

Estimation of the Effects of Greece's 2012 Memorandum on Macroeconomic and Financial Course with FCM

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Abstract

This study evaluates the effects of Greece's 2012 Memorandum on key macroeconomic and financial indicators using Fuzzy Cognitive Mapping (FCM) and statistical analyses, including correlation and linear regression. The Memorandum, implemented as part of Greece's bailout agreement, aimed to stabilize the economy through austerity measures and structural reforms. The analysis focused on variables such as GDP, public debt, the equilibrium of current transactions, and the government budget. The results revealed significant impacts, with GDP and public debt showing mixed responses to the measures. Specifically, while certain policies led to a modest increase in GDP, they also contributed to a substantial reduction in the government budget and public debt. The findings underscore the complex and sometimes contradictory effects of austerity measures, highlighting the need for more nuanced and targeted fiscal policies in crisis management. This study provides valuable insights into the long-term economic consequences of the 2012 Memorandum on Greece's economy.

Keywords

2012 Memorandum, Second Economic Adjustment Programme for Greece, Macroeconomics, Financial Crisis, Regression Analysis, FCM, DSS

1. Introduction

1.1. The Course of the Greek Economy after the 2010 Memorandum

The first Economic Adjustment Program's design faced significant challenges

during the Greek financial crisis, prompting the involvement of the International Monetary Fund to address these issues. Greece's primary challenge was its banking sector, which was burdened by massive private debt that borrowers could not repay. These non-performing loans (NPLs), held by individuals and companies, severely disrupted the banking sector's operations and economic stability, particularly in terms of capital adequacy and credit growth (Ahmed et al., 2021).

The first fiscal adjustment program for Greece failed to achieve its goal of restoring the country's market access. As a result, on May 14, 2012, Eurozone finance ministers approved a second program, providing an additional €130 billion between 2012 and 2014, with an extension until June 2015. The European Financial Stability Facility (EFSF), established in August 2010, played a key role in fully financing the second program, covering €144.7 billion of the total €164.5 billion. Unlike the first program, which relied on bilateral loans, the second program involved private sector participation to improve Greece's debt sustainability and economic prospects, including a voluntary bond exchange (Cheng, 2020). However, the program concluded without Greece regaining access to international markets, leading to a third program in August 2015 that provided €86 billion in funding until 2018 (Colasanti, 2016).

Assessments of Greece's debt sustainability during this time indicated that the deteriorating economic and banking conditions were due to political instability, strict capital controls, and delays in decision-making and revenue collection (European Commission, 2015). These factors led to a significant increase in public debt compared to 2014 when debt levels had improved thanks to lower borrowing costs and partial financing from domestic sources. The debt-to-GDP ratio was expected to decrease to 124% by 2020, assuming strict adherence to the program's terms. However, by early 2015, it became clear that the necessary reforms were not fully implemented, creating uncertainty that undermined the potential for economic and fiscal improvement. The worsening debt-to-GDP ratio (Cherif & Hasanov, 2018) was attributed to downward revisions of growth rates, primary surplus estimates, political uncertainty, capital constraints, and reduced revenues from privatizations, alongside increased funding needs for the banking sector due to delayed NPL collection and deteriorating assets.

Many economic analysts and rating agencies have concluded that the first Memorandum of Understanding had devastating effects on the Greek economy, with no visible benefits. The miscalculation of fiscal multipliers by the program's designers led to a sharp decline in personal income and consumer demand in Greece, exacerbating the economic downturn (Standard & Poor's, 2012). The global financial markets amplified the impact of austerity measures, extending their duration and severity without a solid decision-making framework (De Grauwe & Ji, 2013). Additionally, the influence of unions and interest groups within Greece was underestimated by the program designers, hindering the completion of reforms. According to Kaplanoglou & Rapanos (2012), this issue persists despite Greece's engagement in subsequent fiscal programs.

In this scenario, Eurozone technocrats may have aimed to transform Greece into a more flexible and efficient state, but this would have required rapid societal and cultural adjustments, which were overlooked (Sklias & Maris, 2013). Since 2009, Greece's economic situation has been internally devalued through wage cuts, boosting competitiveness and lowering the prices of goods and services. However, the economy's rigidity persisted because wage reductions were more significant than price decreases. The current account balance showed surpluses for the first time after years of deficits, indicating temporary economic stabilization. This improvement was primarily due to sharp reductions in imports, while exports remained low (Alcidi et al., 2016) compared to other Eurozone countries.

The course of the main macroeconomic and financial figures of Greece's economy, between 2010 and 2015, are presented in Figure 1 below.

