EVALUATING THE SUSTAINABILITY OF JAMAICA'S FISCAL DEBT POLICIES

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May 20, 2013

ABSTRACT

This paper ultimately aims to test the fiscal sustainability of Jamaica by analyzing how the government reacts to changes in its debt position. To accomplish this, the paper estimates a fiscal reaction function using the Ordinary Least Squares (OLS) method. The paper finds, that, despite rising debt ratios, there is empirical evidence that the public debt is sustainable. However, the paper also indicates that the government needs to take a more active approach in managing its debt position.

Keywords: Fiscal Sustainability, Fiscal reaction function, public debt, deficits

JEL No: C22, E62, H62, H63

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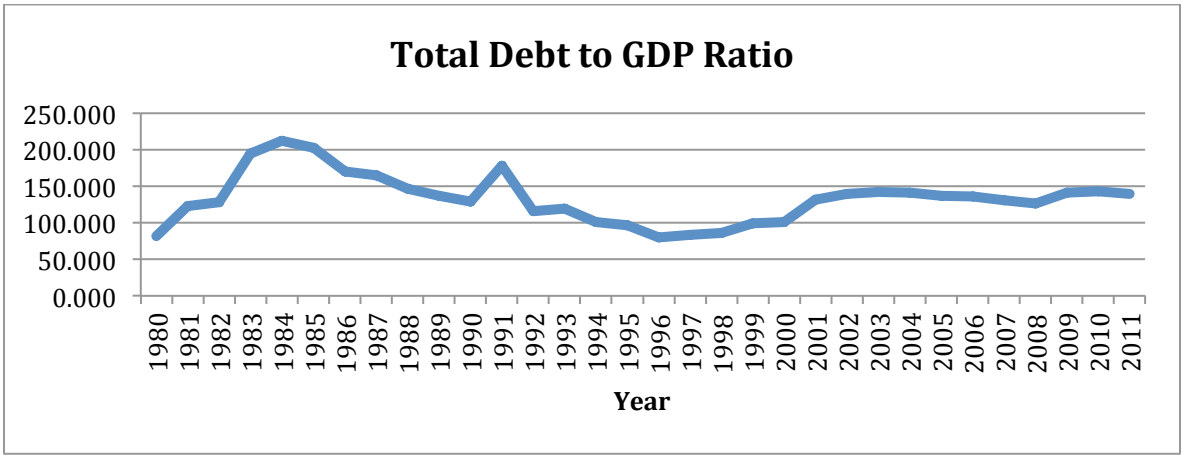
1 Introduction

Jamaica's debt sustainability has come to fore in the last decade as a major deterrent preventing the country from unlocking its growth potential. Jamaica is the fourth most indebted country in the world behind Lebanon, Japan and the Seychelles (King & Richards, 2008).[2]The country's high public debt burden has severely reduced the fiscal space for the economy to achieve sustained growth and development because of high debt servicing (Blavy, 2006). Hence, with an increasing debt to GDP ratio the crucial question is whether the debt is sustainable. Recent attempts have been made to control the debt – Jamaica Debt Exchange (JDX) and National Debt Exchange (NDX). Despite this, the structural problems that continue to persist indicate that we may follow the path of the Ukraine.

According to International Monetary Fund (IMF) estimates, the Jamaica's debt is currently estimated at 140 % of GDP. This enormous debt has placed a stranglehold on growth prospects for the country.

Figure 1: Total Public Debt to GDP Ratio, 1980-2011



[2] As measured either relative to GDP or population.

Moreover, the World Bank recognizes the 1996 financial crisis to be the starting point of the most recent major fiscal problems in the country. The fiscal situation is comprised of a large debt overhang, which in itself is considered a critical problem facing Jamaica.

Figure 1 above shows the evolution of the total public debt as a percent of GDP. Jamaica's public debt level climbed significantly between 1980 and 1984, reaching a high of 212% in 1984. Following a fall from the high of 1984 to about 129% in 1990, we again see a spike as public debt rose to 178% in 1991. Furthermore, since the period 1990 to 1996 where the total debt to GDP fell to a low of 80%, the debt to GDP ratio has been climbing and has reached a high of 140% in 2011. Of note, within the period 1996 to 2003 the debt to GDP almost doubled.

Figure 2*:* Primary Surplus to GDP Ratio, 1980-2011

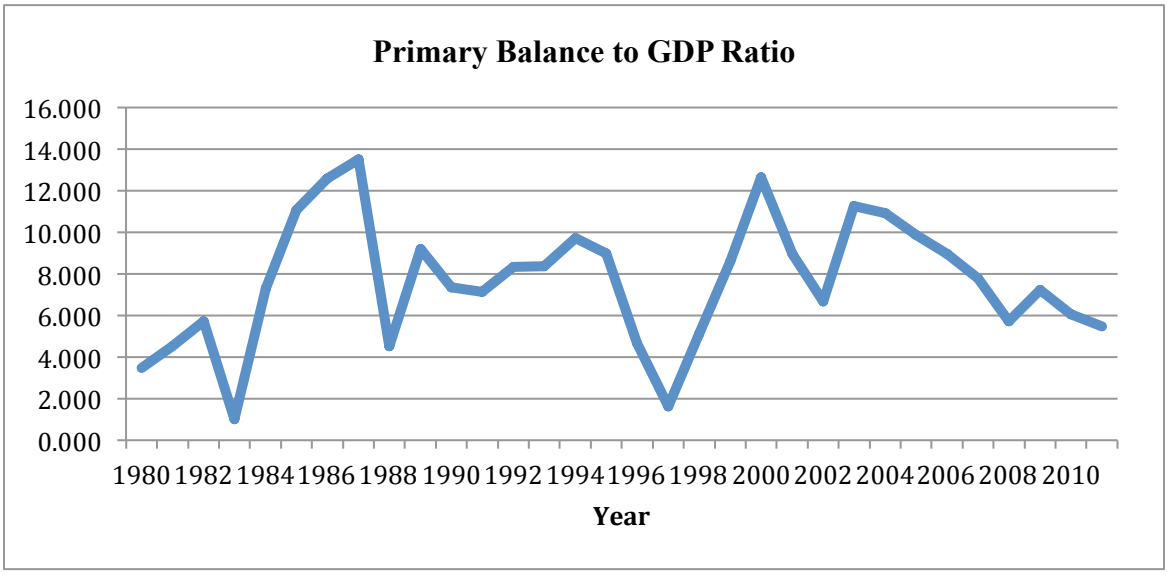


Figure 2 above shows the evolution of the primary balance to GDP ratio. Over the period 1980- 2011 primary surplus has remained positive. The years 1993 and 1996 registered the smallest figures of 1.006 and 1.626 respectively. The significantly low primary

balance in 1996 coincides with the recognized starting point of the country's fiscal problems by the World Bank.

The purpose of this paper is to assess the quantitative scale of the adjustment of the primary balance to the debt obligations of the country. The remainder of the paper is organized as follows section 2 provides a brief description of Jamaica's fiscal debt restructuring programmes while section 3 provides a literature review. Section 4 provides a description of the theoretical background. In section 5 the methodology employed is presented. Section 6 presents a description the data. In section 7 the results are presented and discussed. In section 9 the diagnostics of the model is presented. Finally, section 10 concludes and provides policy recommendations.

2 Bond Structuring Programmes

In an effort to recover from the high debt overhang in the context of gaining support from the IMF and other development agencies, the Jamaican government launched two bond restructuring programmes. The first bond restructuring programme was launched on January 14, 2010. It was introduced as a pre-condition to final negotiations on a Stand-By Agreement (SBA) with the IMF. The programme was successful in exchanging approximately $700 billion local fixed rate and USD denominated bonds with new bonds with extended maturities and reduced interest rates.[3] In addition, the programme did not include external debt and the amount of principal to be repaid was unchanged. This indicated that the focus of the exchange was on debt service rather than debt reduction.

[3] The IMF stipulated the JDX programme as a condition in order to provide Jamaica with US$ 1.2 billion in support from the other multilaterals amounting to another 1.2billion. (Scotia)

The IMF (2010) notes, that since the approval of the SBA and the completion of the debt exchange, financial market conditions have improved significantly. Market interest rates have fallen to levels not seen since the 1980s and the foreign exchange market has stabilized. Also, financial institutions have been able to absorb the lower-than-expected valuation and income losses from the debt exchange, and there have been no requests for access to the Financial System Support Fund. Despite these achievements, generally, economic activity remains weak. Montecino & Johnson (2011) found that even after the debt restructuring of 2010, Jamaica's economic and social progress has suffered considerably from the burden of an unsustainable debt.

Notwithstanding the successful participation of the JDX, Jamaica was not successful in fully implementing the IMF Stand-By Agreement. Consequently, the National Debt Exchange (NDX), another debt restructuring programme was launched on February 12, 2013. Again, the aim of the programme is the extension of the maturity profile on all domestic debt and also a reduction in coupon payments. The initiative is required to have full participation, a stipulation required by the IMF. The overall intention is to reduce the government's interest costs in order to bring the debt to more sustainable levels and to smoothen the maturity profile of the debt. This will assist the government in getting to the targeted debt to GDP level of 95% over the next seven years from its current level of 140%. (National Commercial Bank, 2013)

3 Literature Review

There exists a vast body of literature that has studied fiscal sustainability over the last two decades. It has been studied from both a theoretical and an empirical perspective. Afonso

(2005) defines fiscal sustainability in two ways. These are

1. The value of public current debt must be equal to the sum of future primary surpluses;
2. The present value of public debt must approach zero in infinity.

Bohn (1991) suggest that traditionally empirical studies have asserted that the path for government debt must satisfy a constraint of the form $\lim_{N\to\infty} \frac{1}{(1+r)^N} \cdot E_t[D_{t+N}] = 0$ to be considered sustainable.[4] He argues that such an approach has a theoretical and empirical flaw[5]. From an empirical perspective traditional sustainability tests explicitly or implicitly assume that the rate of return on government debt is on average above the rate of economic growth, a condition that does not hold for historical US data. As such, he derives and implements a new test for sustainability that does not rely on particular relation between interest rates and growth rates. This approach is the fiscal reaction function.

