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WHAT WAS THE ROLE OF MONETARY POLICY IN THE GREEK FINANCIAL CRISIS?

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Abstract
To what extent is Greece's current economic crisis the result of monetary policy misalignment between the European Central Bank and Greece? We use a risk adjusted Taylor Rule to examine Greece's monetary policy from 1993 to the present. We argue that the monetary policy of the Bank of Greece satisfies several criteria for a good monetary policy. The monetary policy of the ECB, on the other hand, exhibits characteristics that suggest it had a destabilizing effect on the economy of Greece. That is, whereas the ECB could have balanced excessive fiscal stimulus with a contractionary monetary policy, the ECB's actual expansionary monetary policy may have reinforced the fiscal stimulus and led to further destabilization.

JEL Classification: E00, E50, E58
Keywords: Greece, Monetary Policy, Bank of Greece

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1. Introduction

The sovereign debt crisis in Greece has posed major problems in financial markets and has nearly caused the breakup of the euro. It would be worthwhile to study the causes of the crisis. Much of the media coverage of the economic crisis in Greece has emphasized unsustainable fiscal policies as a leading cause. Popular, moralizing narratives describe a profligate Greece using deficit spending for unsustainable social programs; these popular narratives have contributed to the reluctance of stable countries like Germany to provide bailouts. Austerity measures and fiscal consolidation in Greece are widely prescribed as a necessary remedy.

Fiscal policy tells only part of the story of the crisis, however. In adopting the euro and joining the European Economic and Monetary Union, Greece ceded control of its monetary policy to the European Central Bank in Frankfurt, which sets euro interest rates based on the conditions in the entire eurozone. Given the importance of monetary policy, it is important to determine what kind of monetary policies were in place under the separate regimes of the Bank of Greece and the European Central Bank. Clarida, Gali, and Gertler (1998, hereafter CGG) have developed a suitable method, based on Taylor's (1993) research in monetary policy rules, for characterizing monetary policy by its response to macroeconomic conditions such as inflation and output gaps. The response of a policy rule to macroeconomic conditions allows researchers to draw inferences about that policy's effectiveness. Once a central bank's policy rule is estimated, it can be used to simulate how it would have reacted under hypothetical macroeconomic conditions. Taking the estimated policy rule of a highly respected central bank, like the Bundesbank or the Federal Reserve, one can construct a counter-factual monetary policy to use as a benchmark to which other policies can be compared.

We propose to analyze the monetary policies of the Bank of Greece and the European Central Bank. Based on estimated policy rules, we shall determine whether each policy would be expected to have a stabilizing or destabilizing effect on the macroeconomy of Greece. We shall then evaluate each central bank's realized policy in light of a hypothetical policy constructed from the Bundesbank's and Federal Reserve's estimated policy rules. Based on these analyses, we hope to discover whether monetary policy contributed to Greece's current economic crisis, and to gain a better understanding of how Greece has been affected by adopting the euro as its currency.

In the following section we shall introduce the economic background of Greece. Greece has experienced a succession of very different monetary regimes, and knowledge of these special circumstances will help with interpreting the analysis. In the third section we present our hypothesis. In the fourth section we describe our analytical method. In the fifth section we report the results of our Taylor rule analysis using the Bundesbank as a proxy for a conservative central bank. As a robustness check, we augment our analysis by investigating whether differences in expropriation risk between Germany and Greece may have biased our results. The sixth section offers a further robustness check, where we conduct a second counterfactual analysis using the Federal Reserve's, rather than the Bundesbank's, estimated Taylor rule. In the seventh section we discuss our results. The eighth section is our conclusion.

2. The Economic Situation of Greece

2.1 Expansion of Social Programs: 1974-1993

In the year 1974, momentous changes swept through Greece: the authoritarian regime collapsed, King Constantine II was deposed, and a new democratic government was established. Prior to this period, Greece had attained low inflation and a credible peg to the United States dollar. However, inflation rose with the elimination of the Bretton Woods constraints; the first oil shock; and internal populist pressure for income redistribution, full-employment policies, and expansionary fiscal policy (Alogoskoufis 1995).

Inflation, which averaged 3.8% annually from 1954 to 1973, rose to an average of 18.1% from 1974 to 1993. Output growth, which averaged 7.1% from 1954 to 1973 (the so-called "Greek Miracle"), fell to an average of 2.1% from 1974 to 1993. The result was a lengthy period of stagflation; several industries were nationalized, calling into question the security of property rights in Greece (Alogoskoufis 1995). The Bretton Woods peg gave way to a "crawling" peg, with several devaluations and failed attempts to regain credibility (Panagiotidis and Triampella 2005). Government fiscal deficits, intended to accomplish income redistribution, were financed by debt and seigniorage (Lazaretou 2003).

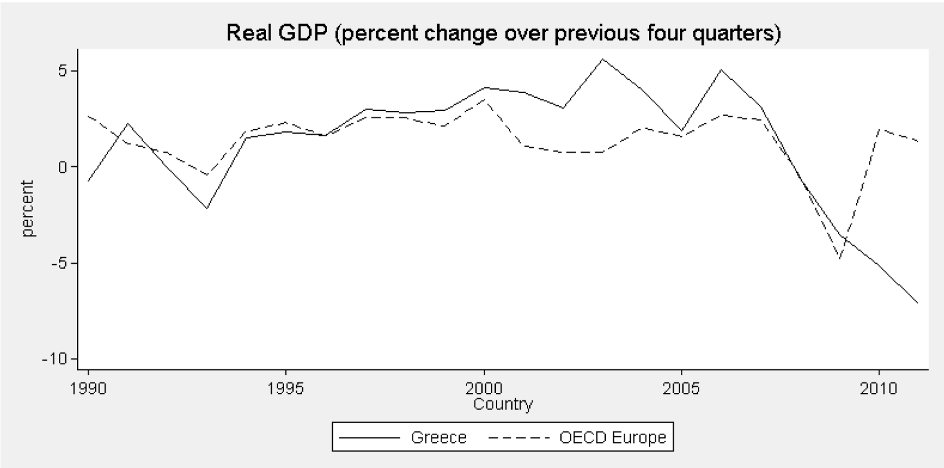

Figure 1. Prior to the sovereign debt crisis, real GDP growth in Greece outpaced that in the other European OECD member countries.

2.2 Maastricht Treaty and Convergence: 1993-2001

In 1993, Greece signed the Maastricht Treaty, pledging to converge economically with her future currency partners. To attain convergence, Greece set out to tighten fiscal policy and curb inflation according to a plan approved in March of 1993; the government had already abandoned this plan before the end of the year, and approved a more gradual plan in June of 1994.