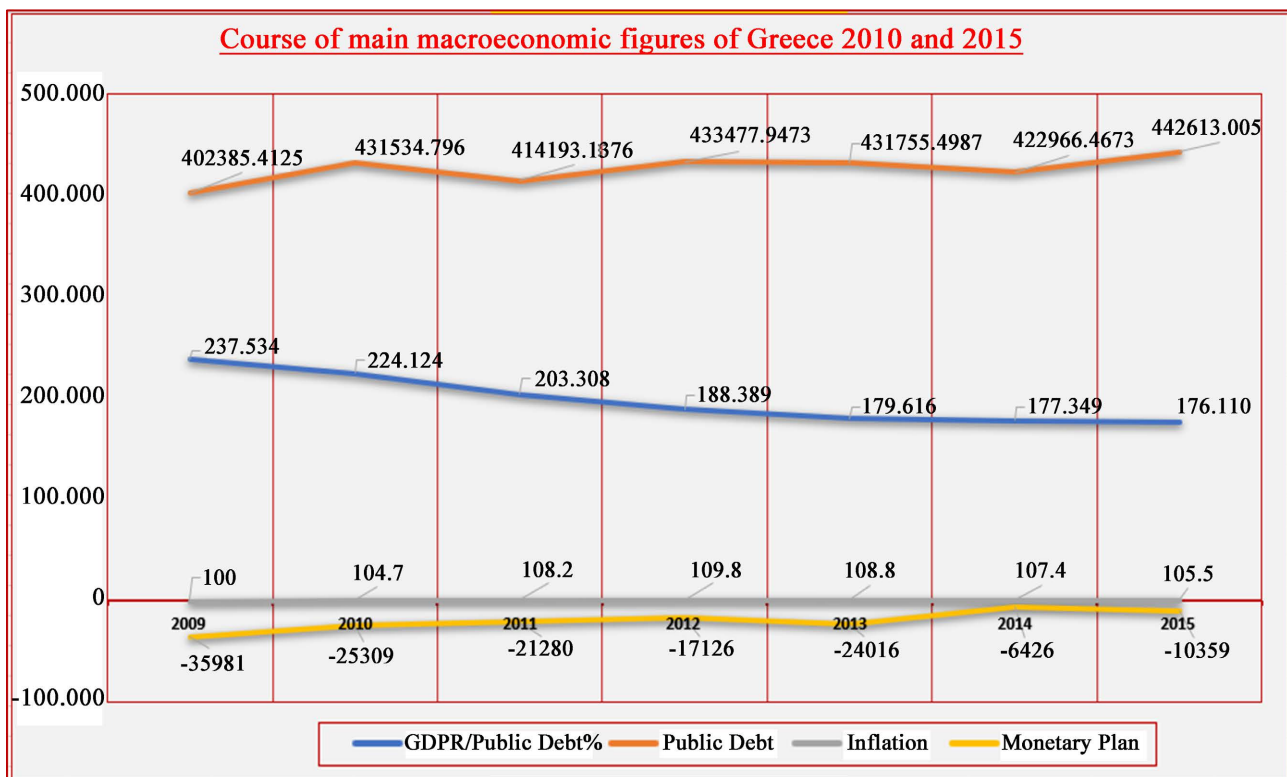


Figure 1. Course of main macroeconomic and financial figures of Greece between 2010 and 2015. Source: Created by the authors.

1.2. Second Economic Adjustment Programme for Greece (2012 Memorandum)

The Second Economic Adjustment Programme for Greece, initiated in March 2012, was a crucial step in addressing the deepening economic crisis that had gripped the country since 2010 (Siani-Davies & Siani-Davies, 2017). This program came on the heels of the first bailout package and aimed to stabilize Greece's economy by implementing comprehensive structural reforms, fiscal consolidation measures, and substantial debt relief. Unlike the first program, which focused heavily on immediate austerity measures, the second adjustment program sought

to address the structural weaknesses of the Greek economy, including inefficiencies in the public sector, labor market rigidity, and pervasive tax evasion (Tinios, 2016). The program was heavily supported by the European Commission, the European Central Bank (ECB), and the International Monetary Fund (IMF), collectively known as the Troika.

One of the significant components of the second program was the focus on restoring fiscal sustainability through substantial budget cuts and tax reforms. The Greek government was required to implement austerity measures that included reductions in public sector wages and pensions, as well as increases in VAT and other taxes (Krajewska, 2014). These measures, while necessary to reduce the budget deficit, exacerbated the recession, leading to a sharp contraction in economic activity and a dramatic increase in unemployment (Petrakis & Kostis, 2020). The social impact of these austerity measures was severe, with widespread protests and political instability reflecting the public's growing discontent with the government's approach to the crisis.

In addition to fiscal consolidation, the second program placed a strong emphasis on structural reforms aimed at enhancing the competitiveness of the Greek economy (Provopoulos, 2014). Reforms in labor markets, product markets, and the pension system were designed to make the economy more flexible and growth-oriented. These measures included liberalizing professions, reducing barriers to competition, and modernizing public administration. However, the implementation of these reforms was often slow and met with significant resistance from various interest groups. The lack of full ownership by the Greek government and the public's opposition to the reforms hindered their effectiveness, leading to delays in achieving the desired economic outcomes (Pelagidis & Mitsopoulos, 2016).

The debt relief component of the second program, known as the Private Sector Involvement (PSI), was another critical aspect. Under the PSI, private creditors agreed to a significant "haircut" on their Greek bond holdings, effectively reducing Greece's debt burden by about €100 billion (Cheng, 2020). This was intended to make Greece's debt more sustainable in the long run. However, while the debt restructuring provided temporary relief, the underlying issues of Greece's economic structure and the harsh austerity measures meant that the debt trajectory remained unsustainable (Nikiforos et al., 2015). The economic and social strain of the program led to further political instability, culminating in a series of elections and the eventual rise of the anti-austerity Syriza party, which challenged the continuation of the program in its original form.

1.3. The Following Effects of the 2012 Memorandum on the Greek Economy

In 2013, Greece recorded its first primary budget surplus, reaching 0.8% of GDP, thanks to a significant reduction in state expenditures and a notable increase in government revenues (Meghir et al., 2017). Similarly, the country's financial stability improved, with increased liquidity and reduced dependency of the banking

sector on Central Bank support (Karavitis, 2018). However, despite this stability, the credit shortage in the market persisted, as banks continued to struggle with non-performing loans (NPLs) even after significant recapitalization and liquidity support. These NPLs are highly sensitive to changes in their determining factors, which vary depending on the type of loan, with business, housing, and consumer loans being the most affected (Chavaz, 2016). According to Louzis et al. (2012), the main drivers of changes in Greek NPLs are shifts in GDP growth, unemployment rates, public debt levels, and government borrowing costs.

In 2014, there was a renewed interest from investors in Greece, enabling the country to temporarily re-enter the financial markets. The yield on Greek long-term government bonds decreased, and various reforms were introduced, including improvements in tax collection and administration, public administration, and public financial management (Christodoulakis, 2015). However, according to an IMF report from 2014, while the Greek government complied with the economic assistance program's requirements, the overall macroeconomic environment did not show significant improvement. Public debt was expected to decrease to 128% of GDP by 2020, but its overall trajectory remained concerning. To achieve a significant reduction, Greece would need to maintain primary budget (Government Budget) surpluses above 4% of GDP and achieve substantial nominal GDP growth during those years (House & Tesar, 2015).

The failure to adequately meet the targets and implement the reforms recommended by the fiscal adjustment programs, combined with the worsening of financial and macroeconomic conditions due to delays in decision-making by the bodies overseeing the Greek program and the imposition of strict capital controls, further undermined the sustainability of Greek debt (IMF, 2015).

The activation of the IMF's exception to its financing rule was triggered by dire predictions about the sustainability of public debt in certain countries, which were exacerbated by concerns about the potential spread of Greece's crisis during the first two bailout programs (Helleiner, 2014). The application of this "systemic exception" removed the immediate requirement for countries to reduce public debt to receive large-scale financial aid, driven by fears of a global systemic risk. However, IMF officials later recognized and acknowledged that the application of this exception resulted in significant negative consequences, which only became apparent after several years, despite attempts to allow for flexibility (IMF, 2016).

1.4. Literature Review

The study investigates the impact of Greece's 2012 Memorandum on key macroeconomic indicators using Fuzzy Cognitive Mapping (FCM) and regression analysis. This approach allows a deeper understanding of how Greece's austerity policies affected GDP, public debt, and other fiscal elements, offering valuable insights into the effectiveness of fiscal policies during economic crises. The significance of this research lies in its potential to aid policymakers in evaluating the effects of austerity measures, which have often been controversial (Balasoiu et al.,

2023). By applying FCM, the study introduces a sophisticated analysis model capable of capturing complex economic interactions that traditional models may overlook, thereby enriching the discussion on sustainable economic recovery strategies (Kosko, 1986; Krimpas et al., 2023).

The course of Greece's main equilibriums from 2009 to 2015 can be seen in Figure 2 below.