Adedji and Williams (2007) find that the current debt stock is one of the main factors that affect fiscal performance. They suggest that the connection between current policy actions and long-run solvency is based on the assumption that the primary balance systematically responds to previous changes in the public debt. They suggest that a government may fall in debt for numerous reasons. A government may resort to debt accumulation to improve human capital by spending on education and also to improve

[4] where r is the safe interest rate, D_{t+n} government debt at the start of period t+n and E_t the conditional expectation at time t (Bohn, 1991)

[5] "From a theoretical perspective, the question whether or not a transversality constraint has to hold is a general equilibrium issue. In asserting a constraint without providing a general equilibrium setting, one has to rely implicitly in some other body of theory that may or may not be appropriate for the empirical analysis." (Bohn, 1991)

physical capital by financing physical infrastructure improvement (Adedeji and Williams, 2007). However, they recognize that indebtedness poses risks such as high public debt, adverse impact on economic performance and debt crises.

Work in this area is of the utmost importance because of the harm that unsustainable fiscal policy can have on an economy. Buiter (2004) argues that unsustainable fiscal policy may result in lower public spending and higher tax revenues than planned for, high inflation rates, and default on public debt. Ultimately, this could weaken macroeconomic conditions and increase the exposure of economies to exogenous shocks. In addition, de Castro Fernandez and Hernandez de Cos (2000) argued that unsustainable fiscal policies involve a risk of future interest rate increases which leads to a slowdown in economic growth.

Stoian and Campeanu (2010) documents the development of the theory and empirical test used in determining fiscal sustainability in the literature. The seminal approach is based on the theory of the Intertemporal Budget Constraint (IBC) and the transversality condition. The theory suggests that fiscal policy is sustainable when governments can use primary surpluses to finance the initial public debt stock.

This builds on the seminal work of Hamilton and Flavin (1986) who base their work on the assumption that in the long run real interest rate and real growth rate are constant. Various other approaches have been adopted such as Wilcox (1989) who introduces variable interest rates and also allows negative discount rates.

Two classical methodological approaches to investigating fiscal sustainability are identified by Stoian and Campeanu (2010). Firstly, the unit root test as used in Hamilton

& Flavin (1986), Trehan and Walsh (1991). The unit root test was used to test for stationarity in the stock of public debt. Trehan and Walsh (1991) who in order to test empirically the absence of Ponzi games in the context of the government financing constraint proposed to test the stationarity of the first difference of the stock of public debt. Corsetti and Roubini (1991) and Uctum and Wicken (2000) used Dickey-Fuller Test for unit roots, Generalized Flood-Garber Test and Restricted Flood-Garber Test.

Secondly, co-integration test as used in Hakkio and Rush (1991), Afonso (2000) and Payne (1997). The empirical approach of analyzing the sustainability of fiscal policy through co-integration tests was developed by Hakkio and Rush (1991). The authors conclude that when there is no co-integration the fiscal deficit is not sustainable while when there is co-integration the deficit is sustainable. However, when government expenditures are growing faster than government revenues the deficit may not be sustainable.

Bohn (1998) first used the fiscal reaction function approach in answering the question of how governments react to the accumulation of debt. He found that the U.S. primary surplus is an increasing function of the debt-to-GDP ratio. He concludes that the positive response of the primary surplus to changes in debt also shows that U.S. fiscal policy is satisfying an intertemporal budget constraint.

Moreover, for South Africa, Burger, Stuart, Jooste and Alfredo (2011) used various methods to estimate fiscal reaction functions. These methods include Ordinary Least Squares (OLS), Vector Autoregression (VAR), General Method of Moments (GMM), and Vector Error- Correction (VECM). The variety of modeling techniques was used to

ensure robustness and explore various aspects of the data. [6]

They purport that "Fiscal reaction functions usually specify, for annual data, the reaction of the primary balance/GDP ratio to changes in the one-period lagged public debt/GDP ratio, controlling for other influences." The paper finds that since 1946 the South African government has run a sustainable fiscal policy, by reducing the primary deficit or increasing the surplus in response to rising debt.

Additionally, Stoian and Campeanu (2010) used a fiscal reaction function to analyze how the primary government balance in Central and Eastern European countries react in the short term, in order to assess fiscal sustainability in the long run. The fiscal reaction function model was estimated using a database consisting of quarterly data between 2000 and 2008. The results show that the governments of Bulgaria, Czech Republic, Estonia, Hungary, and Lithuania try to increase the primary surplus, or at least to lower the primary deficit, when public debt is increasing. This action makes fiscal sustainability easier to achieve in the long run. On the other hand, for Latvia, Poland, Romania, and Slovakia, sustainable fiscal policy is expected to become more difficult to attain given the opposite response of those governments to public debt shocks.

6

- The OLS is the standard approach used
- The VAR captures multiple interactions between the variables
- GMM estimations address the concern that the explanatory variables and the error term might be correlated due to non- linearity, measurement error or simultaneity
- A TAR model considers differentiated reactions of the primary balance/GDP ratio to positive and negative output gaps. State-Space modeling over the longest sample to investigate parameter changes.

Further supporting this contemporary view of analyzing fiscal sustainability the IMF (2003) along the lines of Bohn (1998) estimated fiscal policy reaction functions for emerging and industrial economies, with debt as an explanatory variable. A key finding is that primary surpluses respond to increasing debt levels, and that this response is stronger at high debt levels for industrial economies, whereas for emerging economies there is less response to an increasing debt ratio.

According to de Mello (2008) the main hypothesis to be tested when estimating a fiscal reaction function is that the government adjusts the primary budget balance in response to changes in indebtedness. In essence the goal is to determine the extent to which the debt dynamics are sustainable over time. He suggests that all levels of government react strongly to changes in indebtedness by adjusting their primary budget surplus targets.

Budina and Wijnbergen (2008) also criticize the seminal approach. They argue that academic literature that focused mainly on techniques to establish whether historical debt and deficit processes are characterized by unit roots such as the work of Hamilton and Flavin 1986 is backward looking. The backward perspective limits its usefulness after policy reform. To study fiscal sustainability in Turkey after the crisis in 2001 Budina and Wijnbergen (2008) combine a dynamic simulations approach as used in Burnside (2005) with a steady-state consistency approach introduced by Anand and van Wijnbergen (1988). They hoped to bring these approaches together in a user-friendly tool applicable in a data-sparse environment.

They suggest that "the tool is more policy oriented than most approaches by going beyond distributions of debt stocks to the evaluation of the full future distribution of the fiscal adjustment required to stabilize debt-output ratios (rdr). The fiscal sustainability

tool incorporates an endogenous debt feedback rule for the primary surplus, a fiscal policy reaction function." (Budina & Wijnbergen, 2008)

4 Theoretical Considerations

The beginning for the analysis of government finance is the period-by-period budget equation. The budget identity (1) shows that the stock of public debt at the start of period t +1 (B_{t+1}) develops from the previous period's debt B_t plus the financing requirement needed F_t.

$B_{t+1} = B_t + F_t$ (1)

Equation can be rewritten such that interest payments can be separated from other expenditures:

$B_{t+1} = (1+r_t)\, B_t - P_t$ (2)

Where P_t is the primary balance (surplus). To account for the effect of growth on borrowing capacity equation (2) can be written in terms of ratios to GDP.

$$\frac{B_{t+1}}{Y_{t+1}}\frac{Y_{t+1}}{Y_t} = (1+r)\frac{B_t}{Y_t} - \frac{P_t}{Y_t}$$

$(1+g)\, b_{t+1} = (1+r)\, b_t - p_t$ (3)

Where Y_t is the level of GDP, g is the nominal growth rate and r the real interest rate.

Furthermore, the primary balance that stabilizes the debt ratio (b_{t+1}) from (3) is given by $p_t = b_t\,(r-g)$ where r and g are measured in real terms. Since real interest rate is generally higher than real growth rate, the primary surplus consistent with a constant debt to GDP ratio increases with the initial debt stock and the difference between the real interest rate and the real growth rate.

In relation to Bohn (1998) the primary balance is used as the operational target in the fiscal reaction function:

$p_t = \delta Z_t + \beta b_{t-1} + \varepsilon_t$ (4)

Where: p_t = primary balance-to-GDP ratio (surplus/deficit) at time *t*; b_{t-1} = public debt-to-GDP ratio at time *t-1*; Z_t = set of explanatory variables at time *t*; *α, β, δ* = coefficients; εt = error terms (white noise). (Stoian & Campeanu, 2010)

From equation (3)

$$b_{t+1} - b_t = \left[1 - \left(\frac{1+r-\beta}{1+g}\right)\right] b_t - \frac{Z_t}{1+g} \quad (5)$$

Assuming Z_t is stationary the sign of the term in the square brackets determines whether debt ratio is mean reverting in the sense of converging towards some finite level pinned downed the average of Z_t. A positive sign implies mean reversion and will be observed if $r - \beta < g$. Hence p can be interpreted as the largest difference between the real interest rate and real growth that remains consistent with mean reverting ratio.

Looking closer at equation (3) it can be seem that the debt/GDP ratio depends on its own lag, the interest rate, the economic growth rate and the primary balance. Although, the debt/GDP may be stationary standard stationarity test may find it difficult to reject the null hypothesis of a unit root (Bohn, 1998).

Further considerations for Fiscal Sustainability (Forward Looking)

A government is said to follow a sustainable debt policy if the present value of the public debt converges to zero asymptotically and the no ponzi game condition holds. The evolution of public debt can described by a stochastic differential equation- (see, Fincke and Greiner, Kloeden and Platen, 1995: 76)

$dB_t = (r(t) - \beta(t))B_t + a_1(t)dW_t)$ (6) with W_t a Weiner process with $W_t \sim N(0,t)$, $t \geq 0$ and diffusion $a_1(t)$. Solving equation (6) and multiplying both sides by $e^{-\int_{t_0}^{t} r(\tau)dt}$ leads to

$$e^{-\int_{t_0}^{t} r(\tau)dt} B_t = e^{-\int_{t_0}^{t} \beta(\tau)dt} \left(B_{t_0} + \int_{t_0}^{t} e^{\int_{t_0}^{t} (\beta(\mu) - r(\mu)d\mu} a_1(\tau)W_\tau\right), (7)$$

with $B_{t_0} > 0$ public debt at time $t = t_0$ and sustainability $\lim_{t\to\infty} e^{-\int_{t_0}^{t} r(\tau)dt} B_t = 0$

Equation (7) shows that $\int_{t_0}^{t} \beta(\tau)d\tau$ must asymptotically converge to plus infinity so that the present value of public debt converges to zero. Hence, this implies that the reaction coefficient β must, on average, be positive for the path of public debt to be sustainable.

