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The Impact of Macroeconomic Factors on the Price of Gold

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The Impact of Macroeconomic Factors on the Price of Gold

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An Abstract of a Thesis
In
Applied Economics

Submitted in Partial Fulfilment
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Abstract of Thesis

My thesis is that macro factors have been important to the change of the gold price, but have had a differential impact in three factors: Gross Global Product (GGP), real interest rate, and U.S. dollar index (USDI). I estimated the 1st difference of the gold model to determine the impact of macro factors on the price of gold per quarter. The model was estimated using the OLS approach the sample size was 148. I make use of data from Federal Reserve Bank of St. Louis economic data. The result was that 1st difference model had statistically insignificant coefficients. I tested the model for 1st differences gold price in and found the regression of the coefficients support my hypothesis relationship between the real price of gold and the real GGP, the real interest rate, and the real USDI in the 1st difference form.

The outcome of this course is my written thesis. My anticipation is that my thesis can be validated by my investigation, and I expected to find several unique macro factors affecting the real price of gold that have affected future prediction. The evaluation of this course will be the assessment of my thesis and oral defense (with Power Points) by my thesis committee.

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Yunhao Sun

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Date

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By
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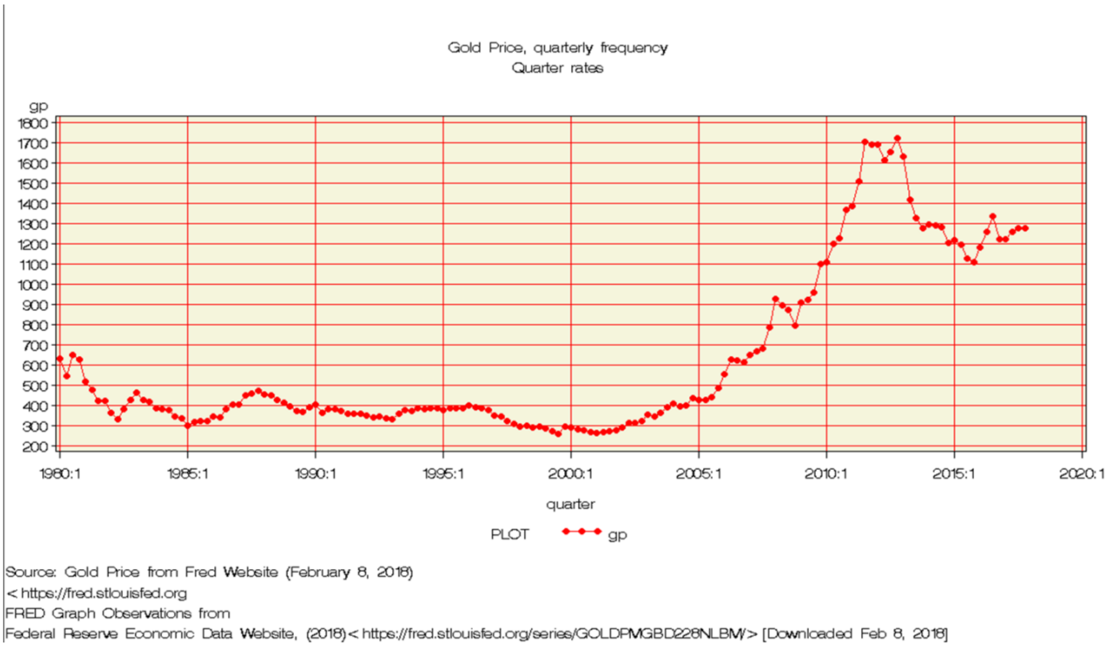
1 INTRODUCTION

1.1 Background

Much research was stimulated on gold prices with the end of the Bretton Woods system. The Bretton Woods system was on international agreement on how often adjutant were the keeps inflator low, reminding employment and economy traumas of trade exchange rates would be established after World War II. It was a monetary standard based on the U.S. dollar and gold. The system stipulates that the dollar would linked to gold, and the currencies issued by IMF members would maintain a fixed exchange rate with the U.S. dollar.

In 1971, the United States left the Bretton Woods monetary system. However, the tradition of fixing an official price of gold in United States remained. Since then, the price of gold has skyrocketed with the large increase in the amount of U.S. dollars. Economists have observed that gold prices are correlated with inflation. So they began to study how the price of gold was related to the United States GDP, inflation, the US dollar index, the S & P 500 index, the Dow Jones Industrial Average and other macroeconomic variables, and even the relationship between oil prices, in an attempt to find a universal relationship.

Figure 1 Gold Price Line Regression



Source: The Gold Price is from the FRED Website, ICE Benchmark Administration Limited (IBA), Gold Fixing Price 3:00 P.M. (London time) in London Bullion Market, based in U.S. Dollars [GOLDPMGBD228NLBM], retrieved from FRED, Federal Reserve Bank of St. Louis, accessed February 8, 2018, https://fred.stlouisfed.org/series/GOLDPMGBD228NLBM.

The real price of gold varies considerably during this period, as seen in figure 1. Theoretical research shows that there should be a relationship between real macroeconomic variables, such as, real world GDP, real interest rates, inflation rates and the real U.S. dollar index, and the real gold price.

1.2 Factors affecting the price of gold

Below a list of the factors are provided which affect the price movements of gold. This research identifies the number of macro factors that are most closely related to gold prices.

1.2.1 The economic situation of the United States

The Dollar Index (USDI) for gold is an indicator of the exchange rate of USD in the international foreign exchange market, which is negatively correlated with international gold price.

A fall in the USDI means the US dollar depreciates and the value of gold increases, investors buys gold and reduces the demand for USD. This will leads the rising demand for gold. At the same time, international dollar price of gold appreciate.

At the same time, the United States can rely on the dollar-dominated world currency economic system to obtain a very impressive number of “seignior age” are come the form of world resources and commodities. The "no-profit" effect of the dollar's world currency status is a major factor in the continued strength of the U.S. economy.

1.2.2 Supply and demand of gold

Gold demand is mainly for consumption, deposit, and investment. Usually, the price of gold in determined by determines international economic development. When economy rises, the demands of gold increase too. A country’s central bank’s holdings of official gold reserves are used to guard against financial risks. For regular investors, gold is investment and is a used to hedge against inflation.

According to the World Gold Council, the demand for gold increased by 15% in the first half of 2016 to 2,335 tons and the investment demand soared by 16%. This is the peak since 2009. However, the supply of gold increased by only 1% in the first half of 2016, the slowest pace of supply growth since the first half of 2008. This supply growth is less than the demand growth and was one of the reasons gold prices rose sharply in 2016.

1.2.3 Monetary policy direction

The specific implementation of monetary policy includes increasing the deposit-reserve ratio, lifting the discount rate and so on. The implementation of monetary policy may also have an impact on the supply of money. Increasing the money supply can lead to a decline in the purchasing power of the currency. A decrease in the purchasing power of the currency, which in turn will cause the price of gold rises. Conversely, a decrease in the supply of money may result in the purchasing power to increase and the price of gold the fall.

On one hand, tightening monetary policy is usually reflected in the market interest rate increases. Interest rates increases make the cart holding gold rise. This should weaken the demand for inventory.

On the other hand, the Federal Reserve rate hikes will increase the yield of USD assets. This will make international funds flow into dollar bonds and other assets, which will lead to a decline in gold prices.

On the contrary, loose monetary policy is manifested in lower market interest rates. This reduces cart of holding gold increase the demand for gold, leading to a rise in gold price.

1.2.4 Inflation

Gold has a function of building against inflation. Gold hedging function in inflation is expected or has occurred when investors reflect. A lot of investment funds from the bond stock market into the gold market, leading to gold rose.

The reason gold and its derivatives is used the hedge inflation in that its price moves in opposite situation of the value of the dollar. Therefore, if inflation reduces the value of the dollar, the price of gold rises.

The important factor affection on the price of gold is the real interest rate. The real interest rate is the nominal interest rate adjusted for inflation. In periods when real interest rates are low, people are more willing to hold gold.

1.2.5 Global economic situation

Economic development leads to increased need for global liquidity. Therefore, this increases the scale of investment in various derivatives, thus contributing to a rise in gold prices. During an economic crisis, global liquidity is reduced, but because gold is a safe-haven in a period of uncertainty, international gold prices will rise.

In addition, global economic development will increase the residents of gold consumption and investment needs. China and India have a tradition of gold consumption, as the two countries try to accelerate development of their economies, the demand for gold also increases.

Because gold's consumer demand is relatively stable and safe-haven demand tends to lead to overshoot of the gold price, the overall effect is that when GGP is less than expected or is significantly slower than the previous period, gold prices will form short-term support, and vice versa.

1.2.6 U.S. real interest rate

When the economy is overheated or inflation is rising, many central banks will raise interest rates and tighten credit. After the overheated economy and rising inflation are effectively controlled, the country will lower the interest rate. If the interest rate of a certain currency rises, then the interest income from holding such a currency will increase, attracting investors to buy the currency, so that the currency will be favorably supported. On the contrary, the return to holding the currency will be weakened if domestic interest rates fall.

The price of gold is affected by interest rates, but it is mostly effected the real interest rate. The real interest rate after deducting inflation is the opportunity cost of holding gold. In times when the real interest rate is negative, people are more willing to hold gold.

1.3 Purpose and Significance of the Study

As a special commodity with both commodities and monetary attributes, gold determines that it has the role of hedging function and risk-avoidance features at the same time.

Through the analysis of the present situation, some macroeconomic factors of gold prices from 1980 to 2017, and statistical analysis, we find that there is a positive correlation between the trend of gold prices and the world GDP. There is a negative correlation between the trend of the gold prices and the real interest rate. There is a positive correlation between gold prices and the inflation rate in the United States. There is also a negative relationship between gold prices and the USDI. We will estimate an econometric model to determine the relationship between real gold price trend and real Gross Global Product (GGP), the real interest rate, inflation rate, and USDI.

1.4 Scope and Limitations of the Study

Based on the previous scholars' research, this paper merely lists four of the most important aspects of analyzing gold prices from macroscopic influencing factors. The data is taken from quarterly real gold prices from 1980 through 2016, seasonally adjusted GGP, 10-year bond interest rates, inflation rate, and USDI.

The data has some limitations and one-sidedness. On the one hand, we want to make sure that we can compare all the variables on the same timeline, and also make sure the data set big enough. Therefore, we use quarterly data from 1980 to 2016.

On the other hand, since several economic crises were included during the period of the data selection we studied, data error may be present, resulting in instability of the overall data. However, we still hope to find the guiding role of these macro gold price factors in the price of gold from the limited data set.

2 LITERATURE REVIEW

In a study the role of gold in modern international asset pricing, Sinclair Davidson, Robert Faff, and David Hillier find that although the real premium of gold has been negative since the early 80s, many industries still have a large number of gold commodities. In addition, this exposure previously stated was stable and consistent in the 20-year study. Asset pricing tests reflect the null hypothesis that the world's industrial market and gold exposure are equal to 0, providing new evidence that gold remains an important place in today's economy.[1]

Some analysts say that in view of Barrick's hedging program a substantial impact on the price of gold will be challenging because they have a lot of factors, such as supply and demand, GDP, interest rate, inflation, or government policy. West Wind Partner, Mr. Williams said: "any of the dollars denominated gold prices are not properly understood for any producer or any central bank manipulation." Barrick did not receive bank charges. The price, he says, "is mainly in the U.S. economy, interest rates and inflation."[2]

Although gold has been growing as an investment option for many years, its role in a diversified portfolio is unclear. The author critically studies such hot topics as "gold is a hedge against inflation." Investors are faced with the following dilemma.

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1 Sinclair Davidson, Robert Faff, David Hillier, "Gold Factor Exposures in International Asset Pricing," *Journal of International Financial Markets, Institutions and Money* (2003): 271-89, www.elsevier.com/locate/econbase.

2 Kurt Eichenwald, "Gold Is On the Rise, so What's Bugging Barrick?," *New York Times* (2003): 1, fromhttp://proxy.buffalostate.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=n5h&AN=29148465&site=ehost-live<A href="http://proxy.buffalostate.edu:2048/login?url=http://search.ebscohost.com/login.aspx?d.

The current price of gold is at an historical high. If the prominent emerging markets increase gold holdings, the actual price of gold may rise from today's high.[3]

During the period from 1972 to1982, gold prices have had huge fluctuations. Gold prices traced out two principal cycles during this decade. The development of the world economy may affect the gold price trend. The authors' research has led them to conclude that the gold price cycle of the past ten years has been largely driven by speculation and, in turn, affected by cyclical forces in the world economic recession. Specifically, the impact of three factors - inflation expectations, exchange rate fluctuations and interest rate changes may affect gold speculation.[4]

Most arguments for asset holdings of gold are not supported by data analysis. Nevertheless, it is suggested by some that gold as a commodity be part of a diversified portfolio, especially if investors and central banks decide to increase demand for gold and even rise.[5]

Sherman built a model that, includes log tension index, the real euro-dollar rate, the log U.S. trade weighted exchange rate, the log real GNP/GDP world, the log excess liquidity, and unanticipated inflation. This was estimated by the econometric model. Their result that suggests the costs of adjustment is outweighed by the gains.[6]

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[3] Claude B. Erb, CFA, and Campbell R. Harvey, "The Golden Dilemma," *Financial Analysts Journal* 69, no. 4 (2013): 10-42.

