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A REVISIT ON THE ROLE OF MACRO IMBALANCES IN THE US RECESSION OF 2007-2009: A FREQUENCY DOMAIN APPROACH

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ABSTRACT

This paper revisits Paul's (2010) and Tiwari and Pandey's (2013) results and finds new evidence regarding the role of macro imbalances in the US recession of 2007-2009, starting from mentioned authors' works. Using Paul's (2010) dataset, our results are obtained based on Breitung and Candelon's (2006) approach of Granger-causality in the frequency domain. The main findings reveal that growth in the fiscal deficit and the trade deficit influences each other, thus increasing the twin deficits. This pair generates a low interest rate and private saving. At the same time, the low level of interest rate reduces the level of private saving, having great contribution to the housing bubble. Neither fiscal deficit nor trade deficit has a direct impact on GDP.

Keywords: Macro imbalance, Recession, Causality, Frequency domain, USA

JEL Classification: H62, P33, E43, O16, G01, C53

Introduction

The US recession of 2007-2009 is the most important event of the last decades, with strong global economic implications also. By complexity of implications and magnitude, the causes and effects of US recession generates strong debates among researchers and policymakers. Most of these specialists have focused their attention, with predilection, on the causes of this recession.

In this direction, an important work belongs to Paul (2010). He investigates the US recession, using a vector Autoregressive (VAR) approach, with a sample covering the period 1987Q3 to 2009Q4. The considered variables are Fed rates, savings rates, fiscal deficits, trade deficits, and GDP growth. The main outputs show that the trade deficits and fiscal deficits have generated the lower interest rate and declining output during 1987-2009. Further, this lower interest rate caused a decrease in the level of saving, which contributed to the housing bubble. Concluding, the author states that low saving and twin deficits have caused the recession. Paul's (2010) study has its starting point in the investigations of Taylor (2008, 2009), Gjerstad and Smith (2009), Holt (2009), and Jones (2010).

Few years after, Tiwari and Pandey (2013) show that the approach of Paul (2010), based on VAR model, could produce biased outputs in the presence of nonlinearity in the series. As a consequence, the authors revisit Paul's (2010) conclusions by using the nonlinear Granger causality tool a la Hiemstra and Jones (1994), which is an improvement over Baek and Brock (1992). Compared to the Paul's (2010) findings, Tiwari and Pandey (2013) don't obtain any evidence for the twin deficits hypothesis. On the other hand, they stress that it is the fiscal deficit which was the main reason for macro imbalances in the US recession of 2007-2009 and "it is not the low interest rate which caused low savings but it is low rate of savings which caused the low rate of interest rate which caused boom" (Tiwari and Pandey 2013: 2328).

Our exploration revisits the Paul (2010) and Tiwari and Pandey's (2013) results and finds new evidence regarding the role of macro imbalances in the US recession of 2007-2009, starting from mentioned authors' works. Using the Paul's (2010) dataset, our results are obtained based on Breitung and Candelon's (2006) approach of Granger-causality in the frequency domain. The main findings reveal that the fiscal deficit and trade deficit influence each other, increasing the twin deficits. This pair generates a low interest rate and private saving. At the same time, the low level of interest rate reduces the level of private saving, having great contribution to the housing bubble. Nor fiscal deficit neither trade deficit has a direct impact on GDP.

These results partially confirm the findings of Paul (2010) and Tiwari and Pandey (2013) but offer some new insights by providing the evidence of cyclical effects of one variable on another. These differences come from the methods used in the investigations. Paul (2010) performs VAR models, while Tiwari and Pandey (2013) choose the nonlinear Granger causality a la Hiemstra and Jones (1994).