5 Methodology

The paper will use a Fiscal Reaction Function (FRF) which is a tool used to assess fiscal policy sustainability in the long run. The FRF allows one to test a government's response to changes in public debt. An increasing public debt-to-GDP ratio is expected to generate an immediate fiscal policy reaction consisting in an improvement of the primary balance (a lower deficit or a higher surplus). It is considered a backward-looking model based on historical data that indicates whether governments had the ability in the past to run higher surpluses, or at least to lower the primary deficit, when public debt increased (Stoian & Campeanu, 2010).

If governments were able to generate primary surpluses in the past, and fiscal policy was flexible enough to respond to increasing public debt, then future higher surpluses assessed as meeting the constraints imposed by the Intertemporal Budget Constraint (IBC) in the long run will not create difficulties and fiscal sustainability will be easier to achieve. Conversely, if the FRF shows that the government reacted in the opposite way and lowered surpluses when public debt increased, then, in the future it will be difficult to meet the IBC constraints and fiscal sustainability will be difficult to achieve in the long run (Stoian & Campeanu, 2010).

Once the primary surplus responds positively to an increase in debt, then the government's fiscal reaction function can be viewed as sustainable, providing the no

ponzi game condition holds. For simplicity, this examines whether $\beta > 0$ in equation (4). (Stoian & Campeanu, 2010)

From equation (4) the explanatory variable Z_t , the set of other determinants of the primary surplus is crucial to the analysis, Bohn (1998) uses the level of temporary government spending (GVAR) and a cycle indicator (YVAR) based on Barros (1979) tax-smoothing model. He compares regressions with and without GVAR and YVAR to demonstrate the importance of their inclusion in the regression model. He concludes that including these variables adjust the model for cyclical factors and fluctuations in government spending. The inclusion of the set of explanatory variables is a reoccurring theme throughout the literature. Various literature try to incorporate explanatory variables that best capture the evolution of the debt to GDP and primary surplus to GDP ratios.

In this sense, Bohn (2005) used the squared debt-to-GDP. De Mello (2005) used the lagged primary balance, indebtedness, and inflation, while also allowing for institutional variables that took into account the impact of different fiscal laws. Kirchgaessner and Prohl (2006) added as explanatory variables expected inflation and temporary fluctuations in government military expenditure. Also, IMF (2003) estimated the fiscal reaction function for industrial and emerging countries using the primary balance as a dependent variable. This study represented an extension of Bohn's (1998) paper and showed that a response of the primary balance to public debt shocks indicates "the consistency of fiscal policy with long-run solvency" (IMF, 2003, p. 127).

The specific fiscal reaction function will take the form of:

$$p_t = \beta b_{t-1} + \delta_1 ygap_{t-1} + \delta_2 gvar_t + \delta_3 p_{t-1} + \varepsilon_t \qquad (8)$$

It is assumed that the lagged debt ratio b_{t-1} affects the primary surplus ratio, in order to take account of causality. The variable $ygap_{t-1}$ gives the deviation of real GDP from its trend and was computed using the Hodrick-Prescott filter. Positive values for $ygap_{t-1}$ indicate booms and negative values indicate recessions. It captures the impact of the business cycle on the budget. To capture inertia in government behavior a lagged value of the primary surplus is added as an explanatory variable. If the current disturbance is unrelated to the lagged primary surplus, then the standard results concerning the consistency of the ordinary least-squares regression procedure retain their validity.[7] The variable gvar gives the deviation of real public spending from its normal value. Positive values indicate expenditures above the normal level and vice versa. It was computed using the Hodrick- Prescott filter.

As a second test for fiscal sustainability, the paper will test for stationarity of the public deficit including interest payment. This test was proposed by Trehan and Walsh (1991). However, the use of this test for this paper is inspired by Fincke and Greiner (2010). The authors suggest that a positive response of the primary surplus may not be sufficient to conclude sustainability because it does not ensure that the debt to GDP ratio remains bounded.[8]

6 Description of Data

The data used in this paper were obtained from varied sources. Total Debt Stock was obtained from Economic and Social Survey Jamaica (ESSJ) series (1980-2007) and the IMF (2007-2011). GDP and Primary Balance (1980-2011) were obtained from the Ministry of Finance and Planning. Also, real interest rate and real growth rate was

[7] This potential problem will be analyzed in section 9.

[8] The likelihood of this is greater for countries with a positive trend in the debt to GDP ratio

obtained from the World Bank.

The ratios primary balance to GDP and Total debt stock to GDP were calculated by simple division. The output gap was constructed with the Hodrick-Prescott filter where real GDP, which was obtained from the IMF was used (See Table 1 below for Descriptive Statistics).

Table 1: Descriptive Statistics

	p_t	b_t	ygap	gvar	Real interest rate %	Real growth rate
Mean	7.6338	133.0823	-.0001321	-7.38e-09	6.38843	1.6791
Minimum	1.006	79.6	-.03701	-11.6503	-12.79	-3.993
Maximum	13.506	212.4	.04285	14.8545	20.29	7.7
Standard Deviation	3.0419	33.7562	.01488	4.8681	8.0057	2.63897

Observations: 32

Using a correlation matrix, p_t shows a positive correlation with b_t and p_{t-1} (the lag of itself). However, it is negatively correlated with $ygap_t$ and $gvar_t$. The variable b_t displays a negative correlation with gvar and a positive correlation with ygap and p_{t-1}. The variable $ygap_t$ is positively correlated with gvar and p_{t-1}. All correlations are low which suggests that multi-collinearity may not be a problem (See Table A1, Appendix A).

Scatter plots of the primary surplus (b_t) against all the independent variables were constructed. The scatter plots confirm the results from the correlation matrix (See Figures 3-6, Appendix B).

In addition, time plots of all variables were also constructed. They indicate that the variables maybe stationary at levels as the variables do not seem to be increasing over time. (See Figures 7-10, Appendix C). To corroborate the analysis correlogram tests on each variable was done (See Figure 11-14, Appendix C).

Stationarity of Data

Bohn (1998) suggests that if debt and the primary surplus are both non-stationary while Z_t and the error term is stationary then one could interpret a simple regression of p_t on b_t as a cointegrating regression. However, he argues that if primary surplus to income and debt to income are stationary then a regression of primary surplus to income on debt to income that omits other determinants of the primary surplus will produce inconsistent results because of omitted variables bias.

Having illustrated the possible issues that standard stationarity test may have on the stationarity of the debt/GDP, the paper uses Augmented Dickey-Fuller, Phillips-Perron and KPSS test for unit root for robustness. The table below shows the order of integration of each variable based on the overall results of the three tests. All variables are I (0) at the 5% level. Furthermore, the model is not affected by the possible misspecification of the standard unit root tests.

Table 2: Order of integration of all variables

Variables	Specification	ADF test-statistic (p-value)	KPSS Test test-statistic	PP Test test-statistic	Order of Integration
p_t	Levels	-3.519*** (0.0007)	0.0745 Lag 3	-3.419 $^{\#\#}$ (0.0103)	I (0)
b_{t-1}	Levels	-3.587*** (0.0017)	0.106 Lag 4	-2.669 $^{\#}$ (0.0796)	I (0)
$ygap_{t-1}$	Levels	-5.287 *** (0.0000)	0.072 Lag 5	-5.443$^{\#\#\#}$ (0.0000)	I (0)
Gvar	Levels	-4.179 *** (0.0007)	0.188 Lag 9	-4.023$^{\#\#\#}$ (0.0013)	I (0)

ADF test critical t values (1 percent, 5 percent and 10 percent) (indicated by ***; ** and *)

KPSS critical values (1 percent, 5 percent and 10 percent) (indicated by $^{+++}$; $^{++}$ and $^{+}$).

PP critical values (1 percent, 5 percent and 10 percent) (indicated by $^{\#\#\#}$; $^{\#\#}$ and $^{\#}$)

7 Discussion of Results

Table 3: Regression results
(Dependent variable: primary surplus, percent of GDP)

	Coefficients	Stand. Error	t-stat	Pr (>t)
b_{t-1}	0.02308	0.01205	1.92	0.066
$ygap_t$	-74.3467	28.5581	-2.60	0.015
$gvar_t$	-0.1479	0.08596	-1.72	0.097
p_{t-1}	0.3801	0.1362	2.79	0.010
Constant	1.7632	1.7607	1.000	0.326
R^2 (adj): 0.4662	DW: 1.9057			

The symbols *, **, and *** indicate that the estimated coefficient is significantly different from zero at the 10, 5, and 1 percent level, respectively.

Estimates of the fiscal reaction function are in the table above. All regressions use Ordinary Least Squares (OLS). As shown in table 3 above, the average of the coefficient for the public debt ratio b_{t-1} is positive and significant at the 10% level. The variables $ygap_{t-1}$ and $gvar_t$ enter negatively with $ygap_{t-1}$ being significant at the 5% level while $gvar_t$ is only significant at the 10% level. The lag of primary surplus p_{t-1} has a positive sign and is significant at the 1% level. Furthermore, the goodness of fit is given by R^2 (adj) = 0.4662 and the Durbin-Watson test statistic of 1.91 does not indicate correlation of the residuals. (See section 9 for more tests)

Bohn's Test for mean reverting debt ratio

From (3) we established that mean reversion on the debt ratio occurs if r - β < g. Let $\bar{r}$ denote the average real interest % (Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator) and let $\bar{g}$ denote the average real growth rate. The average real interest rate was 6.39% while the average GDP-growth was 1.68%.

Using the regression coefficient β, which equals 0.0231

We have: 0.0639 - 0.0231 = 0.0408 > 0.0168. Hence, the β is not large enough to be consistent with a mean reverting debt ratio. The results imply that despite the positive reaction of the primary surplus the debt may not be fiscally sustainable.

Trehan and Walsh Test

Using the test for fiscal sustainability proposed Trehan and Walsh (1991), the paper test empirically for the absence of Ponzi games in the context of the government financing constraint by conducting stationarity test on the first difference of the stock of public debt (inclusive of interest payment).