Parallel to fiscal reform, Greece also conducted monetary reform. Inflation fell from 23.3% in October of 1990 to 3.9% in December of 2000. As part of the convergence program, the Bank of Greece engaged in a foreign-exchange policy known as the "hard drachma" policy. The Bank of Greece announced an official exchange rate target, which would serve as an important benchmark in Greece's monetary policy. Indeed, Arghyrou (2009) uses Taylor rules to find that Greek interest rates in the 1990's were statistically significantly correlated with domestic inflation, but even more significantly with foreign interest rates, namely those of the Bundesbank, and later the ECB. Furthermore, he determines that foreign interest rates were more important during normal demand conditions, with domestic inflation being more important during overheating demand conditions.

Tavlas and Papaspyrou (n.d.) note that during the first phase of the convergence program, 1995-1997, inflation halved and GDP growth accelerated. They attribute both of these outcomes to the high credibility of the Bank of Greece's foreign-exchange peg. Previously, the Bank of Greece had not announced specific exchange-rate targets; the drachma had experienced decades of devaluation since the collapse of Bretton Woods. Nevertheless, the drachma increased in value with respect to PPP and became increasingly overvalued until an exchange-rate crisis in 1998. Even after the 1995 announcement of a fixed exchange-rate target, an inflation differential persisted between Greece and the rest of Europe. Arghyrou (2009) uses an Uncovered Interest Parity model to estimate that markets demanded a 9-11% risk premium on drachma denominated assets from 1990 through 2000. Tavlas and Papaspyrou (n.d.) identify several obstacles to the strong drachma policy. High interest rates, necessary to suppress domestic inflation, led to capital inflow, which was costly to sterilize for the Bank of Greece. Furthermore, a current account deficit widened as the drachma became increasingly overvalued. These factors, combined with international financial turbulence following the devaluation of the Thai Bhat in July 1997, strained the Greek money market, ultimately leading to the collapse of the drachma's peg in March 1998. The Bank of Greece devalued the drachma by 12% and entered into the wide-fluctuation band Exchange Rate Mechanism. In the years that followed, Greece moved closer to the Maastricht Treaty's convergence criteria, and was permitted to join the euro.

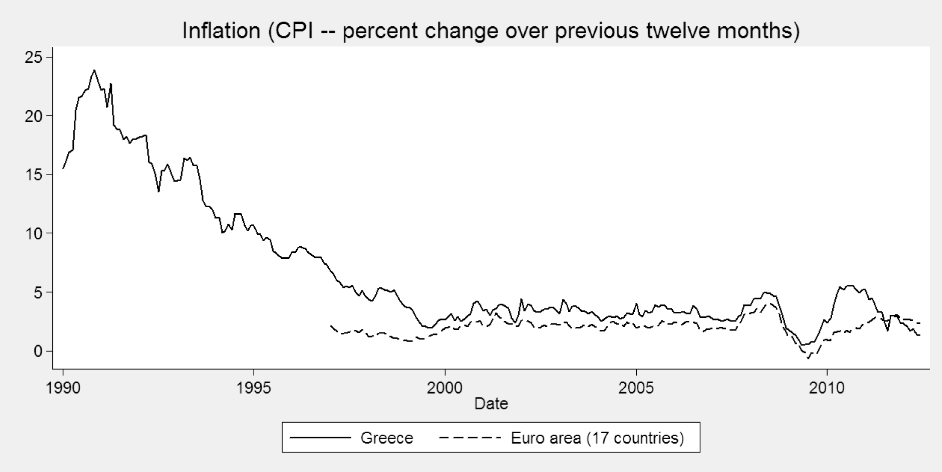

Figure 2. Inflation in Greece cooled from 23.3% in October, 1990 to 3.9% when Greece joined the euro in December, 2000. Despite progress toward convergence in the 1990s, inflation in Greece did not drop below the Eurozone average until July of 2011. From 2001 through 2008, average CPI inflation was 3.5% in Greece and 2.4% in the Eurozone.

Greek monetary policy in the convergence era, which spans from 1993 through 2000, is importantly characterized by the external constraints of foreign-exchange targets, which historically have been important in Greece; during the Greek Miracle period, 1954-1973, the Bretton Woods system had provided such a constraint.

2.3 Accession, Growth, and Crisis: 2002-2012

Greece formally adopted the euro on January 1, 2001. Drachma overnight interest rates, continuing their downward trend from the 1990s, had fallen to 6.16% in December, 2000; and when Greece adopted the euro in January, euro overnight rates were at 4.76%, then fell over the course of several years, reaching a low of about 1.97% in November, 2003, then rising slowly to a high of 4.3% in August, 2008, as the financial crisis was breaking (see Figure 3). Greece, both in money markets and in the sale of government debt, enjoyed considerably lower interest rates than it experienced under the drachma regime. A Taylor-rule counterfactual analysis by Arghyrou (2009) suggests that, during this period, the ECB set interest rates lower than the Bank of Greece would have. Arghyrou argues that such lower interest rates could potentially cause inflation in Greece, resulting in overheated demand, real-exchange-rate overvaluation, and current account deficits. Furthermore, he argues, Greece's accession to the euro eliminated the risk premium of drachma-denominated assets. The elimination of this risk premium would increase inflation and current-account deficits in the short term, but the inflation and deficits would subside in the medium-term.

Nevertheless, government final consumption expenditure decreased as a share of GDP immediately after accession, and only gradually increased before rising sharply to a peak in 2009:Q4. It is perhaps interesting that the government share of GDP in Greece did not exceed that of the weighted average of all European OECD countries until 2009:Q4. Furthermore, Greece experienced strong economic growth after her accession to the euro.

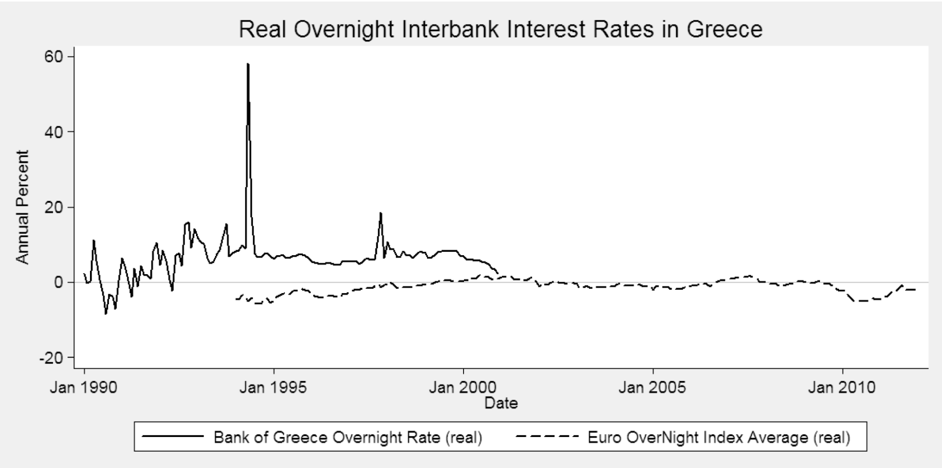

Figure 3. Prior to adopting the euro in January of 2001, the Bank of Greece determined Greece's monetary policy.