[4] I. S. Gulati and Ashoka Mody, "Orginternational Gold Price Movements, 1972-1982," *Economic and Political Weekly*, Nov. 13-20, 1982, 1861-70, accessed April 2, 2015, http://www.jstor.org/stable/4371576.

[5] Campbell R. Harvey J. Paul Sticht, "The Truth About Gold: Why It Should (Or Should Not) Be Part of Your Asset Allocation Strategy," *CFA Institute*, March, 2013, 9-17.

[6] Eugene J. Sherman, "A Gold Pricing Model: Gold Markets Are Not Mysterious and Can Be Analyzed Systematically," *Journal of portfolio management*, 1983, 68-70.

Geoffrey H. Moore compared the gold with stocks, T-bonds, and separated three of them to analyze what leaded the gold price, to determine whether additional economic indicators related to the price of gold would be useful as a guide to investors.[7]

The relevance of gold in the determination is the value of the US dollar as an international reserve currency after 1971. There is an inverse relationship between the value of the dollar and the price of gold. There is a positive correlation between gold prices and inflation. A statistically significant relationship between gold prices and monetary policy is represented by a dynamic model of the lagged co-integration.[8]

Laughlin discusses gold prices in different countries and different banks from 1850 to 1885. It is important that we recognize that great changes in price may occur, regardless of the scarcity or abundance of precious metals. As the standard of payment contract, gold and silver will change the number of price changes, in order to adapt to the various causes of independent of precious metals. The concerns about the appropriate deferred payment standards will never be taken care.[9]

Oxford Economics used the Oxford global model scenario analysis shows that gold may be particularly strong in extreme economic situations, especially high inflation, a weak dollar and with rising financial pressure. However, in the case of deflation, gold performed well. The EU sovereign default caused by the high level of

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[7] Geoffrey H. Moore, "Gold Prices and a Leading Index of Inflation," *M.E. Sharpe, Inc.* 33, no. 4 (August 1990): 52-56, accessed 02 Apr 2015,http://www.jstor.org/stable/40721178.

[8] JEAN-GUY LORANGER, "Did Gold Remain Relevant in the Post-1971 International Monetary System?" (diss., Université de Montréal, May 2012), 1-34.

[9] J. Laurence Laughlin, "Gold and Prices Since 1873," *The Quarterly Journal of Economics,* 1, no. 3 (Apr. 1887): 319-55, accessed May 8, 2017,http://www.jstor.org/stable/1882761.

economic pressure led to the flight of security assets. Therefore, the potential role of gold in a balanced portfolio is "clear". In addition, our analysis shows that the optimization of gold and other assets, the lack of correlation means that even in the long term the actual return is negative, and the volatility of the portfolio may also play a role in reducing portfolio volatility.

The optimal portfolio allocation for gold in baseline scenario is 4-9%, depending on risk preference. These considerations may partly explain why the use of gold as an investment tool seems to be on the rise, driven by investment demand from less than 15% to around 40% in 2010. With the central bank in 2010 as a net buyer of gold since the late 1980s, this is the first time it seems there is evidence that various types of investors are reassessing the value of gold.[10]

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[10] Oxford Economics, *The Impact of Inflation and Deflation On the Case for Gold* (New York: Oxford Economics, 2011), 3-41.

3 METHODOLOGIES

The purpose of our model was to investigate the effects on macroeconomic factor the price of gold. More specifically, we estimated the macro effects on the price of gold in first difference form. Our model is to estimate the regression model of gold prices. The model was not designed for forecasting purposes.

3.1 Description of Data

The data was obtained from the Bureau of Economic Analysis------U.S. Department of Commerce,[11] Bureau of Labor Statistics,[12] and Federal Reserve Bank of St. Louis (FRED).[13] The data selection was on a quarterly basis. The years that were observed were from 1980-Ⅰ to 2016-Ⅳ. The data was adjusted to real terms by adjustment for the impact of inflation. I use the real GGP in billions of current dollars in this section. In my previous paper, I determined real GGP is more related with the volatility of gold price. Unfortunately, I could only find yearly data of nominal GGP on International Monetary Fund (IMF) website.[14] Then, I use a formula below to calculate the yearly real GGP. Finally, I used SAS to convert the yearly data to quarterly data in this case. As a result of that literature, I can hypothesize that there is positive correlation between GGP and price of gold.

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11 BEA is an agency of the Department of Commerce. Along with the Census Bureau, BEA is part of the Department's Economics and Statistics Administration.

12 The Bureau of Labor Statistics (BLS) of the U.S. Department of Labor is the principal federal agency responsible for measuring labor market activity, working conditions, and price changes in the economy.

13 FRED is focus on support the service, such as automation, data, library, and editorial services.

14 "International Monetary Fund, Data, World Economic Outlook Database, October 2017, 4. Report for Selected Country Groups and Subjects," International Monetary Fund (IMF), http://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?sy=1980&ey=2017&scsm=1&ssd=1&sort=country&ds=.&br=1&c=001%2C110%2C163%2C119%2C123%2C998%2C200%2C901%2C505%2C511%2C903%2C205%2C440%2C406%2C603&s=NGDPD%2CPPPGDP&gr (accessed February 19, 2018).

$$\text{Real GGP} = \frac{\text{Nominal GGP}}{\frac{\text{GGP deflator}}{100}} \quad ^{15}$$

At the same time, I used the quarterly real gold fixing price at 3:00 p.m. (London time) in the London Bullion Market,[16] based on U.S. dollars per troy ounce. Because we are concerned with the long term trends, gold is a luxury, I think of the price without any seasonal adjustment. It fluctuates more in the morning, and I want a relatively stable price to use in this model, so I chose the 3:00 p.m. gold price. [17]

The real interest rate used here is the Moody's seasoned AAA Corporate Bond Yield.[18] The inflation rate is measured by the rate of change in the U.S. CPI-all urban consumers non-seasonally adjusted in this model.[19] I calculate the inflation rate based on the quarterly data. There is a negative correlation between real interest rate and the price of gold. However, there is a positive correlation between the inflation rate and the price of gold.

In addition, I added the real trade-weighted U.S. dollar index in our gold model[20] and found that the real U.S. dollar index is inversely proportional to gold price. The

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15 Andrew Abel B., Ben Bernanke S., and Dean Croushore, *Macroeconomics*, 8th ed. (Boston: Pearson Education, Inc., 2014), 44.

16 ICE Benchmark Administration Limited (IBA), "Gold Fixing Price 3: 00 P.m. (London Time) in London Bullion Market, Based in U.S. Dollars© (Goldpmgbd228nlbm)," Federal Reserve Economic Data, March 20, 2015, accessed May 10, 2017, https://fred.stlouisfed.org/series/GOLDPMGBD228NLBM#0.

17 Because the afternoon gold price market is more stable than in the morning.

18 Federal Reserve Bank of St. Louis (FRED). "Long-Term Government Bond Yields: 10-year: Main (Including Benchmark) for the United States (IRLTLT01USM156N)." https://fred.stlouisfed.org/series/IRLTLT01USM156N (accessed February 19, 2018).

19 CPI-All Urban Consumers (Current Series), "All Items in U.S. City Average, All Urban Consumers, Not Seasonally Adjusted（cuur0000sa0）," Bureau of Labor Statistics, accessed May 10, 2017, https://data.bls.gov/cgi-bin/dbdown?Your+request+was+invalid+for+this+Data+Access+Service.+Please+attempt+other+data+requests.+Thank+you+for+using+LABSTAT..

20 "Trade Weighted U.S. Dollar Index: Major Currencies (DTWEXM)," Federal Reserve Bank of St. Louis (FRED), February 2, 2018, https://fred.stlouisfed.org/series/DTWEXM (accessed February 20, 2018).

first reason for this is that the world's gold market is generally priced in U.S. dollars. The depreciation of the U.S. dollar is bound to cause the price of gold to rise. For example, at the end of the 20th century, the price of gold went into a trough, and people dropped gold from their portfolios. The price has kept growing with the U.S. economy for 100 consecutive months, and the U.S. dollar is strong. The second reason is that the U.S. dollar is the pillar of the current international monetary system, and the U.S. dollar and gold are the most important reserve assets. The firmness and stability of the U.S. dollar weakened the position of gold as a reserve asset with value-preserving uses. Third, U.S. GDP still accounts for one-fourth of the world's GDP. The total foreign trade volume is the highest in the world, and the world economy is deeply affected by it. The price of gold is generally inversely proportional to the world economy. The fourth reason is that gold is an alternative investment tool for US dollar assets. When the US dollar moves strongly, the opportunity to invest in the appreciation of the US dollar will increase, and investors will buy the US dollar. On the contrary, when the dollar is weak, investors will tend to invest in gold and the price of gold will be strong.

3.2 Procedure

Multivariate linear regression was used as the main technique (ordinary least squares (OLS)) to estimate the coefficients. The software that was used for the regression was SAS version 9.4.

In order to test my hypothesis, we estimated a regression using the SAS statistical software package. The parameters of our model were estimated, along with the coefficient of determination, and the t and F values (these values will be explained in the following section). Several tests were conducted on the regression.

We obtained our data from several economic statistic data websites. The most useful website is FRED. We can find most of the data on that website no matter the real or nominal for the period from 1980 to 2016. First, we obtained the quarterly gold price, interest rates, and US dollar Index on FRED,[21] but could only find the monthly inflation rate at this site. The real GGP quarterly is difficult to find. We found it at the International Monetary Fund. Next, we saved the data in Excel. Then, we used Excel to comment on the monthly Consumer Price Index for All Urban Consumers to quarterly inflation. Finally, I move my data to the "Gold Price" set from excel to SAS. We then ran a linear regression to get the estimated parameters t and F values and also test the A-D test and J-B test and other useful tests.

3.3 Hypothesis

Based on the review of literature, we believe the price of gold is determined by the following model. The four major factors in the model are given below. Those factors are the real level of GGP, the real interest rate[22], inflation rate, and USDI.

[21] U.S. Bureau of Economic Analysis, "Real Gross Domestic Product (Gdpc1)," Federal Reserve Economic Data, April 28, 2017, accessed May 10, 2017, https://fred.stlouisfed.org/series/GDPC1.

[22] Moody's, "Moody's Seasoned AAA Corporate Bond Yield© (AAA)," Federal Reserve Economic Data, May 8, 2017, accessed May 10, 2017, https://fred.stlouisfed.org/series/GDPC1#0.

$$GP_t = f\left(\overset{+}{GGP_t}, \overset{-}{INT_t}, \overset{+}{INF_t}, \overset{-}{USDI_t}\right)$$

$$GP_t = f\left(\overset{+}{GGP_t}, \overset{-}{INT_t}, \overset{+}{INF_t}, \overset{-}{USDI_t}\right) + \varepsilon_{t_1}$$

$$\varepsilon_{t_1} \sim N(0, \sigma^2)$$

$$GP_t = \alpha_0 + \alpha_1 GGP_t + \alpha_2 INT_t + \alpha_3 INF_t + \alpha_4 USDI_t + \varepsilon_{t_1}$$

Where:

GP_t = Real Gold Price U.S. Dollars per Troy Ounce, Quarterly, Base year=1982-1984 (Not Seasonally Adjusted)

GGP_t= Quarterly Real Gross Global Product in billions of current dollars， Base year=1983 (Seasonally Adjusted)

INT_t= Quarterly Real Interest Rate on Moody’s AAA Corporate Bond Yield for 10 year bonds (Seasonally Adjusted, percent)

INF_t= Quarterly Inflation Rate as measured by the rate of change in the CPI-All Urban Consumers, Adjusted by base year=1982-1984 rate of inflation (Current Series, percent)

$USDI_t$= Real Trade Weighted U.S. Dollar Index: Major Currencies, Adjusted by base year=1983 (Not Seasonally Adjusted)

We hypothesize that when there is a rise in GGP per quarter with seasonal adjustment or inflation rate, there is also an increase in gold price. When the real interest rate per quarter without seasonally adjusted or real USDI goes up, real price of gold goes down. As a result, we expect that the signs of the coefficients for real GGP and inflation to be positive, but real interest rate and real USDI are expected to be negative. We also hypothesize a linear model functional form. The formal econometric of the hypothesis shown here below: expression

$H_0: \alpha_0 = 0 \quad H_0: \alpha_1 \leq 0 \quad H_0: \alpha_2 \geq 0 \quad H_0: \alpha_3 \leq 0 \quad H_0: \alpha_4 \geq 0$

$H_1: \alpha_0 \neq 0 \quad H_1: \alpha_1 > 0 \quad H_1: \alpha_2 < 0 \quad H_1: \alpha_3 > 0 \quad H_1: \alpha_4 < 0$

These indicate that I would expect to reject null hypothesis for all four coefficients.

<u>The appropriate decision rule for the t-test:</u>

The decision rule to reject the null hypothesis is based on two criteria. The first deals with the critical t-value being lower than the absolute value of the calculated t-value. The second criterion that must also be satisfied is that the sign has to agree with the alternative hypothesis.

If the critical t-value is higher than the absolute value of the calculated t value and the sign doesn't agree with the alternative hypothesis, we will "accept" the null hypothesis. Alternatively, we do not have evidence to reject the null hypothesis.

In this model, a 5% level of significance was used. This was used because it is conventional except in circumstances when we know something is unusual about the relative costs of making a type Ⅰ versus a type Ⅱ error.