Total government deficit was found to be stationary since the absolute value of the test statistic 5.932 was greater than all the Dickey Fuller critical values. Hence public debt can be considered sustainable. This holds because the present value of public debt asymptotically converges to zero when public debt rises linearly since it is discounted with an exponential factor. (See Figure 15, Appendix D)

9 Diagnostics Test for Linear Regression

Checking for Non-Linearity

Plots of the standardized residuals against each of the predictor variables in the regression model were constructed. The residual versus predictor variable plots do not indicate a clear departure from linearity and as such there doesn't seem to be a problem of non-linearity (See Figures 16-19, Appendix E). Additionally, augmented component-plus-residual plots against each independent variable where constructed. The smoothed lines for all plots are very close to the ordinary regression line, and the entire pattern seems pretty uniform. Overall, non-linearity does not seem to be a concern. However, a few outliers do create some deviation of the smoothed lines (See Figures 20-23 Appendix F).

Test for Endogeneity

To test for a potential issue with endogeneity, the paper analyzes the plots of the standardized residuals against each independent variable to see if the independent variable may be correlated with the error term in the model (See Figures 16-19, Appendix E). The plots show no clear relationship between the residuals and the independent variables. In addition, a correlation matrix of the residuals and all the independent variable shows that the residuals show no correlation with the independent variables (See Table E2, Appendix E). The residual plots and the correlation matrix shows no clear indication that the residuals are correlated with the independent variables. Therefore, endogeneity does not seem to be an issue.

Checking Homoscedasticity of Residuals

Based on the plot of residuals versus fitted (predicted) values the model is well-fitted (See Figure 24, in Appendix G). There is no clear pattern to the residuals plotted against the fitted values. Furthermore, the white test and Breusch-Pagan / Cook-Weisberg test was also done. Both test show large p-value of 0.9473 and 0.8407 respectively. Therefore, the null hypothesis that the variance is homogeneous cannot be rejected (See Figure 25, Appendix G).

Checking for Multicollinearity

All variables VIF values are less than 10. Also the degree of collinearity of all variables are lower than 0.1 (See Table 5, Appendix G).

Checking for no serial correlation

The Durbin Watson d-statistic is 1.91 and indicates there is no statistical evidence of possible serial correlation. Also, the Durbin Watson alternative test and The Breusch-

Godfrey LM test for autocorrelation were used and had p-values of 0.8912 and 0.8789 respectively and thus failed to reject the null of no serial correlation. Hence, the paper concludes that model does not suffer from autocorrelation (See Figure 26, Appendix G).

Model Specification

The Ramsey Regression Equation Specification Error Test (RESET) shows that we could not reject null that the model has no omitted variables (See Figure 27, Appendix G). The Specification linktest also supports the model specification. The variable _hatsq created by the linktest was highly insignificant and therefore indicates that the model is well specified [9] (See Figure 28, Appendix G).

Checking Normality of Residuals

To check for the normality of residuals a kernel density plot, standardized normal probability plot and Quantiles of residuals against quantiles of normal distribution are constructed. The kernel density plot with the normal density overlaid shows the residual is close to a normal distribution (See Figure 29, Appendix H). Moreover, the standardized normal probability plot is sensitive to non-normality in the middle range of data. It indicates a slight deviation within the middle range (See Figure 30, Appendix H). The Quantiles of residuals against quantiles of normal distribution is sensitive to non-normality near the tails. The plot shows no clear deviation in the tail. Consequently, from a graphical perspective it can be accepted that the residuals are close to a normal distribution (See Figure 31, Appendix H). Also, the Shapiro-Wilk normality test, which is based on the assumption that the distribution is normal, had a p-value of 0.5171. This

[9] The linktest creates two new variables, the variable of prediction, _hat, and the variable of squared prediction, _hatsq. The model is then refit using these two variables as predictors. _hat should be significant since it is the predicted value. On the contrary, _hatsq should not be significant because if the model is specified correctly, the squared predictions should not have much explanatory power.

high p-value indicates that the residuals are normally distributed since the assumption cannot be rejected (See Figure 32, Appendix H).

10 Conclusion

This paper studies the issue of fiscal policy sustainability in Jamaica. It estimates a fiscal reaction function in collaboration with a unit root test to empirically analyze the sustainability of Jamaica's debt policies. The analysis shows whether the inter-temporal budget constraint holds and solvency is given. The debt situation in Jamaica seems to be stable since the estimated reaction coefficient of the public debt to GDP (lagged) ratio is positive on average and the budget deficit (including interest payments) is stationary. However, the estimated reaction coefficient is only statistically significant at the 10% level and suggests that the coefficient should be considered with caution. In addition, it suggests that the governments should put more emphasis on stabilizing public debt. The government exhibits inertia in its behavior and needs to be more proactive in managing its response to its debt. Also, the debt to GDP ratio was not found to be mean reverting based on Bohn (1998) test. This suggests that despite the positive corrective measures of the government, in the event of shocks, fiscal policy response would not be sufficiently strong to bring the debt ratio gradually back to its initial level.

In regards to limitations of the study the political and social feasibility of the results of the estimated coefficient must be considered. These factors may restrict the likelihood that the necessary response of the government can be achieved. Also, the primary surplus to GDP contains an upper bound as the government will not be able to increase government revenue at will, or decrease expenditure to react to particularly high values of the debt to GDP. Therefore, the levels at which the government can feasibly react is

essential in determining fiscal sustainability. Another limitation is that the tests used do not give an all-encompassing analysis of Jamaica's situation. As such, despite the fact that the test provides meaningful insights into the fiscal situation more aspects of the fiscal situation should be considered.

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Appendix A

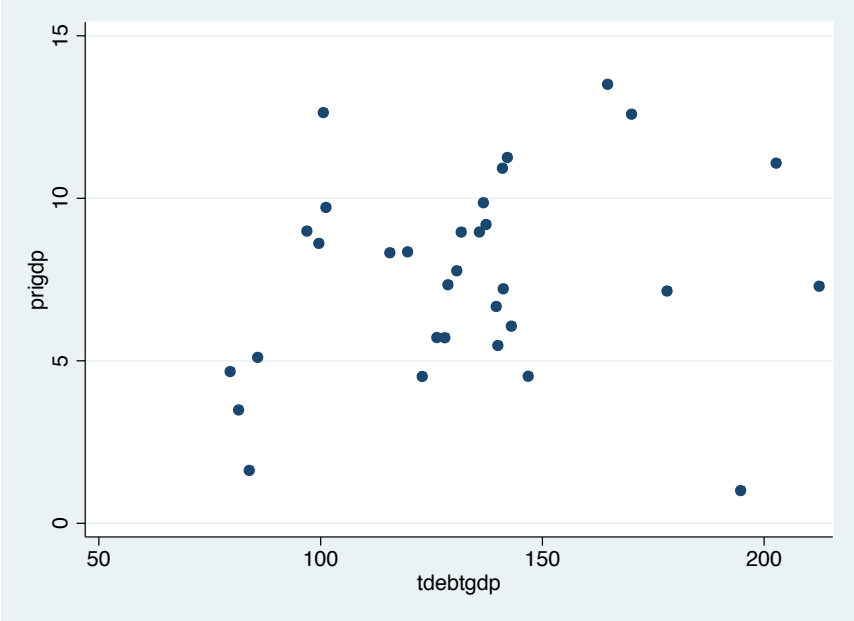
Table A1: Correlation Matrix

	p_t	b_t	$ygap_t$	$gvar_t$	p_{t-1}
p_t	1.0000				
b_t	0.1466	1.0000			
$ygap_t$	-0.4180	0.0114	1.0000		
$gvar_t$	-0.4358	-0.1380	0.2948	1.0000	
p_{t-1}	0.4355	0.0113	0.1126	-0.1305	1.0000

Appendix B

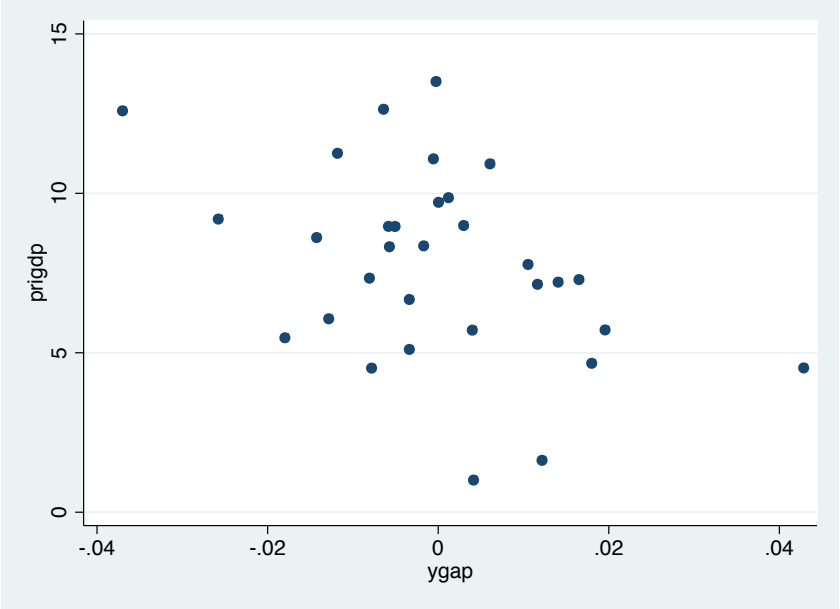
Scatter Plots

Figure 3: Primary Surplus/GDP against public debt stock/GDP



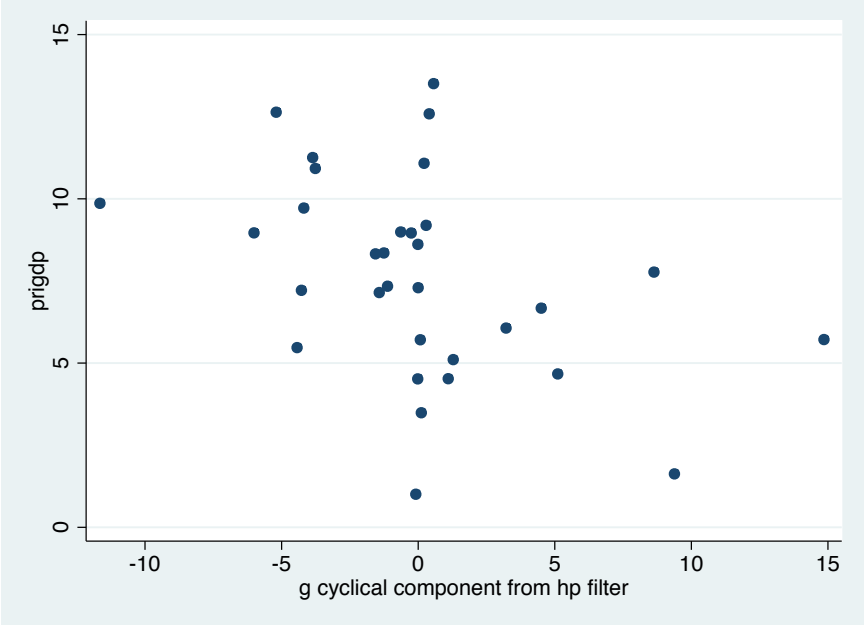
prigdp = primary surplus/GDP, tdebtgdp = public debt stock/GDP