It is worth noting, however, that the OECD's statistics for Greece are taken from the National Statistical Service of Greece, which the European Commission criticized in a January 2010 report, describing actual instances of misrepresented data, especially in GDP and budget deficit as a percent of GDP. Indeed, the National Statistical Service of Greece revised GDP figures upward by as much as 25% in some quarters, purportedly by including the black-market and illegal-goods sectors, with the apparent purpose being to keep its budget deficit to GDP ratio within specific bounds (International Herald Tribune 2006, Economist 2011b).

Problems began to emerge in Greece during the late 2000's financial crisis and economic downturn, with the sovereign debt crisis beginning to unfold in 2010. Specifically, the government of Greece had accumulated large debts, saw declining tax revenues as a result of the recession, faced unsustainable interest rates in bond markets, and was on the brink of insolvency. A Greek government default would be catastrophic for Greece, and for not only the banks in Greece, but also those in the rest of Europe. So far, European leaders have addressed this situation through a combination of additional bailout loans, debt renegotiations and "haircuts," and austerity measures for the Greek government. The process of dealing with Greece has been particularly difficult because of the conflicting viewpoints: some, especially in fiscally strong countries like Germany, hold that Greece was a profligate country and deserves to default; others support bailouts because of the enormous risks facing the European financial system as a whole, even in sound countries like France and Germany; and still others would support bailouts but worry about the problem of moral hazard. The Greek debt crisis has even, at times, called into question the very survival of the euro as a common currency (Economist 2011a).

3. To What Extent was Monetary Policy a Factor?

The broad consensus is that the Greek sovereign debt crisis was caused by poor fiscal policies, with the Greek government running budget deficits to finance social programs. In the past, Greece was accustomed to doing this without dire consequence because it could escape its debts through inflationary finance and currency devaluation; that is, proper monetary policy offered a counterbalance to fiscal policy. Today, however, Greece cannot devalue its currency unilaterally because it shares a currency with countries like Germany. To what extent has Greece's lack of a nationally appropriate monetary policy exacerbated, or even caused, its current crisis?

Monetary policy in Greece has been exceptional in the past nineteen years. Monetary policy, as practiced by the Federal Reserve, for example, is often intended to stabilize inflation at a low level, and to mitigate the business cycle. From 1993 until 2000, however, Greece's monetary policy was focused not only on inflation and stabilizing output, but also on maintaining a foreign-exchange peg (under tremendous speculative pressure) and converging to the requirements of the Maastricht Treaty with respect to several indicators, including inflation. From 2001 to the present, Greece's monetary policy has been determined not by a Bank of Greece in Athens setting interest rates with only the Greek economy in mind, but by the European Central Bank in Frankfurt setting interest rates for the entire eurozone.

Furthermore, if the central bank restricts credit, interest rates will rise, businesses will be less likely to invest, and economic output will fall. On the other hand, when central banks undertake monetary expansion to depress interest rates, the economy will enjoy a short-term boom, but the risk develops that credit will be allocated into speculative bubbles that will burst, driving down asset prices and leading to a period of deflation and economic contraction. Central banks are thus generally encouraged to set interest rates between these two hazards. Taylor's (1993) policy rule is meant to provide a middle ground for central bankers.

It would be interesting, given the potential for monetary policy to affect the macroeconomy, to assess what kind of monetary policy was in use in Greece during the period in question. CGG (2000) have provided a method for estimating Taylor-rule coefficients to describe a monetary policy and characterize the general behavior of a central bank. Furthermore, they use these coefficients to perform counter-factual analyses that suggest what one central bank might have done given certain economic conditions. Specifically, we can determine whether a central bank followed the Taylor principle, i.e., whether the central bank raised real interest rates in response to rising inflation, and vice-versa.

We intend to use CGG's methods to evaluate the monetary policy in Greece during the periods 1993:1-2000:12 and 2001:01-2010:12. If we view the Bundesbank as a highly respected central bank, we can see whether the Bank of Greece set rates higher or lower than this benchmark. Furthermore, we can carry these projections forward and evaluate whether the rates set by the European Central Bank made sense given economic conditions in Greece. Finally, we can estimate Taylor-rule coefficients to characterize the general behavior of the Bundesbank and the Bank of Greece. We can also estimate coefficients for the European Central Bank, but based on Greece's economic data, so that we can analyze the Taylor rule that was *de facto* in use in Greece from 2001 to 2010. Using the Taylor rule coefficients, we can ascertain whether the banks responded to inflation and output gaps in the manner we expect.

Specifically, we expect the following for a stabilizing policy rule: The inflation coefficient β should be greater than one, and the output-gap coefficient γ should be greater than 0. In both cases, the rule applies negative feedback to macroeconomic forces. This policy stimulates the economy with lower interest rates in response to disinflation and decreased output, and dampens an "overheated" economy with higher interest rates in response to inflation and increased output. Such a rule dampens deviations from the target path of prices and RGDP. Clarida, Gali, and Gertler (1998) run a simulation to show that a policy rule with $\beta < 1$ can cause bursts of inflation even without fundamental shocks to the economy, whereas policy rules with $\beta > 1$ do not allow such outbursts.

4. Method

4.1 Estimating the Taylor Coefficients

In this section we derive and explain CGG's (Clarida, Gali and Gertler 1998) Taylor rule. The equation takes the basic form:

$$r_t^* = r^* + \beta\left(E\left[\pi_{t+n}|\Omega_t\right] - \pi^*\right) + \gamma(y_t - E[y_t^*|\Omega_t]) \tag{1}$$

where

r_t^*	is the implied nominal interest rate at time *t*
r^*	is the long-run equilibrium nominal interest rate
β	is the inflation reaction coefficient
E	is the expectations operator
π_{t+n}	is the inflation n periods from time *t*
Ω_t	is the information set available to policymakers at time *t*
π^*	is the target rate of inflation
γ	is the output-gap reaction coefficient
y_t	the real national output at time *t*
y_t^*	the potential output of the economy at time *t*

It is assumed that the long-run equilibrium interest rate rr^* follows the long-run neutrality of money hypothesis; as such, it is determined by non-monetary factors and can thus be treated as an exogenous constant. If rr^* is known, then equation 1 can be rewritten to specify to specify a target real rate, $rr_t^* = r_t^* - E[\pi_t|\Omega_t]$,

$$rr_t^* = rr^* + (\beta - 1)\left(E\left[\pi_{t+n}|\Omega_t\right] - \pi^*\right) + \gamma\left(E\left[y_t\ |\Omega_t\right] - y_t^*\right) \tag{2}$$

Equation 2 demonstrates the Taylor Principle: if $\beta < 1$, the real interest rate will decrease as inflation increases. Conversely, if $\beta > 1$, the real rate will increase as inflation increases.