4 STATIONARY AND NON-STATIONARY TIME SERIES

Since we use time series data we need to address the issue of stationarity. A stationary time series is one whose basic properties do not change over time. In contrast, a non-stationary variable has some sort of upward or downward trend. A time series variable is considered to be stationary only if three properties are satisfied: the mean of X_t is constant over time, the variance of X_t is constant over time and the simple correlation coefficient between X_t and X_{t-k} depends on the length of the lag(k) but on no other variable k. consequently, if one these properties are not met we have a non-stationary data series.[23]

There are three popular tools to use testing for stationary. First, we can scan for stationarity by graphical analysis. We need to plot the data against time. We determine if the mean of the variable is increasing or decreasing dramatically over time.[24] The graphs provide clues about whether the time series is a random walk with or without drift and if it appears to have a trend. If the data series has a trend we can indicate that it may be non-stationary. Second, we can use correlograms test to have a preliminary stationarity report. The correlograms can help identify if it is a random process and a random walk process.[25] Third, after preliminary tests for stationarity, we can use the Dickey-Fuller test. Dickey–Fuller test is one-sided because the alternative hypothesis is that $\delta < 0$ (or $\rho < 1$). We noted that a random walk process may have no drift, or it

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[23] Studenmund A. H., *Using Econometrics: A Practical Guide*, 7th ed. (Boston: Pearson, 2017), 424-25.

[24] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 793-830.

[25] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 749-752.

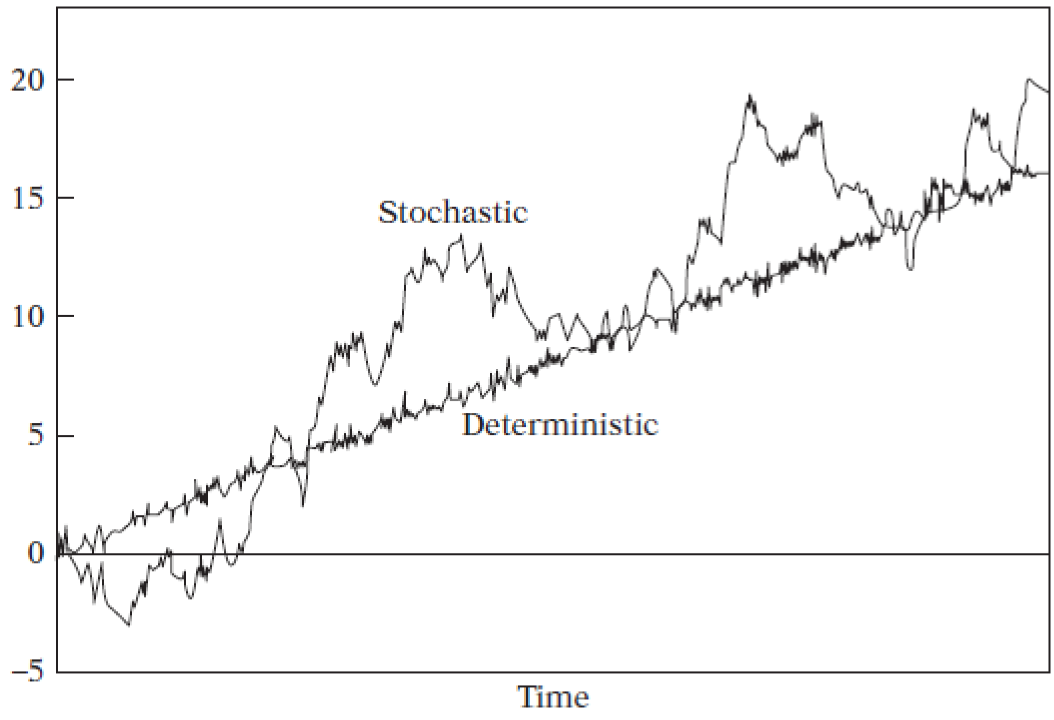
may have drift, or it may have both deterministic and stochastic trends.[26] In our model, we used the random walk with drift from for our null hypotheses.

In the literature review, we found out it is more secure to use three techniques analysis for the stationarity test in our case. Hence, we use graphs, correlograms and the Dickey-Fuller tests for stationarity.

4.1 Graphical Analysis

We used SAS to plot each time series data sets. We also graphed our variables against time. These variables were graphed against time and compared to simulated graphs that represent different types of non-stationary and stationary process. The simulated graphs are provided by several texts. We used those provided in Gujarati and Enders to guide our preliminary test for non-stationary.

Figure 2 Deterministic versus stochastic trend



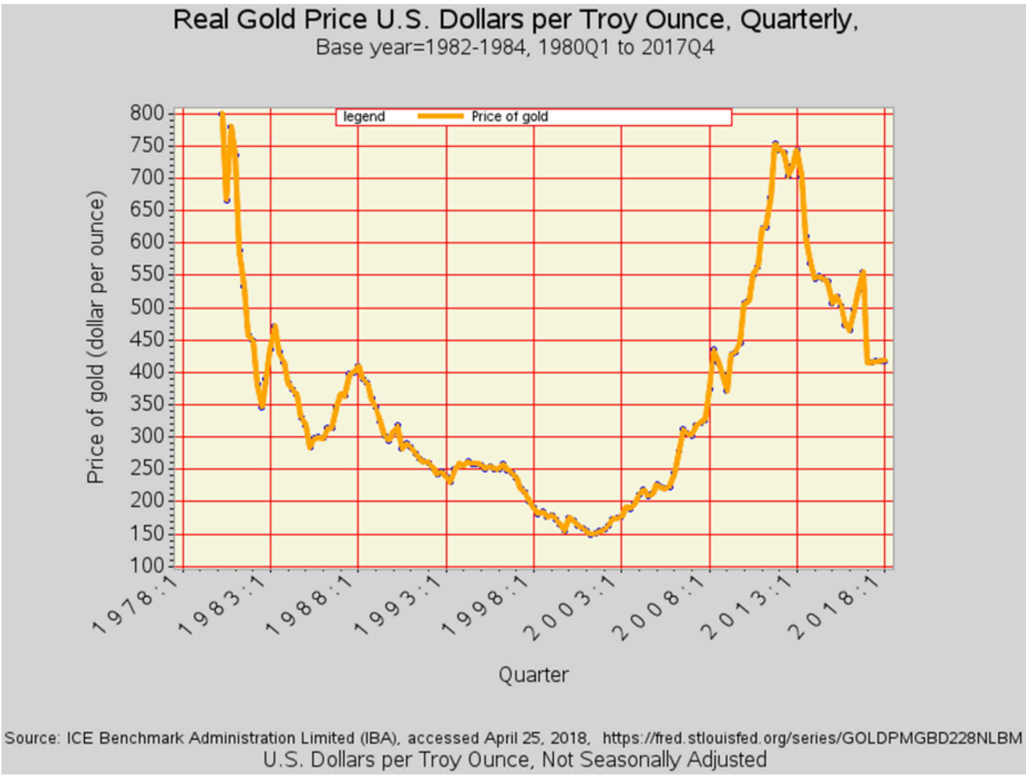
Source: Charemza et al., op.

[26] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 755.

As we have seen on Gujarati's text book, it shows in figure 2 that if our variable follows the stochastic, it means this variable is non-stationary. Otherwise, if the graph follows the deterministic, we can say this variable is stationary. Hence, the simplest way to make such a time series stationary is to regress it on time and the residuals from this regression will then be stationary.[27]

Below are our preliminary graphical analyses of non-stationarity. (Figure 3 to Figure 7) Figure 3 through figure 7 imply nonstationary in the variables; we can say it is non-stationary. Further statistical analysis will be used to confirm this graphical analysis.

Figure 3 Real Gold Price Stationary Test on Level Basis



[27] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 746.