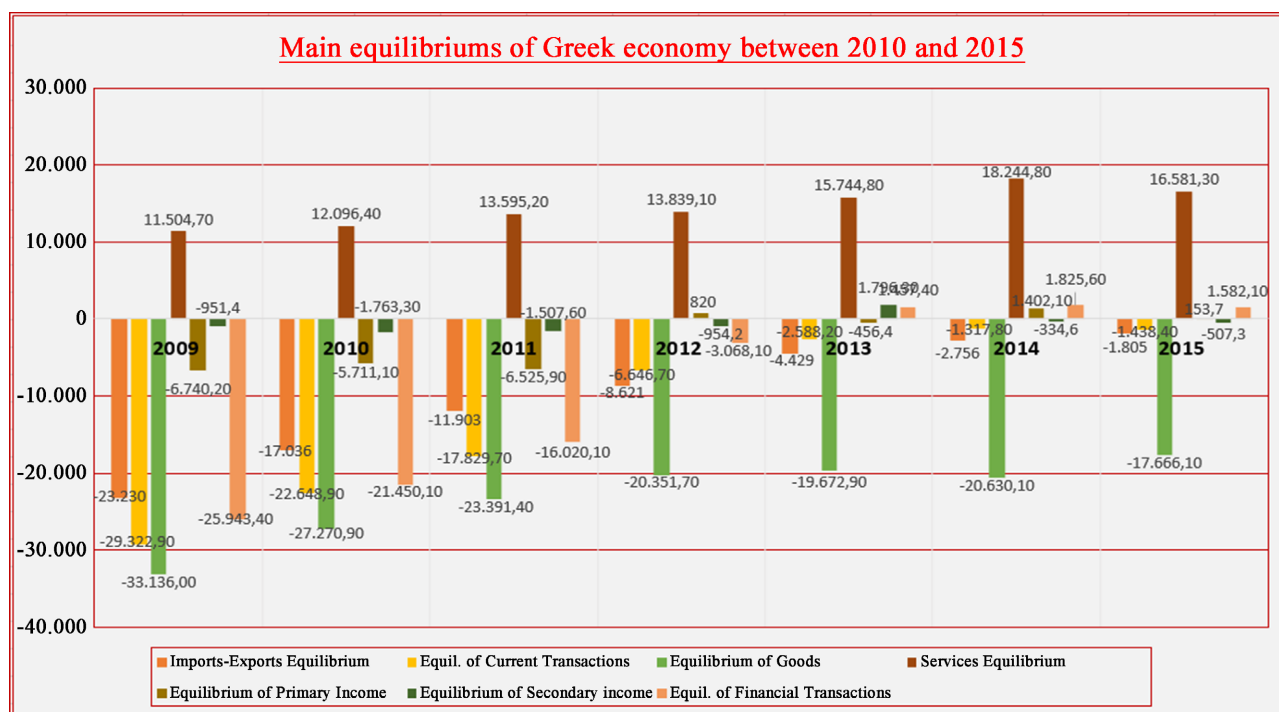


Figure 2. Main equilibriums of the Greek economy between 2010 and 2015. Source: Created by the authors.

This study contributes to the existing literature by emphasizing the role of FCM in economic modeling, which has been used extensively in systems affected by multifaceted influences (Cheng, 2020; Helleiner, 2014). Through its innovative approach, the study demonstrates the practical application of FCM in predicting the outcomes of fiscal measures, making it a useful tool for policymakers dealing with future economic instability (Pelagidis & Mitsopoulos, 2016). However, a limitation exists in the reliance on historical data from 2012 to 2015, which may restrict the applicability of the findings to current economic contexts. Additionally, FCM's reliance on expert judgment introduces some subjectivity, which may affect the precision of the model outcomes (Migkos et al., 2022).

Research on the economic crises in Greece highlights the critical role of structural reforms and fiscal policies (Alcidi et al., 2016). Several scholars argue that the first Memorandum of 2010 laid the groundwork for austerity measures, which, despite intentions to restore fiscal balance, led to socio-economic hardships (Sklias & Maris, 2013). According to Tinios (2016), rigid labor markets and inefficiencies within Greece's economic system exacerbated these challenges, and the

initial measures were not sufficiently adapted to the national economic structure. By addressing these gaps, the 2012 Memorandum aimed to enhance Greece's fiscal stability through comprehensive restructuring policies.

The use of FCM in economic analysis has gained traction, particularly for its ability to model systems where variables are interdependent and dynamically interact (Kosko, 1986; Krimpas et al., 2023). Studies applying FCM in economic contexts, such as the works by Cheng (2020) and Petrakis and Kostis (2020), underscore the flexibility of this approach in assessing policy impacts. The introduction of agent-based and system-dynamics models alongside FCM further enriches the toolkit available for analyzing policy effects, as these models allow for the simulation of economic scenarios and prediction of variable interdependencies (Nikiforos et al., 2015).

While existing studies highlight the effects of austerity on Greece's economy, few incorporate methodologies that allow for scenario testing and complex interaction modeling, as seen with FCM. This study fills this gap by applying FCM to capture the nuanced responses of key economic variables to fiscal policies under the 2012 Memorandum. In doing so, it provides a more dynamic view of policy impacts, offering a novel perspective on the interplay between fiscal interventions and macroeconomic indicators.

2. Materials and Methods

The aim of this study focused on the examination and analysis of potential determinant factors of the key macroeconomic and financial figures of the Greek economy, after the implementation of the second Memorandum in 2012 until mid-2015 (right before the third one). Therefore, the research methodology and hypotheses are presented below, and aim to support the extraction of potential insights into the Greek economy that could indicate determinant or predictive factors of the course/decline of the main macroeconomic and financial figures.

2.1. Research Methodology

The research methodology of the present study starts with the data collection from the official websites of the European statistics agency, Eurostat (<https://ec.europa.eu/eurostat>), and the Greek statistic agency, Elstat (<https://www.statistics.gr/>). The referred data include the Greek economy's most important macroeconomic and financial figures, e.g., GDP, public debt, production, equilibrium of current transactions, government budget, taxes, imports and exports of goods and services, etc., for 2012 until 2014.

Then, the next step of the methodological concept lies in the extraction of statistical coefficients capable of verifying the settled research hypotheses and providing further insights regarding the specific economic features that mostly affected Greece's GDP, Public Debt, Equilibrium of Current Transactions, and Government Budget, during the second Memorandum. The deployed statistical methods included correlation and simple linear regression (SLR) models.

The final step of the methodology that would lead to the extraction of the research's main conclusions, refers to the development of an FCM model that provides a static simulation of the main macroeconomic and financial figures of Greece based on specific values of other economic features. In this way, the authors should test potential scenarios of important economic features of the Greek economy, during the 2012 Memorandum and after, and eventually extract valuable insights for the preferred macroeconomic policy that should have been applied.