Figure 4: Primary surplus/GDP against ygapt



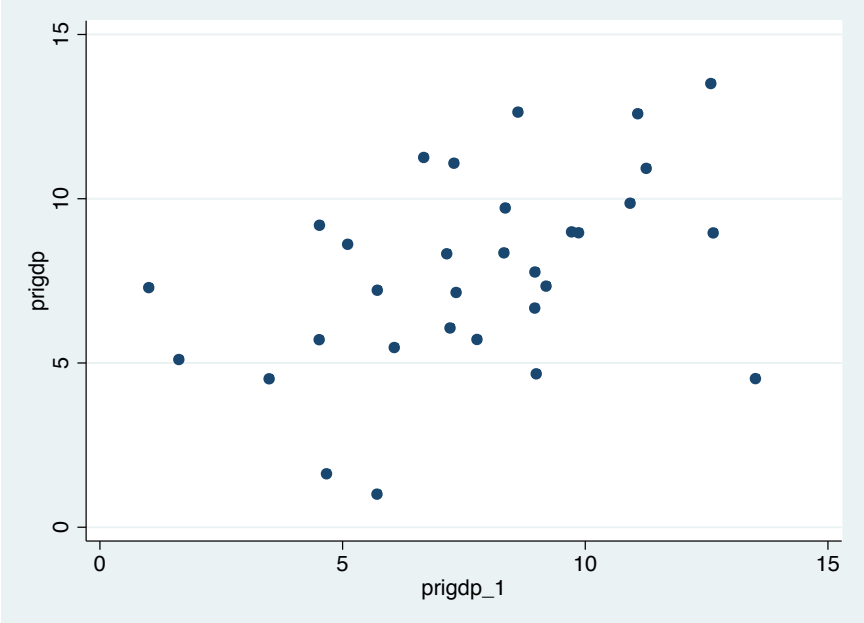
prigdp = primary surplus/GDP

Figure 5: Primary surplus against $gvar_t$



$gvar_t$ = g cyclical component from hp filter

Figure 6: Primary surplus against p_{t-1} primary surplus (lagged)



Appendix C

Time Plots

Figure 7: Primary surplus over the period 1980-2011

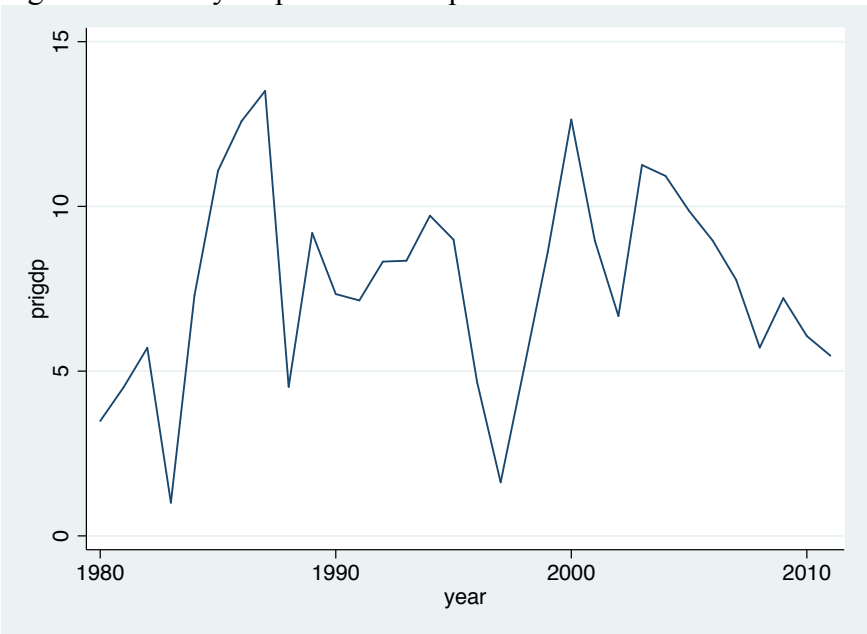


Figure 8: Public debt stock over the period 1980-2011

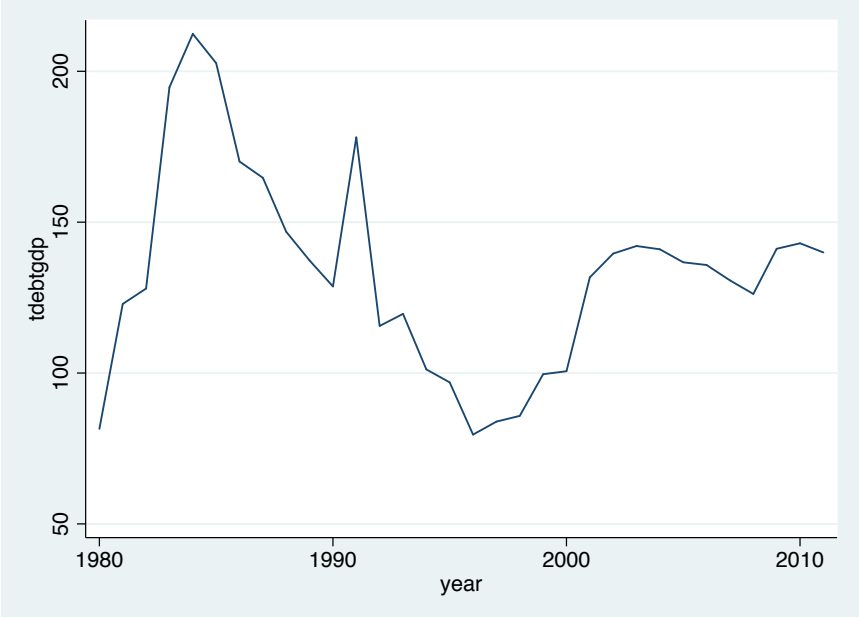


Figure 9: ygap over the period 1980-2011

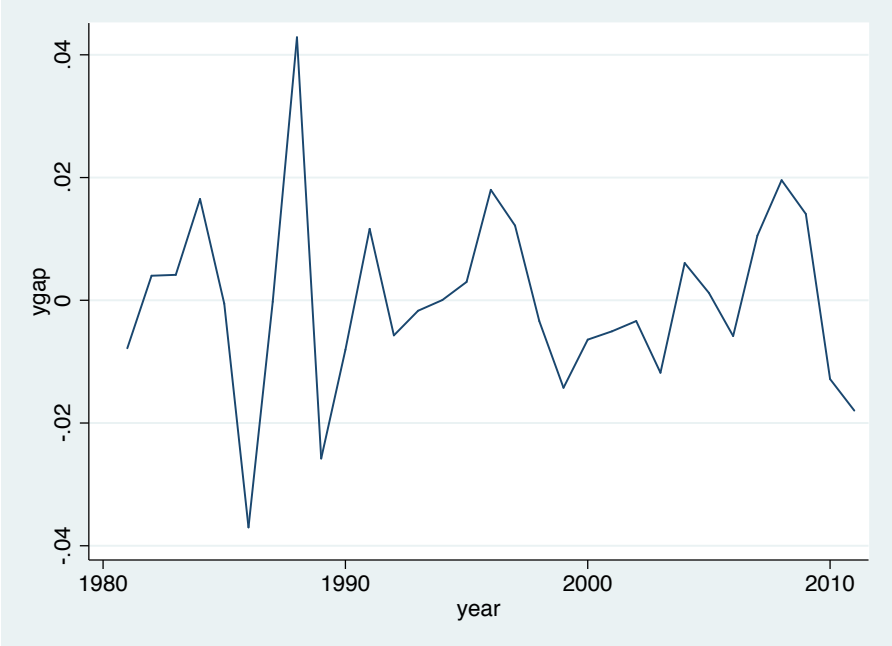
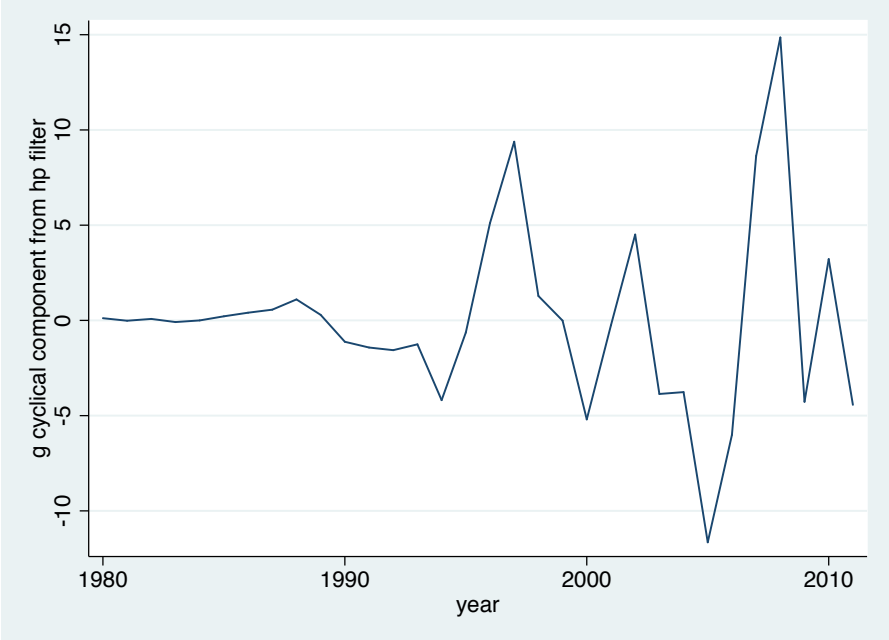


