP was around 3%. Additionally, the IMF's 4th review, published in July 2011 (Report No. 11/175), stated that the IMF could not deem Greece's debt as sustainable "with high probability." A 2nd economic adjustment programme was deemed necessary due to the funding shortfall of the 1st programme and the sovereign's indisputable inability to tap the bond market at any point throughout 2011 - 2012.

3.1.2 2nd Economic Adjustment Programme

The 2nd Economic Adjustment Programme for Greece was signed on March 1st, 2012. It was similar to the 1st programme in that there was a bailout loan accompanied by new austerity measures, and different in that it introduced a debt restructuring component known as the Private Sector Involvement (PSI). The bailout amounted to €130 billion and was funded by the European Financial Stability Facility (EFSF)[8] and the IMF. With respect to the austerity measures, the 2nd programme was essentially a continuation of the 1st programme, comprising a more detailed and targeted series of fiscal and competitiveness - enhancing reforms. The programme set primary balance targets of -1% for 2012, 1.5% for 2013, 3% for 2014, and 4.5% for 2015. A key component was the extension of labor market liberalization measures introduced in the 1st programme, including a 22% reduction in the minimum wage of the private sector. On the

[8] The EFSF is a fund which was founded by EZ member states in mid-2010 to lend to countries which had lost access to markets. It was not involved in the First Economic Adjustment Programme for Greece, in which EZ funds to Greece were disbursed via bilateral loans pooled through the GLF.

public-sector front, the 2nd programme required a sharp reduction in employment, as well as reforms in tax governance, the pension system and health system (Pagoulatos, 2018).

With respect to the debt restructuring component, the 2012 PSI resulted in an unprecedented exchange of approximately €199 billion out of €205 billion of eligible privately-held GGBs into GGBs with longer maturities and lower coupon rates (ESM, 2020). A 53.5% nominal haircut was thus exercised on 97% of eligible privately-held GGBs. For context, among high- and middle-income sovereign states, only three debt restructurings have imposed greater nominal losses on private creditors: Serbia and Montenegro (2004 - 71%), Argentina (2005 - 76%), and Iraq (2006 - 91%).

About €50 billion from the 2nd bailout package was earmarked for the recapitalization of Greek systemic banks and recapitalization or resolution of smaller banks (European Court of Auditors, 2017). Additionally, in late 2012, further reprofiling measures were taken through the Official Sector Involvement (OSI). Rather than direct nominal haircuts, the OSI provided indirect sovereign debt relief, including the return of profits earned by EZ central banks under the Securities Markets Programme (SMP). These profits arose from the purchase of GGBs at deep discounts and their subsequent redemption at full face value upon maturity. Furthermore, a bond repurchase round was launched in 2012, through which Greece bought back a portion of its debt in the secondary market at largely discounted prices. This led to an approximate net debt reduction of €20.6bn, equivalent to about 11% of Greece's 2012 GDP.

The 1st and 2nd programme were carried out amid severe public turmoil and social unrest, yet implementation remained considerable - a result attributable to the tight conditionalities tied to each disbursement of bailout funds. On the contrary, "ownership" of each programme by the Greek government that had ratified it was low in comparison to the level of programme ownership demonstrated by the governments of other EZ distressed countries (Pagoulatos, 2018). This was particularly evident with respect to the 2nd and 3rd programme. Programme implementation and Greece's adherence to creditors' conditionalities were severely interrupted by the national elections of January 2015, after which the newly elected Greek government committed to unilaterally terminate the bailout programmes, give an end to austerity and restructure Greek sovereign debt, all while remaining in the EZ. A series of events followed,

under which Greece came to the brink of exiting the EZ in mid-2015. Ultimately, the government reversed its policy and agreed to the 3rd Economic Adjustment Programme for Greece on July 13th, 2015.

3.1.3 3rd Economic Adjustment Programme

The 3rd programme came after the exertion of brinkmanship by the newly elected Greek government, and was the end-result of an erratic 6-month negotiation period between the government and the Troika. Under the palpable - as it appeared in early to mid-2015 - threat of Grexit, a bank run took place, which is visible in Figure 8. Greek bank deposits amounted to some €159bn in June 2015, down from €208bn in the beginning of 2015; the €49bn deposit outflow in that period means a significant 23.6% of total bank deposits were withdrawn within a range of 6 months. The continuation of outflows culminated in the imposition of capital controls in late June 2015, amid a period of severe banking sector destabilization and liquidity constraints.

The bailout loan agreed under the 3rd programme amounted to a commitment of up to €86bn over three years (August 2015 - August 2018). Funds were disbursed by the ESM,[9] and primary surplus targets were set at 0.25% for 2015, 0.5% for 2016, 1.75% for 2017, and 3.5% for 2018. Aside from fiscal austerity, the reform agenda placed emphasis on the pension system and the establishment of a structure for reducing banks' non-performing exposures (NPEs). Factoring in Greece's economic derailment, the 3rd programme entailed some debt reprofiling, and was more flexible and realistic in its assumptions compared to the previous two (Zettelmeyer et al., 2018).

What changed from the 2nd to the 3rd programme was the Troika's definition of debt sustainability. Between 2011 - 2015, Greece's debt sustainability was primarily assessed on the basis of its debt-to-GDP ratio, a stock variable that measures the overall size of debt at one given point in time. The Troika shifted its emphasis to a flow variable in 2015, interpreting Greece's debt sustainability as a measure of its Gross Financing Needs (GFN), which can be defined as:

$$GFN_t = Primary\ Deficit_t + Interest\ Payments_t + Debt\ Maturing_t$$

[9] The ESM is an EZ crisis fund established in late 2012, and serves as the permanent successor of the temporary EFSF.

In its June 2015 Debt Sustainability Analysis (Report No. 15/165), the IMF specified that debt sustainability should be judged by whether Greece's GFN remained within 15% - 20% of its GDP.

Overall, each successive programme provided greater leeway with respect to fiscal adjustment. The terms of the 2nd programme were less restrictive than the 1st, given Greece's demonstrated fiscal consolidation efforts between 2010 - 2012. Similarly, the 3rd programme involved the mildest form of adjustment on the basis of the depth and severe effect of austerity measures implemented throughout 2010 - 2014. Lastly, the 2nd and 3rd programme included debt relief; the 2nd programme involved both debt reprofiling and restructuring (PSI), while the 3rd programme entailed only reprofiling measures, targeting maturity extensions and concessional coupon rates without any face-value haircuts.

In section 3.2, an empirical analysis is conducted to examine whether the three Greek programmes served the dual objective of: (i) preventing contagion in the EZ, and (ii) restoring market confidence for Greece.

3.2 Vector Autoregression Analysis & Impulse Response Functions

3.2.1 Methodology

In order to test for EZ contagion, a vector autoregression (VAR) model is employed using daily 10Y and 2Y yields, and examining responses across EZ distressed countries, Germany, and France. For this model, a short-term maturity was preferred over the benchmark 10Y maturity because, in theory, debt in the front end of the yield curve is more sensitive to perceived near-term default risk, and may thus exhibit more pronounced spillover findings (Xu et al., 2023). However, the availability of 2Y yield data presented some limitations. Although Greek 2Y yield data was available for the first and third bailout period, it was not consistently available for the second bailout period. This can be attributed to Greece's de facto exclusion from capital markets between April 2010 - April 2014, which effectively precluded the issuance of Greek 2Y debt and led to high illiquidity in the trading of that instrument.

By placing Greek yields first in the VAR ordering for EZ contagion, the Cholesky decomposition allows for a shock to Greek yields to have a contemporaneous effect on the selected EZ

countries' yields, but not vice versa. This ensures that the observed responses reflect spillovers originating from the Greek yield shock rather than concurrent feedback effects.

With respect to the market confidence analysis, VAR is employed across the entire financial intervention period (May 2010 - August 2018), using the monthly unemployment rate and monthly Industrial Production Index (IPI) as separate proxies for austerity, and the monthly Greek 10Y yield as a proxy for market sentiment. The rationale behind applying the entire crisis time range for these VARs is twofold: it allows for (i) a high number of observations that yield statistically significant findings, and (ii) an observation of the long-term effects of policy choices implemented through the three bailout programmes for Greece.

The formula used to obtain orthogonalized Impulse Response Functions (IRFs) can be expressed as:

$$\Theta_i^0 = \Phi_i P$$

where Θ_i^0 is the orthogonal impulse response i periods post-shock, Φ_i is a dynamic multiplier matrix at time horizon i, and P is a lower-triangular Cholesky matrix.

The matrix P is used to orthogonalize error terms, i.e., to transform the correlated residuals ε_t into uncorrelated structural residuals, such that:

$$\Sigma = PP'$$

where Σ is the variance - covariance matrix of the reduced-form shocks.

In the IRFs that follow, the black line represents the mean response, whereas the boundaries set by the upper and lower red dotted lines denote 95% bootstrap confidence intervals based on 100 executed simulations.

3.2.2 EZ Contagion

1st Programme

The VAR model is a 7-variable VAR(4) with the daily 2Y sovereign yields of Greece (impulse), and Ireland, Spain, Italy, Germany, France, Portugal (response). The lag length is based on the Akaike Information Criterion (AIC) and is expressed in matrix form as:

$$\begin{bmatrix} y_{GR,t} \\ y_{IE,t} \\ y_{SP,t} \\ y_{IT,t} \\ y_{DE,t} \\ y_{FR,t} \\ y_{PT,t} \end{bmatrix} = c + A_1 \begin{bmatrix} y_{GR,t-1} \\ y_{IE,t-1} \\ y_{SP,t-1} \\ y_{IT,t-1} \\ y_{DE,t-1} \\ y_{FR,t-1} \\ y_{PT,t-1} \end{bmatrix} + A_2 \begin{bmatrix} y_{GR,t-2} \\ y_{IE,t-2} \\ y_{SP,t-2} \\ y_{IT,t-2} \\ y_{DE,t-2} \\ y_{FR,t-2} \\ y_{PT,t-2} \end{bmatrix} + A_3 \begin{bmatrix} y_{GR,t-3} \\ y_{IE,t-3} \\ y_{SP,t-3} \\ y_{IT,t-3} \\ y_{DE,t-3} \\ y_{FR,t-3} \\ y_{PT,t-3} \end{bmatrix} + A_4 \begin{bmatrix} y_{GR,t-4} \\ y_{IE,t-4} \\ y_{SP,t-4} \\ y_{IT,t-4} \\ y_{DE,t-4} \\ y_{FR,t-4} \\ y_{PT,t-4} \end{bmatrix} + \varepsilon_t$$

where c is a 7 x 1 vector of intercepts, A_i is a 7 x 7 matrix of coefficients, and ε_t is a 7x1 vector of error terms.

Figure 14 presents the IRFs derived from the estimated VAR(4) model. 2Y yield spillovers are significant for Ireland, Italy, and Portugal; a one-unit shock in Greek 2Y yields leads to a significant contemporaneous effect in the 2Y debt of Ireland and Italy, and a significant effect on the 2Y debt of Portugal 1 day post-shock. On the other hand, Spain, Germany, and France exhibit non-significant findings.

To enhance the robustness of spillover findings, a VAR(1) is re-estimated using daily 10Y sovereign yields instead of 2Y yields. The lag length is selected based on the Bayesian information criterion (BIC). Figure 15 plots the IRF for the VAR(1) model. This time, spillover effects are significant at lag 0 for all EZ distressed countries and remain non-significant for Germany and France.