Figure 4 Real GGP Stationary Test on Level Basis

Figure 5 Real Interest Rate Stationary Test on Level Basis

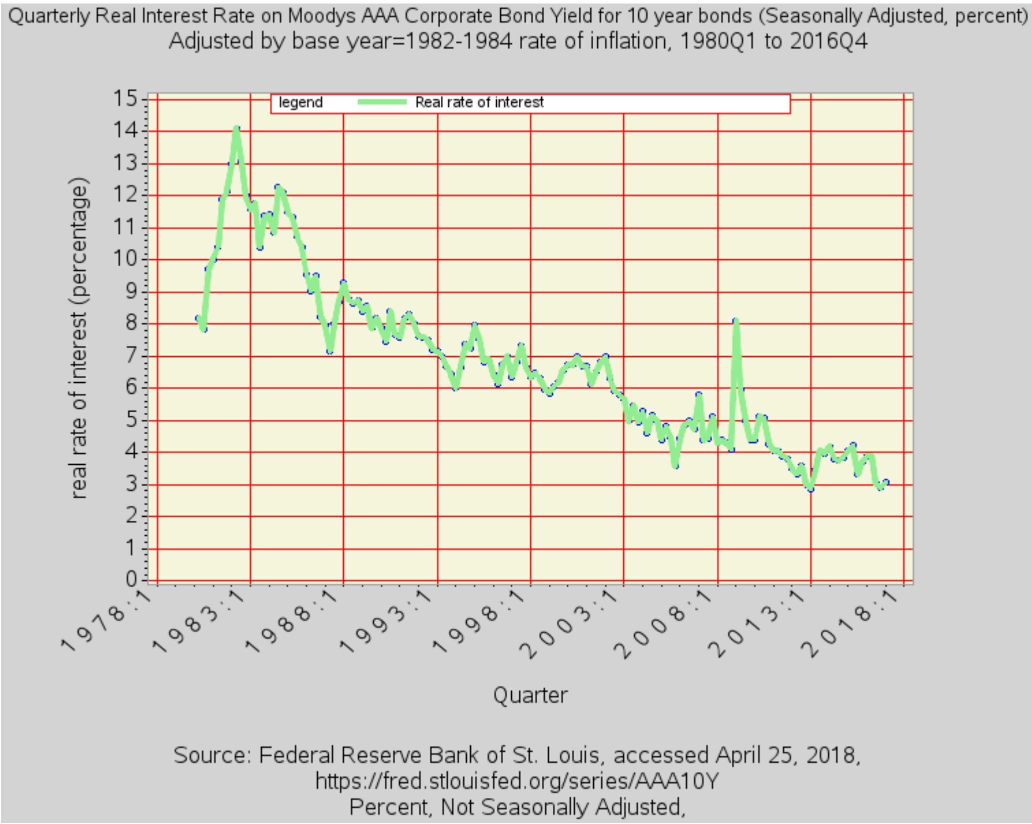


Figure 6 Inflation Rate Stationary Test on Level Basis

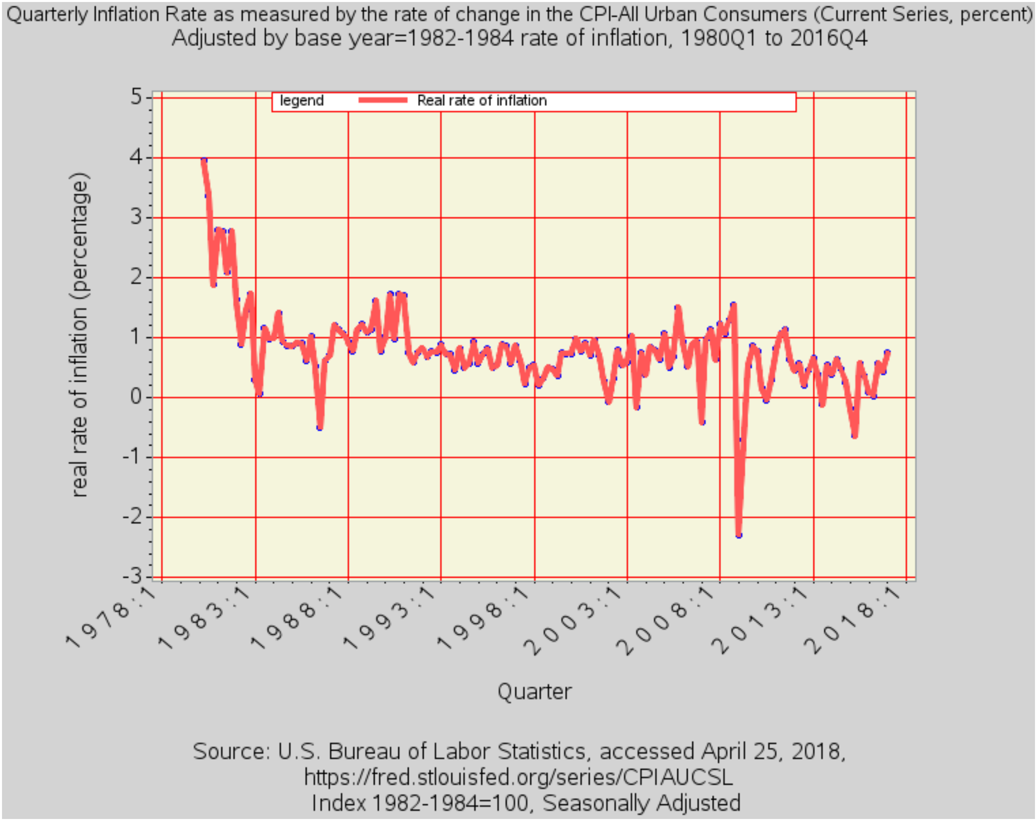
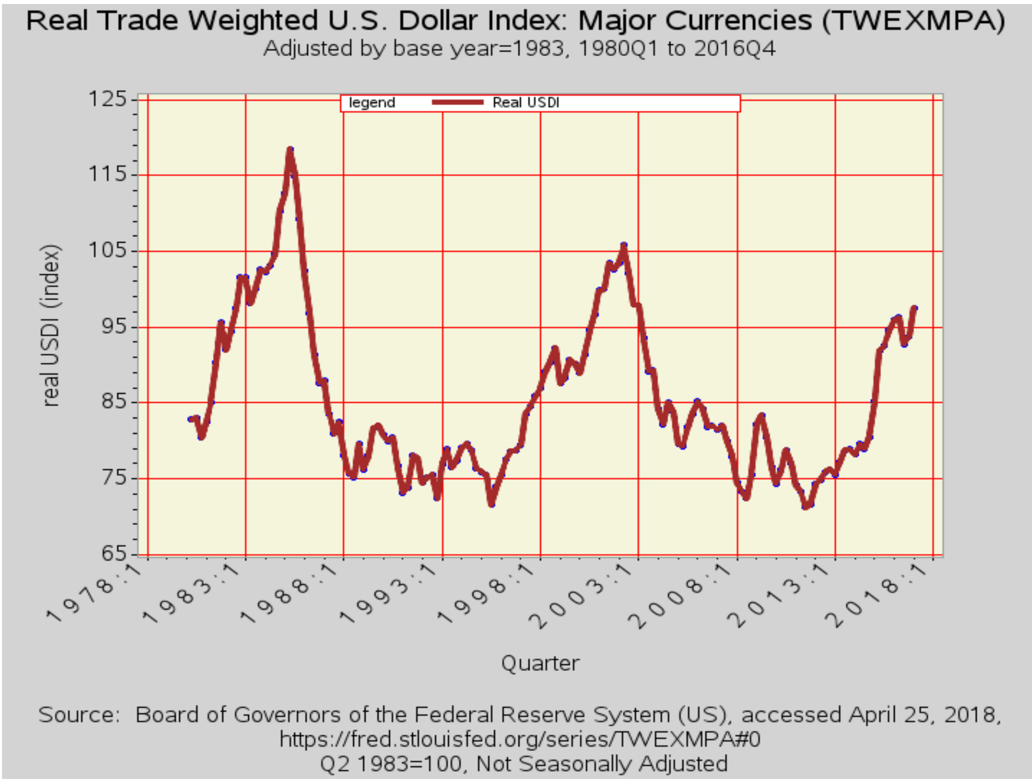
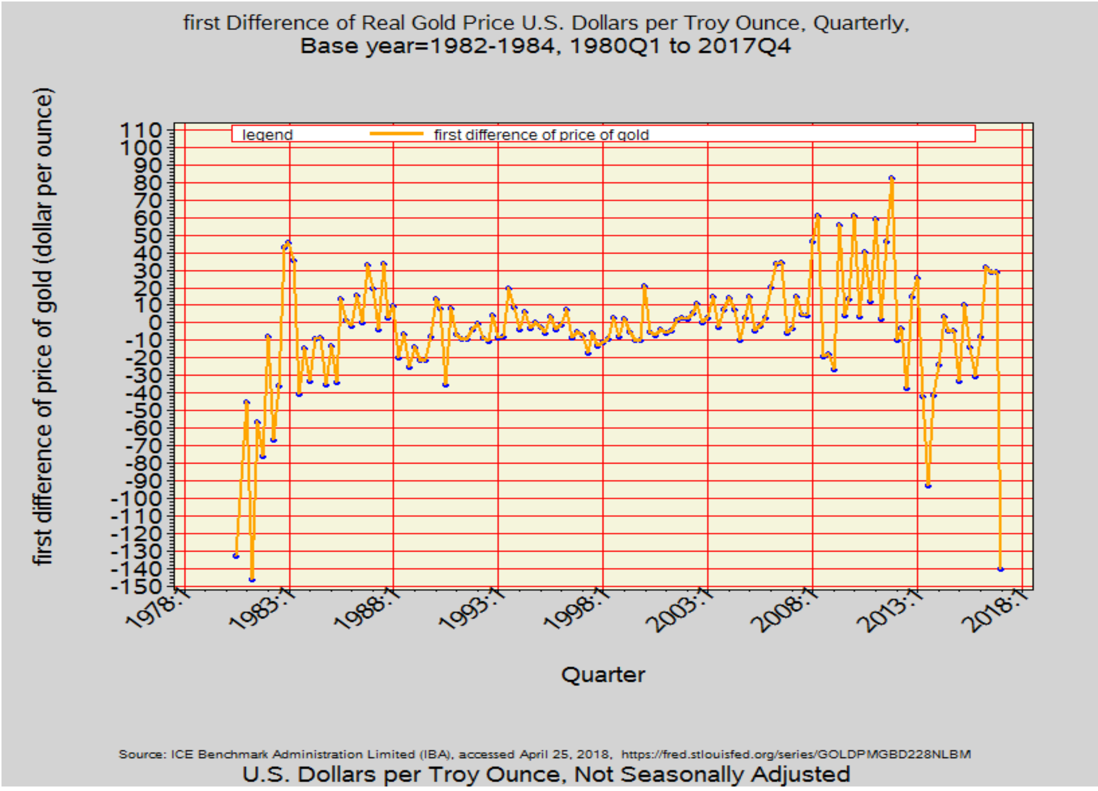


Figure 7 Real USDI Stationary Test on Level Basis



The next step in the graphical analysis of stationary is to test whether the first differences are stationary. This analysis is shown in Figure 8 to Figure 11.

Figure 8 Real Gold Price Stationary Test on First Difference Basis



From figure 8, we can see on the both ends, the real price of gold may non-stationary. But from 1983 to 2008, gold prices look stationary on first difference form.

Figure 9 Real GGP Stationary Test on First Difference Basis

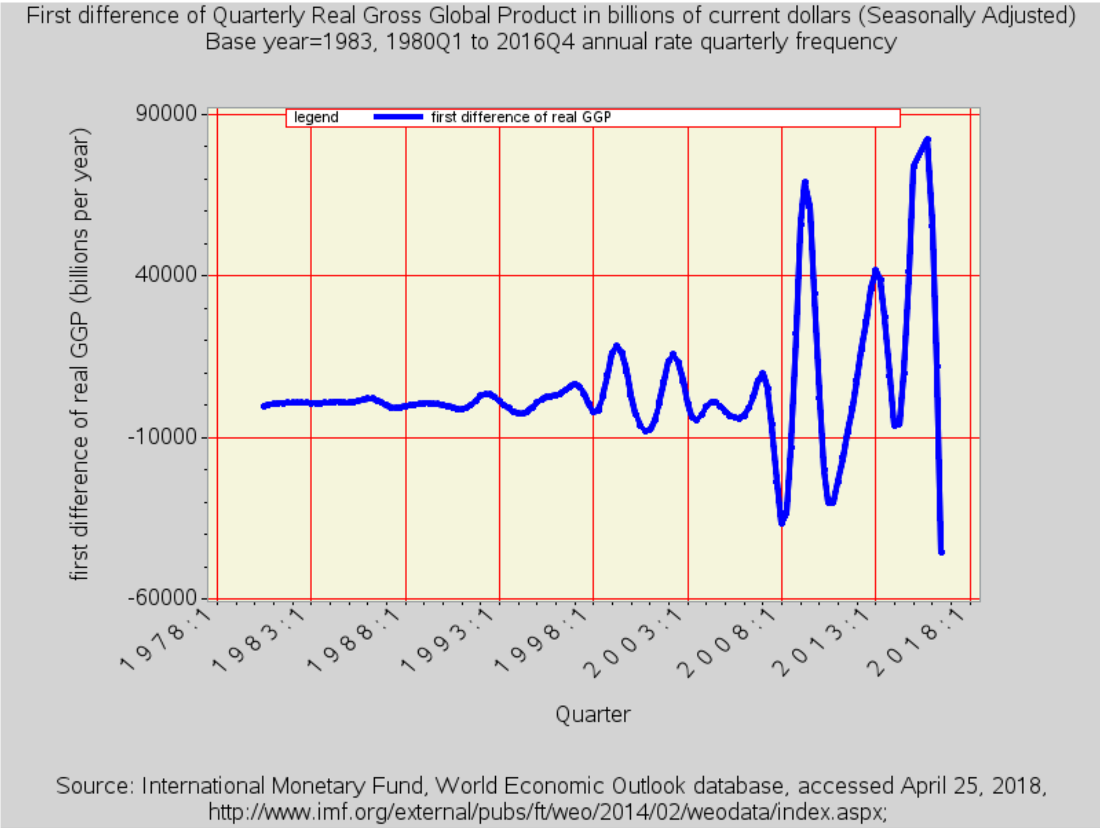
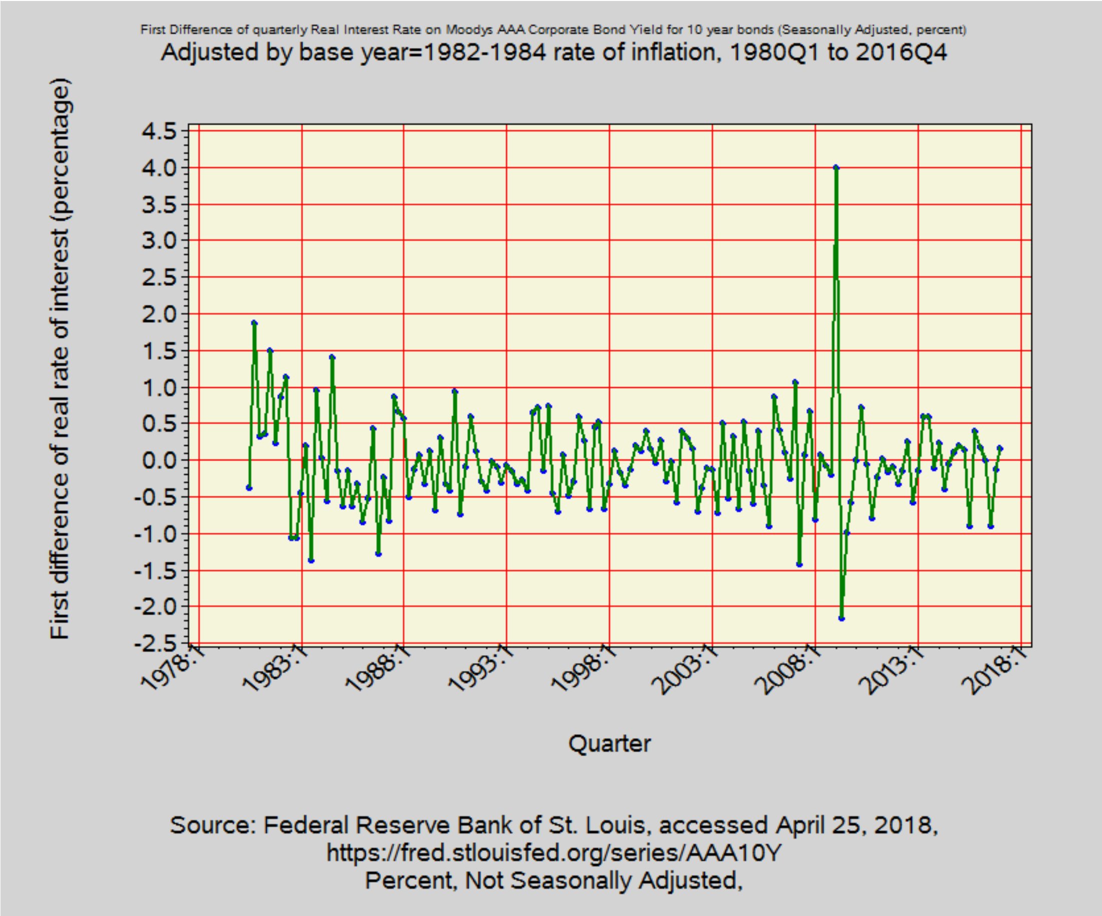