Our approach extends the literature in the field related to the role of macro imbalances in the US recession of 2007-2009, following the Breitung and Candelon's (2006) tool, a more refined approach of Granger-causality, in the frequency domain. Unlike classical causality à la Granger (1969), this tool can be applied across all periodicities generating results in the short run, over the business-cycle frequencies, and in the long run. In this way, it can exactly reveal for which periodicity one variable can Granger-cause the other. Unfortunately, the popular Granger-causality test (developed either in linear or nonlinear framework) falls to show. Therefore, the persistence of the interaction between two variables is also showed by evidencing their main turning points at different ranges of frequency.

This approach has been used in quite a few studies, its scope being limited to studies in the area of monetary policy and stock market. In this context, we can mention the contributions of Assenmacher-Wesche and Gerlach (2007), Assenmacher-Wesche and Gerlach (2008a,b), Assenmacher-Wesche et al. (2008), Lemmens et al. (2008), Gronwald (2009) and António (2010). To the best of our knowledge this is the first study in the area of public finance that applies such an innovative approach. The method assumes that the additional variable is able to forecast the low frequency component of the variable of interest one period ahead. The rest of the paper is organized as follows: Section 2 describes the methodology, while Section 3 presents the data and empirical findings. Section 4 concludes.

Methodology: Causality Test in Frequency Domain

Granger (1969) test proposal reveals whether a variable *X* causes another one *Y* by identifying how much of the current *Y* can be explained by the past values of *Y*. Further, it is analysed how the adding lagged values of *X* generate more accuracy in explanation. In other words, the variable *Y* Granger-causes *X* when *X* can be used to predict Y or related coefficients of lagged *X*'s are significant. On the other hand, Granger and Lin (1995) note that the direction of causality differs across frequency bands. Lemmens et al. (2008) claim that the stationary series can be decomposed by frequency as they register uncorrelated components with a single frequency ordinate. Unfortunately, the classical tool developed by Granger (1969)

completely neglect the possibility that strength and/or direction of causality can vary over different frequencies.

Breitung and Candelon's (2006) seems that fixed this issue by developing a new approach of Granger-causality but in the frequency domain.[1] Based on Granger's (1969) contribution, they consider the causality as a spectral interdependence between two decomposed series representing a sum of "instantaneous", "feedforward" and "feedback" causality terms.

Breitung and Candelon (2006) reconstructed the connection between *x* and *y* in Vector Autoregressive (VAR) equation as follows:

$$x_t = a_1 x_{t-1} + \ldots + a_p x_{t-p} + \beta_1 y_{t-1} + \ldots + \beta_p y_{t-p} + \varepsilon_{1t} \quad (1)$$

Now, the null hypothesis of Geweke, $M_{y \to x}(\omega) = 0$, corresponds to the null hypothesis of

$$H_0: R(\omega)\beta = 0 \quad (2)$$

where β represents the vector of the coefficients *y* and

$$R(\omega) = \begin{bmatrix} cos(\omega)\, cos(2\omega) \ldots . cos(p\omega) \\ sin(\omega)\, sin(2\omega) \ldots \ldots . sin(p\omega) \end{bmatrix} \quad (3)$$

The F statistic in the case of relation (3) is approximately distributed as $F(2, T - 2p)$ for $\omega \in (0, \pi)$, as Breitung and Candelon (2006) emphasise.

On the other hand, the authors claim that the "causality at low frequencies implies that the additional variable is able to forecast the low frequency component of the variable of interest one period ahead." (p. 376).

Data and Empirical Findings

The dataset used in this investigation is the Paul's (2010) sample,[2] covering the period 1987Q3 to 2009Q4. The considered variables are Fed rates, savings rates, fiscal deficits, trade deficits, and GDP growth. The Fed rates or interest rates (FR) and private savings rates (Saving) in percentages are taken from the Federal

[1] In statistics, frequency domain uses mathematical functions or signals with respect to frequency, rather than time.

[2] We are thankful for Prof. Paul for sharing the data, which he used in the analysis in his paper. Data source for related variables can be found in his paper.