Interest rates are seldom adjusted instantaneously. Therefore, to allow for "interest rate smoothing," CGG model the interest rate as an AR(1) process as in:

$$r_t = (1-\rho)r_t^* + \rho r_{t-1} + v_t \tag{3}$$

where r_t is the *actual* nominal interest rate at time t, $\rho \in [0,1]$ is the degree of interest rate smoothing, and v_t is an i.i.d. error term representing a random disturbance.

Substituting equation (1) into equation (3) and collapsing the expectations operators, we obtain

$$r_t = (1-\rho)[\alpha + \beta\pi_{t+n} + \gamma x_t] + \rho r_{t-1} + \epsilon_t \tag{4}$$

where $\alpha \equiv r^* - \beta\pi^*$, $x_t \equiv (y_t - y_t^*)/y_t^*$, and the error term ϵ_t is defined as

$$\epsilon_t \equiv -(1-\rho)\{\beta(\pi_{t+n} - E[\pi_{t+n}|\Omega_t]) + \gamma(x_t - E[\pi_t|\Omega_t])\} + v_t$$

Importantly, ϵ_t, is a linear combination of forecast errors

$$\{\beta(\pi_{t+n} - E[\pi_{t+n}|\Omega_t]) + \gamma(x_t - E[\pi_t|\Omega_t])\}$$

and a random disturbance v_t, and is assumed to be *i.i.d.* (CGG 1998). The coefficients of equation (4) can be estimated by generalized method of moments estimation (GMM).

4.2 Applying Germany's Rule to Greece: The Counter-Factual Analysis

While the Bank of Greece struggled for political independence and credibility during the periods we examine, the German Bundesbank has enjoyed considerable independence and high credibility. Therefore, we use the Bundesbank's Taylor-rule coefficients as an example of a "good" policy-reaction function. Using the Bundesbank's coefficients and Greece's economic conditions, one may form a conjecture about the monetary policy that would have existed in Greece had the governors of the Bundesbank continued to make decisions as they would for Germany, but instead considering economic conditions in Greece. We compare these conjectural interest rates to the actual interest rates of the Bank of Greece (until December of 2000) and of the European Central Bank (from 2001 forward). This analysis aims to provide some basis of a "good" policy from which to discern whether the Bank of Greece acted wisely in managing the affairs of its own country, and whether the European Central Bank was appropriately responding to conditions in Greece.

By calculating the average real interest rate in Germany, we obtain $\overline{rr}_{de}$, denoting Germany as "*de*" for convenience. By estimating equation 4 using data from Germany and performing the appropriate arithmetic, we obtain the coefficient vector $\{\alpha_{de}, \beta_{de}, \gamma_{de}, \rho_{de}\}$.

Instead of using Germany's average real interest rate $\overline{rr}_{de}$ to estimate a conjectural monetary policy for Greece, we use the average real interest rate for Greece, $\overline{rr}_{gr}$, because the factors that determine the long-run equilibrium real interest rate are considered to be exogenous to monetary policy. Thus, $\overline{rr}_{de}$ is exogenous to the Bundesbank, just as $\overline{rr}_{gr}$ is exogenous to the Bank of Greece; each central bank takes this as a datum. We calculate the constant term for the Bundesbank's reaction function given Greece's long-run real interest rate:

$$\alpha_{de|gr} = \overline{rr}_{gr} + (1-\beta_{de})\pi^*_{de}.$$

This term $\alpha_{de|gr}$ will be used in place of a_{de} for the counter-factual analysis because $\alpha_{de|gr}$ properly accounts for the target rate of inflation, π^*, which is endogenous to the Bundesbank's monetary policy, and rr^*_{gr} (estimated as $\overline{rr}_{gr}$), which we assume is exogenous to monetary policy in general. Therefore, in our counter-factual analysis, the implied interest rate for Greece given the Bundesbank's Taylor-rule coefficients, $r^*_{t,gr|de}$, is given by a modification of equation 4:

$$r_{t,gr|de} = (1-\rho_{de})\left(\alpha_{de|gr} + \beta_{de}E\left[\pi_{t+n,gr}|\Omega_t\right] + \gamma_{de}E\left[x_{t,gr}|\Omega_t\right]\right) + \rho_{de}r_{t-1,gr|de}. \quad (5)$$

The counter-factual rate depends upon the interest rate in the previous period, r_{t-1}. The counter-factual rate for the initial period was estimated using (5) without the inertial lag term. Because the coefficients were estimated using expectations of forward looking data, we estimate predicted values for future CPI inflation and the output gap using the variables from the instrument set.

4.3 Data Selection

We use the OECD's consumer price index (percent change over previous year) to measure inflation, and the OECD's index of industrial production, specifically all industry, as a proxy for output. The industrial production index was processed through a Hodrick-Prescott filter ($\lambda = 129{,}600$) to de-trend the data; we divided the difference between the realized values and the smoothed values by the smoothed values and multiplied this ratio by 100 to obtain a percentage output gap. We use overnight interbank interest rates to estimate Taylor rules for the Bundesbank and the Bank of Greece. CPI and industrial production data for "Germany" refer to West Germany prior to 1991 and refer to unified Germany from 1991 to the present.

Following CGG, we select instruments that would be of use to monetary policy makers in forecasting future inflation and output gaps: the spread between long term and short term interest rates, the producer price index, the growth rate of the M2 money stock, as well as lagged values of the output gaps and inflation.

Long term and short term rates for Germany and the euro area are taken from the OECD. The government of Greece did not regularly issue fixed-income securities until 1997, so we estimate Greek sovereign debt yields from long-term and short-term corporate bond yields obtained from the Bank of Greece. The producer price index is the Domestic Producer Price Index for Manufacturing, obtained from the Federal Reserve Economic Database (FRED). M2 growth for Greece is taken from the Bank of Greece, from FRED for Germany, and from the ECB for the euro. The Deutchmark-US dollar exchange rate is used for Germany, following CGG (1998), and was obtained from the OECD.

The Bundesbank's coefficients were estimated using data from January 1980 to December 1998. The Bank of Greece's coefficients were estimated using data from January 1993 to December 2000. The ECB's coefficients were estimated using data from January 2001 to December 2010.