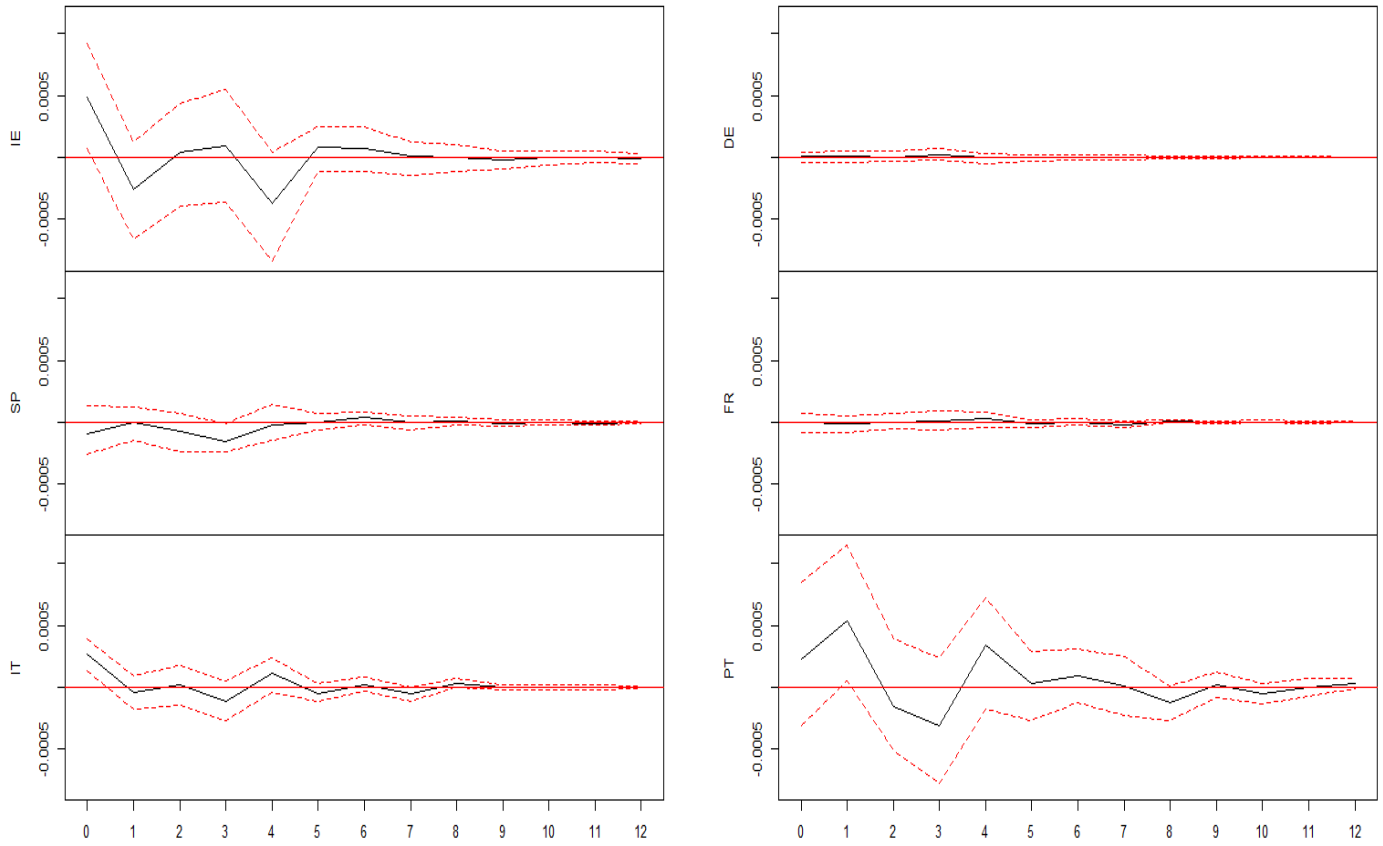

Figure 14: Orthogonal impulse response of Irish, Spanish, Italian, German, French and Portuguese 2Y yields from a unitary shock in the Greek 2Y yield, non-cumulative, May 3rd 2010 - March 1st 2012, daily, 95% bootstrap CI, 100 runs. *Data from Investing.com.*

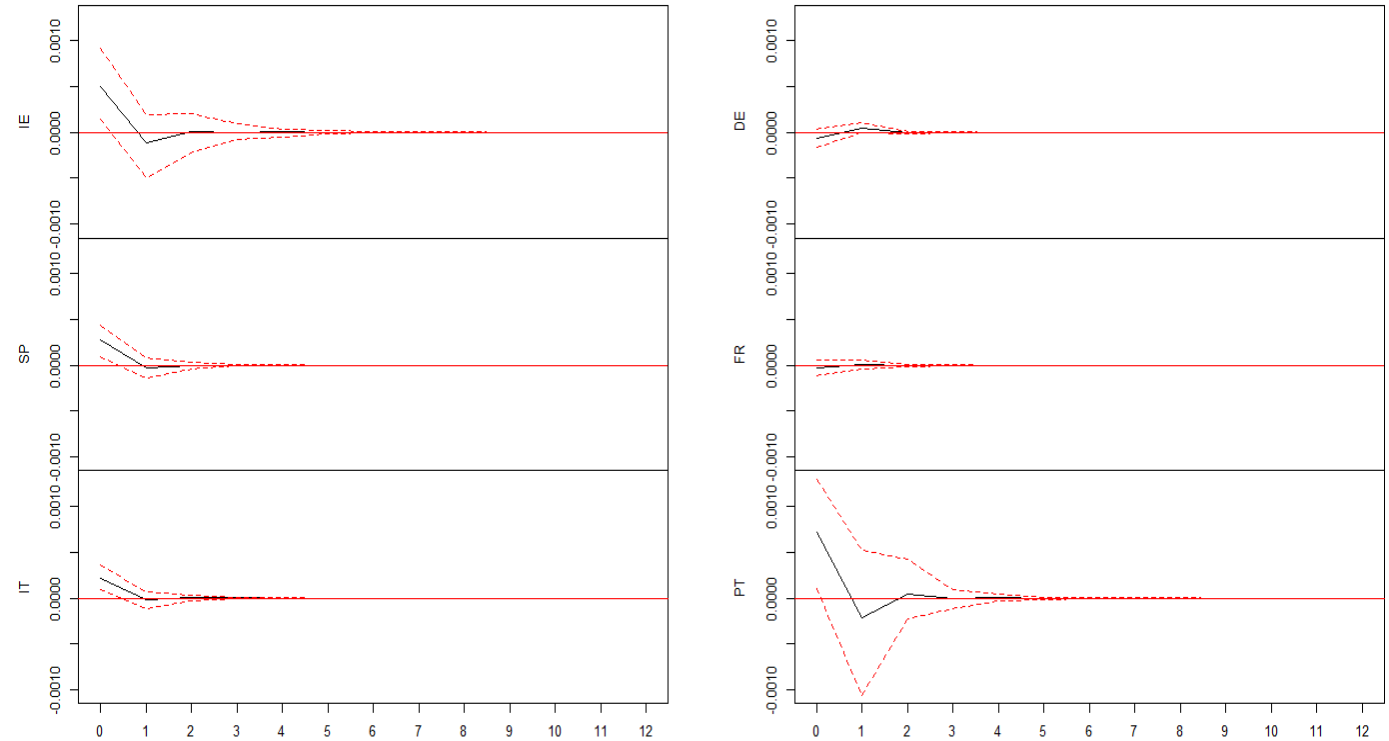

Figure 15: Orthogonal impulse response of Irish, Spanish, Italian, German, French and Portuguese 10Y yields from a unitary shock in the Greek 10Y yield, non-cumulative, May 3rd 2010 - March 1st 2012, daily, 95% bootstrap CI, 100 runs. *Data from Investing.com.*

The above IRF findings suggest that, overall, the 1st bailout package did not succeed in preventing contagion to the EZ, particularly to EZ distressed countries. Nonetheless, it shall be noted that IRF results for the 1st programme reflect a maturity-specific contagion dynamic. For 2Y yields, Portugal exhibits a delayed spillover effect while Spain exhibits non-significant effects. In contrast, the significant and immediate 10Y responses for both countries suggest that Greek shocks may have been interpreted as signals of structural sovereign credit risk, thereby prompting an immediate adjustment of the benchmark 10Y risk premium. Naturally, this contradicts the earlier theory that 2Y debt would exhibit more pronounced spillover effects, and supports the notion that mid- to long-end maturities acted as the primary transmission channel of contagion during the 2010 - 2012 crisis phase.

However, it is important to acknowledge that financial markets do not always respond in a fully rational or linear manner. Markets' behavior during periods of elevated uncertainty is often shaped by sentiment, herd dynamics, and imperfect information, which may lead to over- or under-reactions in yield movements. Consequently, some of the observed IRF patterns may reflect not only economic fundamentals, but also the inherently noisy and sometimes inconsistent nature of sovereign bond markets under stress.

2nd Programme

The contagion IRF for the 2nd Economic Adjustment Programme for Greece is derived from a VAR(1) model using the daily 10Y sovereign yield of Greece (impulse), and Ireland, Spain, Italy, Germany, France, Portugal (response). The lag length selection is based on the BIC. Figure 16, which plots the IRF for the VAR(1), reveals evidence of significant immediate 10Y yield spillovers to all EZ distressed countries and non-significant findings for Germany and France. The IRF results for the 2nd programme - which included debt restructuring - are similar to findings from the 1st programme and in particular the 10Y IRF, where yield spillovers are significant for all EZ distressed countries. This reinforces the view that, under the 2nd programme, Greek sovereign risk continued to transmit to the EZ periphery.

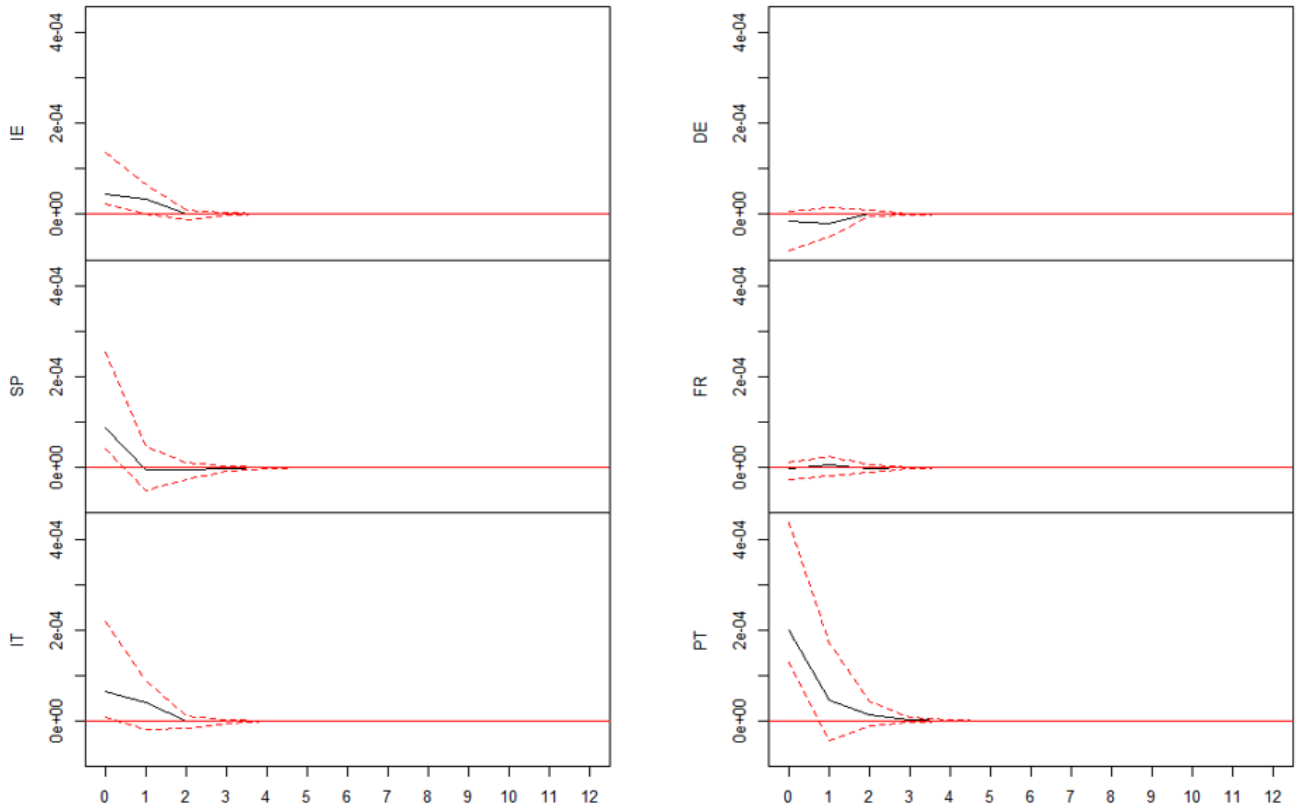

Figure 16: Orthogonal impulse response of Irish, Spanish, Italian, German, French and Portuguese 10Y yields from a unitary shock in the Greek 10Y yield, non-cumulative, March 2nd 2012 - June 31st 2015, daily, 95% bootstrap CI, 100 runs. *Data from Investing.com.*

3rd Programme

The first contagion IRF for the 3rd Economic Adjustment Programme for Greece is based on a VAR(1) model. The lag selection is in line with both the AIC and BIC. The model's variables are the daily 2Y sovereign yield of Greece (impulse), and Ireland, Spain, Italy, Germany, France, Portugal (response). The IRF is plotted in Figure 17 and indicates statistically significant 2Y yield spillovers to Spain, Italy, and Portugal. Ireland, Germany and France do not exhibit significant findings. The second contagion IRF for the 3rd programme is derived from a VAR(1) using daily 10Y sovereign yields. The lag length aligns with both the AIC and BIC. Figure 18, which plots the IRF for this VAR(1), shows that contemporaneous 10Y yield spillovers from Greece are significant for all EZ distressed countries and non-significant for Germany and France.