Figure 10: gvar over the period 1980-2011



gvar = g cyclical component from hp filter

Correlograms

Figure 11: Correlogram of b_t

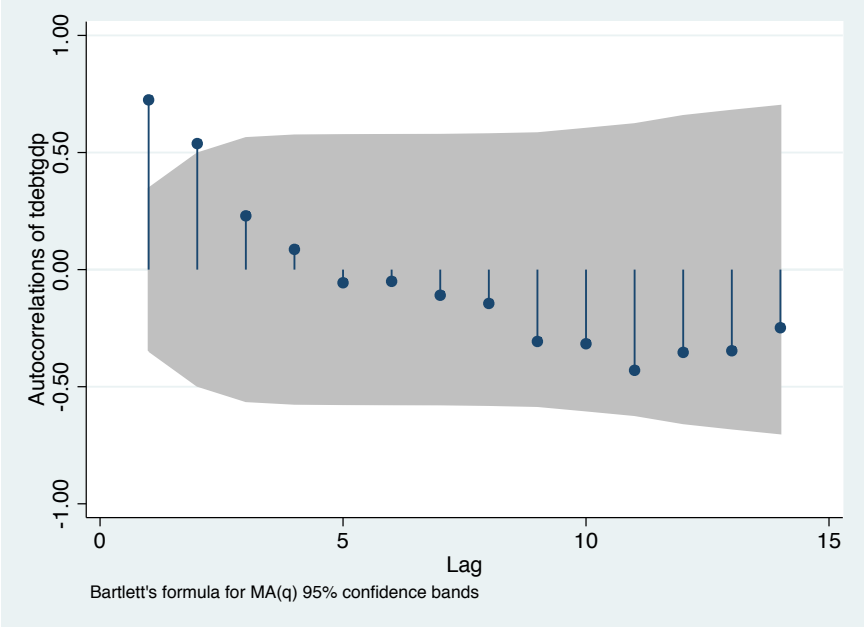


Figure 12: Correlogram of $gvar_t$

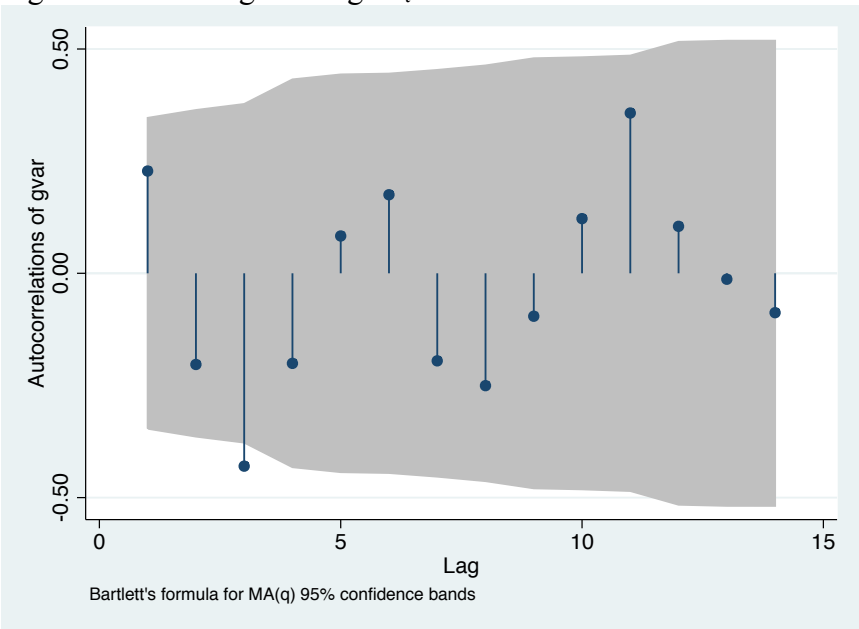


Figure 13: Correlogram of p_t

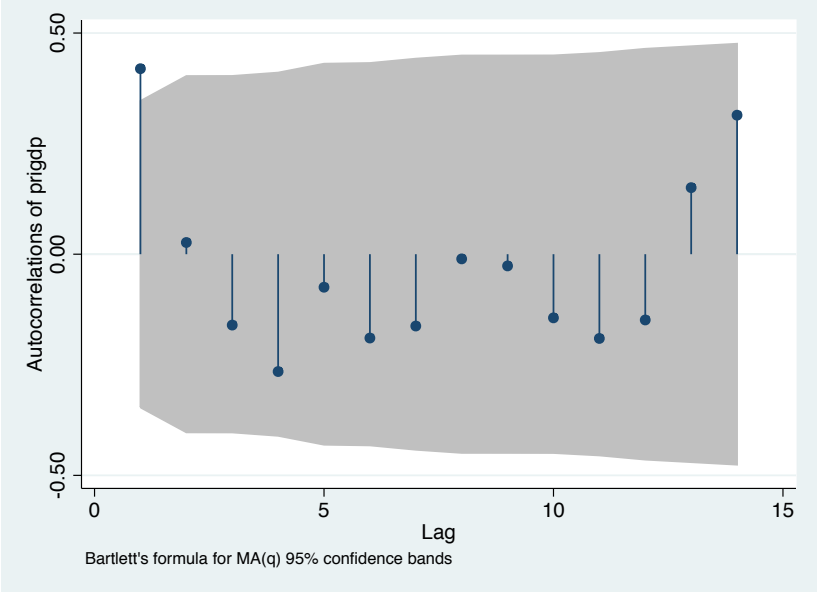
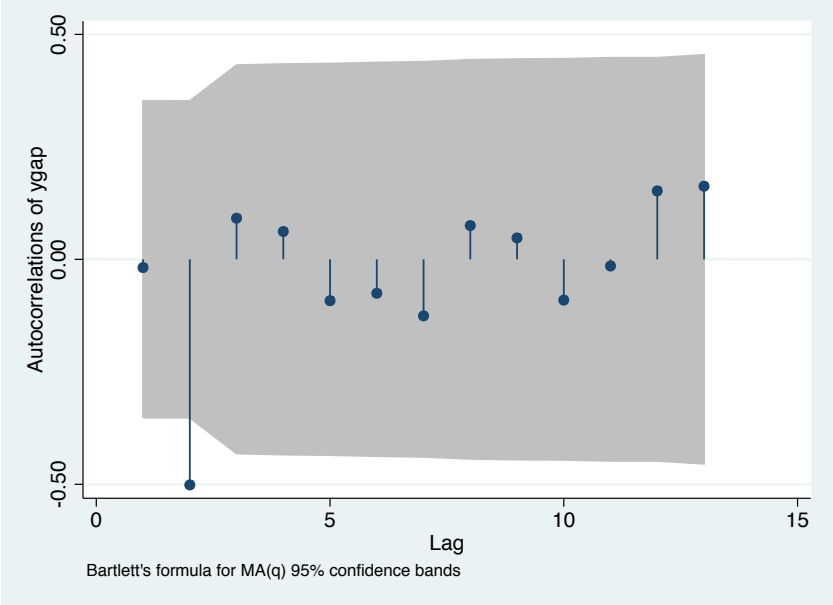


Figure 14: Correlogram of ygap



Appendix D

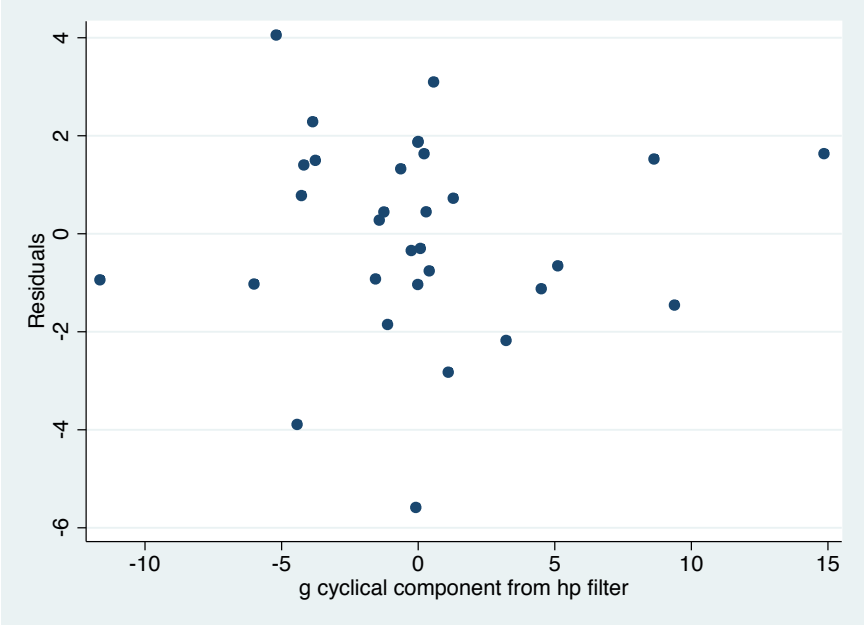
Augmented Dickey Fuller Test results for government deficit (including interest payments):

	Test Statistic	1% critical value	5% critical value	10% critical value
Zt	-5.932	-2.467	-1.701	-1.313

D.public_deficit	Coef.	Std. Err.	t-stat	P>t	[95% Conf.	Interval]
L1.	-1.0637	0.1793	-5.93	0	-1.4310	-0.6964
_cons	0.6992	4.2352	0.17	0.87	-7.9763	9.3746