2.2. Research Hypotheses

Moving to the paper's research hypotheses, it should be mentioned that the present article tends to discover which macroeconomic and financial figures of the Greek economy, during the period of the second Memorandum (2012-2015), have a stronger impact on Greece's main performance indexes (GDPR, Public Debt, Equilibrium of Current Transactions, Government Budget). By examining the connection between 25 key economic indicators of the Greek economy (such as product taxes, inflation rate, net savings, and foreign residents) and its primary macroeconomic variables (GDP, public debt, current account balance, and government budget) during the 2012 Memorandum, the authors can grasp the overall impact of the Memorandum's measures on Greece's economy. This approach allows for an evaluation of the effectiveness of the 2012 Memorandum's measures. Therefore, the research hypotheses supporting the outlined methodological and research framework are presented below:

Hypothesis 1 (H1): Key economic features, affected by the Memorandum of 2012, significantly impact Greece's GDPR figure.

Hypothesis 2 (H2): The impact of the affected by 2012 Memorandum Greek features on Public Debt is significant.

Hypothesis 3 (H3): Greece's Equilibrium of Current Transactions is being significantly affected by the variation of Greek economic features caused by the obstruction of the 2012 Memorandum.

Hypothesis 4 (H4): A significant effect is provoked to Greece's Government Budget from Greek economic features afflicted by the Memorandum of 2012.

3. Results

3.1. Statistical Analysis

To support the verification of the research hypotheses, the authors performed 4 simple linear regression (SLR) models, with dependent variables the 4 main macroeconomic and financial figures of the Greek economy: GDP, Public Debt, Equilibrium of Current Transactions, and Government Budget. As independent variables for all of the referred dependent ones, a plethora of financial and macroeconomic indexes were used, like exports, imports, production, product taxes, consumer expenditure, subsidies on products, government expenditure, etc. The authors used the Enter method to automatically exclude any insignificant independent variables and thus, extract the regression models that best fit the dependent

variables' variation. To do this task and ensure the result's validity and reproducibility, the normality of the variables' distribution, among other tests, like data directionality and correlation (Pearson, 1895), was verified. In **Table 1**, the main descriptive statistics of the study's variables are presented.

Table 1. Descriptive statistics.

Variables	Mean	Min	Max	Std. Deviation
GDP	198061.428	176110.000	237534.000	24527.289
Public Debt	425560.894	402385.410	442613.010	13543.600
Equilibrium of Current Transactions	-11684.657	-29322.900	-1317.800	11472.197
Government Budget	-20071.000	-35981.000	-6426.000	9889.147
Import Taxes/Duties	27826.714	26110.000	28760.000	1022.910
Travelers from EU Countries	1260.071	1084.980	1502.130	139.637
Equilibrium of Primary Income	-2436.828	-6740.200	1402.100	3695.438
Foreign Exchange Reserves	4898.571	3857.000	55350.00	662.053
Foreign Investment	1080.000	-592.000	2273.000	898.892
Production	320209.857	287504.000	375814.000	33625.328
Exports	52641.142	45089.000	57576.000	4429.072
Antidumping Taxes	4248.714	3475.000	4878.000	468.652

n = 7 observations/years (2009-2015). Source: Created by the authors.

As can be seen from **Tables 2-5**, the variables of import taxes/duties, travelers from EU countries, equilibrium of primary income, foreign exchange reserves, foreign investment, antidumping taxes, exports, and production of goods were found to impact significantly all of the 4 dependent variables (GDP, Public Debt, Equilibrium of Current Transactions and Government Budget). More specifically, the deployed SLR models had an $R^2 = 1.000$, and all of the independent variables included had a significant impact on the dependent variables, with p-values < 0.01 significance level. Therefore, for every 1% increase in import taxes/duties, travelers from EU countries, equilibrium of primary income, foreign exchange reserves, and foreign investment production of goods:

- GDP varies by -2.6%, 4.9%, -6.2%, 10.5%, -1.7%, and 103.5% accordingly.
- Public debt varies by 147.3%, -27.1%, 105.2%, 15.3%, -131.5%, and -0.1% accordingly.
- Government budget varies by 43.1%, -35.9%, 21.7%, -6.9%, 34.4%, and -102.3% accordingly.

Moreover, for every 1% increase in exports, antidumping taxes, travelers from EU countries, equilibrium of primary income, foreign exchange reserves, foreign investment, Equilibrium of Current Transactions varies by 71.2%, -0.1, 9.5%,

28.8%, -5.3%, and -18.2% accordingly. Thus, the research hypotheses H1-H4 are verified, meaning that specific economic features of the Greek economy during the 2012 Memorandum had a significant impact on Greece's key macroeconomic and financial figures (GDP, Public Debt, Equilibrium of Current Transactions, and Government Budget).

$$\begin{aligned} \text{GDP}_t = & -0.026\text{Import Taxes}_t + 0.049\text{Travelers EU}_t \\ & - 0.062\text{Equil.Primary Income}_t + 0.105\text{Foreign Exchange Avail.}_t \\ & - 0.017\text{Foreign Invest}_t + 1.035\text{Production}_t + \varepsilon_t \end{aligned}$$

Table 2. Linear regression of GDP (2012 to mid-2015).

Variables	Standardized coefficient	R ²	F	p-value	Durbin-Watson	VIF
Import Taxes/Duties	-0.026** (0.000)			0.000		8.659
Travelers from EU Countries	0.049** (0.000)			0.000		5.598
Equilibrium of Primary Income	-0.062** (0.000)			0.000		5.411
Foreign Exchange Reserves	0.105** (0.000)	1.000	-	0.000	2.375	5.557
Foreign Investment	-0.017** (0.000)			0.000		4.245
Production	1.035** (0.000)			0.000		15.235

**Indicate statistical significance at the 99% confidence level. Source: Created by the authors.

$$\begin{aligned} \text{Pub.Debt}_t = & 1.473\text{Import Taxes}_t - 0.271\text{Travelers EU}_t \\ & + 1.052\text{Equil.Primary Income}_t + 0.153\text{Foreign Exchange Avail.}_t \\ & - 1.315\text{Foreign Invest}_t - 0.001\text{Production}_t + \varepsilon_t \end{aligned}$$

Table 3. Linear regression of public debt (2012 to mid-2015).