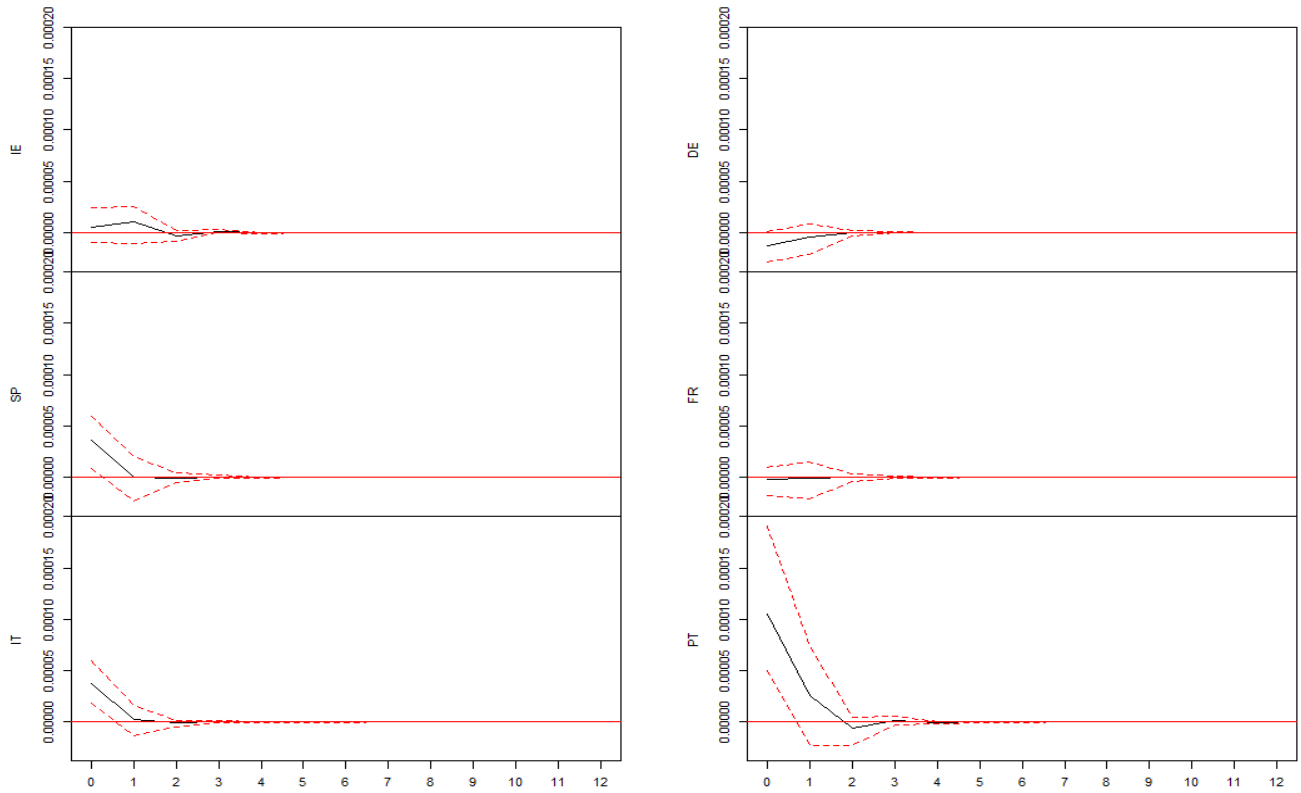

Figure 17: Orthogonal impulse response of Irish, Spanish, Italian, German, French, and Portuguese 2Y yields from a unitary shock in the Greek 2Y yield, non-cumulative, August 19th 2015 - August 20th 2018, daily, 95% bootstrap CI, 100 runs. *Data from Investing.com.*

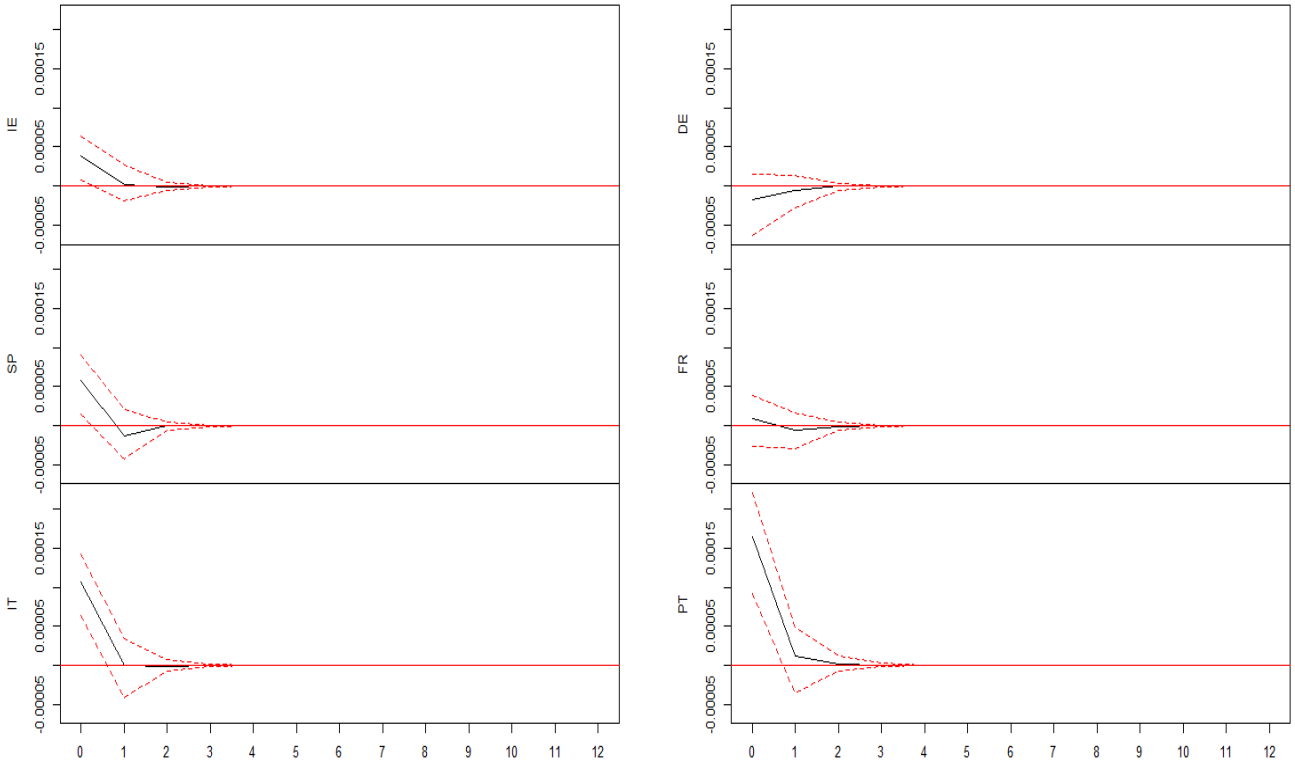

Figure 18: Orthogonal impulse response of Irish, Spanish, Italian, German, French, and Portuguese 10Y yields from a unitary shock in the Greek 10Y yield, non-cumulative, August 19th 2015 - August 20th 2018, daily, 95% bootstrap CI, 100 runs. *Data from Investing.com.*

Similar to IRFs for the 1st and 2nd program, IRFs for the 3rd bailout programme suggest that it did not succeed in preventing contagion to the EZ.

3.2.3 Austerity - Market Confidence

Impulse: Unemployment, Response: 10Y Yield

The IRF is based on a bivariate VAR(3) model using the monthly Greek unemployment rate (u_t) as impulse and 10Y yield (y_t) as response. The lag length selection follows the AIC. The VAR(3) model can be expressed in matrix form as:

$$\begin{bmatrix} u_t \\ y_t \end{bmatrix} = c + A_1 \begin{bmatrix} u_{t-1} \\ y_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} u_{t-2} \\ y_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} u_{t-3} \\ y_{t-3} \end{bmatrix} + \varepsilon_t$$

where c is a 2 x 1 vector of intercepts, A_i is a 2 x 2 matrix of coefficients, and ε_t is a 2 x 1 vector of error terms.

Figure 19 presents an IRF that plots the response of the Greek 10Y yield from a unitary shock in unemployment. The IRF suggests that an increase in unemployment did not have a significant effect - let alone a reduction - on the 10Y yield across the period May 2010 - August 2018. There is a slight positive reaction in the mean response of 10Y yields peaking in the 2nd month post-unemployment shock, but the long-term effects seem to dissipate. Additionally, the confidence bands are wide and consistently include zero, thereby indicating no significant causal relationship between the two variables over a 12-month horizon.

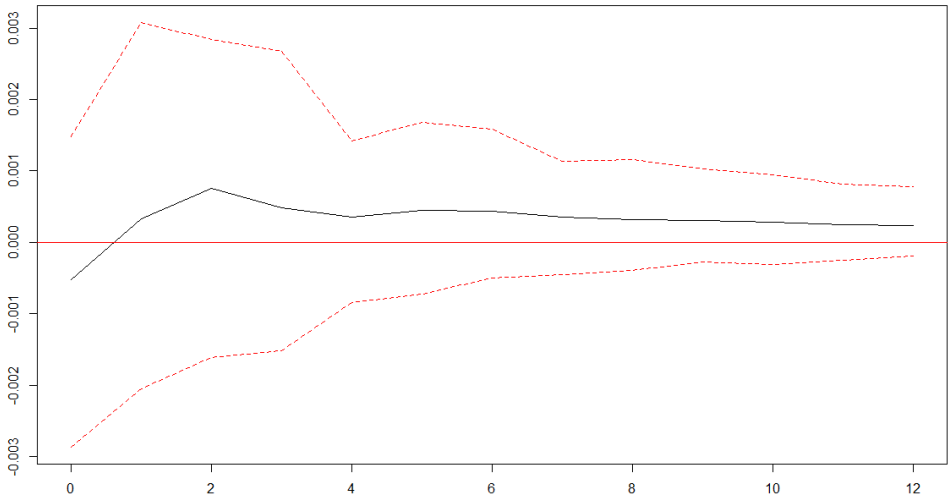

Figure 19: Orthogonal impulse response of the Greek 10Y yield from a unitary shock in the Greek unemployment rate, non-cumulative, May 2010 - August 2018, 95% bootstrap CI, 100 runs. *Data from the Bank of Greece & the Hellenic Statistical Authority.*

Based on the IRF analysis, it can be argued that an increase in unemployment did not lead to a significant reduction in the Greek 10Y yield, suggesting that austerity did not lead to restoration of market confidence during the course of the three Greek bailout programmes.

Impulse: IPI, Response: 10Y Yield

Once again, a bivariate VAR(3) model was estimated in line with the AIC. This time, the monthly Greek IPI (IPI_t) and 10Y yield (y_t) are used as endogenous variables. Figure 20 plots the response of the Greek 10Y yield to a negative unitary shock in the Greek IPI. The mean contemporaneous response appears negative at first, though this is likely statistical noise considering that the response turns positive 1 month post-shock, reaches its positive peak 2 months post-shock and then reverts to negative territory 3 months post-shock. In any case, the effect fades over time and is overall not statistically significant. Thus, at the 95% confidence level, the data does not indicate a robust negative impact on the 10Y yield from a negative one-unit shock in IPI.

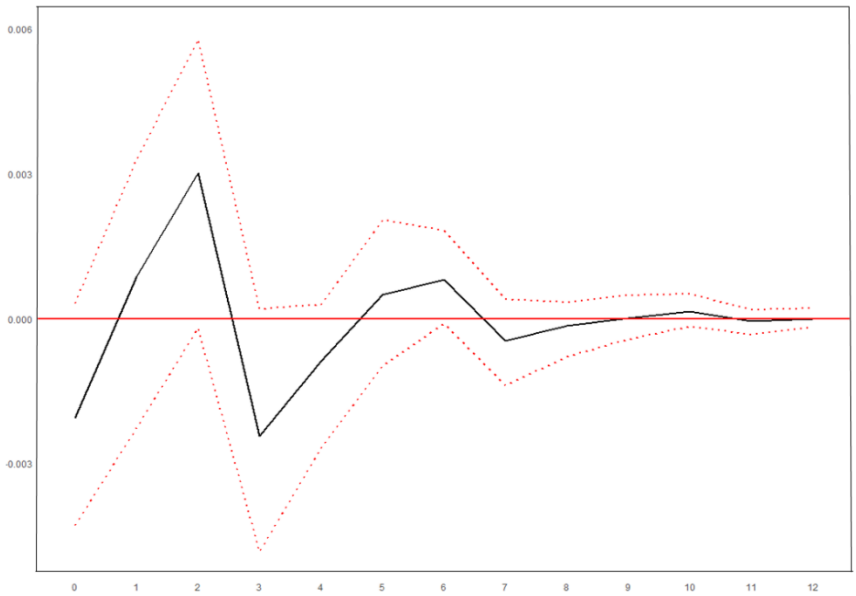

Figure 20: Orthogonal impulse response of the Greek 10Y yield from a negative one-unit shock in Greek IPI, non-cumulative, May 2010 - August 2018, 95% bootstrap CI, 100 runs. *Data from the Bank of Greece & the Hellenic Statistical Authority.*

Based on the above IRF, it can be argued that a decrease in the Greek IPI did not lead to a significant reduction in the Greek 10Y yield, suggesting again that implementation of austerity did not lead to restoration of market confidence during the course of the three bailout programmes.