Reserve (2010) and Bureau of Economic Analysis (2010), while the GDP, trade deficits (TD), and fiscal deficits (FD), expressed in 2005 constant prices, are offered by Bureau of Economic Analysis (2010). Further, GDP is deflated and transformed in growth rates, having percentage final form.

Inspiring from Hürtgen and Rühmkorf (2014) and Gaysset et al. (2018), the evolutions of GDP growth rate, Fed and saving rates, and twin deficits are presented in Figures 1-3 in Appendix. It is clear that the opposite evolutions of Fed vs. saving rates, and fiscal vs. trade deficits, coexist with sinusoidal evolution of GDP growth rate.

Results of correlation and descriptive statistics are presented in the Table 1, in Appendix, matching the results of Paul (2010).

The study begins with the tests of stationarity. We find that all the variables under analysis are integrated of order one (i.e., $I(1)$). Therefore, for analysis of Granger-causality in the frequency domain, we transformed data into the first difference form, which makes the variables stationary and gives efficient results. We reported results of frequency domain Granger-causality analysis in Figure 4 to Figure 12. These figures report the test statistics, along with their 5% critical values (broken lines) for all frequencies (ω) (which are expressed as fraction of π) in the interval $(0, \pi)$. The frequency, (ω), on the horizontal axis can be translated into a cycle or periodicity of T months by $T = 2\pi/\omega$ where T is the period.[3] Note that since high frequencies are having short periods and vice versa, figures of Granger-causality at frequency domain stand reversed, with short-term fluctuations/cycles at the right end and long-term movements/cycles at the left. Noteworthy to mention that as all variables are in the first difference form therefore, they should be interpreted in terms of growth rates. However, for ease of writing we report them as original level form.

First, the short-and long-run of Granger-causality from FR to FD is reported in Figure 4, in Appendix. The result shows that FR Granger-causes FD at short to medium frequency level, for frequencies belong to interval (0, 1.8). FR is able to forecast FD at frequencies corresponding to the very long run to 3.5 months cycle. In the same time, Figure 5, in Appendix, shows that TD Granger-causes FD at short-frequency level. The null hypothesis of no predictability is rejected at 5% level of significance for frequencies in the range of $\omega \in (0, 1)$. In this case, the

[3] The frequency,ω, of a cycle is related to its period, T, measured in number of observations, by the formula $T = 2\pi/\omega$; π takes its usual value i.e., $\pi = 22/7$. Thus a frequency of $\pi/4$ corresponds to a period of 8 observations, or 2 years given the quarterly observations and 8 months for monthly observation.

TD forecasts FD at frequencies corresponding to the very long-run to 6 months cycle. The next output, illustrates in Figure 6, in Appendix, denotes the causality from FD to FR. The null hypothesis of no predictability is not rejected at 5% level of significance for frequencies in the intervals (0, 0.9) and (1.4, π). Thus, FD is able to forecast FR only for frequencies belong to interval (0.9, 1.4), which correspond to 7 months and 4.5 months cycle, respectively. The result of the short- and long-run Granger-causality from TD to FR is reported in Figure 7, in Appendix. TD Granger-causes FR at short-frequency level i.e., in the frequencies range of $\omega \in (0, 1.1)$ corresponding to the very long run to 6 months cycle.

In two cases there is not any Granger-causality, as Figures 8 and 9 illustrate: FD and TD does not Granger-cause GDP, both at the short-and high-frequency level. The null hypothesis of no predictability is not rejected at 5% level of significance for all frequencies in the interval (0, π).

Further, Figure 10 reveals the evidence of Granger-causality from FD to saving. The null hypothesis of no predictability is not rejected at 5% level of significance for frequencies in the intervals (0, 0.2) corresponding to the very long run to 31 months cycle, and (1.5, 2.1) corresponding to the 4 to 3 months cycle. Figure 11, in Appendix, indicates that TD Granger-causes Saving at short-frequency level, for frequencies belong to interval (0, 0.9) that corresponds to the very long run to 7 months cycle.