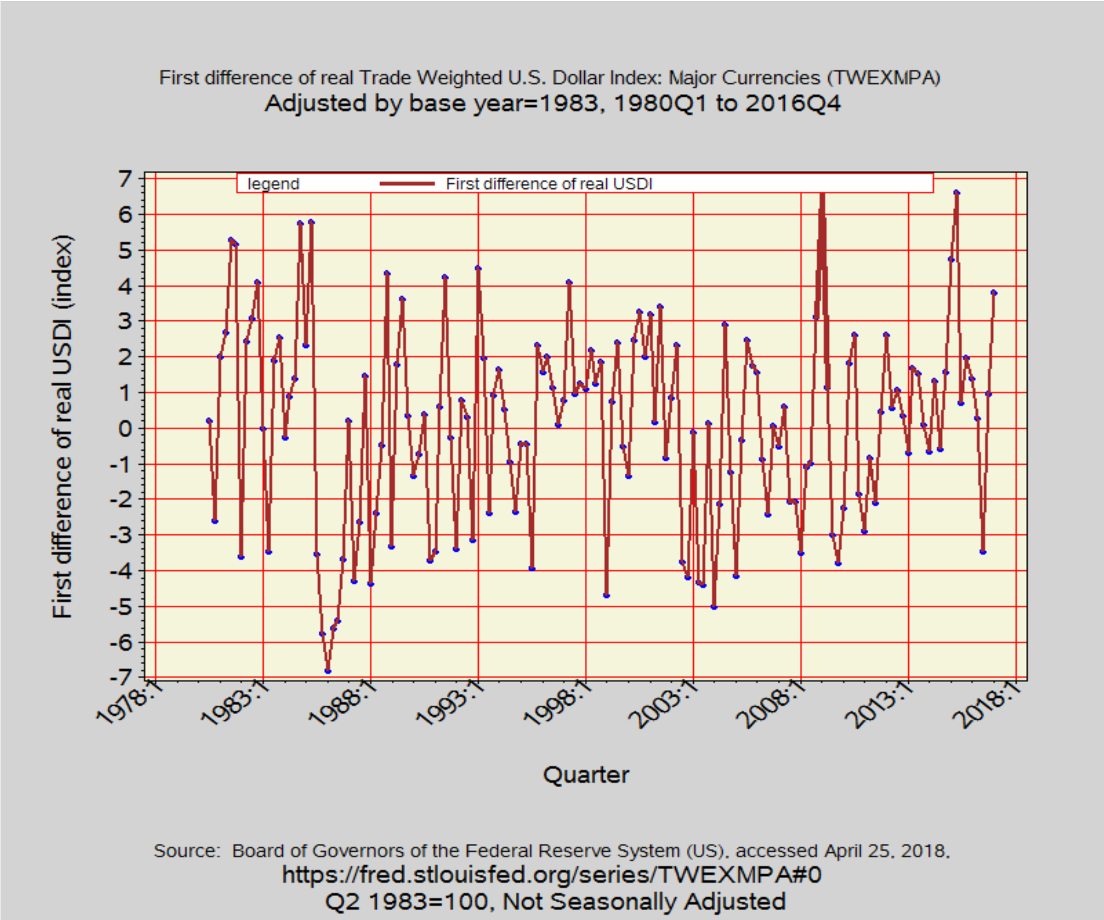
Figure 9 is also stationary until the 2008 financial crisis when real GGP becomes more volatile. It means the financial crisis may affect the world GDP for couple of years. But we still can say the GGP on first difference basis are stationary.

Figure 10 Real Interest Rate Stationary Test on First Difference Basis



The figure 10 shows the real rate of interest is stationary on first difference form, except for a short period during the 2008 economic crisis.

Figure 11 Real USDI Stationary Test on First Difference Basis



The figure 11 means the USDI is stationary on first difference form, but is more volatile than the other variables. It fluctuates greatly throughout the interface.

From the figures above, we can see all variables are stationary on first difference basis. But there still have evidence of non-stationarity in every time series, and there are some non-stationary parts on the graphs, the figure of real gold prices looks like on both ends are non-stationary. Real GGP shows a big break on the right side. Overall, in order to use the correlogram and the Dickey-Fuller test, we have to compare the figures above with the graphs of variables with price of gold.

4.2 Correlograms

Our description of the criteria for deciding on whether our time series manifested non-stationary is largely based on Gujarati. We have five variables, which are the price of gold, GGP, interest rate, inflation rate, and USDI.

The real gold price correlogram shows in appendix B Table B a-1. The table shows us the autocorrelation coefficient starts at a very high value and declines very slowly toward zero as the lag lengthens. The correlogram up to 36 lags is shown in Table B a-1. The autocorrelation coefficient starts at a very high value at lag 1 (0.954) and declines very slowly. Thus it seems that the LGDP time series is non-stationary. The conclusion is this time series is non-stationary, they may be non-stationary in mean or variance or both.

The following in appendix B Table B a-2 shows the GGP correlogram. The table shows us the autocorrelation coefficient starts at a very high value and declines very slowly toward zero as the lag lengthens. Even we have 36 lags in this graph, it still did not touch the zero. But finally it will toward zero as well. The correlogram up to 36 lags is shown in Table B a-2. The autocorrelation coefficient starts at a very high value at lag 1 (0.972) and declines very slowly. Thus it seems that the LGDP time series is non-stationary. The conclusion is this time series is non-stationary; they may be non-stationary in mean or variance or both.

Appendix B Table B a-1 looks like the correlogram of interest rate in level is non-stationary.

The correlogram of these 148 purely random error terms is as shown in appendix

B Table B a-4; we have shown this correlogram up to 36 lags. We will comment shortly on how one chooses the lag length. For the time being, just look at the column labeled AC, which is the sample autocorrelation function, and the first diagram on the left, labeled Autocorrelation. The solid vertical line in this diagram represents the zero axis; observations to the right of the line are positive values and those to the left of the line are negative values. As is very clear from this diagram, for a purely white noise process the autocorrelations at various lags hover around zero. This is the picture of a correlogram of a stationary time series. Thus, if the correlogram of an actual (economic) time series resembles the correlogram of a white noise time series, we can say that time series is probably stationary.

The USDI correlogram up to 36 lags also shows a pattern similar to the correlogram of the random walk model in Table B a-5. The autocorrelation coefficient starts at a very high value at lag 1 (0.978) and declines very slowly. Thus it seems that the LGDP time series is non-stationary.

In order to make all the time series stationary, we use the 1st difference test to examine the correlation graph again for the previously non-stationary sequences. At 1st difference of correlation, the autocorrelation of gold price, interest rate, and USDI showed up clearly as white noise. We concluded that the gold price, interest rate, and USDI time series are the stationary sequences. GGP time series became stationary when we use the correlogram of 1st difference. For now, in appendix B, Table B b-1 through Table B b-5 depicts the time series plots of our remaining variables. All of these variables seem to exhibit stationarity in the correlogram of the 1st difference.

4.3 Dickey-Fuller Test

The Dickey-Fuller test for a random walk and a random walk with drift and the appropriate decision rule are indicated below:

In a random walk with drift both the mean and variance change with time. It is modeled by the equation below:

$$\delta = 1 - \beta$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$$

The appropriate decision rule is:

One-sided t-test on the hypothesis that $\delta = 1 - \beta$.

$$H_0 : \delta \geq 0$$
$$H_A : \delta < 0$$

The decision rule to reject the null hypothesis is based on two criteria. The first criterion considers whether δ larger than or equal to 0. The second criterion is to determine whether the critical tau-value is lower than the absolute value of the estimated tau-value. If we reject the null hypothesis, then we can say that the statistical evidence is consistent with stationarity.

The idea here is if β is 0, that means δ is 1, and you have got a problem because this explain the change. If β is 1, that means δ is 0. Then, in this situation, the lag doesn't matter, as we don't have drift in the change. If this parameter is not statistically significant, then there is no drift in the change.

The Dickey-Fuller test involves determining whether the values of the delta are equal to zero. If the values of delta are zero the behavior of the time series would suggest evidence of non-stationarity. Our Dickey-Fuller test for each variable takes the functional from below.

Real gold price (GP_t): $\Delta\mathrm{GP}_t = \beta_1 + \delta\mathrm{GP}_{t-1} + u_t$

Real Gross global product (GGP_t): $\Delta\mathrm{GGP}_t = \beta_1 + \delta\mathrm{GGP}_{t-1} + u_t$

Real interest rate (INT_t): $\Delta\mathrm{INT}_t = \beta_1 + \delta\mathrm{INT}_{t-1} + u_t$

Inflation rate (INF_t): $\Delta INF_t = \beta_1 + \delta INF_{t-1} + u_t$

Real U.S. Dollar Index (USDI_t): $\Delta USDI_t = \beta_1 + \delta USDI_{t-1} + u_t$

We estimated these equation using both SAS and EViews. Because the delta are tends to 0, and the change is constant, so we didn't put it in the table. The results for the estimated coefficients of the Dickey-Fuller equations are as follows:

Table 1 The results for the estimated coefficients of the Dickey-Fuller Test

Levels	Tau(τ) values	Critical Tau(τ) values	Calculated Durbin-Watson	Calculated Durbin-Watson lower limit	Calculated Durbin-Watson upper limit
GP_t	-1.33	-2.89	1.49	1.72	1.75
GGP_t	1.50	-2.89	2.07	1.72	1.75
INT_t	-1.05	-2.89	2.33	1.72	1.75
INF_t	-3.16	-2.89	2.06	1.72	1.75
USDI_t	-0.09	-2.89	1.93	1.72	1.75

The Dickey-Fuller test is applied to the levels. The Dickey-Fuller tests involve regressions conducted on the first difference of the levels against the lagged value of the levels. We obtained critical values with 5% level significance, n=150, and k=1. The Dickey-Fuller tests use critical values from a tau distribution. The critical tau value for a random walk with drift is -2.89. The critical tau-values are only an approximation since our sample size is a 148 and the critical tau-values provided in the text were for sample sizes of 100 and 250. We chose the critical tau-value with a sample size of a 100. The null hypothesis of the Dickey-Fuller test is the time series is non-stationary. If the absolute calculated tau value is larger than the critical tau value we can reject the null hypothesis and the evidence is consistent with stationary.

We also used the Durbin-Watson d statistic to determine whether our time series exhibits serial correlation. If the estimated Durbin-Watson d statistic is less than the lower limit d_L value, then we can reject the null hypothesis and evidence is consistent with positive serial correlation. If the calculated d statistic is greater than the upper limit d_U, then we had to accept the null hypothesis and evidence suggests no positive serial correlation. If the estimated d statistic falls in between the critical upper limit and the critical lower limit, then we cannot reject or accept the null hypothesis and can conclude the test is inconclusive. The critical upper and lower limit for sample size of 150 and for k=1, d_L is equal to 1.72 and d_U is equal to 1.75. The tau tests and Durbin-Watson d tests are expressed as follows:

Table 2 The Summery of tau tests and Durbin-Watson d tests

Levels	Tau(τ) tests	Durbin-Watson d_U tests	Durbin-Watson d_L tests
GP_t	|-1.33|>|-2.89|	|1.49|<|1.75|	|1.49|<|1.72|
GGP_t	|1.50|>|-2.89|	|2.07|>|1.75|	
INT_t	|-1.05|>|-2.89|	|2.33|>|1.75|	
INF_t	|-3.16|<|-2.89|	|2.06|>|1.75|	
$USDI_t$	|-0.09|>|-2.89|	|1.93|>|1.75|	

The table above summarizes the results of the Dickey-Fuller tests. The estimated tau-values for inflation rate were less than the critical tau-values. But the real gold price, real GGP, real interest rate, and real USDI were higher than the critical tau-values. Therefore, in inflation rate we cannot reject the null hypothesis which we conclude the evidence is consistent with stationary. But in real gold price, real GGP, real interest rate, and real USDI cases we can reject the null hypothesis and we consist them with non-stationary.

The calculated d statistics for GP_t is less than the critical lower limit. Therefore, we reject the null hypothesis and there is statistical evidence of positive serial correlation. The Dickey-Fuller test is invalid when the serial correlation result is positive. We cannot reject the null hypothesis and the evidence suggests most of the variables exhibit results consistent with no positive serial correlation.

An alternative test is the augmented Dickey-Fuller test which is designed to test for non-stationary in presence of positive serial correlation. After the testing for positive serial correlation we used the calculated tau-values to test for non-stationary. We found the serial correlation problem still was not eliminated. This means we had to try another test for non-stationary. We try to use the 1st difference test for non-stationary, and analyze the data to make them stationary. Below are the results for the Dickey-Fuller test:

Table 3 The First Difference Result for the Dickey-Fuller Test

levels	Tau(τ) values	Critical Tau(τ) values	Calculated Durbin-Watson	Calculated Durbin-Watson upper limit	Calculated Durbin-Watson lower limit
ΔGP_t	-7.40	-2.89	1.87	1.72	1.75
ΔGGP_t	-3.94	-2.89	2.12	1.72	1.75
ΔINT_t	-14.27	-2.89	1.96	1.72	1.75
ΔINF_t	-9.72	-2.89	2.05	1.72	1.75
$\Delta USDI_t$	-8.47	-2.89	1.93	1.72	1.75

The Dickey-Fuller test is applied to the 1st difference basis. We used the 1st difference for our special case. This test involves regression the 1st difference of the levels against the lag of the level basis. The critical tau-value is for a 5% level of significance and n=100. The critical tau-value for a random walk with drift is -2.89. The Durbin-Watson d statistic critical values is for n=150 and k=1. The tau tests and Durbin-Watson d statistic are expressed as follows：

Table 4 The Summery of First Difference Tau Tests and Durbin-Watson D Statistic

Levels	Tau(τ) tests	Durbin-Watson d_U tests
ΔGP_t	|-7.40|>|-2.89|	|1.87|>|1.75|
ΔGGP_t	|-3.94 |>|-2.89|	|2.12|>|1.75|
ΔINT_t	|-14.27|>|-2.89|	|1.96|>|1.75|
ΔINF_t	|-9.72|>|-2.89|	|2.05|>|1.75|
$\Delta USDI_t$	|-8.47|>|-2.89|	|1.93|>|1.75|

The table above is used to summarize our estimated tau-values for every non-stationary variable. These estimated tau-values are greater than the critical tau-values in absolute value. Therefore, we have statistical evidence that each variable is stationary on first difference basis according to the Dickey-Fuller tau(τ) test.