4. The 2012 Greek Debt Restructuring

In March 2012, private creditors' acceptance of the proposed PSI terms met the required Collective Action Clause (CAC) threshold on Greek-law GGBs. The threshold stipulated a minimum approval rate of two-thirds within a quorum of 50% of the aggregate face value, i.e., 50% * 66.67% * €177bn (Zettelmeyer et al., 2013). The Greek government thus activated the CACs which had been retrofitted to Greek-law GGBs,[10] securing a 100% participation rate in the PSI for these bonds (see Table 2). The CAC thresholds for foreign-law GGBs were more demanding: CACs were individual rather than aggregate (i.e., bond-by-bond), two-thirds of the outstanding principal typically needed to vote, and 75% of votes cast within that quorum had to approve the PSI (Martinelli, 2016).[11] Of the €28bn in total eligible foreign-law GGBs, €6.4bn did not participate in the PSI (≈3% of eligible debt). The ECB and EU national central banks also did not participate in the PSI and simply conducted an off-market swap of their existing GGBs for new GGBs with different ISINs but unchanged financial terms and maturities (Xafa, 2014).

	EUR (bn)	**% of accepted bids**
Eligible debt	**205**	
Greek-law GGBs	177	
Foreign-law GGBs	28	
Accepted bids	**199**	
Greek-law GGBs	177	
Foreign-law GGBs	22	
Non-participation	**6**	
Cancelled debt	**107**	**53.5**
Restructured debt	**92**	**46.5**
New GGBs	62	31.5
EFSF notes	30	15
Non-participating creditors	**56**	
ECB	43	
EU national central banks	13	

Table 2: Greek debt exchange, March 2012. *Data from the ESM, ECB, and Bank of Greece.*

[10] For the legislation pertaining to Greek-law CACs, see Greek Law 4050/2012.
[11] Foreign-law GGBs comprised 31 English-law issues and 1 New York-law issue, as per Xafa (2014).

The 2012 Greek PSI became the largest sovereign debt restructuring in history by volume (Buchheit, 2016), as it ultimately cancelled approximately €107bn of GGBs held by private-sector creditors, or 57% of Greece's 2012 GDP. However, actual debt relief of the Greek sovereign amounted to €69bn (37% GDP) since, based on data from the Bank of Greece (2012), €38bn (20% GDP) from the 2nd bailout package was allocated to Greek banks for PSI-related losses on their GGB holdings.

Under International Accounting Standard (IAS) 39, Greek banks were required to mark-to-market the new GGBs and EFSF notes received through the exchange (European Securities and Markets Authority [ESMA], 2012). The market value of the new GGBs was lower than their nominal value, thus the 46.5% nominal value of the PSI package (31.5% in new GGBs and 15% in EFSF notes - see Table 2) did not reflect an equivalent market-based value. To more accurately capture the financial impact of the PSI, section 4.1 turns to a NPV analysis, which accounts for the market valuation of the instruments received in the exchange under different discount rate scenarios. Section 4.1 thus aims to: i) estimate the NPV losses incurred by the private sector under the PSI, and ii) compare findings with the NPV loss figures published by the Bank of Greece for domestic banks' GGB portfolios.

4.1 Analysis of the PSI

4.1.1 Composition and Cash Flow Structure of the PSI bundle

PSI participants were given the following bundle for every €100 nominal of original GGBs (ESM, 2020; Zettelmeyer et al., 2013):

1) Short-term EFSF notes at 15% of the face value. The EFSF component was split into: i) 50% maturing in March 2013 with a 0.4% coupon, and ii) 50% maturing in March 2014 with a 1% coupon. The EFSF notes functioned as a "financial sweetener" to the PSI, as they carried near-zero credit risk and provided cash-like liquidity to participants.
2) English-law GGBs at 31.5% of the face value. The GGB component consisted of 20 separate tranches with a 10-year grace period (2012 - 2022) and staggered bullet maturities thereafter (2023 - 2042), i.e., one tranche maturing every year starting in 2023. This effectively replicated a near-identical amortization schedule of 5% per year over the period 2023 - 2042. The GGB component carried a step-up coupon structure:

2% between February 2012 - February 2015, 3% between February 2015 - February 2020, 3.65% in February 2021, and 4.3% between February 2021 - February 2042.

3) Detachable GDP-linked bonds paying up to 1% additional interest on the principal of the new GGBs, provided that real and nominal GDP growth exceeded specified thresholds starting in 2015. The GDP-linked component will not be incorporated into the NPV analysis due to the high degree of conditionality and uncertainty attached to its cash flows. The value of the GDP-linked bonds is inherently option-like and stochastic, making those bonds more appropriate for option-pricing models, which is beyond the scope of this NPV analysis.

Table 3 presents the payment schedule of the PSI bundle:

Year	GGB Principal Outstanding (1)	GGB Coupon rate (2)	GGB Principal Payment (3)	GGB Coupon Payment (4) = (1) * (2)	EFSF Payment (5)	Total Cash Flows (6) = (3) + (4) + (5)
2013	31.5	2.00%	0	0.63	7.53	**8.16**
2014	31.5	2.00%	0	0.63	7.58	**8.21**
2015	31.5	2.00%	0	0.63	0	**0.63**
2016	31.5	3.00%	0	0.95	0	**0.95**
2017	31.5	3.00%	0	0.95	0	**0.95**
2018	31.5	3.00%	0	0.95	0	**0.95**
2019	31.5	3.00%	0	0.95	0	**0.95**
2020	31.5	3.00%	0	0.95	0	**0.95**
2021	31.5	3.65%	0	1.15	0	**1.15**
2022	31.5	4.30%	0	1.35	0	**1.35**
2023	29.93	4.30%	1.575	1.35	0	**2.93**
2024	28.35	4.30%	1.575	1.29	0	**2.86**
2025	26.78	4.30%	1.575	1.22	0	**2.79**
2026	25.20	4.30%	1.575	1.15	0	**2.73**
2027	23.63	4.30%	1.575	1.08	0	**2.66**
2028	22.05	4.30%	1.575	1.02	0	**2.59**
2029	20.48	4.30%	1.575	0.95	0	**2.52**
2030	18.90	4.30%	1.575	0.88	0	**2.46**
2031	17.33	4.30%	1.575	0.81	0	**2.39**
2032	15.75	4.30%	1.575	0.74	0	**2.32**
2033	14.18	4.30%	1.575	0.68	0	**2.25**
2034	12.60	4.30%	1.575	0.61	0	**2.18**
2035	11.03	4.30%	1.575	0.54	0	**2.12**
2036	9.45	4.30%	1.575	0.47	0	**2.05**
2037	7.88	4.30%	1.575	0.41	0	**1.98**
2038	6.30	4.30%	1.575	0.34	0	**1.91**
2039	4.73	4.30%	1.575	0.27	0	**1.85**
2040	3.15	4.30%	1.575	0.20	0	**1.78**
2041	1.58	4.30%	1.575	0.14	0	**1.71**
2042	0	4.30%	1.575	0.07	0	**1.64**

Table 3: Estimated payment schedule for the PSI bundle (excluding GDP-linked bonds).

4.1.2 Discount Rate Selection

GGB Component

In order to base NPV scenarios and discount-rate assumptions on actual market behavior, quantiles of the 10Y GGB yield distribution are estimated over the 3-year period March 2009 - March 2012.[12] The 10Y yield is selected as the discount-rate proxy for two key reasons. First, the benchmark 10Y yield was the most liquid and reliable reference for investor required returns on Greek debt throughout the period 2010 - 2012, when Greece had lost access to bond markets. Second, although the principal of the new GGBs issued under the PSI bundle was fully redeemed in 30 years, its structure (10-year grace period and 5% annual amortization thereafter) gives them an effective duration that is closer to a 10-year bullet bond than an ultra-long bond, rendering the 10Y yield a more appropriate proxy. The derived discount rates are broadly consistent with prior analyses by Eurobank (2012), IMF (2012), and Zettelmeyer et al. (2013).

Scenario	Quantile	Discount Rate	Assumptions
Optimistic	25th percentile	≈ 6%	At least 90% PSI investor participation; restructuring classified as voluntary thus no activation of CACs; no CDS triggered; improvement in market sentiment and decrease in GGB yields; strengthening of outlook for Greek solvency post-PSI
Base Case	50th percentile	≈ 11%	Investor participation > 75% but < 90% ; restructuring not classified as voluntary; CACs + CDS triggered; partial restoration of investor confidence; Greek banks mark large but manageable losses; moderate solvency risk persists
Pessimistic	75th percentile	≈ 16%	PSI investor participation below 75% ; restructuring not able to be imposed via CACs; large portion of debt remains unexchanged; Greece faces rising default risk and worsened solvency outlook; Greek banks absorb larger losses due to retained exposure to non-restructured GGBs
Stress Case	90th percentile	≈ 19%	PSI fails; surge in yields on Greek debt; market capitulation; Greek banks suffer heavy and unsustainable losses

Table 4: Discount rate scenarios, GGB component of the PSI bundle.

[12] The selection of this broader time range ensures that the derived discount rates incorporate pre-PSI and pre-default risk premia, offering a more appropriate basis for quantifying the "optimistic" NPV scenario.

EFSF Component

Discounted at 0.5% ; a conservative rate that is consistent with the very low risk profile of the EFSF and yields on comparable 1 and 2 year German bunds around the PSI period.

4.1.3 Valuation of the PSI bundle

Table 5 provides the NPV estimations of the PSI bundle under the four different discount rate scenarios:

Discount Rate (%)	GGB Component	EFSF Component	NPV of PSI bundle	NPV Loss (%, rounded)
6	21.93	14.99	**36.92**	**63**
11	12.05	14.99	**27.04**	**73**
16	7.47	14.99	**22.47**	**78**
19	5.88	14.99	**20.88**	**79**

Table 5: Estimated NPV losses from the PSI under different discount rate scenarios (excluding GDP-linked instrument).

The estimated NPV losses from the PSI in Table 5 are compared with similar data published by the Bank of Greece in Table 6: the PSI loss on Greek banks' GGBs alone amounts to €33.88bn, implying a rounded NPV loss of 78%. However, when accounting for an additional €3.86bn of PSI losses on state-related loans, the total gross PSI loss rises to approximately €38bn (Bank of Greece, 2012). Importantly, the NPV loss implied by the Bank of Greece aligns with the modelled NPV loss under the pessimistic (16%) discount rate scenario.

Bank	Face amount of GGBs	PSI loss of GGBs	
NBG	13,748	10,985	
Piraeus	7,063	5,686	
Eurobank	7,001	5,517	
ATEbank	5,164	3,873	
Postbank	4,197	3,306	
Alpha	3,898	3,087	
Others	2,572	1,422	**NPV Loss (%, rounded)**
Total	**43,643**	**33,876**	**78**

Table 6: Greek banks' estimated PSI-related NPV losses in GGB holdings (in millions), as per the Bank of Greece (2012).

The close correspondence between modelled and official NPV losses supports the hypothesis that private sector participants priced the PSI issue of GGBs using high discount rates, presumably reflecting substantial perceived sovereign risk, liquidity constraints and general uncertainty regarding Greece's economic recovery. Moreover, the imposition of losses on state-related loans underscores the systemic impact of the PSI on Greek banks' balance sheets, beyond merely sovereign debt exposures. This reinforces the argument that the PSI, while achieving debt relief for Greece, imposed deep market-based losses on banks - losses that were significantly higher than what the nominal restructuring figures initially suggested. Evidently, the comparative analysis between modelled and official estimates validates the use of elevated discount rates in valuing the PSI bundle.

4.1.4 The 2012 Debt Buyback

In December 2012, Greece carried out a bond buyback operation in coordination with domestic and international private creditors. Through the buyback, Greece aimed to retire a portion of the new GGBs issued in the PSI exchange, thereby reducing its public debt. An eventual bond repurchase by Greece was a matter envisaged by the PSI operation, but the IMF necessitated it in late 2012 when it conditioned the further disbursement of Extended Fund Facility funds (i.e., the IMF component of the 2nd bailout package) on Greece's reduction in public debt.

On December 18th, €31.9bn of face-value GGBs issued in the PSI exchange were cancelled, funded by an €11.3bn loan facility from the EFSF.[13] Of the €31.9bn of GGBs participating in the buyback, €14.1bn came from Greek banks and €17.8bn came from foreign banks. The buyback was conducted as a Dutch auction with upper and lower price ranges, and was executed at a mean purchase price of 0.34/euro (Public Debt Management Agency [PDMA], 2012). Through this operation, Greece reduced its public debt stock by €20.6bn, equal to 11% of its 2012 GDP.