Finally, the last result is presented in Figure 12, in Appendix. In this case, FD Granger-causes TD at short to medium frequency level, i.e., in the range of $\omega \in (0, 2.8)$. In other words, FD is able to forecast TD at frequencies corresponding to very long run to 2 months cycle.

Concluding Remarks

The US recession of 2007-2009 has generated a strong debate among researchers in the last years. This investigation finds new evidences regarding the role of macro imbalances in the US recession of 2007-2009, starting from Paul (2010) and Tiwari and Pandey (2013) works. Using Paul's (2010) dataset, our results are obtained based on Breitung and Candelon's (2006) approach of Granger-causality in the frequency domain.

The main findings reveal that the growth in the fiscal deficit and the trade deficit influences each other particularly in the long run thus increasing the twin deficits over the long run. Further, we found that growth in the trade deficit is able to provide long-run forecast for the growth in the private savings. At the same time,

the low level of the growth in the interest rate reduces the level of the growth in the private saving, having great contribution to the housing bubble.

Another interesting output reveals that fiscal deficit and trade deficit do not have a direct impact on GDP. In the US, seems that the GDP is directly affected especially by twin deficits and saving, explaining in this mode its disturbance during the recession as result of financial crisis.

Our results partially confirm the findings of Paul (2010) and Tiwari and Pandey (2013), however, we provide the evidence of cyclical movement of the causal direction between the interest variables which is our major contribution.

If Paul (2010) reveals a strong direct influence of twin deficits on GDP, we don't find any evidence in this direction. At the opposite side, Tiwari and Pandey (2013) don't obtain any evidence for the twin deficits hypothesis. Moreover, the author noted that it is the growth in the fiscal deficit which was the main reason for macro imbalances in the US recession of 2007-09 and "it is not the low interest rate which caused low savings but it is low rate of savings which caused the low rate of interest rate which caused boom" (Tiwari and Pandey 2013: 2328).

These differences come from the methods used in the investigations. Paul (2010) performs VAR models, while Tiwari and Pandey (2013) select the nonlinear Granger causality *à la* Hiemstra and Jones (1994). Our approach follows the Breitung and Candelon's (2006) more refined approach of Granger-causality, in the frequency domain, which assumes that the additional variable is able to forecast the low frequency component of the variable of interest one period ahead.

Regarding policy implications, it is required for US policymakers to adjust the macroeconomic balances, especially controlling the fiscal and trade deficit. At the same time, a coherent policy of twin deficits and interest rate it is also required especially during the recession periods caused by financial crisis.

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Appendix

Figure 1: Twin deficits in US between 1987 and 2009 (deflated billions of chained 2005 dollars)

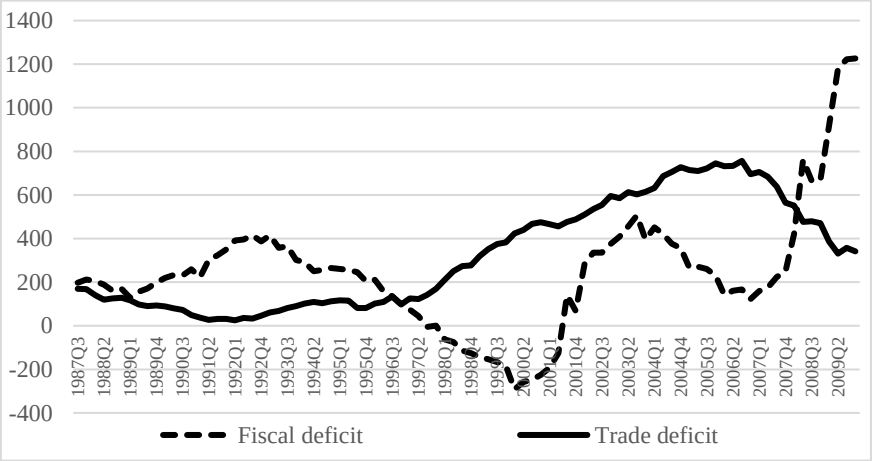


Figure 2: Fed and saving rates in US between 1987 and 2009 (percentages)