Variables	Standardized coefficient	R ²	F	p-value	Durbin-Watson	VIF
Import Taxes/Duties	1.473** (0.000)			0.000		8.659
Travelers from EU Countries	-0.271** (0.000)			0.000		5.598
Equilibrium of Primary Income	1.052** (0.000)	1.000	-	0.000	0.000	5.411
Foreign Exchange Reserves	0.153** (0.000)			0.000		5.557

Continued

Foreign Investment	-1.315** (0.000)	0.000	4.245
Production	-0.001** (0.000)	0.000	15.235

**Indicate statistical significance at the 99% confidence level. Source: Created by the authors.

$$\begin{aligned} \text{Equil Current Transt} = & 0.712\text{Exportst} - 0.001\text{Antidumping Taxest} \\ & + 0.095\text{Travelers EUt} + 0.288\text{Equil.Primary Incomet} \\ & - 0.053\text{Foreign Exchange Avail.t} \\ & - 0.182\text{Foreign Investt} + \varepsilon t \end{aligned}$$

Table 4. Linear regression of equilibrium of current transactions (2012 to mid-2015).

Variables	Standardized coefficient	R ²	F	p-value	Durbin-Watson	VIF
Exports	0.712** (0.000)			0.000		15.930
Antidumping Taxes	-0.001** (0.000)			0.000		5.688
Travelers from EU Countries	0.095** (0.000)	1.000	-	0.000	0.932	2.291
Equilibrium of Primary Income	0.288** (0.000)			0.000		5.706
Foreign Exchange Reserves	-0.053** (0.000)			0.000		3.291
Foreign Investment	-0.182** (0.000)			0.000		2.935

**Indicate statistical significance at the 99% confidence level. Source: Created by the authors.

$$\begin{aligned} \text{Govern Budgett} = & 0.431\text{Import Taxest} - 0.359\text{Travelers EUt} \\ & + 0.217\text{Equil.Primary Incomet} \\ & - 0.069\text{Foreign Exchange Avail.t} \\ & + 0.344\text{Foreign Investt} - 1.023\text{Productiont} + \varepsilon t \end{aligned}$$

Table 5. Linear regression of government budget (2012 to mid-2015).

Variables	Standardized coefficient	R ²	F	p-value	Durbin-Watson	VIF
Import Taxes/Duties	0.431** (0.000)			0.000		8.659
Travelers from EU Countries	-0.359** (0.000)	1.000	-	0.000	1.000	5.598
Equilibrium of Primary Income	0.217** (0.000)			0.000		5.411

Continued

Foreign Exchange Reserves	-0.069** (0.000)	0.000	5.557
Foreign Investment	0.344** (0.000)	0.000	4.245
Production	-1.023** (0.000)	0.000	15.235

**Indicate statistical significance at the 99% confidence level. Source: Created by the authors.

3.2. Fuzzy Cognitive Model

Subsequently, to strengthen the SLR models' outputs and to extract potential further insights for the Greek economy's macroeconomic figures course, the authors proceeded to perform an FCM model and 3 discrete scenarios. FCMs are fuzzy graph structures that illustrate causal relationships, allowing for varying degrees of causation between unclear causal elements (Kosko, 1986). As a "soft computing" method, FCMs integrate fuzzy logic with neural networks to model complex systems. Despite their flexibility, the creation of FCMs heavily depends on human expertise and knowledge (Krimpas et al., 2023). FCMs use a parametric pattern of interpretation where static features, representing knowledge, are shaped by defining key attributes like process variables, the nature of positive or negative correlations among them, and the strength of connections between factors. The concept of idea maps underpins FCM research methods, which are implemented through chart and diagram analyses of a system's elements. These frameworks can simulate processes influenced by numerous variables, with efforts focused on mapping correlation coefficients and the overall structure (Migkos et al., 2022).

In the earlier stages of the analysis, data were gathered on variables within the Greek economy that had a substantial impact on its key indicators, including GDP, Public Debt, Current Account Balance, and the Government Budget. This dataset comprises eight independent variables, which were analyzed to assess their influence and explanatory power regarding the selected dependent variables, ultimately determining the effectiveness of the second Memorandum's measures. The data underwent further examination using the Pearson correlation coefficient test, yielding 12 statistically significant correlations. Notably, strong correlations were observed at a significance level of 0.01, highlighting the dynamic nature of the four primary explanatory variables of the Greek economy, which share several common independent variables. The variation in the statistical analysis variables revealed a causal relationship between variables with high Pearson correlations ($r > 0.8$).

The arrow's direction indicates the nature of the relationship between variables, with its thickness corresponding to the strength of the correlation. Blue arrows represent positive correlations, while orange arrows denote negative ones. This concept map was generated using the *MentalModeler* (2024) software. The use of fuzzy cognitive mapping in this dynamic environment improves the study's

capacity for evaluation and explanation.

After constructing and illustrating the fuzzy cognitive representation map (Figure 3), the authors moved on to develop and analyze three scenarios using FCM to depict the response of key indicators of the Greek economy during the 2012 Memorandum. Before running the state forecast scenarios, the correlation levels between variables were defined, with 1 as the maximum value and -1 as the minimum for all variables in the sample. The selection of the three Fuzzy Cognitive Mapping (FCM) scenarios is based on exploring a range of policy priorities and their potential impacts on Greece's economy under the 2012 Memorandum.

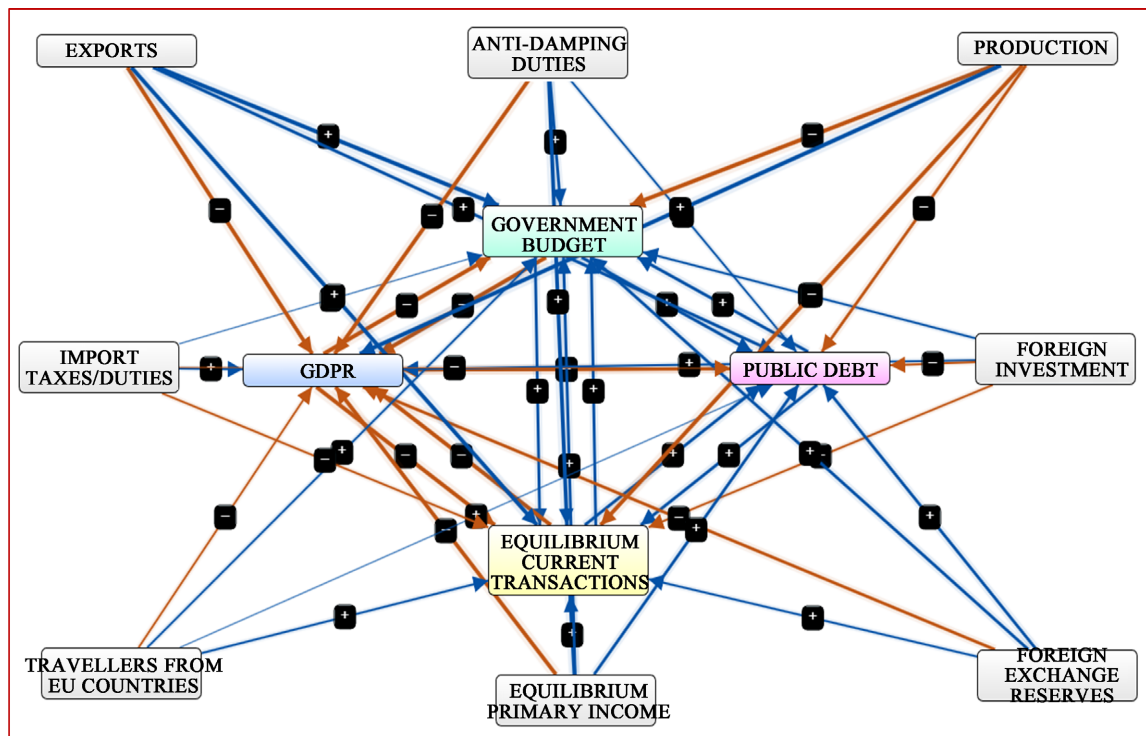


Figure 3. FCM model deployment. Source: Created by the authors.