Appendix E

Figure 16: Standardized residuals against $gvar_t$



gvar/g cyclical component from hp filter

Figure 17: Standardized residuals against $ygap_{t-1}$

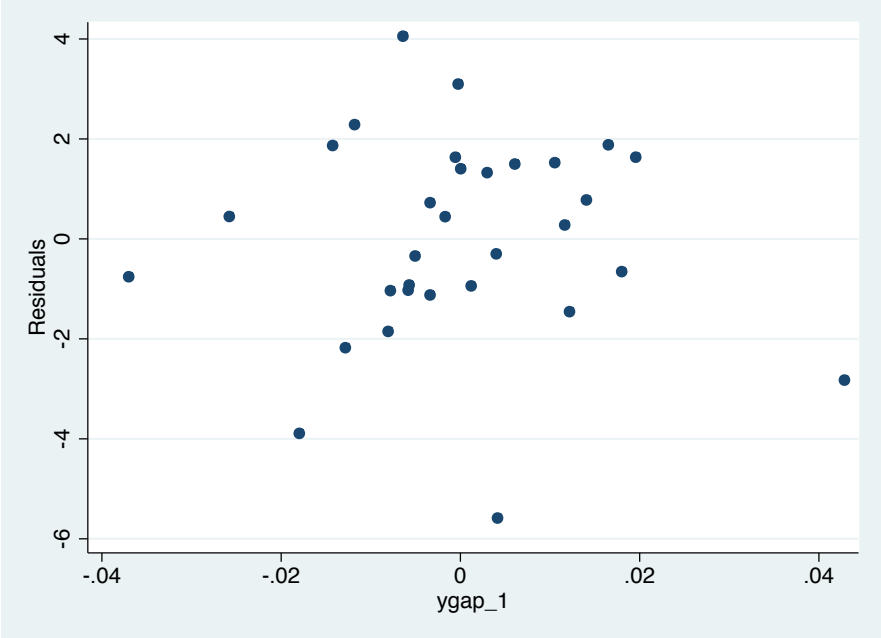
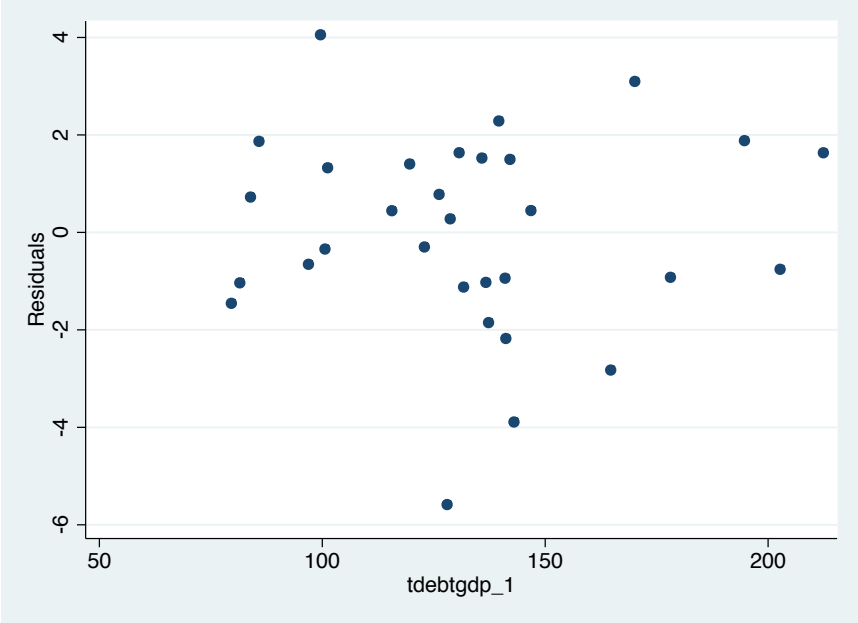
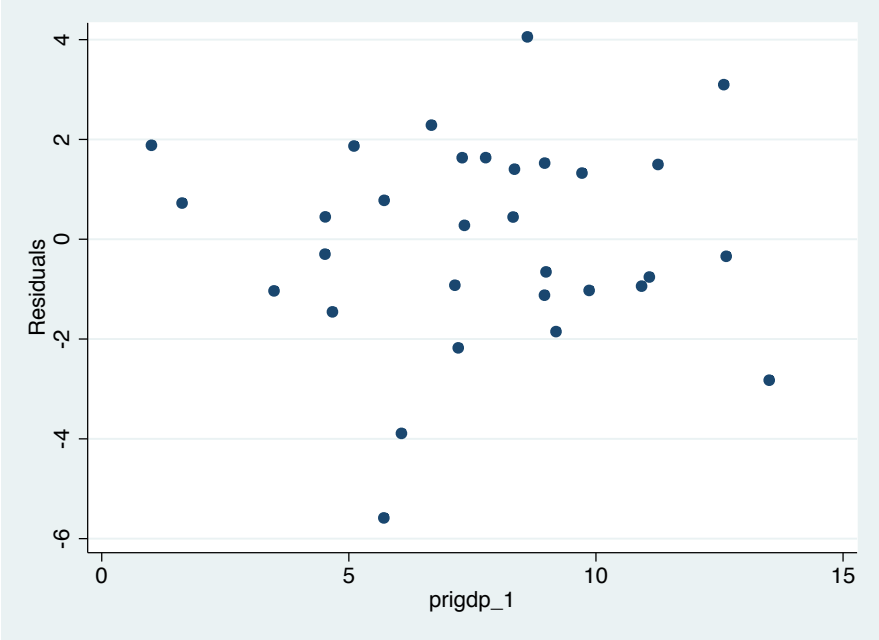


Figure 18: Standardized residuals against b_{t-1}



tdebtgdp_1=total public debt (lag)=b_{t-1}

Figure 19: Standardized residuals against p_{t-1}



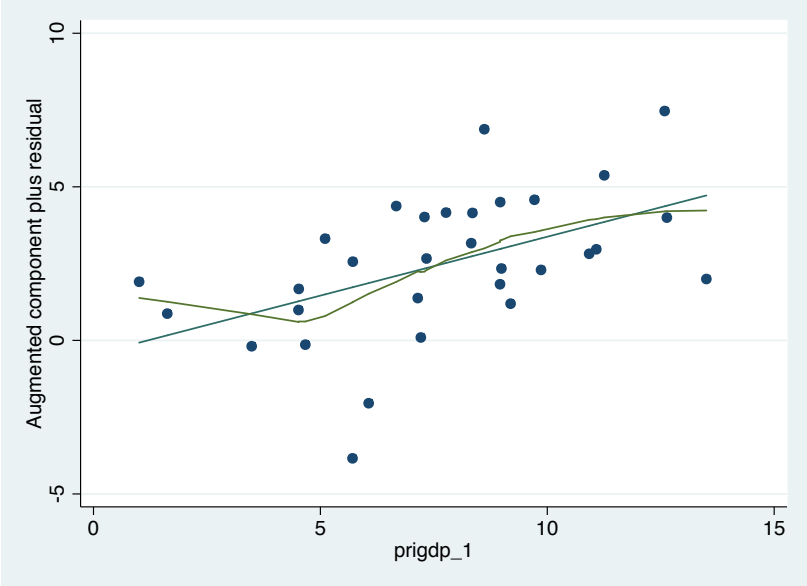
prigdp_1/p_{t-1}/primary surplus to GDP ratio (lagged)

Table E2: Correlation Matrix showing residuals and independent variables

	Residuals	b_{t-1}	$ygap_{t-1}$	$gvar_t$	p_{t-1}
Residuals	1.000				
b_{t-1}	0.0000	1.000			
$ygap_{t-1}$	0.0000	-0.0777	1.000		
$gvar_t$	- 0.0000	-0.1201	0.2948	1.000	
p_{t-1}	0.0000	0.2125	0.1126	-0.1305	1.000

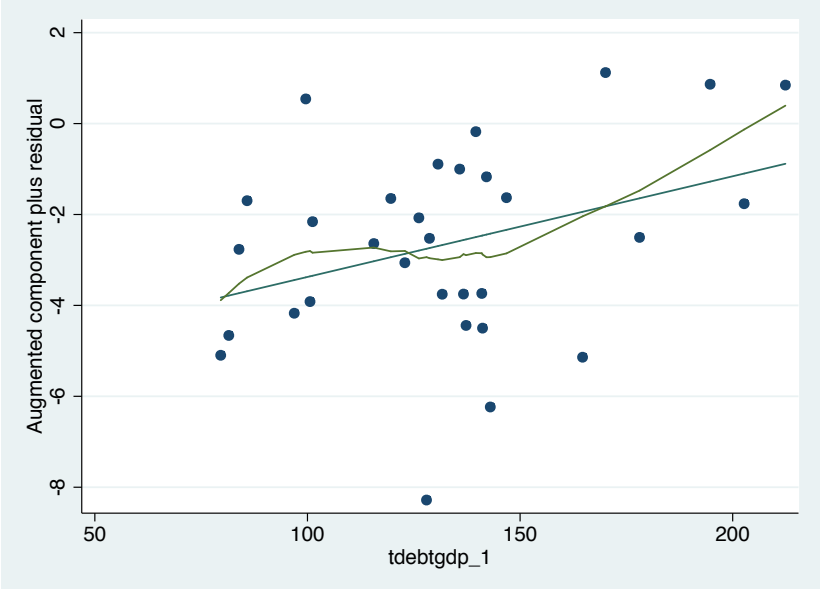
Appendix F

Figure 20: Augmented component plus residual against p_{t-1}



prigdp_1/p_{t-1}/primary surplus to GDP ratio (lagged)

Figure 21: Augmented component plus residual against b_{t-1}



tdebtgdp_1/b_{t-1}/total public debt to GDP ratio (lagged)

Figure 22: Augmented component plus residual against gvar

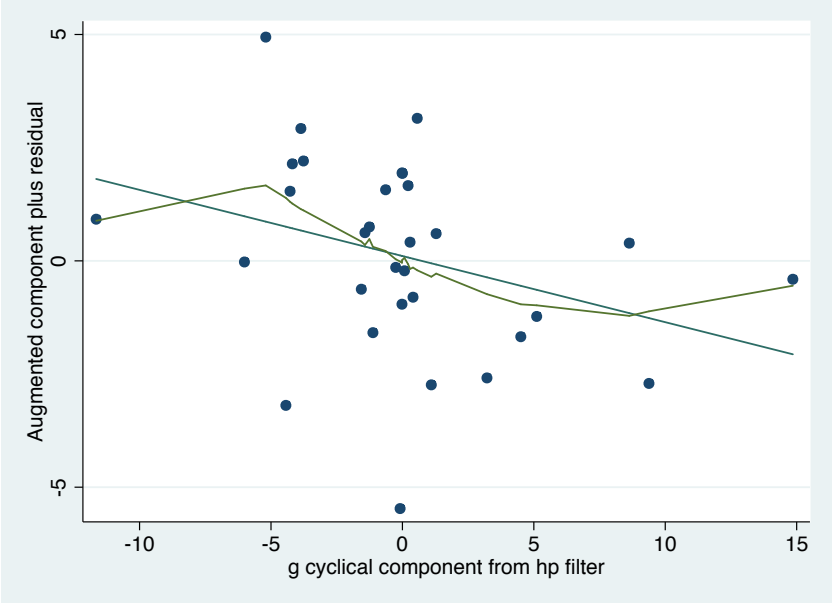
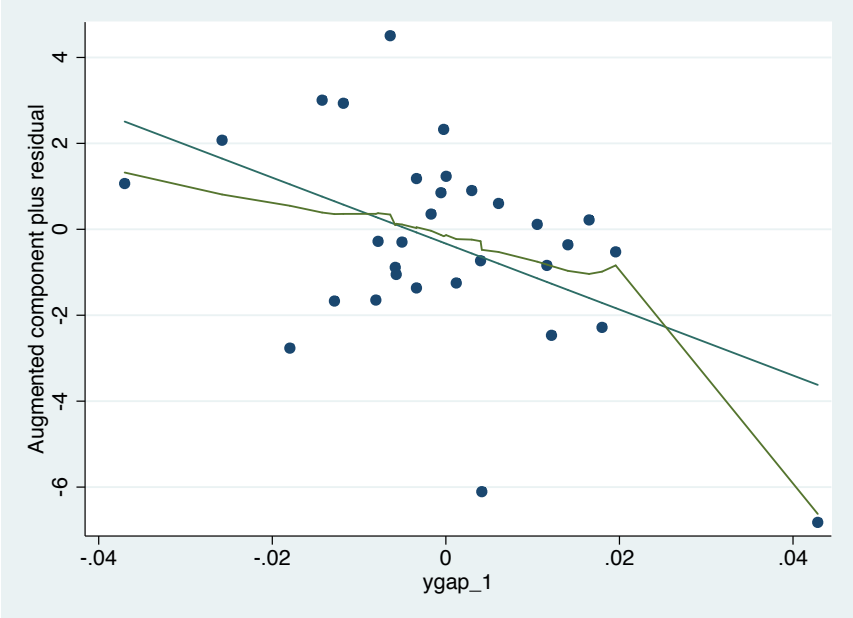