To estimate the risk-premium, we use the PRS Group's "Investment Portfolio" risk factor, which specifically accounts for expropriation risk/contract viability, profits repatriation, and payment delays. It should be interesting to note that Greece and Germany have similar risk indices for the period under consideration (see Figure 5). We also use overnight interest rates from the OECD database. To represent the European Central Bank's monetary policy, we use the Euro OverNight Index Average, or EONIA, which is an average of all euro-denominated overnight money-market rates in Europe.

Important to our econometric analysis is the assumption of stationarity of nominal interest rates, CPI inflation, and the output gap. The intuition provided by economic theory is that these series should be stationary: output gaps should be stationary if economic output tends towards its potential level, monetary authorities striving for price stability generally keep inflation within certain bounds, and real money market interest rates are seen as varying about a long-run mean value that reflects the time value of money and the fundamental need for liquidity in markets. Taking into account the low power of the Dickey-Fuller test to reject nonstationarity, especially in small samples, we test for stationarity over the entire observed values for our data, and are able to reject a unit root at 0.1 p-value for the series we use, allowing for drift[1].

5. Results

5.1 Analyzing Taylor-Rule Coefficients

First we estimate Taylor-rule coefficients for the Bundesbank and the Bank of Greece using each bank's domestic data. We also estimate Taylor-rule coefficients for the

1. We reject the null of a unit root using Augmented Dickey-Fuller tests with one lag and a trend. Six lags were required for the EONIA series.

European Central Bank, but with inflation and output-gap data taken from Greece after its accession to the eurozone. From these estimated coefficients we can infer the character of each policy. The results appear in Table 1. Each policy rule is specified with three lags of the overnight interest rate to eliminate autocorrelation in the residuals[2]. In no cases are we required to reject the model's overidentification restrictions[3].

Table 1. Interest Rate Policy Rules

	Central Bank	α	β	γ	ρ1 + ρ2 + ρ3	$\overline{rr}$
1	Bundesbank	2.76	1.20	0.43	0.94	3.34
		(0.16)	(0.05)	(0.04)	(0.00)	(1.24)
2	Bank of Greece	6.17	1.10	-0.27	0.84	6.94
		(0.19)	(0.03)	(0.04)	(0.01)	(1.90)
3	ECB (Greece's data, 2001:1-2010:12)	1.77	0.23	0.32	0.96	-0.32
		(1.41)	(0.39)	(0.15)	(0.02)	(0.92)
4	ECB (Greece's data, 2001:1-2007:12)	2.27	0.16	0.32	0.95	-0.30
		(1.64)	(0.46)	(0.13)	(0.02)	(1.00)

Note: Standard errors are shown in parenthesis. These coefficients were estimated using the generalized method of moments with a heteroskedasticity and autocorrelation consistent weighting matrix using the Newey-West optimal lag-selection algorithm. For the BOG's policy rule, using one lag of the interest rate in the Taylor rule was sufficient to eliminate autocorrelation in the residuals. For the Bundesbank and ECB, three lags of the interest rate were required to eliminate autocorrelation.

For the Bundesbank (Table 1, row 1), which serves as an example of how a highly respected central bank acts, we estimate Taylor-rule coefficients for the period 1980:1-1998:12. The variables β, γ, and ρ are all significant at the $p = 0.01$ level. The inflation response coefficient β takes a value greater than one, implying that the Bundesbank's policy rule satisfies the "Taylor principle" criterion. We can additionally reject the hypothesis that $\beta < 1$ at $p=0.04$ significance. The output-gap coefficient γ has a positive sign, which we expected of a stabilizing response. The smoothing coefficient ρ takes a value close to its upper bound of 1, which implies that the Bundesbank adjusted interest rates very gradually.

For the Bank of Greece (Table 1, row 2), coefficients were obtained based on data from January 1993 to December 2000, because the period prior to 1993 was characterized by a very different monetary policy regime with far less central-bank independence and far greater government dependence on seigniorage revenue. We

2. Using a Ljung-Box Q test with 40 lags, we did not find evidence of autocorrelation. Under the null hypothesis, the error term is independently distributed, with the lowest p-value we observe being 0.4321.
3. We do not reject the null hypothesis of Hansen's J-test, with the lowest p-value observed being 0.9639.

replace the observed overnight rates for May 1994 and October-November 1997 with interpolated values to exclude the effects of the two speculative attacks on the Greek money market (see Figure 3); in these attacks, global financial forces overpowered the Bank of Greece, and so the interest rates during these periods should not be considered representative of the Bank's policy rule.

The inflation coefficient β is found to be statistically significant, and takes a value greater than 1, implying that the Bank of Greece's policy rule, like the Bundesbank's, satisfies the Taylor principle. We can additionally reject the hypothesis that $\beta<1$ with much higher than $p=0.001$ significance. The sign on the output-gap coefficient is negative. This is the opposite of what we would expect of a stabilizing policy rule. The implications of this are not entirely clear. The lag coefficient ρ is estimated at 0.84 (s.e. 0.01). This value is less than the estimate for Germany. The Bank of Greece's lower observed value of ρ for the period 1993-2000 is likely explained by the high interest-rate volatility of 1993 and 1994.

The observed value of Greece's $\overline{rr}$ is somewhat high (Table 1, row 2) in comparison to Germany's (row 1S), but this is likely a consequence of the time period selection. Because the Bank of Greece was bringing about disinflation prior to adopting the euro, the average real interest rate observed during this period is likely an overestimate of the true, long-run equilibrium real interest rate (CGG 2000). CGG's method assumes that rr^*, the long-run equilibrium real interest rate, can be estimated by taking the average real interest rate over the period in question. Because our observations include a period of disinflation, real interest rates were unusually high and are likely a biased estimate of the true long-run equilibrium real interest rate.

Compare this to the European Central Bank period (Table 1, rows 3 and 4). To allow for the possibility that the Greek sovereign debt crisis has forced the ECB to adopt unconventional monetary policies, we examine two periods, a longer one covering January 2001 through December 2010, and a shorter one covering January 2001 through December 2007. Both calculations find statistically significant and positive γ coefficients on the output gap, which CGG would characterize as stabilizing. Yet both also reject the hypothesis $\beta>1$ at the $p=0.05$ significance level, which CGG would characterize as destabilizing. The smoothing coefficient ρ is comparable to the Bundesbank's value. Somewhat more problematic is that since Greece joined the euro, real interest rates have been, on average, negative.