Each scenario is designed to represent a distinct fiscal approach:

1) Broad Economic Stimulation (Scenario 1): This scenario simulates an across-the-board increase in economic features, aiming to assess the effects of stimulating various sectors simultaneously. It reflects a policy priority focused on promoting growth through increased economic activity, testing the feasibility of a comprehensive fiscal expansion during a crisis.

2) Comprehensive Contraction (Scenario 2): This scenario models a reduction in key economic features, representing an austerity-driven approach aimed at reducing public debt and controlling budget deficits. This helps explore the trade-offs involved in aggressive fiscal contraction and the potential risks of such measures on economic performance and stability.

3) Selective Adjustment (Scenario 3): In this scenario, certain features are increased while others are decreased to simulate a balanced approach. This reflects

a mixed strategy, where policymakers selectively promote growth sectors while tightening other areas. It tests the effectiveness of a more nuanced, targeted approach to achieve a stable balance between debt reduction and economic stimulation.

These scenarios allow the study to provide insights into how each approach impacts Greece's key economic indicators. By comparing these distinct fiscal strategies, the study aims to inform policymakers on the trade-offs and potential outcomes of various policy combinations, supporting more effective decision-making in economic crisis contexts.

3.2.1. Scenario 1: Increase of all Economic Features

In the first scenario (as seen in **Figure 4**), the authors seek to discern the effect of a 20% increase in all of the selected economic features (import taxes/duties, travelers from EU countries, equilibrium of primary income, foreign exchange reserves, and foreign investment production of goods, exports and antidumping taxes) on the main macroeconomic and financial figures of GDP, Public Debt, Equilibrium of Current Transactions and Government Budget. GDP increased by 4%, the Government Budget decreased by 9%, the Equilibrium of Current Transactions decreased by 8%, and Public Debt decreased by 7%. Although all of the selected features were increased in this scenario, the GDP only increased by 4% and the Public Debt decreased by 7%. This indicates that a more diverse strategy should be implemented to achieve more balanced results for the main macroeconomic figures.

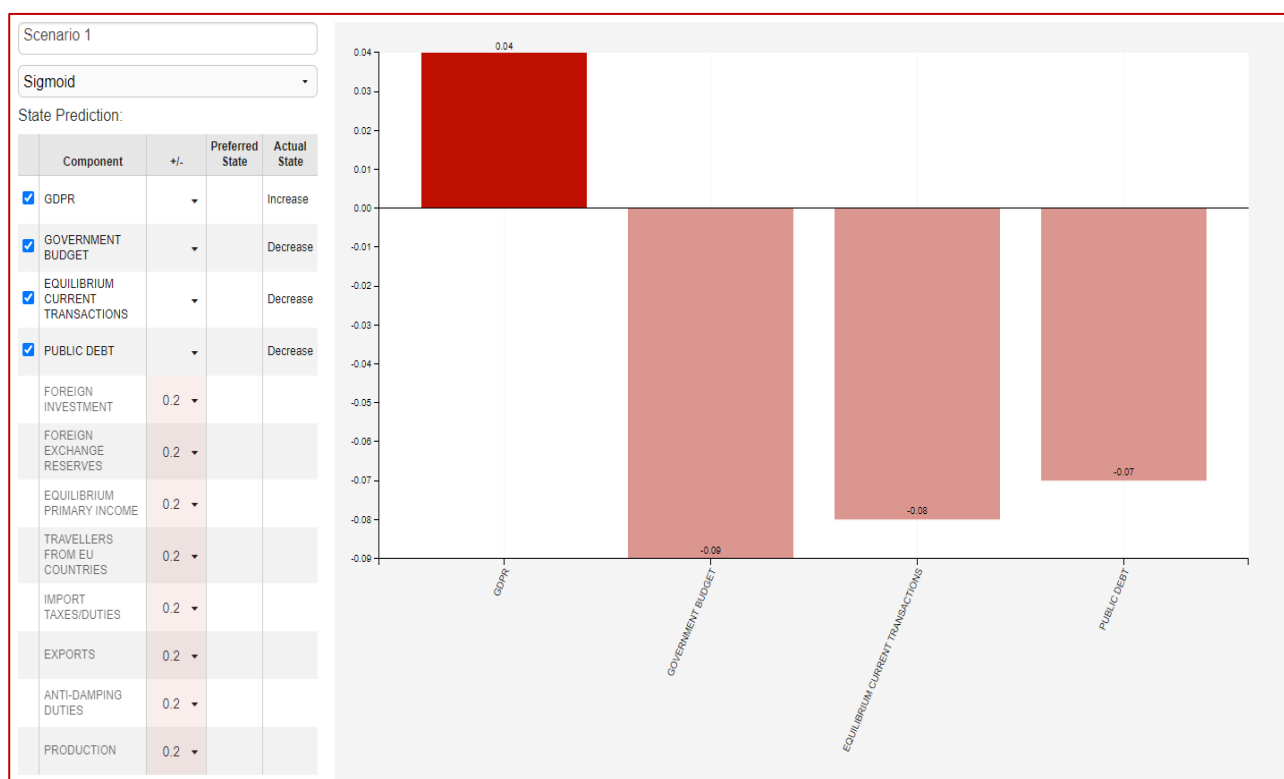


Figure 4. FCM Scenario 1. Source: Created by the authors.

3.2.2. Scenario 2: Decrease of All Economic Features

In the second scenario (as seen in **Figure 5**), the authors seek to discern the effect of a 20% decrease in all of the selected economic features (import taxes/duties, travelers from EU countries, equilibrium of primary income, foreign exchange reserves, and foreign investment production of goods, exports and antidumping taxes) on the main macroeconomic and financial figures of GDP, Public Debt, Equilibrium of Current Transactions and Government Budget. GDP increased by 27%, the Government Budget decreased by 47%, the Equilibrium of Current Transactions decreased by 40%, and Public Debt decreased by 31%. Such a scenario seems quite unlikely to be applied since a decrease of nearly 50% in the Government Budget could not be a viable solution.