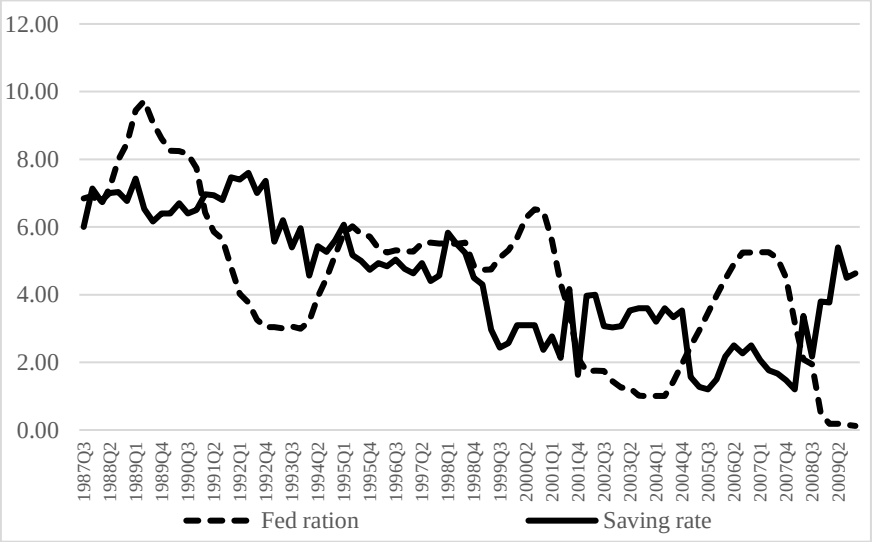


Figure 3: GDP grow rate US between 1987 and 2009 (percentage)

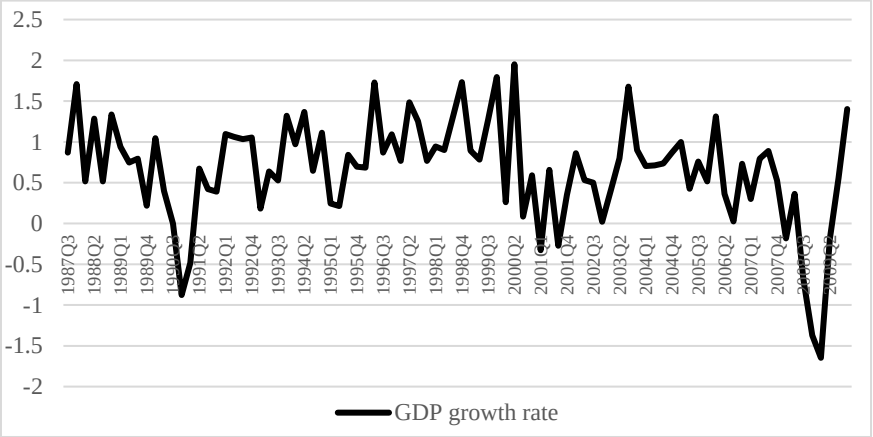
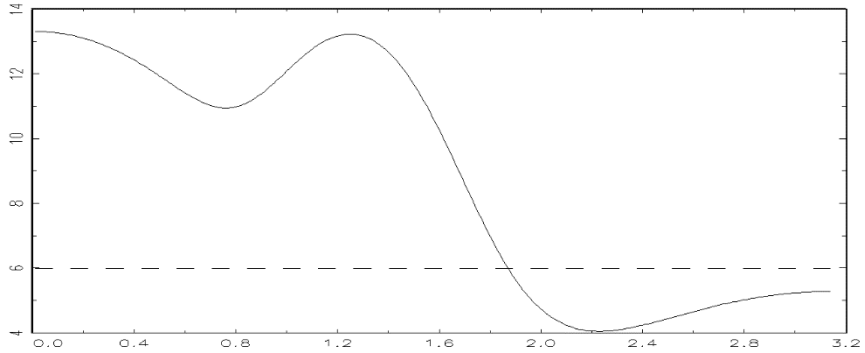