5.2 Counter-Factual Analysis

In our counter-factual analysis, the Bundesbank's Taylor-rule coefficients are used to generate a series of implied interest rates, $r_{gr|de}$, based upon economic conditions in Greece. Figure 4 presents the counterfactual overnight interest rate for Greece, using the Bundesbank's Taylor rule coefficients and Greece's economic data. Also presented are two series of realized interest rates, one which represents the monetary policy of the Bank of Greece, and the other which represents that of the European Central Bank.

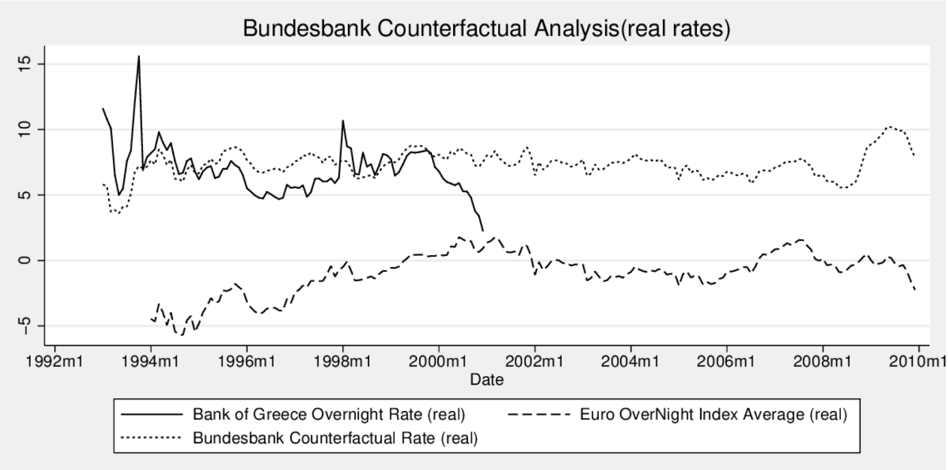

Figure 4. Implied interest rates for Greece using Bundesbank Taylor rule coefficients. Observed rates for May 1994 and October-November 1997 were replaced with interpolated values.

Table 2. Counterfactual Analysis: Differences from Bundesbank Implied Target Rate

Series	E[diff*]	Stdev[diff*]	Min	Max
Bank of Greece	0.34	2.24	-8.39	5.28
European Central Bank	7.67	1.14	6.16	10.32

Note: Data from May 1994, October-November 1997 foreign exchange crises were excluded. diff* = (counterfactual rate) - (realized rate). Bank of Greece data are from 1993:1 to 2000:12, ECB data are from 2001:1 to 2010:12.

If the foreign exchange crises of May 1994 and October-November 1997 are excluded, one can observe by mere visual inspection that there was little difference between the Bank of Greece's actual interest rates, and those calculated hypothetically from the Bundesbank's policy rule. An appreciable difference emerges, however, after Greece's transition to the euro, when the Bundesbank would have set rates much higher than the ECB actually did.

Table 2 presents this inference numerically. Realized interest rates were subtracted from the counter-factual implied series (with the foreign exchange crises removed). The Bank of Greece set interest rates, on average, only 34 basis points below what was implied by the Bundesbank's policy rule, adjusted for expropriation risk, and excluding the two foreign exchange crises. The European Central Bank, on the other hand, set rates an average of 7.67% below the Bundesbank's hypothetical rate.

5.3 Risk Adjustment

A counter-factual analysis could be biased if there exist differences in expropriation risk, which affects the risk premium demanded by lenders. Whereas Germany is perceived as a highly developed and stable economy, Greece has suffered from high inflation and a turbulent political climate. To account for this, we adjust the implied interest rate for Greece given the Bundesbank's Taylor-rule coefficients, $r^*_{t,gr|de}$, using:

$$rr^*_{t,i} = R_f + \theta\varphi_{t,i} + \epsilon_t \tag{6}$$

where the index i denotes a given country, and the "return" refers to the overnight interest rate. We denote the risk for country i at time t as $\varphi_{t,i}$; we denote the risk-free rate, or intercept term, as R_f, and the market risk premium as θ. Note that we use real interest rates in estimating the risk premium. This prevents differing inflation targets across countries from affecting measurements of the actual market risk premium, which would appear in real returns. In finding a risk-premium with which to adjust interest rates implied by the Bundesbank's coefficients for the Greek economy, we combine two versions of equation 6, subtracting the equation for Germany from the equation for Greece:

$$rr^*_{t,gr} - rr^*_{t,de} = \{R_f + \theta\varphi_{t,gr} + u_t\} - \{R_f + \theta\varphi_{t,de} + v_t\} = \theta(\varphi_{t,gr} - \varphi_{t,de}) + e_t \tag{7}$$

The risk premium is exogenous to monetary policy and is best thought of as a component of the long-run equilibrium real interest rate, rr^* (it will be estimated from real interest rates). Therefore, the risk premium should be added to rr^*, which does not appear directly in equation (5), but rather is a component of $a = r^* + \beta\pi^*$, where $rr^* = r^* - \pi^*$. Consequently, we include the risk premium by adding the difference in returns $\theta(\varphi_{t,gr}-\varphi_{t,de})$ to α, so that $\alpha'_t = rr^* + \theta(\varphi_{t,gr} - \varphi_{t,de}) + \beta\pi^*$. This value can be substituted in place of a non-risk-adjusted α to define a new risk-adjusted interest rate series,

$$r'_t = (1-\rho)[\alpha'_t + \beta\pi_{t+n} + \gamma x_t] + \rho r'_{t-1}. \tag{8}$$

From the "Investment Portfolio" cross-sectional time series from the PRS Group, we obtain a risk index for each country. The indices vary from 1 (riskiest) to 12 (safest). From the OECD's database we construct a cross-sectional time series of interest rates and inflation rates, from which we obtain a cross-sectional time series of real interest rates.

One important task is to determine which data to include. The objective of this analysis is to determine a market risk premium. Some of the countries sampled experienced hyperinflation at some point during the observation period. Credit markets experiencing hyperinflation are very different from those not experiencing hyperinflation. Specifically, we want to find a market risk premium for Greece, which has not experienced hyperinflation from 1993 to the present. Consequently, data from countries experiencing hyperinflation or countries with exceptionally high risk levels were excluded so that this risk premium for Greece would be formed based on a like comparison. Specifically, all countries with a risk level more severe than 4 were excluded, as Greece's worst risk level since 1993 was a 4, and markets riskier than this are probably heavily influenced by non-market forces (whereas the purpose of this test is to determine a market risk premium). We also excluded all countries with real interest rates less than -10%, as interest rates more negative than this are also not likely the result of market action.