Figure 5. FCM Scenario 2. Source: Created by the authors.

3.2.3. Scenario 3: Partial Increase/Decrease of Economic Features

In the third scenario (as seen in **Figure 6**), the authors seek to discern the effect of a 20% increase in import taxes/duties, equilibrium of primary income, foreign exchange reserves, production of goods and exports, and a 20% decrease in foreign investment, travelers from EU countries and antidumping taxes, on the main macroeconomic and financial figures of GDP, Public Debt, Equilibrium of Current Transactions and Government Budget. GDP increased by 10%, the Government Budget decreased by 20%, the Equilibrium of Current Transactions decreased by 18%, and Public Debt decreased by 12%. This scenario features the desired results of a significant GDP increase and Public Debt decrease during the 2012 Memorandum, while in the meantime, the Government Budget and Equilibrium of Current Transactions face a tolerable decrease of 20% and 18%.



Figure 6. FCM Scenario 3. Source: Created by the authors.

4. Discussion and Conclusions

The analysis of Greece's 2012 Memorandum highlights the intricate relationship between various economic measures and their impact on key macroeconomic indicators such as GDP, Public Debt, Government Budget, and the Equilibrium of Current Transactions. The regression analysis revealed that variables like import taxes, foreign exchange reserves, and foreign investment significantly influenced these indicators. Notably, while the production of goods had a substantial positive impact on GDP, it negatively affected the Government Budget, underscoring the complex trade-offs involved in economic policymaking. These findings suggest that while certain measures might boost GDP, they could simultaneously strain public finances, complicating efforts to achieve balanced economic growth.

The FCM scenario analysis further underscores the challenges of economic management during the 2012 Memorandum period. In the first scenario, despite a 20% increase in all selected economic features, GDP only saw a modest rise of 4%, while Public Debt decreased by 7%. This scenario illustrates that even with broad economic stimulation, the growth in GDP might not be proportionate, indicating that other underlying issues such as structural weaknesses in the economy could dampen the effectiveness of such measures. The scenario also suggests that a one-size-fits-all approach may not yield the desired outcomes across all macroeconomic indicators, pointing to the need for more nuanced and targeted economic strategies.

The second and third scenarios provide further insights into the potential consequences of different economic strategies. The second scenario, which simulated

a 20% decrease in economic features, resulted in a significant 27% increase in GDP but at the cost of a dramatic 47% reduction in the Government Budget. Such an outcome highlights the risks of aggressive economic contractions, which could undermine fiscal stability. On the other hand, the third scenario, which combined increases in import taxes, production, and exports with decreases in foreign investment and antidumping taxes, produced more balanced results, with a 10% GDP increase and a 12% reduction in Public Debt. This scenario suggests that a more selective approach to economic adjustments could yield better overall outcomes, reinforcing the importance of strategic policymaking.

The 2009 financial crisis wiped out a quarter of Greece's GDP and workforce, resulting in widespread job losses, with the repercussions lasting for at least five more years. The crisis was driven by both domestic and external (European) factors, which led to the disastrous failure of the bailout programs and the country's economic trajectory as a whole (Petraikos, 2014). Key contributors to this failure included the structural weaknesses of Greece's economy, the organization and functioning of its public and political sectors, the unstable structure of the Eurozone economy, and the ineffective crisis management at both the national and European levels.

By early 2014, several macroeconomic indicators in Greece, such as the budget deficit, current account deficit, and public debt, showed signs of improvement. However, the absence of reforms that could have strengthened production, coupled with resistance from unions and interest groups, led to a decline in production and overall economic activity. Consequently, this downturn resulted in lower wages, a renewed rise in unemployment, and an increase in the number of people living near the poverty line.

The results of this analysis demonstrate the significant impact that specific economic measures outlined in Greece's 2012 Memorandum had on the country's key macroeconomic indicators. The regression analysis confirmed that variables such as import taxes, foreign exchange reserves, and foreign investment played critical roles in shaping GDP, Public Debt, Government Budget, and the Equilibrium of Current Transactions. These findings validate the research hypotheses and highlight the importance of considering the broader economic environment when assessing the effectiveness of policy measures. The analysis also underscores the complexity of economic management during periods of crisis, where policy measures can have multifaceted and sometimes contradictory effects on different economic indicators.

The FCM scenarios provide valuable insights into the potential outcomes of different economic strategies. The first scenario revealed that even with broad economic stimulation, the increase in GDP might be modest, indicating that structural issues within the economy could limit the effectiveness of such measures. The second scenario highlighted the risks associated with aggressive economic contractions, which, while boosting GDP, could severely undermine fiscal stability. In contrast, the third scenario offered a more balanced approach, with a

significant GDP increase and a reduction in Public Debt, suggesting that targeted economic adjustments could lead to more favorable outcomes.

Overall, the analysis of Greece's 2012 Memorandum underscores the importance of careful and strategic economic policymaking. The findings suggest that while certain measures can have positive effects on specific macroeconomic indicators, a more nuanced approach is necessary to achieve balanced and sustainable economic outcomes. Policymakers should consider the complex interplay between different economic variables and aim for strategies that promote long-term stability and growth, particularly in the context of managing public debt and fiscal policy. This study highlights the need for ongoing evaluation and adjustment of economic policies to ensure their effectiveness in achieving desired outcomes.

To provide a fuller perspective on the study's findings, it would be beneficial to address certain limitations. For instance, the FCM model relies on predefined causal assumptions, which may limit the accuracy of its predictions if key variables are omitted. Additionally, the study is constrained by data from a limited timeframe (2012-2015), which may restrict the applicability of findings to longer-term economic impacts. Acknowledging these limitations would enhance the study's transparency and reliability, showing awareness of potential constraints within the methodology.

Beyond policy recommendations, the study would benefit from suggesting future research directions, particularly at a regional level. Examining the effects of the 2012 Memorandum across different regions in Greece could reveal significant disparities in economic resilience, employment, and social outcomes, highlighting areas that may have experienced greater economic strain. Such a regional approach would help identify specific regions that require targeted economic support and policy adjustments. This line of research could ultimately inform more balanced, location-specific economic recovery strategies, contributing to a more equitable and sustainable recovery across Greece.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- Ahmed, S., Majeed, M., Thalassinou, E., & Thalassinou, Y. (2021). The Impact of Bank Specific and Macro-Economic Factors on Non-Performing Loans in the Banking Sector: Evidence from an Emerging Economy. *Journal of Risk and Financial Management*, 14, Article 217. <https://doi.org/10.3390/jrfm14050217>
- Alcidi, C., Belke, A., Giovannini, A., & Gros, D. (2016). Macroeconomic Adjustment Programmes in the Euro Area: An Overall Assessment. *International Economics and Economic Policy*, 13, 345-358. <https://doi.org/10.1007/s10368-016-0350-6>
- Balasoiu, N., Chifu, I., & Oancea, M. (2023). Impact of Direct Taxation on Economic Growth: Empirical Evidence Based on Panel Data Regression Analysis at the Level of Eu Countries. *Sustainability*, 15, Article 7146. <https://doi.org/10.3390/su15097146>
- Chavaz, M. (2016). *Dis-Integrating Credit Markets: Diversification, Securitization, and*