4.2 Was the Restructuring the Right Decision?

Section 4.1 established that the PSI imposed deep losses on the books of private creditors; combining the NPV haircut percentage and participation in the Greek restructuring renders it an unprecedented event in the history of sovereign debt restructurings. In light of its exceptional

[13] The €11.3bn figure refers to the cost of the buyback including accrued interest on GGBs held by the private sector. Excluding accrued interest, the purchase price of the GGBs amounted to €10.8bn.

scale and impact, deciding whether the PSI was indeed the right decision requires addressing two key questions. First, setting aside concerns about contagion to the EZ periphery, had Greece's financial distress reached a threshold that would directly warrant restructuring? Second, considering the EZ contagion effects that a Greek restructuring had the capacity to trigger, was there a more effective alternative?

Regarding the first question, fiscal sustainability is commonly assessed through the intertemporal government budget constraint, which requires that the expected present value of future primary surpluses be at least equivalent to the current stock of debt. This can be expressed as:

$$B_t = E_t \sum_{n=1}^{\infty} \left(\prod_{j=1}^{n} \frac{1}{1 + r_{t+j}} \right) S_{t+n}$$

where B_t is debt at time t, E is the expectations operator, r is the real interest rate and S is the primary surplus.

The intertemporal government budget constraint does not require the government to repay its debt in full, nor to reduce it in nominal terms, but rather to ascertain that the discounted sum of future primary surpluses equals the existing debt. A necessary condition is the no-Ponzi game condition for public debt:

$$\lim_{n \to \infty} E_t \left(\prod_{j=1}^{n} \frac{1}{1 + r_{t+j}} \right) B_{t+n} = 0$$

which simply ensures that debt does not grow faster than the rate at which it can be serviced in perpetuity. Theoretically, several debt paths can satisfy these conditions, including paths involving prolonged periods of deficits, as long as fiscal adjustment takes place eventually. A sustainable fiscal trajectory on the basis of the above two mathematical expressions cannot always be credibly assessed by bond market investors. If investors lose faith in the credibility of a sovereign's fiscal path, interest rates may rise to reflect credit risk, which itself can worsen debt dynamics and lead to a self-fulfilling crisis - a scenario that Greece encountered in the run-up to the PSI.

Therefore, a more practical and observable approach to fiscal sustainability involves shifting from the PV framework to a flow-based condition using the debt-to-GDP ratio, as argued by Alogoskoufis (2012). Starting from the flow version of the government budget constraint, we have:

$$B_t - B_{t-1} = r_t B_{t-1} - S_t$$

which expresses that a government deficit generates an increase in sovereign debt. Dividing both sides by GDP, we derive:

$$b_t - b_{t-1} = \left(\frac{r_t - g_t}{1 + g_t}\right) b_{t-1} - s_t$$

where b is the debt-to-GDP ratio, s is the primary surplus-to-GDP ratio, and g is the percent change in GDP. Assuming a steady-state debt-to-GDP ratio, we can rearrange the flow budget constraint to derive the minimum required primary surplus-to-GDP ratio consistent with fiscal sustainability:

$$\overline{s_t} = \left(\frac{r-g}{1+g}\right) b_{t-1}$$

To evaluate Greece's solvency at the time of the PSI, the variables of the above model are computed as follows:

r	calculated as the average of the annualized yield on 10Y GGBs over the period January-March 2012 divided by 4, minus the average of the monthly Greek Harmonised Index of Consumer Prices (HICP) for the same period
g	calculated as the quarter-over-quarter (QoQ) change in seasonally adjusted real GDP from Q4 2011 to Q1 2012
b_{t-1}	taken as Greece's debt-to-GDP ratio in Q4 2011 (end of period)

Table 7: Derivation of inputs to the fiscal sustainability condition for Greece, Q1 2012.

Thus, we have:

$$\overline{s_t} = \left(\frac{\left(\frac{0.26}{4} - 0.017\right) - (-0.0089)}{1 + (-0.0089)}\right) \cdot 1.75$$

$$\overline{s_t} = 0.10 \text{ or } \mathbf{10\% \text{ of GDP}}$$

In Q1 2012, Greece would have needed to run a primary surplus of 10% of GDP merely to stabilize its debt path. In stark contrast, the country recorded a primary deficit of 2.9% of GDP. Given that the threshold for solvency was not met, the conditions for a restructuring as per the debt-stabilizing primary balance model were unequivocally satisfied.

This leads to the second question raised in this section; having determined that Greece's debt was unsustainable in Q1 2012, might there have been a better alternative to the PSI? The decision made in mid-2011 to pursue a Greek PSI arguably played a role in intensifying the EZ crisis (Zettelmeyer et al., 2013; Ardagna & Caselli, 2014), but it has already been established that spillover effects from the Greek crisis to EZ distressed countries were significant even under the programmes which did not contain restructuring (e.g. 1st bailout programme; see section 3.2.2). Considering the risks of an EZ breakup and potential defaults across the EZ periphery, Zettelmeyer et al. (2013) raise the question of whether it would have been more appropriate to settle the Greek crisis via official transfers instead of PSI.[14] This investigation maintains that official transfers would not have been a better option for several reasons.

First, despite the cancellation of €107bn and restructuring of €92bn of privately-held Greek debt, Moody's downgraded its outlook on Greece in March 2012, viewing GGBs as securities "with little prospect for recovery of principal or interest" (Reuters, 2012). Also, in its March 2012 Country Report No. 12/57, the IMF noted that further financing, fiscal adjustment, and potential official sector support might be needed for Greece to return to a sustainable path. To thus both replace the PSI and ensure solvency for Greece, the required official transfer from EZ member states would have had to be massive. Fiscal transfers of this scale, however, are only viable within a federal-type system or centralized fiscal union, which the EZ was (and still is) not.

Second, although the PSI carried systemic risks, the EZ had adopted unconventional monetary policy measures to control those risks. Notably, the ECB had already launched the SMP in May 2010, under which it purchased GGBs in the secondary market to combat selloffs and restore liquidity (ECB, 2010). By the time the SMP concluded in September 2012, the ECB held a nominal amount of €33.9bn in GGBs (ECB, 2013). The ECB's Outright Monetary Transactions (OMT)

[14] Official transfers refer to non-repayable financial support granted by other EZ member states to the Greek sovereign.

programme was the successor of the SMP and although no GGB purchases were made under the OMT, it signaled the ECB's commitment to preserving stability in the EZ (De Grauwe & Ji, 2013). These interventions - though implemented cautiously or even reluctantly (Altavilla, Giannone & Lenza, 2014 ; Szczerbowicz, 2015) - indicate that, theoretically, the ECB did possess the tools necessary to mitigate EZ systemic risks.

Third, reliance on official transfers as a crisis resolution mechanism would have raised significant concerns regarding moral hazard. Moral hazard arises when an entity increases its exposure to risk under the assumption that it will not bear the full consequences of any resulting financial losses. In the context of the Greek crisis, the provision of large-scale official transfers could have undermined fiscal discipline across the EZ by signaling to both markets and governments that excessive sovereign indebtedness might be bailed out by supranational institutions. This argument is consistent with Corsetti, Guimaraes, and Roubini (2013), who suggest that unconditional fiscal support can diminish countries' incentives to maintain fiscal prudence.

Fourth, granting official transfers to Greece would likely have created expectations of similar treatment in other distressed EZ countries, whose sovereign debt yields were contaminated by the Greek crisis. This would expand the scale of required fiscal outlays potentially beyond what was economically viable. In an environment marked by divestment of EZ peripheral debt and increasing market uncertainty, such a development would have tested the limits of intra-EZ solidarity. Thus, from both an economic and an institutional perspective, official transfers not only posed incentive problems but also carried the risk of setting an unsustainable precedent in the EZ.

In sum, the flow-based sustainability analysis demonstrates that Greece's debt in early 2012 was unsustainable under prevailing macroeconomic and market conditions. Accordingly, the restructuring was both necessary and justified. Even if the option of a substantial official transfer was viable - which it presumably was not - the restructuring was the right decision. It was an unavoidable - though inadequate in itself - mechanism toward resolving the Greek debt crisis.

4.3 Could the Restructuring Operation Have Been Handled More Efficiently?

The Greek restructuring can be seen as inevitable and, in many ways, successful: it was swift, orderly, and delivered substantial debt relief for Greece. Simultaneously, it can be criticized with respect to several areas and provide noteworthy lessons for potential future debt restructurings in the EZ. Chief among the concerns is that the PSI was "too little, too late" when it came to restoring Greece's debt sustainability (Xafa, 2014; Zettelmeyer et al., 2013; Guzman et al., 2016).

It can be argued that the structure of the PSI reflected an effort to handle private creditors as delicately as possible, especially in light of the Troika's requisite that i) Greece reach a debt-to-GDP ratio of 120% by 2020 (European Council, 2011), and ii) central banks' GGB holdings be excluded from the haircut. Naturally, the PSI was most likely not perceived as 'delicate' from participants whose losses on GGBs were well above 53.5% in NPV terms, especially if those participants held Greek-law GGBs and were coerced into accepting the restructuring through retrofitted CACs. Nonetheless, authorities strove to ease the restructuring process by offering a range of incentives and participant-friendly regulations.

First, the PSI bundle comprised a highly generous cash sweetener, as participants received top-rated EFSF notes worth 15% of old GGBs' face value - the largest sweetener recorded in the history of sovereign restructurings. For context, based on 180 debt restructurings across 68 countries between 1970 - 2010, Cruces and Trebesch (2013) estimated the mean cash sweetener at 3.6%. Second, the PSI bundle included an upgrade in the legal status of the new GGBs, allowing creditors to exchange old Greek-law GGBs with limited creditor protections for new English-law GGBs with cross-default, negative pledge and pari passu clauses. The seniority and creditworthiness of the new GGBs was further enhanced by a "co-financing agreement", under which Greece's obligations to the GGB bondholders and to the EFSF were treated equally in terms of payment priority. This structure made it difficult for the Greek sovereign to default on private bondholders in the future without simultaneously defaulting on its debt to the EFSF.

Third, Greek and EZ authorities refrained from issuing threats toward holdout creditors, cultivating an environment where, excluding the insertion of CACs, the restructuring could be perceived as voluntary. That perception was confirmed ex-post, as holdouts received full repayment and in due time. Lastly, while Greece did make use of legislative fiat to facilitate the

restructuring, it did so only to retroactively introduce CACs (in the case of Greek-law GGBs) and not to alter the payment terms of its issued debt. Similarly, in the case of foreign-law GGBs, Greece avoided the exertion of pressure on holdout creditors via aggressive legal techniques such as exit consents, which have been employed in past sovereign debt exchanges [e.g., Ecuador (2000), Uruguay (2003)].

Additionally, while not a direct attribute of the handling of the restructuring, it is important to note that the Greek PSI was not nearly as destabilizing as feared with respect to the triggering of CDS payouts. When the International Swaps and Derivatives Association (ISDA) classified the PSI as a credit event in March 2012, payouts were triggered by sellers of CDS protection on Greek-law GGBs (ISDA, 2012). Some market participants had feared that a sovereign default within the EZ would lead to a crisis similar to that caused in the U.S. by the 2008 collapse of Lehman Brothers, but those fears turned out to be disproportionate considering that payouts by sellers of CDS on GGBs amounted to €2.5bn at the time of the PSI (Zettelmeyer et al., 2013). This represented a non-significant 1.4% of the €177bn exchanged Greek-law GGBs.[15] In contrast, the Lehman bankruptcy triggered CDS payouts amounting to a much larger $75bn (Xafa, 2014).

Nonetheless, a series of errors were committed with regard to the Greek restructuring, meaning costs to Greece and/or the EZ which are unjustifiable regardless of the PSI's overall success or the rationale of containing spillovers.

First, the restructuring was delayed until it was (nearly) too late. There is a debate on whether Greece should have called for a restructuring in April 2010, when the sovereign lost access to capital markets and requested a rescue package. Between May 2010 (inception of the 1st bailout programme) and February 2012 (adoption of the 2nd programme), around €58bn worth of GGBs matured and were redeemed at full face value, funded by official loans (Pagoulatos, 2018). Had the PSI taken place in May 2010, a further €31bn of sovereign debt would have been written off (53.5% * €58bn), equal to 16.7% of Greece's 2012 GDP. This is a considerable difference in debt

[15] Premiums demanded by sellers of CDS on Greek debt had become increasingly expensive in the run-up to the PSI, leading to CDS divestment. Indicatively, net notional CDS amounts outstanding stood at $7bn by end-2008 and $6bn by end-2010 (IMF, 2013), figures which were substantially higher than what was ultimately paid out by CDS sellers.

relief that would have enabled a milder fiscal adjustment path and a lower degree of front-loaded austerity.