Before we made any final conclusion we need to check for positive serial correlation. The calculated d statistic for every variable is greater than the critical upper limit. In conclusion, we cannot reject the null hypothesis and there was no statistical evidence of positive serial correlation. This means we can have our final conclusion which is that all of our time series exhibit results that are consistent with stationarity.

After treating the problems of non-stationarity, we ran our regression analysis on first difference basis.

4.4 Test for Co-integration

We can use the Engle-Granger (EG) methodology to generate the residuals and employ generated residuals to estimate a regression of first-differenced residuals on lagged residuals. Some Monte Carlo evidence indicates that Johansen procedure performs better than both single equation methods and alternative multivariate methods.[28] However, co-integration requires the variables to have the same stochastic trends as in our case.[29]

We want to reject the null hypothesis that they are not co-integrated. The coefficient that we estimated is the first difference of first leg. The tau-statistic is large and the p-value is low, therefore, we can reject the null hypothesis. We assuming those are the augmented dickey-fuller test.

Gujarati suggests that the residual term is non-stationary which means rejection of co-integration, this may cause some confusion since they acceptance of the null unit root in the residual suggests rejection of co-integration.[30]

If the error term is not normally disturbed, the F and t test would be questionable useful value. However, if the error term has a 0 mean, has no autocorrelation, no heteroscedasticity, and the independent variables are fixed in repeated sampling then the F and t test can be used by invoking the central limit theorem. Since our sample is large and we know that there is no heteroscedasticity in our gold model. Also, we use Newey-West standard errors to correct for autocorrelation, and then we can affordable use the F and t value.

We are indicating is that if we didn't get the unit root is means stationary, we can

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[28] Bilgili Faik, "Stationarity and cointegration tests: Comparison of Engle - Granger and Johansen methodologies," *Mpra Paper* (1998).
[29] Studenmund A. H., *Using Econometrics: A Practical Guide*, 7th ed. (Boston: Pearson, 2017), 558-559.
[30] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 762-764.

reject that null hypothesis, that means it is co-integrated in Engle-Granger test. As theories suggest, the t-value must be larger than -2.70. From appendix D, we can obviously see all the t-values for our four independent variables are larger than -2.70 in absolute value. By rejecting those variables with high t score, we find evidence for co-integration.

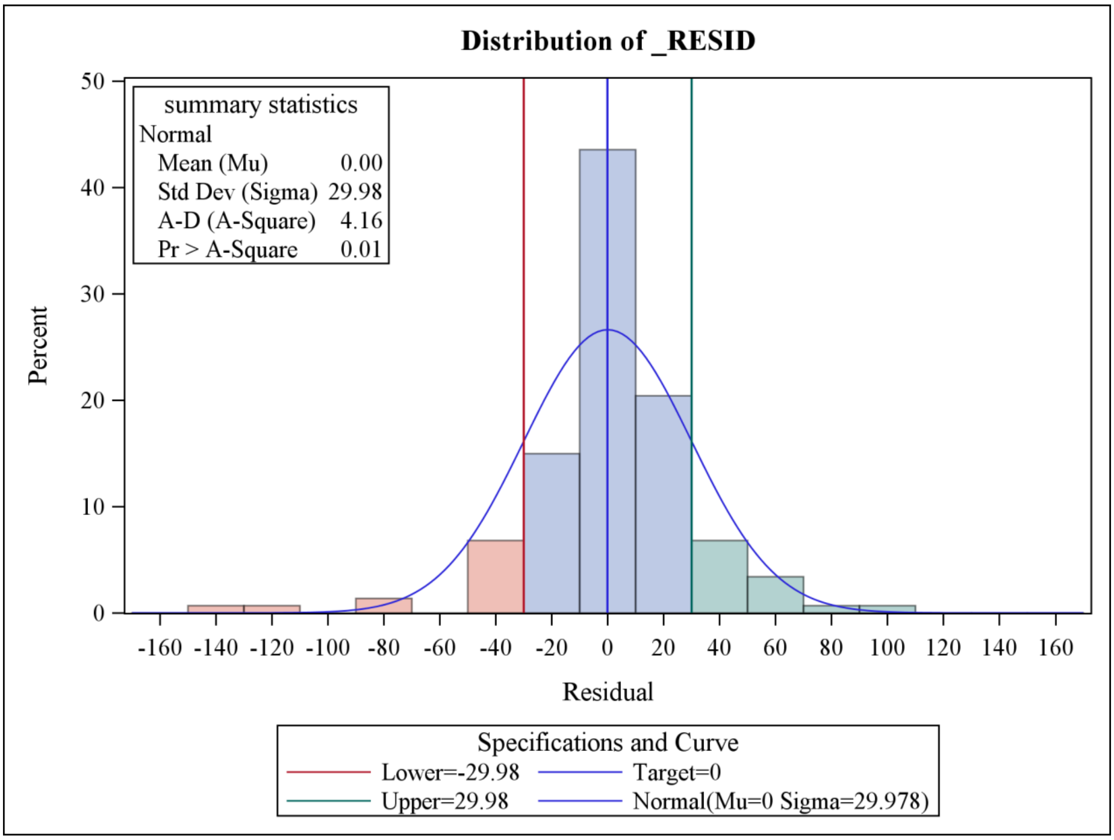
5 HYPOTHESIS RESULTS AND EVALUATION

5.1 Normality test for Gold model with differences in A-D test and J-B test

The Anderson–Darling test is a statistical test of whether a given sample of data is drawn from a given probability distribution. In its basic form, the test assumes that there are no parameters to be estimated in the distribution being tested, in which case the test and its set of critical values is distribution-free.

In statistics, the Jarque–Bera test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The test is named after Carlos Jarque and Anil K. Bera.[31]

Figure 12 A-D test for Gold model in first difference



(Resource: Appendix A2 Gold Model 1: Anderson–Darling test for Non-bootstrapping

[31] Carlos Jarque and Anil K. Bera, “A Test for Normality of Observations and Regression Residuals,” *International Statistical Review* 55 (1987): 163-72.

148 Regression Data for Differences (SAS))

A glance at the bar graph offered describes the rates of gold price model from 1980-Ⅰ to 2016-Ⅳ. The A-D (A-Square) is 4.16, and the probability is only 1 percentage. We expect the data follows the blue curve. But, it is obviously that the bar graph does not follow the pattern, so we rejected the null hypothesis. The value in J-B test is 218.5960 which is much higher than the criteria, and the probability is smaller than 0.01 percentage. So, we can get the same conclusion in the J-B test, more details are shown in the Appendix A2.

5.2 Hypothesis Testing/Result

The dependent variable in every equation must be stationary. After the stationary test, we found when testing for the unit root of the data in level form, it is not stationary. A first difference model is run for the price of gold using SAS 9.4. 0. The estimated equation for 1st difference in the model is indicated below. The numbers in parentheses are the standard errors of the estimates.

5.2.1 Gold Model in First Difference

Equation 1 Estimated Level Specification of gold price model with difference

$$\Delta\hat{GP}_t = -3.09734 + 0.00012973\Delta GGP_t - 9.93113\Delta INT_t - 8.72124\Delta INF_t - 4.46080\Delta USDI_t$$

$$se = (2.54864) \quad (0.00008772) \quad (6.45305) \quad (7.11490) \quad (0.94457)$$

$$t = -1.22 \quad 1.48 \quad -1.54 \quad -1.23 \quad -4.72$$

$$\bar{R}^2 = 0.1821 \qquad F = 7.90$$

From the results, the real GGP is not statistics significant, the real rate of interest is not statistics significant, and the inflation is not statistics significant, only the USDI is statistics significant. Basically, all of the variables were 0, excepted the USDI. That what the t statistics telling us. And what the R square telling us was we were only explaining 18% of the data why the real price of gold change. The only variable are statistics significant was the real USDI. The rest of them are not statistics significant.

The SAS result shows, the change of GP on first difference basis with respect to ΔGGP is about 0.01, suggesting that if the 1st difference of real Gross Global Product goes up by 1 percent, on average, the 1st difference of real price of gold goes up by about 0.01 percent. Thus, on average, if GGP change by one percent, the real price of gold will change $18.

The coefficient for the 1st difference of real interest rate can be interpreted as an change which means that a one percent change in the 1st difference of the real interest rate results in a 10 percentage change in the 1st difference change of real gold price, holding all other independent variables constant. Rising real interest rates are said to be bad for gold because it increases the opportunity cost of holding the yellow metal. This makes sense intuitively as gold pays no interest or dividend, and will therefore be less attractive as compared to risk-free bonds when real interest rates are higher. Gold has generated positive returns during periods of falling real interest rates and negative returns during periods of rising real interest rates. Gold doesn't do interest, bonds give interest, interest are the better deal, people will hold less gold.

The coefficient for the inflation rate indicates that a one percent change in the 1st difference of inflation rate results in a negative 8.7 percent change in the 1st difference of real gold price, holding all other independent variables constant. The sign of the coefficient is negative which is opposite of what was theoretically expected. In times of inflation, investment demand usually increases and gold will perform well.

The coefficient for the 1st difference of real U.S. dollar index is -4.5. It means that a one percent increase in the 1st difference of real trade weighted U.S. dollar index results in a 4.5 percent decline in the 1st difference of real price of gold, holding all other variables constant. It is reasonable and fair. Gold is an alternative investment tool for US dollar assets. When the US dollar moves strongly, the opportunity to invest in the appreciation of the US dollar will increase, and investors will naturally chase the US dollar. On the contrary, when the dollar is weak, investors will tend to invest in gold and the price of gold will be strong as our theory.

T test is not significantly different from 0. So that says there is not relationship between inflation and gold prices. The change in the GGP is not statistics significant; none of them are statistics significant except the USDI. So, we were saying here, this is not a very good model. If the t scores were valid, then they would indicate that all of the estimated coefficients would be statistically significant which is what we got here. The t scores are normally distributed. A histogram of the residuals and an A-D test indicated that there is not support to reject the null hypothesis that the error term is normally distributed. The error term is not normally distributed on A-D test the t-test will be a legitimate test. While, the J-B test indicated that there is support to reject the null hypothesis that the error term is normally distributed. We got the same result for normality test on A-D test and J-B test. Fortunately, most of the coefficients are expected as theory would suggest, except for the rate of inflation.

And the F-value is statistically significant in the model but the $\overline{R}^2$ is only 0.18.

However, the t-value indicated that not all the variables are significant on a 5% level as selected. The model has one significant variable, the first difference of USDI, and the coefficient on first difference of rate of inflation has the wrong sign, the three other dependent variables have the right sign and very low p-value.

5.2.2 The Newey-West Method of Correcting the Gold Model OLS Standard Errors

Instead of the White's heteroscedasticity-consistent standard errors, we use Newey-West method to larger the t-statistics and lower the p-value in our gold model. The Newey-West technique is strictly speaking valid in large samples, our sample sizes have 148 numbers, and we can assume that our sample is a large sample. Because it produces autocorrelation-corrected standard errors, we do not need to worry about the EGLS transformations.[32] Our sample is reasonably large, so we can use the Newey-West procedure to correct our gold model OLS standard errors. According to GMM estimation summary, we obtain the following regression results.

$$\Delta \hat{GP}_t = -3.09734 + 0.00013\Delta GGP_t - 9.93113\Delta INT_t - 8.72124\Delta INF_t - 4.4608\Delta USDI_t$$

$$se = \quad (2.8959) \quad (0.000133) \quad (9.7437) \quad (8.8287) \quad (1.1484)$$

$$t = \quad -1.07 \quad 0.97 \quad -1.02 \quad -0.99 \quad -3.88$$

$$\bar{R}^2 = 0.1821 \qquad F = 7.90$$

Comparing this regression with our gold model in the Newey-West error correction model with the first difference, we find that in both equations the estimated coefficients and the $\bar{R}^2$ value are the same. But, as our expected, the HAC (heteroscedasticity and autocorrelation-consistent) standard errors are much greater

[32] Damodar Gujarati N., *Basic Econometrics*, 5th ed. (Boston: McGraw-Hill Irwin, 2009), 447-448.

than the original gold model OLS standard errors and the t-statistics are much smaller than the OLS original t-statistics. Therefore, it shows that OLS has in fact underestimated the true standard errors.

This is the interpretations of my parameters, but the t tests telling us they were not statistics significant. Part of the problem is that the t test we have because it is not normally distributed.

5.2.3 Interpretations the Theoretically Relevant Variables

There is a negative effect on inflation rate to the real price of gold. We are discussing why the coefficient of rate of inflation had the opposite sign of the theories we found below.

Inflation is a problem, because we would expect that the inflation goes up, the gold price goes up, because it’s a hedging inflation. But this is insignificant statistics. We do not need to care about it.

The purchasing power of a country’s currency is determined based on the price index. When the price of a country is stable, the ability to purchase money is also stable, and inflation has little impact on the people. Moreover, nationals can hold interest on cash, so when investors can choose to invest in currency, they can also hold gold in case of need.

When inflation is very serious, holding cash will not be guaranteed at all. Not only will it not be able to obtain more interest, but it will also lose assets. Cash is not attractive to the people. The people will abandon the currency and choose gold. The increase in demand for gold is likely to push up the price of gold. It is worth noting that the inflation rate in the United States has the greatest impact on gold prices, so investors should pay close attention.

Therefore, the advantages of gold are not only embodied in its rarity, but also reflected in its continued circulation as a non-credit currency in various countries of the world, and gold can be used as an eternal representative of value.