- Lending in a Recovery*. Staff Working Paper No. 617, Bank of England.
- Cheng, G. (2020). *The 2012 Private Sector Involvement in Greece*. Publications Office of the European Union.
- Cherif, R., & Hasanov, F. (2018). Public Debt Dynamics: The Effects of Austerity, Inflation, and Growth Shocks. *Empirical Economics*, 54, 1087-1105. <https://doi.org/10.1007/s00181-017-1260-3>
- Christodoulakis, N. (2015). *Greek Endgame: From Austerity to Growth or Grexit*. Rowman & Littlefield.
- Colasanti, F. (2016). *Financial Assistance to Greece: Three Programmes*. European Policy Centre.
- De Grauwe, P., & Ji, Y. M. (2013). *More Evidence That Financial Markets Imposed Excessive Austerity in the Eurozone (CEPS Commentary)*. Centre for European Policy Studies.
- European Commission (2015). *Debt Sustainability Analysis*. https://ec.europa.eu/info/sites/default/files/economy-finance/ecfin_debt_sustainability_analysis_greece.pdf
- Helleiner, E. (2014). *The Status Quo Crisis: Global Financial Governance after the 2008 Meltdown*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199973637.001.0001>
- House, C. L., & Tesar, L. L. (2015). Greek Budget Realities: No Easy Option. *Brookings Papers on Economic Activity*, 2015, 329-347. <http://www.jstor.org/stable/43752177>
- IMF (2014). *Greece: Fifth Review Under the Extended Arrangement Under the Extended Fund Facility, and Request for Waiver of Nonobservance of Performance Criterion and Rephasing of Access*. IMF Country Report No. 2014/151.
- IMF (2015). *Greece: An Update of IMF Staff's Preliminary Public Debt Sustainability Analysis*. IMF Country Report No. 15/186. <https://doi.org/10.5089/9781513507101.002>
- IMF (2016). *IMF Survey: IMF Reforms Policy for Exceptional Access Lending*. <https://www.imf.org/en/News/Articles/2015/09/28/04/53/sop012916a>
- Kaplanoglou, G., & Rapanos, V. T. (2012). Tax and Trust: The Fiscal Crisis in Greece. *South European Society and Politics*, 18, 283-304. <https://doi.org/10.1080/13608746.2012.723327>
- Karavitis, N. E. (2018). *Fiscal Adjustment and Debt Sustainability: Greece 2010-2016 and beyond*. Working Papers 245, Bank of Greece.
- Kosko, B. (1986). Fuzzy Cognitive Maps. *International Journal of Man-Machine Studies*, 24, 65-75. [https://doi.org/10.1016/s0020-7373\(86\)80040-2](https://doi.org/10.1016/s0020-7373(86)80040-2)
- Krajewska, A. (2014). Fiscal Policy in the EU Countries Most Affected by the Crisis: Greece, Ireland, Portugal, and Spain. *Comparative Economic Research. Central and Eastern Europe*, 17, 5-27. <https://doi.org/10.2478/cer-2014-0020>
- Krimpas, G. A., Krimpas, N. A., & Groumpos, P. P. (2023). An Overview of Making Decisions on Medical Problems Using Fuzzy Cognitive Maps. In IEEE Computer Society, Ed., *2023 14th International Conference on Information, Intelligence, Systems & Applications (IISA)* (pp. 1-6). IEEE. <https://doi.org/10.1109/iisa59645.2023.10345851>
- Louzis, D. P., Vouldis, A. T., & Metaxas, V. L. (2012). Macroeconomic and Bank-Specific Determinants of Non-Performing Loans in Greece: A Comparative Study of Mortgage, Business and Consumer Loan Portfolios. *Journal of Banking & Finance*, 36, 1012-1027. <https://doi.org/10.1016/j.jbankfin.2011.10.012>
- Meghir, C., Pissarides, C. A., Vayanos, D., & Vettas, N. (2017). The Greek Economy before

- and during the Crisis—And Policy Options Going Forward. In C. Meghir, C. A. Pissarides, D. Vayanos, & N. Vettas (Eds.), *Beyond Austerity* (pp. 3-72). The MIT Press. <https://doi.org/10.7551/mitpress/9780262035835.003.0001>
- MentalModeler (2024). <https://www.mentalmodeler.com/scenario/>
- Migkos, S. P., Sakas, D. P., Giannakopoulos, N. T., Konteos, G., & Metsiou, A. (2022). Analyzing Greece 2010 Memorandum's Impact on Macroeconomic and Financial Figures through FCM. *Economies*, 10, Article 178. <https://doi.org/10.3390/economies10080178>
- Nikiforos, M., Papadimitriou, D. B., & Zezza, G. (2015). The Greek Public Debt Problem. *Nova Economía*, 25, 777-802. <https://doi.org/10.1590/0103-6351/3552>
- Pearson, K. (1895). Notes on Regression and Inheritance in the Case of Two Parents. *Proceedings of the Royal Society of London*, 58, 240-242.
- Pelagidis, T., & Mitsopoulos, M. (2016). *Who's to Blame for Greece. Austerity in Charge of Saving a Broken Economy*. Palgrave Macmillan.
- Petrakis, P. E., & Kostis, P. C. (2020). *Policies for a Stronger Greek Economy*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-47079-1>
- Petrakos, G. (2014). Economic Crisis in Greece. European and Domestic Market and Policy Failures. *Région et Développement*, 39, 9-33.
- Provopoulos, G. A. (2014). The Greek Economy and Banking System: Recent Developments and the Way Forward. *Journal of Macroeconomics*, 39, 240-249. <https://doi.org/10.1016/j.jmacro.2013.09.016>
- Siani-Davies, P., & Siani-Davies, M. (2017). *Crisis in Greece*. Oxford University Press.
- Sklias, P., & Maris, G. (2013). The Political Dimension of the Greek Financial Crisis. *Perspectives on European Politics and Society*, 14, 144-164. <https://doi.org/10.1080/15705854.2012.732392>
- Standard & Poor's (2012). *Economic Research: The Eurozone's New Recession Confirmed*. Standard & Poor's Rating Services.
- Tinios, P. (2016). *The Greek Pension Tragedy: A Case of Failure in Governance*. Konrad Adenauer Stiftung, Katoptron, 4. <https://www.des.unipi.gr/wp-content/uploads/2016/06/05.-Tinios-Greek-pension-tragedy-KAS-WP-16.pdf>