This paper argues that the decision not to pursue a restructuring right away (May 2010) might have been theoretically justifiable, as it allowed Greece to implement some form of adjustment before defaulting and/or imposing a coercive deep haircut upfront. What is unjustifiable, nonetheless, is the delaying of the restructuring beyond early to mid-2011, at which point Greece's deepening recession had driven the 1st programme off track. This argument is consistent with both Zettelmeyer et al. (2013) and Xafa (2014). According to Zettelmeyer et al. (2013), the implementation of a "deep restructuring" by mid-2011 would have written off a minimum of €10bn in bond amortizations - that is, debt relief of at least 5.4% of 2012 GDP.

To empirically validate the argument for a Greek restructuring by mid-2011, the debt-stabilizing primary balance model of section 4.2 is applied to the end of Q1 2011. We thus have:

$$\overline{s_t} = \left(\frac{\left(\frac{0.1186}{4} - 0.0443\right) - (-0.036)}{1 + (-0.036)} \right) \cdot 1.48$$

$$\overline{s_t} = 0.033 \text{ or } \mathbf{3.3\% \text{ of GDP}}$$

The estimated primary surplus for Q1 2011 (3.3% of GDP) deviates substantially from the actual budget balance, as Greece recorded a primary deficit of 3.2% of GDP. By April-May 2011, a restructuring was more than justifiable. The delay thereafter simply perpetuated the offloading of privately-held GGBs and thus the amount available for restructuring, as French and German banks sought to cut exposures on Greek debt and passed portions of their GGB holdings on to the official sector, presumably through the SMP operation. This, in the view of Xafa (2014), possibly made an official debt restructuring "inevitable down the road."

Although a nominal haircut on official sector GGB holdings never occurred, it should be noted that had national central banks and the ECB accepted a restructuring of their GGB portfolios under the PSI terms, debt relief would amount to €30bn (€56bn national central bank and ECB holdings* 53.5% haircut), nearly the same as the benefit from introducing the PSI in May 2010 (€31bn). The Institute of International Finance (IIF) does not challenge the exclusion of ECB

holdings from the PSI, but it suggests that other official sector body holdings shall have been subject to the haircut in the sense that they represent "traditional financial investments."

The second error with respect to the handling of the restructuring is that the design of the PSI did not maximize potential debt relief for Greece. Having established the fact that private bondholders had already "absorbed" far more than 53.5% in effective losses by marking-to-market the GGBs in their balance sheets, a deeper nominal haircut would have been economically feasible. Table 8 outlines several counterfactuals pertaining to the PSI operation, under which Greece would have achieved greater debt relief. For instance, a 70% nominal haircut - that is, a haircut 8% lower than the NPV haircut implied by the Bank of Greece - would have achieved additional debt relief of €32bn. Granted, the imposition of a deeper nominal haircut would have necessitated tougher, and likely more time-consuming, negotiations with Greece's private creditors. Given what was at stake, however, Greece could have initiated negotiations with creditors earlier in order to allow more time for a more favorable outcome.

The third point to make, albeit not necessarily an error, is the execution of the December 2012 debt buyback. It was decided that the buyback would be carried out at prevailing secondary market prices (i.e., 'voluntary' buyback) rather than a negotiated price. However, from November 23 (the reference pre-buyback announcement price) to December 12 (the actual date of the buyback) the market price of debt rose by around 22%.[16] This observation aligns with an argument supported by skeptics of buybacks, namely that the announcement of an upcoming voluntary buyback is likely to result in a rise in the price of the underlying instrument, thus yielding a mean buyback price that is more expensive than the pre-announcement price (Bulow, Rogoff & Dornbusch, 1988). In the case of Greece, it must be noted that the price increase from November 23 to December 12 might overestimate the effect of the buyback declaration, given the occurrence of other events in late November to which the debt's price increase can be partially attributed (e.g., OSI and continuation of official creditors' disbursements). It might also be the case that the price increase from November 23 to December 12 underestimated the

[16] In a statement issued by the Eurogroup on November 27, 2012 - in which it announced a 'possible' debt buyback operation by the Greek sovereign - the price of November 23 is interpreted as the indicative pre-buyback price level. The Eurogroup also states that the November 23 price shall be the ceiling at which GGBs are tendered in the buyback (Eurogroup, 2012).

buyback's impact because ECB policymakers had first hinted at a potential debt buyback by Greece on October 12 (see Reuters, 2012). Thus, the possibility of a buyback might have been priced in between October 12 - November 23, thereby leading to a less pronounced price change between November 23 - December 12. The price of debt on October 11 can therefore also be taken as an alternative pre-buyback announcement reference price.

Table 8 presents the additional debt relief that Greece would have achieved with the same EFSF funding (€11.3bn) if it had bought back debt at the secondary market price of November 23 or October 11. The differences are notable; Greece would have written off an additional €7bn of debt based on the price of November 23, or a significant €17bn based on the price of October 11. In hindsight, a negotiated buyback that would have sought to secure a pre-announcement buyback price would have been substantially more beneficial than a buyback at market prices, at least with respect to the objective of reducing sovereign nominal debt.

	Total eligible debt	**Debt relief**
Counterfactuals pertaining to the PSI exchange		
Actual PSI	199	107
Full participation of private creditors	205	110
70% haircut on actual PSI participation	199	139
60% haircut on actual PSI participation	199	119
Actual PSI, plus holdings of national central banks	213	114
Actual PSI, plus holdings of ECB and national central banks	255	137
Counterfactuals pertaining to the December 2012 debt buyback		
Actual buyback (33.8%)		21
Buyback at secondary market price of Nov. 23, 2012 (27.8%)		28
Buyback at secondary market price of Oct. 11, 2012 (21.9%)		38

Table 8: Counterfactuals to the March debt exchange and December debt buyback, in € billion. *Data from the Bank of Greece, ESM, IMF, and Zettelmeyer et al., 2013.*

This leads to the central question with respect to the buyback: did the actual operation, in the mean price that it was executed (≈34%), result in meaningful debt cancellation that improved the sovereign's ability to service its remaining obligations? To evaluate this, Table 9 calculates

the net present value effect of the buyback on the sovereign's debt burden using discount rates based on the 20th, 35th, and 50th percentile of the 10Y GGB yield between March 2009 - December 2012, i.e., an expansion of the time frame incorporated in section 4.1.2. The selection of lower percentile discount rates compared to those in section 4.1.2 is meant to reflect a more optimistic outlook - one that assumes Greece would gradually regain market access and refinance its liabilities at lower costs in light of the restructuring and buyback operations.

In each column of Table 9, both the retired outflow from the GGBs and the newly undertaken liability to the EFSF are discounted using the same rate; given the significantly reduced stock of privately held Greek debt in late 2012, as well as the introduction of the co-financing agreement under the PSI bundle (see p. 40), it would be reasonable to assume a roughly equal default risk towards the private and official sector.

	Discount rate (%)		
	≈ 6	**≈ 9**	**≈ 12**
Reduction in GGB liabilities			
Face value	31.9	31.9	31.9
Present value	7	4.8	3.5
Increase in liabilities to EFSF			
Face value	11.3	11.3	11.3
Present value	1.6	0.63	0.25
Debt relief			
Face value	20.6	20.6	20.6
Present value	5.4	4.2	3.3

Table 9: Debt relief from the December 2012 Greek debt buyback, in € billion.

Based on Table 9, it is evident that beyond the €20.6bn in nominal net debt relief, the buyback did indeed generate relief in present value terms. Depending on the discount rate used, the present value relief reaches from €5.4bn (lowest applied rate) to €3.3bn (highest applied rate), or 2.9% to 1.8% of Greece's 2012 GDP, respectively. Even if one were to perceive the risk of default to the private sector to be greater than the risk of default to the official sector, debt

relief would have still been achieved in present value terms.[17] Although derived values are not exceptionally large, they are still meaningful when accounting for Greece's financial distress at the time, as well as the modest size of the buyback operation.

In conclusion, while the Greek restructuring achieved notable debt relief, it could have been handled more efficiently, even without pursuing the participation of holdouts or the ECB. More specifically, the PSI exchange shall have taken place earlier and with a design that applied a larger haircut on the holdings of participants. At the same time, the December debt buyback would have generated even greater debt relief if it had been negotiated rather than voluntary. The combination of a timely restructuring (e.g. mid-2011) with a different design and capped GGB buyback prices could have generated further nominal debt cancellation of up to €60bn, equivalent to 32% of Greece's 2012 GDP. This, in all likelihood, would have ensured the sustainability of Greece's outstanding debt.

5. An Event Study of the January - August 2015 Crisis Phase

The preceding chapters of this investigation have concentrated on the role and efficiency of crisis resolution mechanisms deployed throughout the Greek sovereign debt crisis. These mechanisms, including the three Economic Adjustment Programmes for Greece and the restructuring operation, represent institutional, structured and rule-based responses to sovereign distress within the EZ area. In contrast, this chapter departs from the financial examination of Greece within an established crisis resolution framework and turns to a period marked by the effective suspension of institutional crisis governance. Specifically, it investigates the period January - August 2015, a tumultuous interval during which the newly elected Greek government openly signaled its reluctance to comply with the existing bailout programme architecture that had governed the country's macroeconomic adjustments since May 2010.

Although Greece had not formally exited the programme, the increasingly adversarial stance toward European institutions and breakdown in negotiations, the expiry of the 2nd bailout programme without renewal and subsequent missed payment to the IMF on June 30, 2015

[17] To a large extent, this can be attributed to the repayment schedule of the EFSF loan that financed the buyback, as the schedule comprises annual amortizations between 2043 - 2049. The extended deferral of amortizations until 2043 significantly reduces the present value of the liability irrespective of the discount rate applied.

effectively placed Greece outside any operational crisis resolution framework from early to mid-2015. This chapter, therefore, studies this period of Greece's de facto disengagement as a unique regime in itself - one marked by the absence of institutional assistance and policy fragmentation. The objective is to analyze the market impact of the period in examination (January - August 2015), during which several non-macro-financial events took place. The event study is conducted with respect to the premium on 5-year Greek CDS, which is used as a dependent variable in section 5.1, and as a response variable in section 5.2.

5.1 Modelling the Greek 5-Year CDS Premium: an ARMAX Approach

Clancy, Gabriele, and Zigriaova (2020) argue that market pricing of Greek sovereign credit risk in early to mid-2015 was influenced by event-driven disruptions that functioned as structural shocks. For July 2015, they report a sharp downward spike in the 1% Value-at-Risk (VaR) of GGBs, accompanied by a decoupling from the 1% VaR of EZ distressed countries' debt. This observation aligns with the period of uncertainty marked by the imposition of capital controls, the subsequent bailout referendum, and heightened Grexit speculation. The observed decoupling and tail risk acceleration reinforce the premise that structural events in the first half of 2015 acted as market-moving catalysts with systemic implications.

To test for this premise, this section applies an econometric approach to Greece's credit risk through the estimation of autoregressive moving average models with exogenous variables (ARMAX). The analysis investigates Greek credit risk by examining the sovereign's CDS premium across three separate time periods: i) January 2010 - March 2012 (1st bailout programme, as well as few months prior to its inception), ii) January 2015 - August 2015 (the turmoil period), and iii) September 2015 - August 2018 (3rd bailout programme). Due to insufficient data, CDS observations between 2012 - 2014 are excluded from this quantitative analysis.

The daily percent return of the Greek 5-year CDS is the dependent variable in all three models, while the exogenous variables are the following daily macro-financial indicators: i) the 10Y GGB yield, ii) the CBOE Volatility Index, and iii) a composite Greek bank equity index constructed as the equally weighted average of percentage returns of the four Greek systemic banks (Eurobank, National Bank of Greece, Alpha Bank, Piraeus Bank). The model for the second time period (January - August 2015) includes three event-driven dummy variables: i) the ECB's February

decision to no longer accept GGBs as collateral under its main refinancing operations (MRO), which forced Greek banks to rely on Emergency Liquidity Assistance (ELA), ii) the imposition of capital controls in late June, and iii) the formal approval of the 3rd Greek bailout programme in mid-July, which signaled re-entry into a structured, institutional crisis resolution framework. By assigning a value of 1 on the day of (and some days after) those three events, the dummies isolate the CDS market impact of critical points throughout the first eight months of 2015.