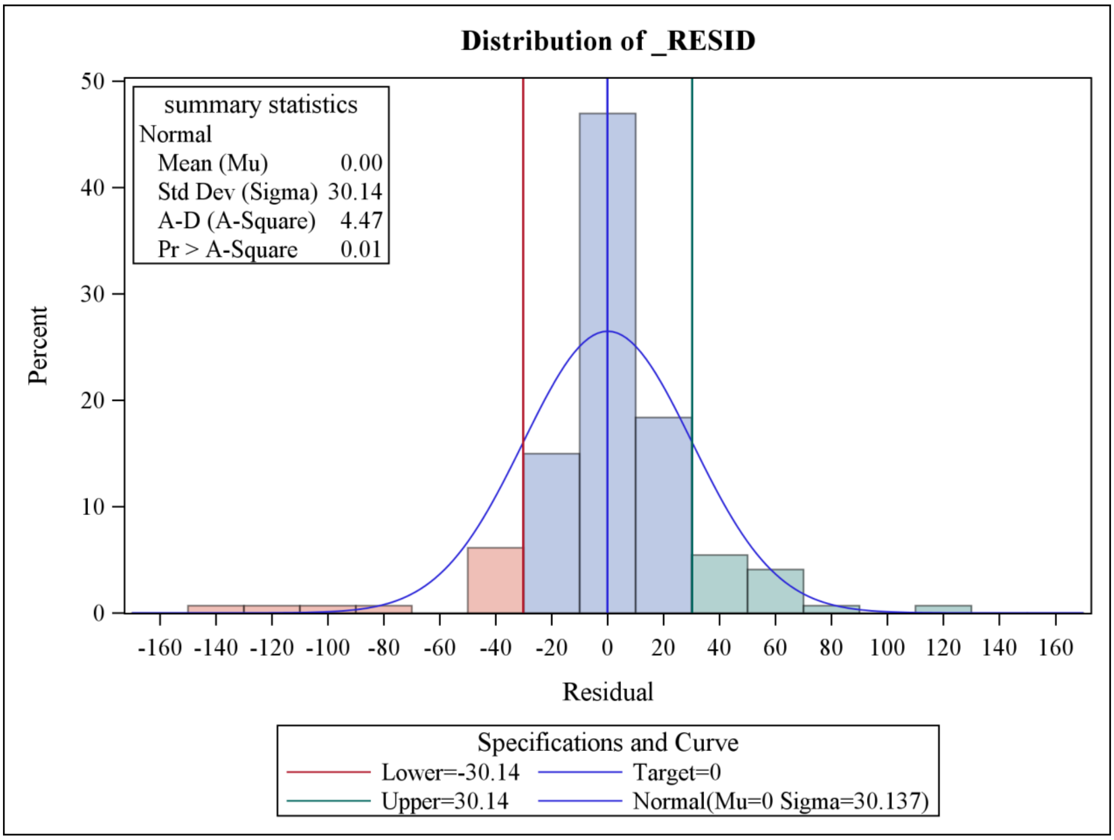
In summary, the performance of gold is not dependent on the inflation rate. This may be a problem with the data set; using monthly data may show the expected theoretical result. When you choose to invest in gold or gold stocks, you shouldn't just hedge the inflation risk of pensions. More and more people are aware of this fact that the increase in investment demand is not necessarily accompanied by rising inflation (history has proved this point). The bottom line of gold investment is to diversify the portfolio and nothing more.

The real USDI was the only relevant variable with the real price of gold. We can say here on quarterly data, the real USDI have more relationship with the real quarterly price of gold.

5.2.4 Adjustment for Multicollinearity

We remind Correlation mastery of Estimates of independent variables, as we can see in appendix A1 Correlation of Estimates table, we find the correlation between real rate of interest and real rate of inflation is particularly high, which is 0.8048. This means there might be multicollinearity between real rate of interest and rate of inflation. One of the ways to correct this situation is that changes in the price of gold affect the income from different interest rates or inflation. We may want to try shorter interest rate but in real terms for our model or revise my regression without the rate of inflation.

Figure 13 A-D test for revise gold model in difference



As we can see in the bar graph offered describes the real rates of gold price model from 1980-Ⅰ to 2016-Ⅳ. The A-D (A-Square) is 4.47, and the probability is only 1 percentage. We expect the data follows the blue curve. But, it is obviously that the bar graph didn't follow the rule, so we rejected the null hypothesis that the residuals are normally distributed. The probability of obtaining such a statistic under the normality assumption is about 0 percent. Therefore, we can get the same conclusion in the J-B test, too. And more details are shows in the Appendix A5 and A6.

In our particularly case, we tried to revise our regression. After we dropped the rate of inflation, and used Newey-West standard error correction model, we obtained the following regression:

$$\hat{\Delta GP_t} = -2.68731 + 0.00013578\Delta GGP_t - 3.56551\Delta INT_t - 4.62086\Delta USDI_t$$

$se =$ (2.8131) (0.000139) (4.7070) (1.1359)

$t =$ − 0.96 0.97 − 0.76 − 4.07

$\bar{R}^2 = 0.1561$ $R^2 = 0.1734$ $F = 10.00$

The result of revise the gold price model is summarized in the equation above. It was even worse now than it was before. Nothing but the real USDI was statistical significant. The interpretation of the coefficient of the 1st difference of real GGP is that a 1 percent change in the real value of real GGP will result in the 0.01 percent change in real price of gold, holding constant the value for interest rate, and USDI. The estimated coefficient for the real interest rate indicates a one percentage decrease in real interest rate result in a 3.6 percentage increase in the 1st difference of price of gold, holding constant the value for GGP, and USDI. The estimated coefficient for the real trade weighted U.S. dollar index is that a one dollar percentage change in the 1st difference of USDI will result in the 4.6 percentage decrease in the 1st difference of real price of gold, holding constant the value for GGP, interest rate and inflation rate.

The F and t value are both invalid, the result is the same as the first regression above. We indicated that we have one significant variable which is the first difference of USDI. But, the most important part is all the signs of the estimated coefficients of the variables are consistent with theory and have very low p-value.

The reason why I took the inflation off is it has an opposite sign than the theory, even the real GGP and the rate of interest also not statistical significant. And there was a highly possible that there is a multicollinearity between real rate of interest and the inflation. Therefore, I chose to remove the inflation.

5.3 Chapter Summary

In this research, using quarterly data may not be useful and does not do well in predicting changes in gold prices. The major issue is that many of the macro variables are not available as monthly or daily data and miss the variability in gold prices. So, we cannot use our research results for gold investment. And even correcting for the standard errors, it didn't change my results. I have a few suggestions, and I will illustrate them below. The first finding is trying to use a different technique. The second finding is getting a different data set. The third finding is doing more research to come up with more representative sample. The fourth finding is trying to find out different methods to resample the original data set with different type of methods. Finally, quarterly data may work, if we have long enough quarterly data. The current data set does not have long enough series. Even there is monthly price of gold, monthly rate of interest, monthly inflation, and monthly USDI, but there is not monthly GGP. If the methods above do not work, finally, we may work on the central limit theorem, and may get the result we want.

Testing showed it was appropriate to use the first difference to enhance the stability of data, and it was better to demonstrate the relevance of the data. Through data analysis, the results are consistent with our original assumptions and we accept the original hypothesis. The best fit to the assumption of the equation is to use the first difference. Therefore, since the variable has a strong theoretical rationale we chose to keep it in the equation.

My major result is that we cannot use quarterly data, it is a theoretical problem that we don’t have a measure and using smoothing technique doesn’t work.

6 FINAL CONCLUSION AND RECOMMENDATIONS

6.1 Re-statement of the Problem

Our original purpose was to investigate the implications of the macroeconomic factors on the real price of gold. Our study has provided, identified, and quantified relationships that can let these implications clarify. The gold model provides quantitative significant measures of the macroeconomic factors' impact on the real price of gold. The estimated results support our contention that there is a significant relationship between the real Gross Global Product, real interest rate, and real U.S. dollar index and real price of gold.

Even the review of literature represents that there have been mixed results reported by other studies. Some studies found a link between the price of gold and those macro factors while others found no link. Accordingly, our model suggests that in long-term period the real Gross Global Product has a positive relationship with the real price of gold. The real interest rate has a negative relationship with the real price of gold; real U.S. dollar index has a negative relationship with the real price of gold. But it may have some differences in the short term, especially for the real rate of interest. Due to this, this factor has stronger volatility, it is not predictable. At the same time, it has the least relevance to the price of gold.

6.2 Conclusion

We ran two regressions in this thesis. They were both on the first differences basis. We were concerned with three variables for our final gold model. These variables are represented by real Gross Global Product, real rate of interest, and real

U.S. dollar index. Every variable was converted to first-order.

One estimated econometric model was estimated with the ordinary least squares (OLS) approach. The model demonstrates a statistically supported linkage between the real price of gold and the macro factors. Theory suggests the further linkage between the real price of gold and real Gross Global Product, real interest rate, and real U.S. dollar index. As expected, if we do not consider about the statistic significant, I found a positive relationship in first difference of real GGP per quarter and first difference of real gold price was statistically significant. I found a negative relationship in real interest rate and first difference of gold price was not statistically significant. I found a negative relationship in first difference of real USDI and first difference of real gold price was statistically significant. Therefore, we can reject the null hypothesis in this case.

If we want to run a macro model that includes GGP, owing to gold prices are so volatile over the year, what we were more willing to picking up the relationship. They do not move the long-term, gold prices are moving randomly over the short period of time, so they are not following this long-term GGP trend.

Our models focus more on real data. Finally, we chose the first difference with our gold model. First of all, all the sign agreed with the alternative hypothesis. Second, all the variables were stationary on first difference form. Third, the model says the only things that they were related the quarterly were the real USDI and real price of gold. The other variables are not related in a quarterly model. And I am focusing on the quarterly model. Last but not least, we have quantified one implication of how the real macroeconomic factors affect the real price of gold. We think that our equations can help in evaluating the macro-influence factors of gold prices.

Our model provides a quantified linkage between real gold price and real world GDP, real interest rate, and real USDI. Nevertheless, one interesting thing is that the result of predicted rate of interest has the in contrast sign than the real interest rate in 2018 first quarterly result. There is a phenomenon that shows that when the rate of interest rises, the real price of gold will not fall indefinitely. Anywise, when the rate of interest falls, it is more likely to lead to a rebound in real gold prices.

Norcini believes that those investors who hold long positions in commodities now have expectations for inflation and the economic improvement.[33] They think that as the economy improves, the use of the metal industry will increase. For long positions in commodities, the strong US dollar trend will lead to a drop in commodity prices.

It is the continuous changes in market sentiment that have an impact on the trend of gold prices, which has caused some commodity markets to fall into the current volatile areas. Investors are looking for signs of economic recovery, but at the same time they are also influenced by other factors that can make them hesitant.

Our study was successful in testing a specification of this model, but further research might enhance the model, because the gold price has high volatile. My idea was I want to see whether or not I could use macro variables on the quarterly basis to forecast gold prices. What we found is that because of the volatility of gold, quarterly

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[33] Dan Norcini, "Dan Norcini Comments on Precious Metals and Currencies." Gold-Eagle, March 6, 2015, https://www.gold-eagle.com/rate/price-of-gold.

model are not a good fit for predicting the gold prices. In next section we suggest research paths that might be taken that could improve the model.

6.3 Recommendations

Even though I use multiple methods to analyze the relationship between real gold prices, real GGP, real interest rate, and real USDI, the model may still have some small problems.

This model doesn't work may be because we only have 148 observations. We may need to find the substitute proxy for the real GGP. There is a problem with our model, so we may come up with other model.

In estimating my model of gold with 1st different approaches to real data I found that there are number of econometric problems that need to be addressed in future studies. I also found low R-Square, heteroscedasticity, autocorrelation; some variables of the data series for some regions were non-stationary and abnormal residuals distributions. Some of these problems were corrected. For instance, using first difference for stationary; I corrected for the heteroscedasticity and autocorrelation problems by using Newey-West standard errors, and I coped with the abnormality residual terms by bootstrapping theorem.

However, future research should conduct the Error Correction Model (ECM) for omitted variables. The gross global product should be substitute by the top gold produces countries total GDP. The other option is that it might be useful to use a dynamic specification with the lag structure. Furthermore, a future study might select another data set or a bigger data set in order to avoid outliers.

This model doesn’t work may be because we only have 148 observations. We may need to find the substitute proxy for the real GGP. There is a problem with our model, so we may come up with other model.

We need continue study with this topic in this area. Gold prices are an interesting and sensitive topic, also have much different type of methods to study on it and do more analysis in this area.

My model has defects, and here is where I am standing. But I will keep working on it to fix the error. I also welcome any of the readers who are caught up in this area and have better suggestions for my model, to feel free to contact me.