Figure 23: Augmented component plus residual against $ygap_{t-1}$



Appendix G

Table 5: Variance inflation factor

Variable	VIF	1/VIF
gvar	1.13	0.882074
ygap_1	1.13	0.884307
prigdp_1	1.09	0.915714
tdebtgdp_1	1.06	0.940240
Mean VIF	1.11	

Figure 24: Residuals versus fitted (predicted) values

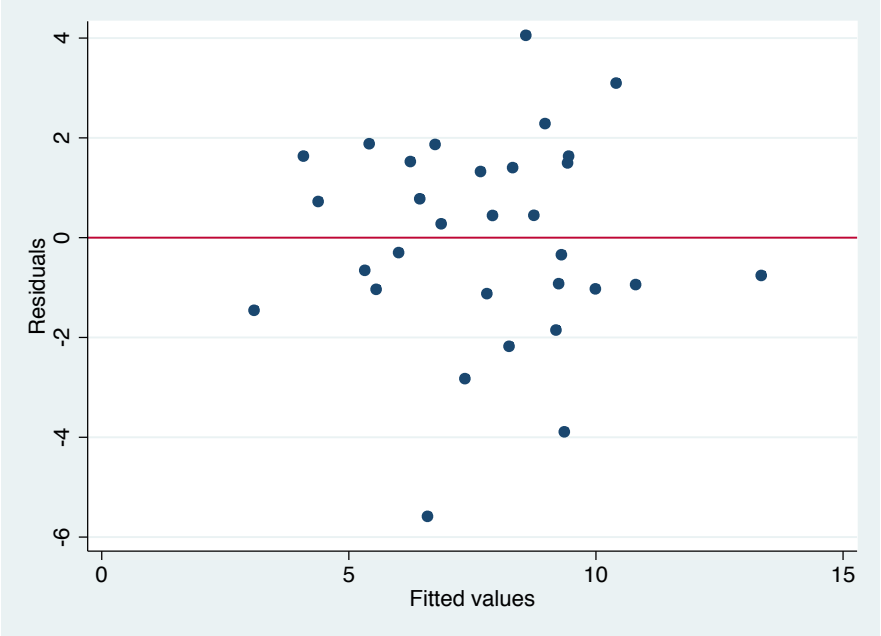


Figure 25: Tests for Heteoskedasticity

Test for Heteroskedasticity	Null	Chi Squared	Prob
Breush-Pagan/Cook Weisberg	Constant variance	0.04	0.8407
White's Test	Constant variance	6.65	0.9473

Figure 26: Tests for Autocorrelation

Test for Autocorrelation	Null	Chi Squared	Prob
Durbin's alternative test	No serial correlation	0.019	0.8912
Breusch-Godfrey LM test	No serial correlation	0.023	0.8789

Figure 27: Ramsey regression specification-error test for omitted variables

Model Specification test	Null	F	Prob
Ramsey RESET test	Model has no omitted variables	0.23	0.8729

Figure 28: Linktest

Source	SS	df	MS
Model	144.85321	2	72.4266051
Residual	124.225441	28	4.43662291
Total	269.078651	30	8.96928838

Number of observations	=	31
F (2, 28)	=	16.32
Prob > F	=	0
R-squared	=	0.5383
Adj R-squared	=	0.5054
Root MSE	=	2.1063

p_t	Coef.	Std. Err.	t-stat	P>t	[95% Conf.	Interval]
_hat	1.212197	0.8961258	1.35	0.187	-0.6234333	3.047827
_hatsq	-0.0135869	0.0562715	-0.24	0.811	-0.1288538	0.1016801
_cons	-0.7651174	3.469276	-0.22	0.827	-7.871607	6.341372

Appendix H

Figure 30: Kernel Density Plot

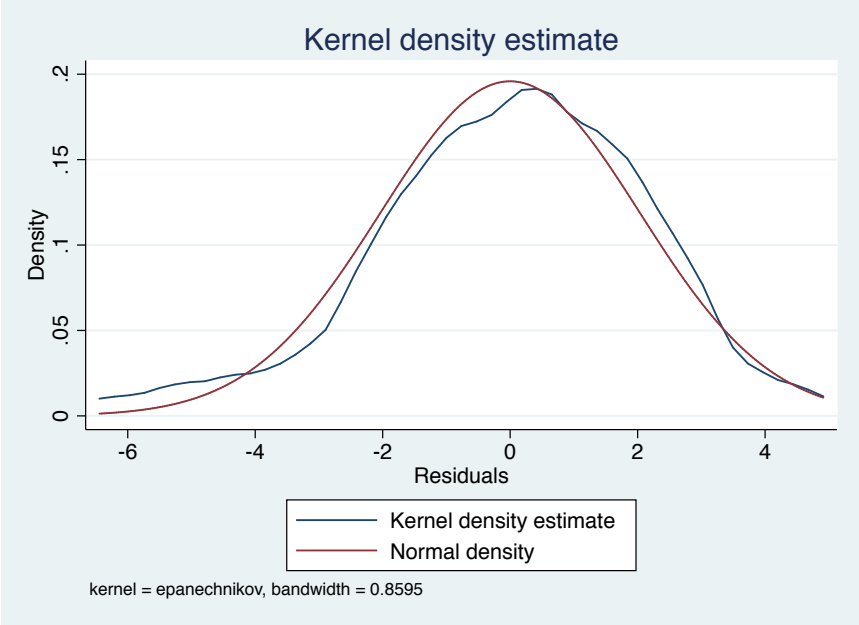


Figure 31: Standardized normal probability (P-P) plot

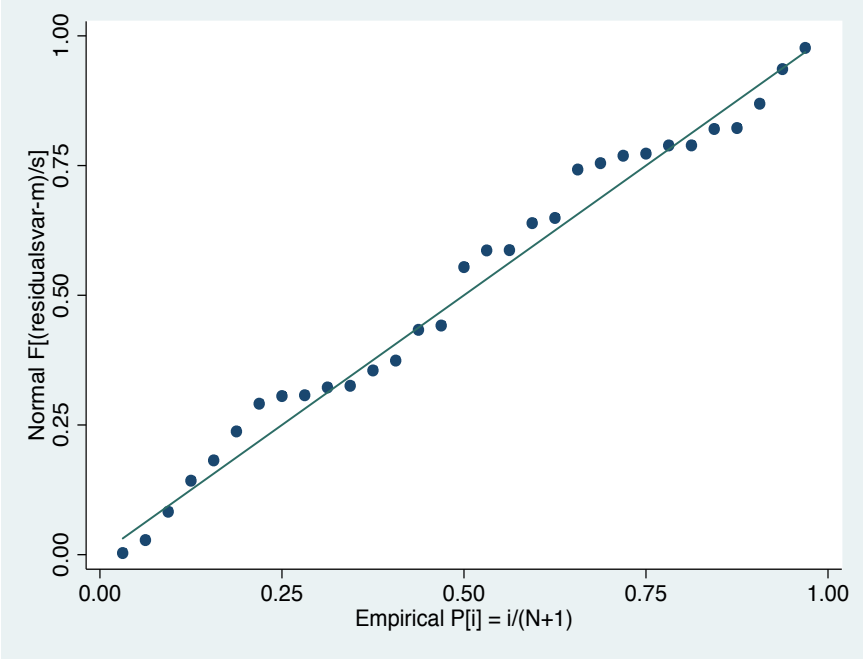


Figure 32: Quantiles of residuals against quantiles of normal distribution

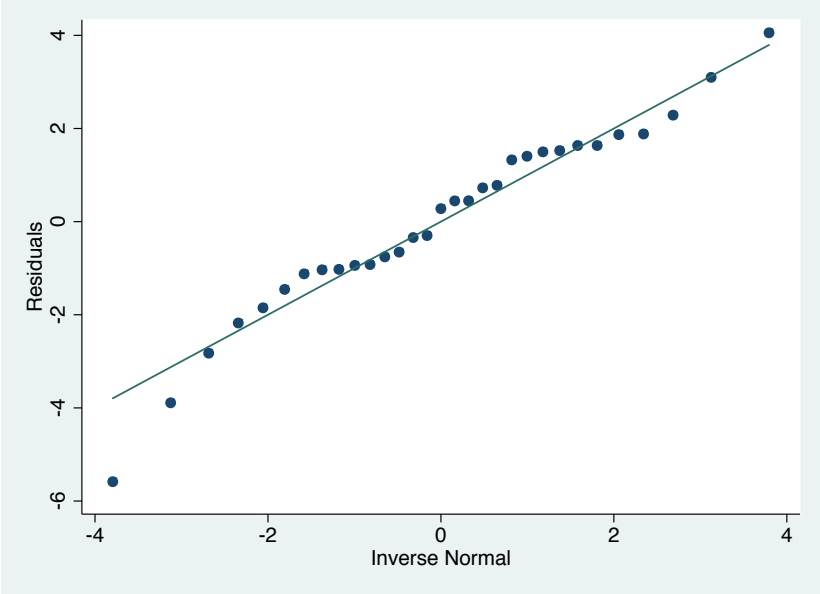


Figure 33: Shapiro Wilk W Test

Normality	Null	Z	Prob
Shapiro Wilk W test	Normality	-0.043	0.51707