For each time period, the model estimated is an ARMAX(2,1,2). The lag selection is based on minimization of AIC and satisfactory residual diagnostics. An ARMAX(2,1,2) with the pertinent dummy variables can be expressed as:

$$\Delta CDS_t = \mu + \varphi_1 \Delta CDS_{t-1} + \phi_2 \Delta CDS_{t-2} + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \beta_1 GRTEN_t + \beta_2 VIX_t + \beta_3 BANK_t + \gamma_1 D_{ECB,t} + \gamma_2 D_{CAPCTRL,t} + \gamma_3 D_{BAILOUT,t} + \varepsilon_t$$

where μ is a drift term (intercept), $\varphi_i \Delta CDS_{t-i}$ is an autoregressive term, $\theta_i \varepsilon_{t-i}$ is a moving average term, $\beta_1, \beta_2, \beta_3$ are coefficients on exogenous variables GRTEN (10Y GGB yield), VIX (volatility index) and BANK (composite bank index) respectively, $\gamma_1, \gamma_2, \gamma_3$ are coefficients on the binary dummy variables D_{ECB} (ECB decision), $D_{CAPCTRL}$ (capital controls) and $D_{BAILOUT}$ (bailout approval) respectively, and ε_t is an error term.

Table 10 presents the results of the ARMAX(2,1,2) model applied to the Greek 5-year CDS spread over the three distinct time periods. For the (first) period January 2010 - March 2012, the model reveals a high and statistically significant impact of GGB yield movements on the CDS spread. The coefficient for GRTEN is 2.9084 ($p < 0.01$), suggesting that CDS markets reacted very strongly to GGB yield changes. Significant, albeit smaller than the GRTEN coefficient, are also the coefficients for VIX (positive) and BANK (negative), indicating that Greek systemic stress was priced into the Greek CDS premium. Additionally, the statistically significant intercept of 0.009 - though small - suggests that, on average, the CDS premium was widening even in the absence of observable shocks or macro-financial exogenous drivers. This constant increase might reflect embedded market pessimism and/or unresolved default risk associated with Greece. The autoregressive and moving average terms were statistically insignificant, suggesting that the bulk of CDS premium dynamics during this time was explained by the model's exogenous variables rather than autocorrelated behavior.

Next, the ARMAX model for the second time period (January - August 2015) captures the pivotal months when Greece faced a potential EZ exit. Here, the standard exogenous variables GRTEN, VIX, and BANK are not statistically significant, underscoring a regime shift where macro-financial indicators cease to impact Greek CDS premium movements. In contrast, the three event-driven dummies are all significant. The coefficient for the capital controls dummy (CAPCTRL = 0.8953) suggests that the restriction of domestic liquidity was a key factor in the pricing of Greek credit risk. The ECB's decision to withdraw collateral eligibility via the MRO and July's approval of the 3rd bailout programme exhibit smaller yet significant coefficients (0.2418 and -0.2026 respectively), reinforcing the argument that structural events, not fundamentals, were guiding risk pricing during that period. Notably, the bailout approval - i.e., Greece's return to a structured and institutional crisis resolution framework - appears to have exerted a calming, albeit modest, effect on the CDS premium.

Turning to the autoregressive and moving average terms of the model, all lags of AR and MA terms are large in magnitude and statistically significant. The AR1 coefficient is positive (0.6698), while the AR2 coefficient is negative (-0.5107); if the CDS premium increased yesterday, it will tend to increase again today, but a positive CDS premium change from two days ago will have a negative influence today. Thus, the effect of past changes appears to fade and oscillate, a feature of volatile markets in which participants rapidly reprice risk. On the other hand, the MA1 coefficient is negative (-0.7189), while the MA2 coefficient is positive (0.8865). In essence, a shock two days earlier continues to influence the CDS premium today, and does so strongly in the same direction. This MA structure is consistent with the behavior of financial markets during periods of turmoil, where risk perceptions reverberate over time rather than being absorbed immediately. As supported by Bosnjak, Novak, and Basic (2019) this shock persistence is a characteristic of crisis environments. Finally, albeit low, the intercept is positive (0.0124) and significant, indicating a systemic upward drift in the CDS spread irrespective of exogenous variables and shocks. Similar to the first period, the positive significant constant for the second period might reflect entrenched pessimism among market participants.

In all, the results for the second period reinforce the view that CDS market behavior during this phase of the Greek crisis was governed by structural shocks rather than macro-financial indicators. This is consistent with the findings reported earlier by Clancy et al. (2020). The

significance of the three dummies, in conjunction with the non-significance of the standard exogenous variables that were found to be significant for the first period, support an interpretation of this second phase as a non-standard risk regime. In such regime, liquidity constraints and shifting expectations about Greece's place in the EZ played a more decisive role in shaping Greek credit risk perceptions than fundamentals.

The ARMAX model for the third and final examined time period presents a resurgence of previous credit risk linkages in that the GRTEN coefficient is again positive and significant (0.273). However, the strength of the relationship between the Greek CDS spread and the 10Y GGB yield is far more modest than in early phase of the crisis, as the GRTEN coefficient was more than 10 times larger in the first period (January 2010 - March 2012; GRTEN = 2.9084). Several explanations can account for the fact that the linkage between bond-CDS pricing weakened considerably in the third period; Greece had re-entered a fiscal adjustment programme, which might have muted CDS market reactions to bond market volatility. Additionally, following years of structural reforms and implementation of crisis resolution mechanisms, markets may have perceived Greek debt as less prone to outright default. This, in turn, would have lowered the extent to which 10Y GGB yields conveyed new or impactful information for pricing the Greek CDS premium.

While the significant GRTEN coefficient for the third period reflects renewed attention to macro-financial signals, VIX and BANK coefficients are statistically insignificant for the third examined period. This suggests that changes in the CDS premium were not significantly sensitive to global market uncertainty and domestic financial sector fluctuations within this re-established institutional framework for Greece. On the other hand, the large and significant AR1 coefficient (1.5534), paired with a negative and significant AR2 (-0.9154), suggests that CDS spread changes exhibited oscillatory dynamics, as they also did in the second examined period. Nonetheless, the net autoregressive influence from the previous two days remains largely positive [1.5534 + (-0.9154) = 0.6380], i.e., CDS spread changes exhibited significant short-run persistence even in the absence of a significant intercept term. The negative intercept term (-0.0015, $p < 0.1$) in itself indicates a possible underlying downtrend for the CDS spread during the third examined period. Lastly, MA1 and MA2 terms are both significant for this period, and reveal a volatile

short-term shock adjustment structure. In terms of ε_t , there is an overcorrection of the previous day's shock (MA1 = -1.5818), and a positive influence from the shock that occurred two days ago (MA2 = 0.9097).

Variable	Jan 2010 - Mar 2012: ARMAX(2,1,2)	Jan - Aug 2015: ARMAX(2,1,2)	Sep 2015 - Aug 2018: ARMAX(2,1,2)
AR1	0.3635 (0.7108)	**0.6698** (0.1964)	**1.5534** (0.0537)
AR2	0.4245 (0.5835)	**-0.5107** (0.2305)	**-0.9154** (0.0375)
MA1	-0.2740 (0.7025)	**-0.7189** (0.1481)	**-1.5818** (0.0717)
MA2	-0.4147 (0.5219)	**0.8865** (0.3129)	**0.9097** (0.0425)
Intercept	**0.0090** (0.0035)	0.0124 (0.0181)	-0.0015 (0.0009)
GRTEN	**2.9084** (0.3841)	-0.4598 (0.2480)	**0.2732** (0.0582)
VIX	**0.1468** (0.0296)	-0.1479 (0.4682)	0.0103 (0.0116)
BANK	**-0.0550** (0.0202)	-0.1414 (0.1494)	0.0025 (0.0107)
ECB	-	**0.2418** (0.0791)	-
CAPCTRL	-	**0.8953** (0.1204)	-
BAILOUT	-	**-0.2026** (0.0656)	-
LB	0.7550	0.0773	0.0820

Table 10: ARMAX model estimates for the Greek 5-Year CDS premium*. LB reports the p-value of the Ljung-Box test with 10 lags. Values significant at 5% are highlighted in bold.*

5.2 Modelling the Greek 5-Year CDS Premium: a VAR Approach

Following comparison of the three aforementioned time periods of the Greek crisis through the ARMAX approach, this section extends the analysis by examining the dynamic responses of the Greek 5-year CDS premium to shocks in key financial variables. Specifically, IRFs are derived from VAR models, which are estimated for each of the three periods. The impulse variables are the 10Y GGB yield (GRTEN) and the composite Greek bank index (BANK). These variables were selected to trace how domestic sovereign and banking risk factors affected CDS pricing under different systemic regimes. The aim of this section is to identify whether the influence of macro-

financial variables on the CDS premium differed noticeably across the timelines. This comparison will allow for a deeper understanding of whether or not changes in CDS were driven by the established macro-financial variables in the period January - August 2015. If the derived IRFs suggest that the CDS premium is responsive to the established variables for the first and third period, and unresponsive for the second period, this will add strength to the argument presented in section 5.1, namely that movements in Greek credit risk during January - August 2015 were driven by exogenous structural factors rather than macro-financial indicators.

In contrast to the ARMAX framework used in section 5.1, where exogenous regressors could be freely included, the VAR model includes endogenous variables - that is, variables which can both impact and be impacted by others within the model. As such, the CBOE volatility index (VIX), which was included in the ARMAX models, is excluded from the VAR model. Although movements in global market volatility can have an influence on Greek CDS pricing (for instance, see Table 10 findings for the first examined period), it is improbable and illogical to assume that changes in Greek financial variables would have the capacity to affect (contemporaneously or not) a globally traded index such as the VIX.

In estimating the VAR models, attention was paid to the ordering of the included variables. The Cholesky decomposition method assumes a causal structure, where the first variable is the most exogenous and each subsequent variable can be contemporaneously affected by the ones listed before it, but not vice versa. Accordingly, GRTEN, a reflection of sovereign credit conditions driven by external market forces and macro-policy announcements, was selected first in the ordering as the most exogenous component. Second in the ordering came BANK, an indicator of the health of the Greek banking sector which can be contemporaneously affected by shifts in Greece's 10Y yield and can itself influence movements in the Greek CDS premium, via factors such as liquidity constraints and bank runs. Lastly, as the response variable, CDS was placed last in the model. This ordering represents an economically intuitive sequence which ensures that the IRFs account for the transmission of macro-financial drivers to the CDS market, without allowing contemporaneous effects from CDS premium movements to the impulse variables. The lag selection across all IRFs (1L) is based on the BIC.

5.2.1 IRF Results: Period 1 (January 2010 - March 2012)

The IRFs for this period show a clear and statistically significant relationship between CDS and both impulse variables (GRTEN, BANK - see Figure 21 and 22 respectively). With respect to GRTEN, a unitary shock to the variable results in a contemporaneous and positive increase in the Greek CDS premium. The effect on the CDS premium becomes insignificant starting from the first day post-shock, as the confidence bands consistently contain the zero line. Overall, Figure 21 suggests that the CDS market reacted to rising sovereign yields, i.e., perceived default risk rose as a result of a positive shock in the 10Y yield.

Similarly, a unitary shock in BANK is accompanied by a statistically significant contemporaneous decline in the CDS premium. This suggests that as Greek banking sector sentiment improved, so did the sovereign's perceived creditworthiness, reflected through an immediate decrease in the cost of insuring GGBs against default. Compared to Figure 21, the IRF of Figure 22 exhibits a more modest CDS response, which however remains significant from lag 0 (contemporaneous) to lag 2 (2 days post-shock). This suggests that a unitary shock to the banking index had a more durable significant effect on the CDS premium than the 10Y yield.

Together, the IRFs for this phase of the crisis provide evidence that CDS premium movements were linked to both impulse variables, consistent with the significant coefficients of GRTEN (2.9084) and BANK (-0.0550) estimated in the ARMAX model of section 5.1.