Table 1: The correlations and descriptive statistics of variables

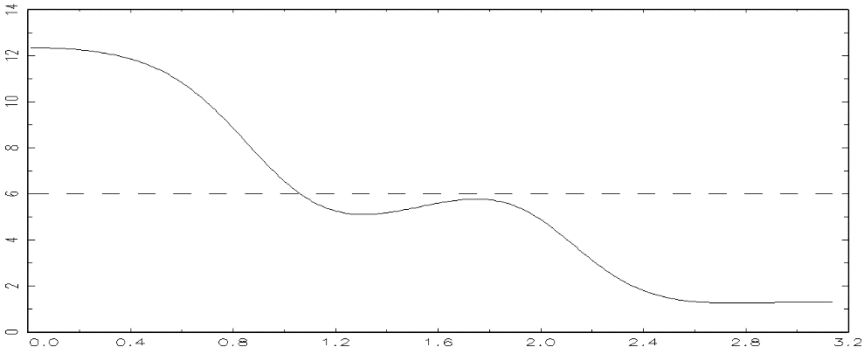
Correlation					
Variables	Fed Rate	Fiscal Deficit	GDP Growth	Saving Rate	Trade Deficit
Fed Rate	1				
Fiscal Deficit	-0.60902	1			
GDP Growth	0.16693287	-0.305938	1		
Saving Rate	0.42260866	0.1084869	0.12243425	1	
Trade Deficit	-0.49485590	0.04961205	-0.13000290	-0.87084829	1
Descriptive statistics					
Mean	4.499000	241.5109	0.663169	4.464819	324.6456
Median	4.990000	230.5815	0.732782	4.566700	274.8000
Maximum	9.730000	1226.422	1.951462	7.600000	756.4000
Minimum	0.120000	-291.6140	-1.647403	1.200000	24.90000
Std. Dev.	2.340018	284.6861	0.633128	1.842776	245.9741
Skewness	-0.010464	1.132413	-0.933979	-0.046723	0.362941
Kurtosis	2.433173	6.013619	5.057897	1.865499	1.608393
Jarque-Bera	1.206489	53.29251	28.96577	4.859343	9.238026
Probability	0.547034	0.000000	0.000001	0.088066	0.009863
Sum	404.9100	21735.98	59.68522	401.8337	29218.10
Sum Sq. Dev.	487.3358	7213108.	35.67576	302.2282	5384788.
Observations	90	90	90	90	90

Figure 4: $H_0: FR \xrightarrow{does\ \ not\ \ Granger-cause} FD$ (lag=4)



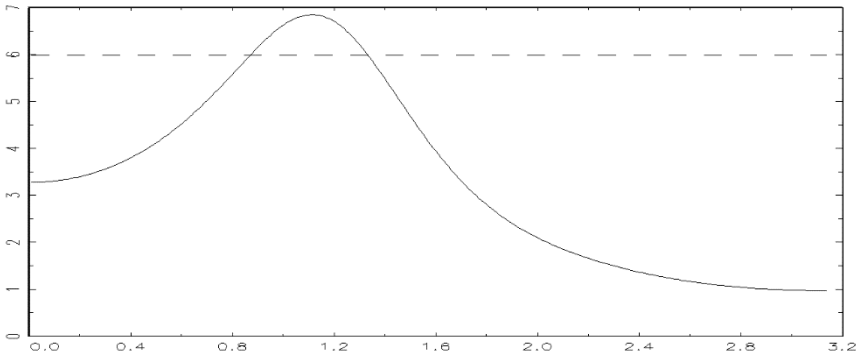
Frequency (ω) *= 2π/cycle length (T).*

Figure 5: $H_0: TD \xrightarrow{does\ \ not\ \ Granger-cause} FD$ (lag=4)