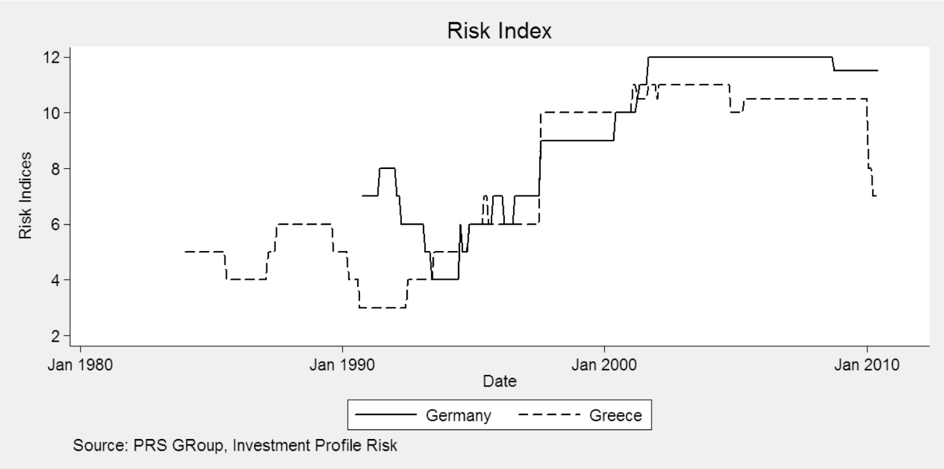

Figure 5. Risk Indices for Greece and Germany.

Using a cross-sectional time-series regression, we estimate the risk coefficient to be -0.30, with a standard error of 0.055; therefore, a 1 point increase in the risk index decreases real interest rates by 0.3%.

The risk adjustment increases the Bundesbank's counterfactual rate by an average of 17 basis points, although the risk-adjusted rate is lower than the unadjusted rate from April of 1998 through December of 2001. Although this gap does widen to a more substantial 60 basis points in June of 2010 (the last month for which data are available), the calculated impact of expropriation is modest during both the Bank of Greece's and the ECB's regimes. Table 3 demonstrates that the Bank of Greece still behaved much like the Bundesbank, whereas the ECB did not.

Table 3. Counterfactual Analysis: Differences from Bundesbank Implied (Risk Adjusted) Target Rate

Series	E[diff*]	Stdev[diff*]	Min	Max
Bank of Greece	0.37	2.13	-8.09	5.12
European Central Bank	7.96	1.16	6.09	10.69

Note: Data from May 1994, October-November 1997 foreign exchange crises were excluded. diff * is equal to the counterfactual rate less the realized rate.

6. Counterfactual Analysis Using Federal Reserve Coefficients

We expand our counterfactual analysis by using the Federal Reserve's policy rule during the period 1982:10-1996:12, which was described by CGG (2000) as corresponding to the "stable" era of recent macroeconomic history. We use GMM estimation to obtain a policy rule for the Federal Reserve using data taken from the OECD: the monthly Federal Funds Rate, output gaps measured from an HP-detrended Industrial Production Index, and the CPI. We use as instruments the spread between ten-year Treasury bonds and three-month Treasury notes as well as the year-over-year growth of the M2 money stock. We risk-adjust the data using the same PRS "portfolio risk" index.

We report the results of estimation in Table 4[4]. We used the Federal Reserve's coefficients to generate a series of counterfactual interest rates. A comparison can be made visually in Figure 6, or quantitatively in Table 5. The Federal Reserve largely concurs with the Bundesbank. A large difference appears between the Federal Reserve's implied rates and the ECB's actual rates. We found that risk adjusting the Federal Reserve's rates had negligible effects on the results.

Table 4. Federal Reserve Policy Rule

Central Bank	α	β	γ	$\rho1+\rho2+\rho3$	$\overline{rr}$
Federal Reserve	2.53	1.08	0.47	0.98	3.15
	(0.95)	(0.28)	(0.09)	(0.00)	(1.87)

Note: Federal Reserve data are from October 1982 to December 1996. Standard errors are shown in parentheses.

4. As in our previous estimations, we specify a model with three lags of the interest rate to eliminate autocorrelation in the residual term, as determined by the Ljung-Box Q test. Hansen's J-test does not lead us to reject the model's overidentifying restrictions.

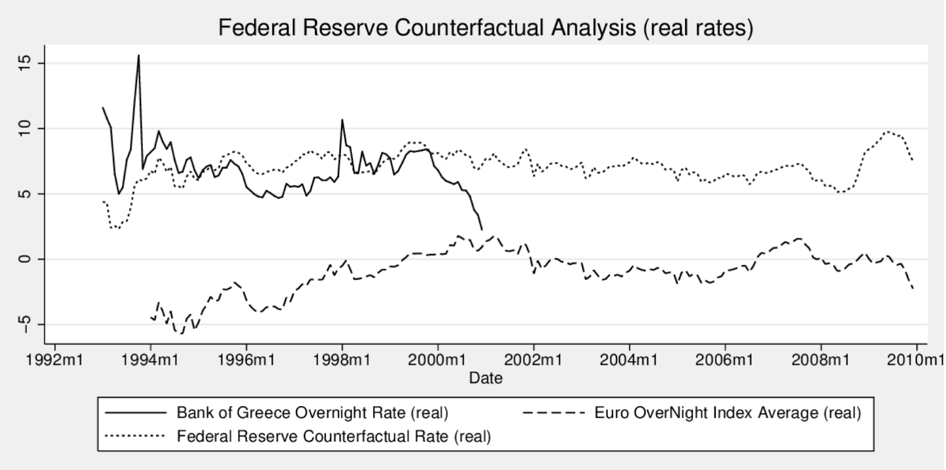

Figure 6. Implied interest rate for Greece based on the Federal Reserve Taylor rule coefficients. Observed rates for May 1994 and October-November 1997 were replaced with interpolated values.

Table 5. Counterfactual Analysis: Differences from Federal Reserve Implied (Risk Adjusted) Target Rate

Series	E[diff*]	Stdev[diff*]	Min	Max
Bank of Greece	-0.17	2.38	-9.08	4.79
European Central Bank	7.61	1.14	5.87	10.24

Note: Data from May 1994, October-November 1997 foreign exchange crises were replaced with interpolated values. diff* is equal to the counterfactual rate less the realized rate.

7. Discussion

We saw that the Bank of Greece set interest rates in accord with the Taylor principle ($\beta > 1$), but did not exhibit the expected response to output gaps (the expected response is $\gamma > 0$), and exhibited a lesser degree of interest-rate smoothing in comparison to Germany. The lack of response to output gaps has economic implications, although there is debate among economists as to whether monetary policy ought to respond to changes in real output. CGG (2000) conjecture that the United States' poor monetary policy in the 1970's may have arisen in part from underestimates of the "natural" rate of unemployment. Furthermore, Greece was at this time pursuing an exchange-rate target; inflation may correlate to exchange-rates in a way that real economic output does not. Thus, the Bank of Greece's efforts to sustain an exchange rate program may have conveniently coincided with attempts to engineer a disinflation.