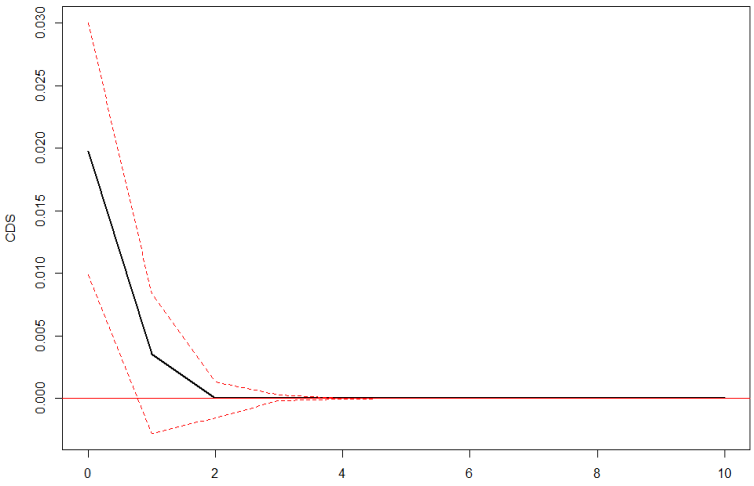

Figure 21: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the GGB 10Y yield, non-cumulative, January 2010 - March 2012, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

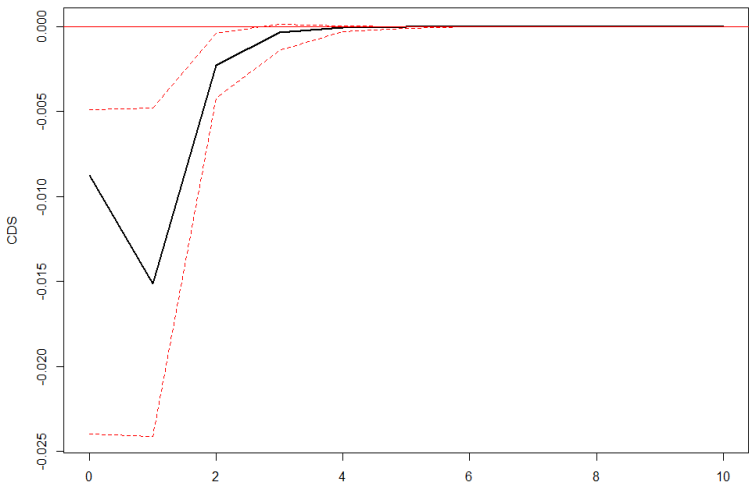

Figure 22: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the composite Greek bank index, non-cumulative, January 2010 - March 2012, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

5.2.2 IRF Results: Period 2 (January - August 2015)

During this phase of the crisis, the IRFs present a markedly different pattern. First, Figure 23 presents an erratic and directionally ambiguous CDS response from a unitary GRTEN shock that deviates from intuitive economic expectations. The plotted IRF portrays a significant immediate CDS response, with the effect heightening 1 day post-shock. Rather than exhibiting a smooth or decaying adjustment path, CDS proceeds to drop below zero and exhibits a negative significant response at lag 3, then rebounds to significant positive territory at lag 5 and fluctuates around the zero line thereafter. This unusual behavior can be a reflection of the systemic instability and uncertainty that existed during this phase of the Greek crisis. This type of oscillating IRF can be described as abnormal and potentially emblematic of a market environment where traditional macro-financial spillover patterns to CDS break down.

Presented in Figure 24, the response of CDS to a one-unit BANK shock is also ambiguous. The IRF plot for the day of the shock displays a (statistically insignificant) borderline negative average effect on the CDS premium, with particularly wide confidence intervals. This suggests that CDS markets responded contemporaneously with great volatility but no defined direction. However, the IRF plot displays a delayed significant negative CDS response, specifically at lag 3. At lag 5, the response becomes positively significant. In addition, with respect to the first four days post-shock, the CDS response moves erratically with shifts in trend direction. Thus, it can be argued that the plotted IRF suggests a deviation from the expected pattern of sovereign credit risk pricing stemming from bank equity performance.

The significant positive contemporaneous CDS response to a GRTEN shock does not align with the insignificant negative GRTEN coefficient (-0.4598), but it is important to note that CDS exhibits a negative significant response three days post-shock. This ‘noisy’ and unstable response might reflect systemic instability or a market that is sensitive to news flow, not just fundamentals. Statistical noise is also apparent in the BANK-CDS IRF, where the response oscillates between significant negative and positive territory without generating clear signals. In all, the IRFs for this crisis phase suggest that CDS premium movements drifted away from their traditional macro-financial linkages and responded more unpredictably to the impulse variables. This observation can be seen as reinforcing the argument that perceptions of Greece’s

creditworthiness during January - August 2015 were more a reflection of structural forces than of fundamental market variables.

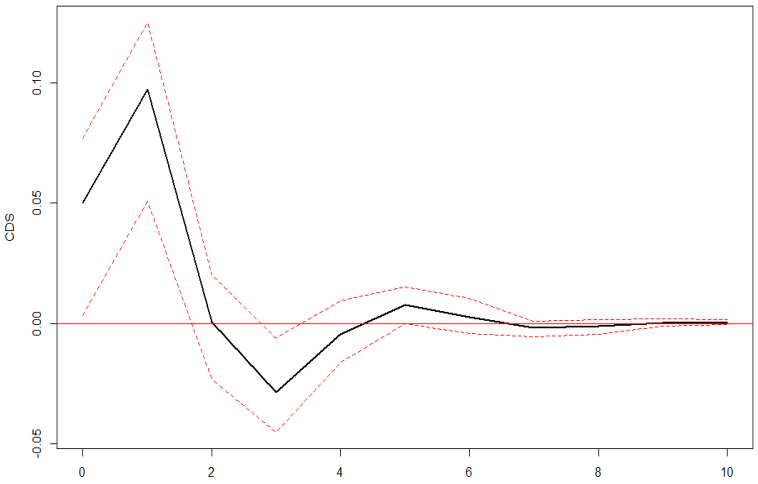

Figure 23: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the GGB 10Y yield, non-cumulative, January - August 2015, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

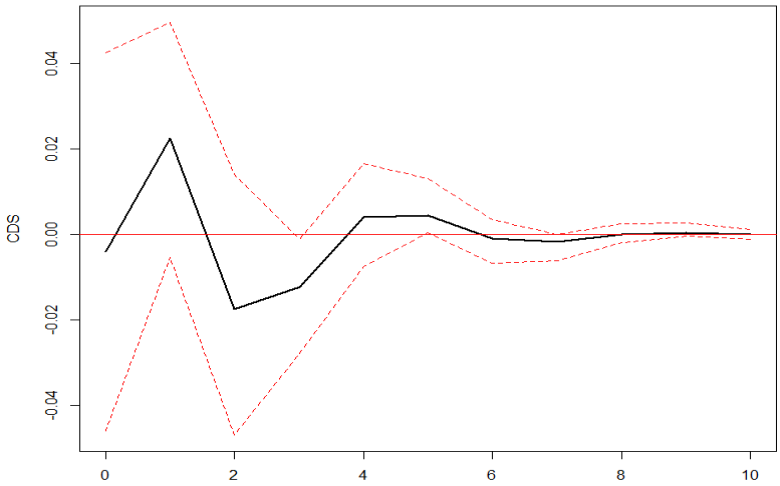

Figure 24: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the composite Greek bank index, non-cumulative, January - August 2015, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

5.2.3 IRF Results: Period 3 (September 2015 - August 2018)

Findings for this period point to a partial normalization. Plotted in Figure 25, the CDS response to GRTEN is positive and significant from the day of the shock until two days post-shock, and the response is smaller in magnitude than that of the period January - August 2015. Contrary to the respective IRF of period 2, the IRF plot of this period is not directionally ambiguous; a unitary GRTEN shock leads to a significant rise in the CDS premium, with the response fading incrementally and moving around the zero line from lag 3 onward.

Similar to period 2, the CDS response to a unitary BANK shock in this period remains muted and statistically insignificant (see Figure 26), though less erratic than during period 2. While the BANK-CDS IRF plot does not provide meaningful conclusions, the wide confidence intervals one day post-shock suggest that uncertainty and disconnect with respect to the bank-sovereign risk pricing channel persisted in this period.

In all, the IRFs for this period send contrasting signals; on one hand, the GRTEN-CDS IRF yields significant positive findings, consistent with the estimation of a significant (and positive) GRTEN coefficient in section 5.1. On the other hand, the BANK-CDS IRF findings remain insignificant,

aligning with the estimation of a non-significant BANK coefficient in section 5.1. Thus, while some traditional macro-financial linkages to CDS pricing did begin to re-emerge, their return was only partial. This asymmetry underscores that, although the CDS market exhibited more stable and rational response patterns after period 2, the full restoration of macro-financial transmission mechanisms observed during period 1 had not yet materialized. The CDS market, while more anchored in sovereign fundamentals, continued to exhibit detachment from domestic financial sector signals.

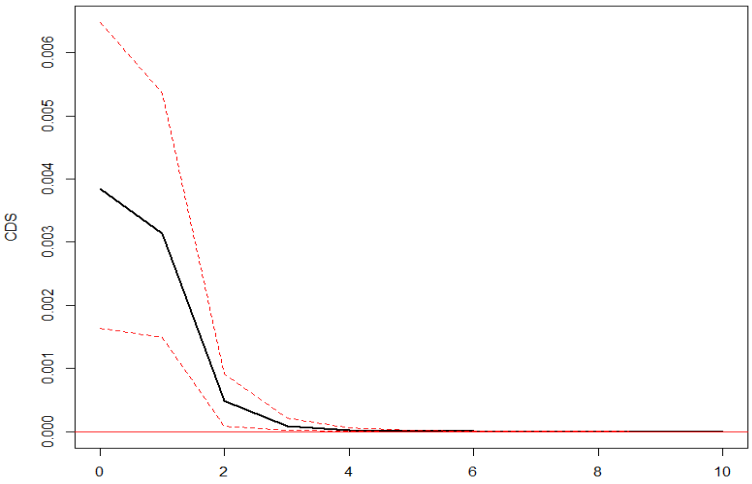

Figure 25: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the GGB 10Y yield, non-cumulative, September 2015 - August 2018, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

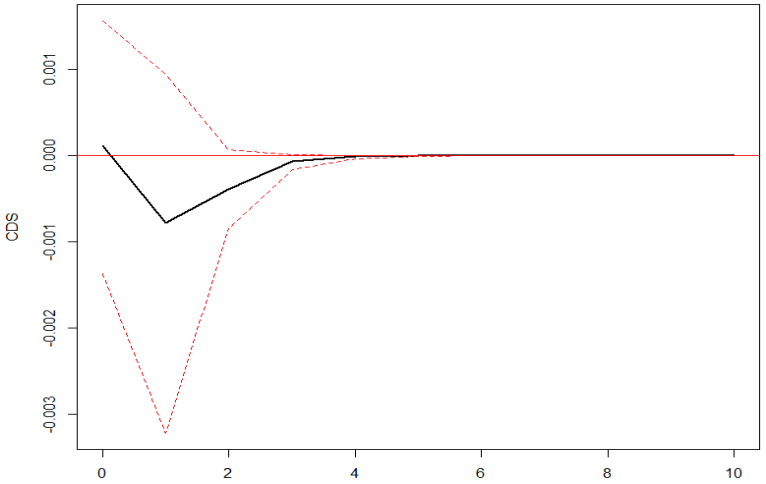

Figure 26: Orthogonal impulse response of the Greek 5Y CDS premium from a one-unit shock in the GGB 10Y yield, non-cumulative, September 2015 - August 2018, 95% bootstrap CI, 100 runs. Data from the Bank of Greece and Investing.com.

6. Conclusion

The Greek sovereign debt crisis offers a unique case study in crisis resolution within a monetary union. It represents a confluence of fiscal mismanagement, excessive reliance on foreign capital, macroeconomic imbalances and, ultimately, failure of both domestic and foreign institutions in containing the perils of the crisis in a timely and effective fashion. This paper has analyzed the crisis and its resolution mechanisms through a combination of qualitative and qualitative assessments, highlighting critical junctures in the evolution of the crisis and the efficiency of subsequent policy responses.

The findings from this investigation demonstrate that the crisis response was characterized by a progressive recalibration of mechanisms; the first bailout programme, grounded in a liquidity diagnosis, did not address the underlying solvency issues and, as argued in this investigation,

delayed the much-needed restructuring. This, in turn, exacerbated Greece's economic downturn and market distrust. The second programme came with a restructuring component (PSI), but it led to significant bank recapitalization needs that reduced the net debt relief to the sovereign. Thus, although the Greek PSI became the largest sovereign debt restructuring in history, it still came short of ensuring Greek debt sustainability in itself. The third programme, approved amid Grexit fears and capital flight, shifted the emphasis toward Gross Financing Needs and offered greater realism in fiscal targets.

Importantly, the empirical results from VAR models and their respective IRFs suggest that none of the three programmes succeeded with respect to containing contagion to the periphery of the EZ. Significant spillover effects from Greek debt to EZ distressed countries' debt were consistently observed in 2Y and 10Y maturities across all bailout phrases. Additionally, the paper's VAR-based assessment of austerity and market confidence suggests a non-existent relationship between economic contraction variables and sovereign bond yields. The absence of statistically significant yield reductions in response to austerity-linked shocks challenges the assumption that fiscal consolidation in itself can restore market confidence. This observation is particularly important considering the social and economic costs of austerity, which include soaring unemployment rates and a large reduction in domestic investment and consumption.

All in all, the Greek case highlights the limitations of reactive crisis resolution mechanisms. It can be argued that Greece's sovereign debt crisis underscores the need for: i) pre-emptive measures in crises triggered by solvency issues, ii) a balanced approach between liquidity support and structural reform, and iii) greater coordination between domestic and supranational institutions to mitigate shocks within currency unions. It is imperative that future crisis resolution mechanisms prioritize early diagnosis of solvency constraints and, arguably, ensure a more appropriate distribution of adjustment costs between public and private stakeholders. Overall, the lessons drawn from the Greek case are crucial not only for the EZ's institutional evolution, but for shaping global approaches to future sovereign crisis resolutions.

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