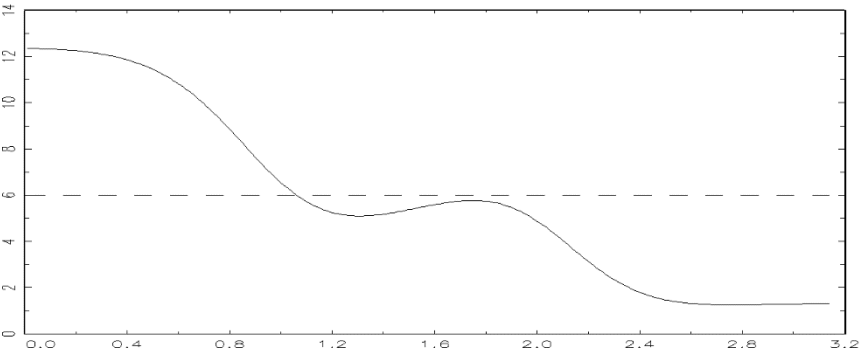
Frequency (ω) *= 2π/cycle length (T).*

Figure 6: $H_0: FD \xrightarrow{does\ \ not\ \ Granger-cause} FR$ (lag=4)



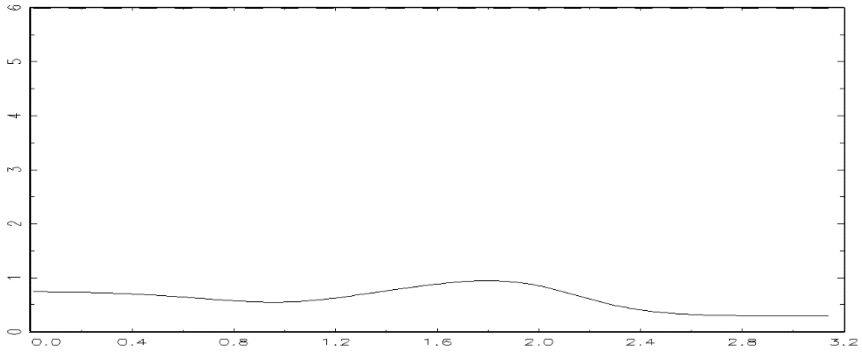
Frequency (ω) *= 2π/cycle length (T).*

Figure 7: $H_0: TD \xrightarrow{does\ \ not\ \ Granger-cause} FR$ (lag=4)



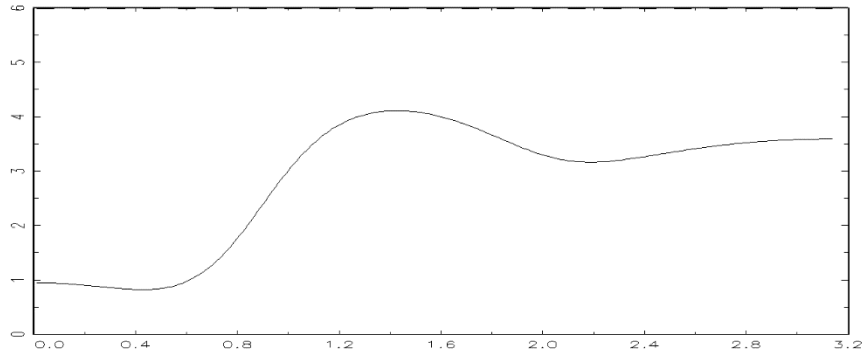
Frequency (ω) *= 2π/cycle length (T).*

Figure 8: $H_0: FD \xrightarrow{does\ \ not\ \ Granger-cause} GDP$ (lag=4)