The lesser degree of interest-rate smoothing is more difficult to explain. Perhaps the Bank of Greece was less able to forecast economic conditions and found the need to make more frequent corrections to the path of interest rates. Perhaps the Bank of Greece faced greater external forces in drachma money markets and was unable to set interest rates precisely. It is possible that interest rate smoothing in Greece was suboptimal; the extent to which the Bank of Greece can be faulted for this and the extent to which this interest-rate volatility impacted the Greek economy are uncertain.

Notwithstanding these two discrepancies between the Bank of Greece's policy and expectations, we observed that the Bank of Greece's actual policy, excluding rates during two foreign exchange crises, coincided largely with a hypothetical policy constructed from the Bundesbank's estimated policy rule. Because the Bundesbank was historically quite highly regarded for its monetary policy, such a similarity between the policies of the Bundesbank and the Bank of Greece constitutes an interesting "endorsement" of sorts for the Bank of Greece. Our additional counterfactual analysis using the Federal Reserve serves to buttress this endorsement. Thus, the Bank of Greece, even while focusing mainly upon an ambitious exchange-rate target in the face of extraordinary speculative pressures, seemingly pursued a quite sound interest-rate policy.

On the other hand, the European Central Bank pursued an interest rate policy that greatly differs from the Bundesbank's. The average real interest rate in Greece over the past decade has been negative. Our study finds evidence that the European Central Bank's interest rate policy would destabilize prices in Greece. This would be consistent with the idea that the ECB sets policies that satisfy several different countries. The positive sign on the output gap coefficient suggests that the ECB was able to pursue a policy that stabilized output in Greece, but it was just such a strategy, one that stabilizes output without stabilizing prices, that the Federal Reserve employed during the Martin-Burns-Miller years, a time not remembered fondly in the macroeconomic history of the United States.

Based upon the Bundesbank comparison, and the fact that real short-term interest rates have been negative for most of the past decade in Greece, it is quite possible that interest rates in Greece have been too low since Greece acceded to the euro. An extended period of monetary easing brings with it a boom, which Greece (if the data are to be trusted) experienced immediately after adopting the euro; the boom, however, often ends with the bursting of credit bubbles and with rising inflation as economic agents agree on prices based on high inflationary expectations. If Greek sovereign debt can be thought of as a credit bubble, then it seems that monetary policy could have contributed to the current crisis, in addition to the budget deficits and other fiscal problems that are commonly discussed. The existence of widening current account deficits in Greece throughout the 2000's may have been exacerbated by the abundance of liquidity in Greek money markets, brought on by the ECB's low interest rates.

Whatever criteria the European Central Bank used in setting interest rates, those criteria did not lead the ECB to set interest rates in accordance with the state of the Greek economy. Even if the GDP data for Greece were completely unreliable, the persistence of negative real interest rates for an extended period is generally a sign either of a deflationary liquidity trap, or a brewing macroeconomic calamity.

It would be worth pointing out that Greek monetary policy during the Greek Miracle (1954-1973), a period of low inflation and high growth, was constrained by the Bretton Woods exchange system. From 1974-1992, the Greek economy faced sluggish growth and persistent inflation, and, in the absence of a firm commitment to a foreign exchange policy, the drachma was repeatedly devalued. The period 1993-2001, like the Greek Miracle, was constrained by a foreign exchange program. Such a correlation could be mere coincidence, but it casts doubt on the assertion that rigid foreign-exchange programs render a central bank unable to respond to the needs of their economies.

It would be worth asking whether Greece should have joined the eurozone to begin with. Where persistent inflation differentials exist, it would be worth determining whether the benefits of integrating into a monetary union outweigh the loss of interest-rate autonomy. Indeed, Greece attained stronger inflation convergence under the Bank of Greece than it did under the ECB; such a result calls for further study of inflation differentials in monetary unions.

8. Conclusion

To summarize, we followed Clarida, Gali, and Gertler's (1998) method for estimating Taylor-rule coefficients and performing a counter-factual analysis to conjecture what the Bundesbank and the Federal Reserve might have done had they been responsible for setting Greece's interest rates. We determined that the Bank of Greece set interest rates very similar to those "optimal Taylor rules" as proxied by the Bundesbank's and Fed's estimated Taylor rules, even after adjusting for differences in expropriation risk. Furthermore, we have shown that the Bank of Greece's Taylor rule functions were "stabilizing" policies, whereas the ECB's was not. We suggest that the European Central Bank, in determining monetary policy for all of the eurozone, set rates that were too low for the economic conditions in Greece. A continued period of low nominal and negative real interest rates may have exacerbated sovereign debt bubbles, which Greece, as a euro member state, could not simply inflate away. In addition to the fiscal element that is often and rightly emphasized, we now add that monetary policy might also have contributed to Greece's sovereign debt crisis.

References

Alogoskoufis, George, "The Two Faces of Janus: Institutions, Policy Regimes and Macroeconomic Performance in Greece," *Economic Policy*, April 1995, 10(20), 147-192.

Argyrou, Michael G., "Monetary Policy before and after the euro: evidence from Greece," *Empirical Economics*, June 2009, 36, 621-643.

Clarida, Richard, Jordi Gali, and Mark Gertler, "Monetary policy rules in practice: Some international evidence," *European Economic Review*, 1998, 42, 1033-1067.

_____,_____, and _____, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," *Quarterly Journal of Economics*, February 2000, 115(1), 147-180.

Economist, The, "Beware of falling masonry," The Economist, November 2011.

______, "Numbers in action," The Economist, November 2011.

Hodrick, Robert J and Edward C Prescott, "Postwar U.S. Business Cycles: An Empirical Investigation," *Journal of Money, Credit and Banking*, February 1997, 29(1), 1-16.

International Herald Tribune, "Greece Revises GDP to include underground activity," *International Herald Tribune*, September 2006.

Lazaretou, Sophia, "Greek Monetary Economics in Retrospect: The Adventures of the Drachma," Working Papers 02, Bank of Greece March 2003.

Panagiotidis, Theodore and Afrodit Triampella, "Central Bank Independence and Inflation: The case of Greece," Discussion Paper Series 2005:7, Department of Economics, Loughborough University July 2005.

Tavlas, George and Theodoros Papaspyrou, "Monetary Policy in Greece on the Road to EMU," Technical Report, Bank of Greece.

Taylor, John B., "Discretion versus policy rules in practice," in *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39, 1993, pp. 195-214.