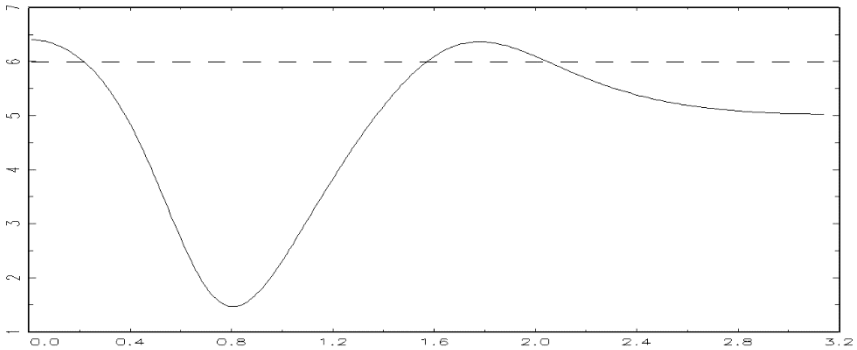
Frequency (ω) *= 2π/cycle length (T).*

Figure 9: $H_0: TD \xrightarrow{does\ \ not\ \ Granger-cause} GDP$ (lag=4)



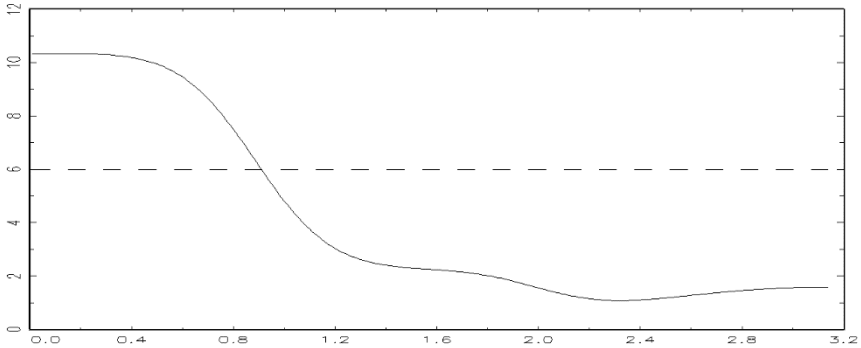
Frequency (ω) *= 2π/cycle length (T).*

Figure 10: $H_0: FR \xrightarrow{does\ \ not\ \ Granger-cause} Saving$ (lag=4)



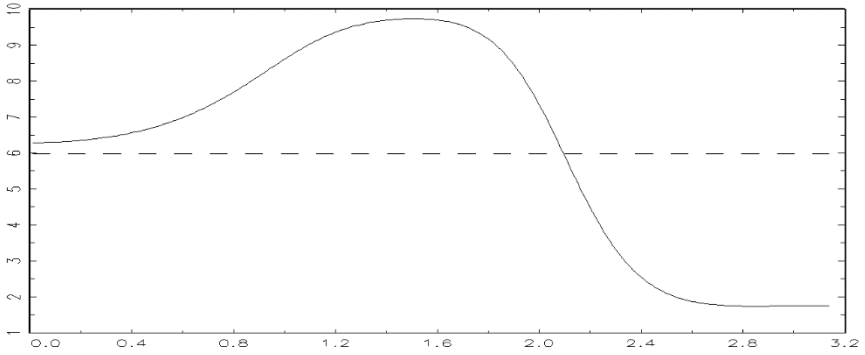
Frequency (ω) *= 2π/cycle length (T).*

Figure 11: $H_0: TD \xrightarrow{does\ \ not\ \ Granger-cause} Saving$ (lag=4)



Frequency (ω) *= 2π/cycle length (T).*

Figure 12: $H_0: FD \xrightarrow{does\ \ not\ \ Granger-cause} TD$ (lag=4)



Frequency (ω) *= 2π/cycle length (T).*

Note: The solid line shows the Granger-causality test statistics over frequencies. The horizontal broken line shows the 5% critical value. The horizontal axis shows the frequency ordinates as fractions of π and vertical axis shows calculated value of F statistic.