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Appendix

Appendix A

A1 Gold Model 1: 148 Regression Data for First Difference Gold Model (SAS)

The REG Procedure

Model: MODEL1

Dependent Variable: realgp1

Number of Observations Read	148
Number of Observations Used	147
Number of Observations with Missing Values	1

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	4	29214	7303.39644	7.90	<.0001
Error	142	131212	924.02564		
Corrected Total	146	160425			

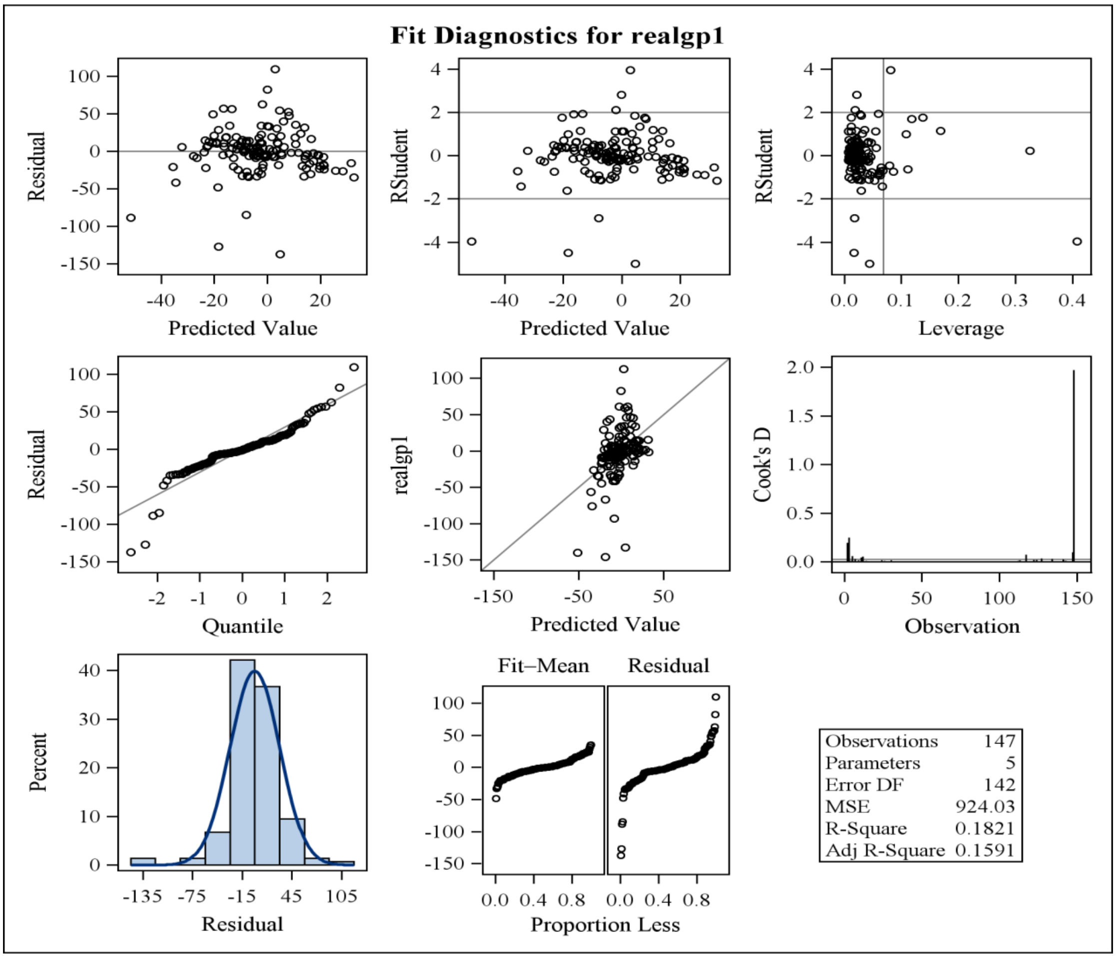
Root MSE	30.39779	**R-Square**	0.1821
Dependent Mean	-2.61578	**Adj R-Sq**	0.1591
Coeff Var	-1162.09174		

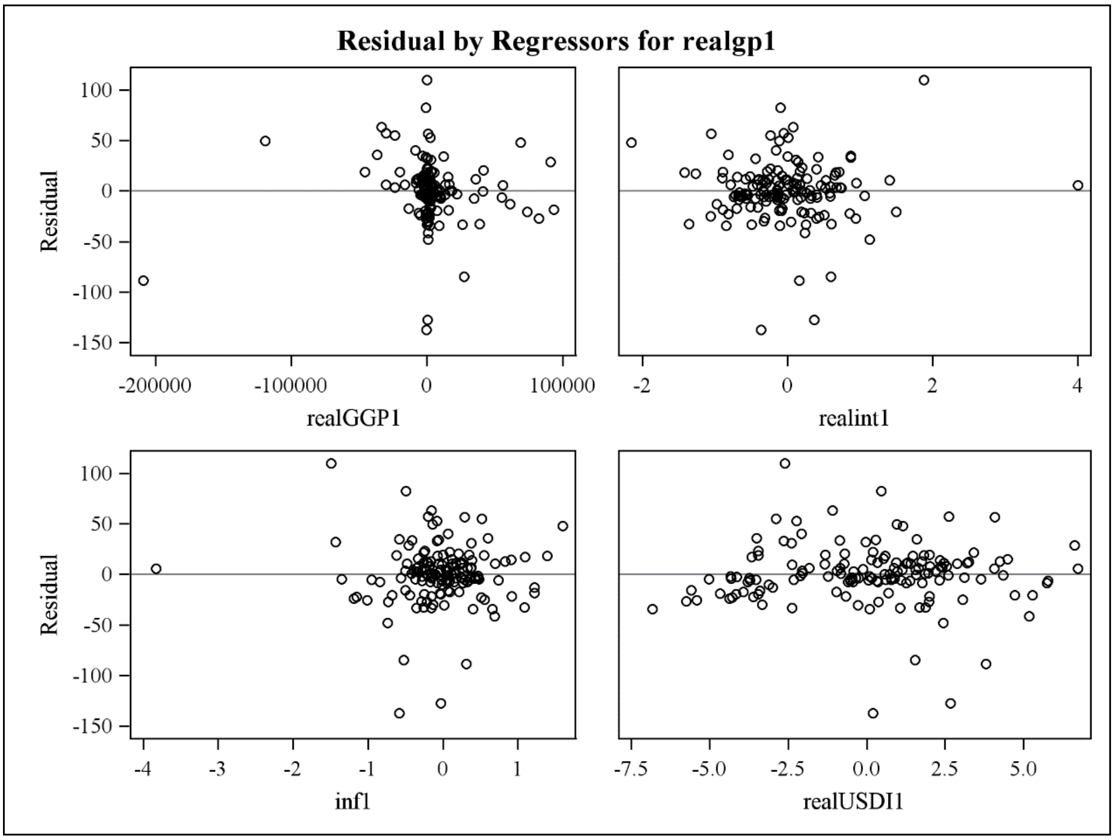
Parameter Estimates							
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Tolerance	Variance Inflation
Intercept	1	-3.09734	2.54864	-1.22	0.2263	.	0
realGGP1	1	0.00012973	0.00008772	1.48	0.1414	0.98827	1.01187
realint1	1	-9.93113	6.45305	-1.54	0.1260	0.33310	3.00210
inf1	1	-8.72124	7.11490	-1.23	0.2223	0.34771	2.87598
realUSDI1	1	-4.46080	0.94457	-4.72	<.0001	0.91969	1.08733

Correlation of Estimates					
Variable	Intercept	realGGP1	realint1	inf1	realUSDI1
Intercept	1.0000	-0.0927	0.1418	0.1312	-0.0574
realGGP1	-0.0927	1.0000	0.0461	0.0563	-0.0972
realint1	0.1418	0.0461	1.0000	0.8048	-0.2482
inf1	0.1312	0.0563	0.8048	1.0000	-0.1382
realUSDI1	-0.0574	-0.0972	-0.2482	-0.1382	1.0000

Test of First and Second Moment Specification		
DF	Chi-Square	Pr > ChiSq
14	13.04	0.5232

Durbin-Watson D	1.705
Number of Observations	147
1st Order Autocorrelation	0.046

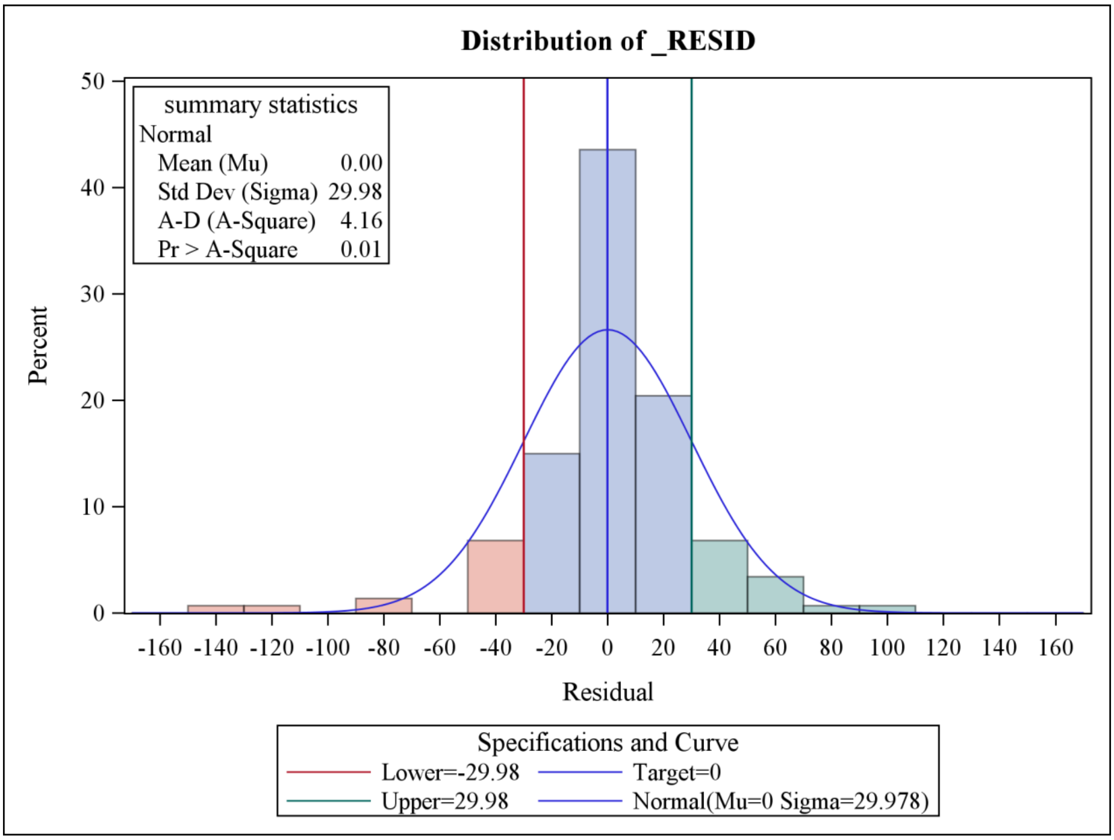

Fit Diagnostics for realgp1
Residual
Predicted Value
RStudent
Leverage
Quantile
realgp1
Cook's D
Observation
Percent
Residual
Fit–Mean
Proportion Less
Observations 147
Parameters 5
Error DF 142
MSE 924.03
R-Square 0.1821
Adj R-Square 0.1591


Residual by Regressors for realgp1
Residual
realGGP1
realint1
inf1
realUSDI1

A2 Gold Model 1: Anderson–Darling Test for 148 Regression Data for First Difference Gold Model (SAS)

GOLD MODEL 1 A-D test

RESIDUALS OF GOLD REGRESSED ON MACRO FACTORS (DIFFERENCE)



The CAPABILITY Procedure
Fitted Normal Distribution for _RESID (Residual)

Parameters for Normal Distribution		
Parameter	**Symbol**	**Estimate**
Mean	Mu	0
Std Dev	Sigma	29.97849

Goodness-of-Fit Tests for Normal Distribution					
Test	**Statistic**		**DF**	**p Value**	
Kolmogorov-Smirnov	**D**	0.14081		**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	0.70858		**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	4.15734		**Pr > A-Sq**	<0.005
Chi-Square	**Chi-Sq**	1067.67240	10	**Pr > Chi-Sq**	<0.001

Percent Outside Specifications for Normal Distribution

Lower Limit		Upper Limit	
LSL	-29.980000	USL	29.980000
Obs Pct < LSL	9.523810	Obs Pct > USL	11.564626
Est Pct < LSL	15.864307	Est Pct > USL	15.864307

Quantiles for Normal Distribution		
	Quantile	
Percent	Observed	Estimated
1.0	-127.27517	-69.7404
5.0	-34.14119	-49.3102
10.0	-27.29190	-38.4190
25.0	-8.70957	-20.2202
50.0	-0.85198	0.0000
75.0	11.69749	20.2202
90.0	33.36194	38.4190
95.0	49.38935	49.3102
99.0	82.41646	69.7404

A3 Gold Model 1: Jarque–Bera Test for 148 Regression Data for First Difference Gold Model (SAS)

GOLD MODEL 1 J-B test

RESIDUALS MODEL OF GOLD REGRESSED ON MACRO FACTORS

(DIFFERENCE)

The AUTOREG Procedure

Dependent Variable	realgp1

Ordinary Least Squares Estimates			
SSE	131211.641	DFE	142
MSE	924.02564	Root MSE	30.39779
SBC	1440.85783	AIC	1425.90567
MAE	19.3627368	AICC	1426.3312
MAPE	515.361438	HQC	1431.9809
Durbin-Watson	1.7053	Total R-Square	0.1821

Miscellaneous Statistics			
Statistic	Value	Prob	Label
Normal Test	218.5960	<.0001	Pr > ChiSq

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-3.0973	2.5486	-1.22	0.2263
GGPS11	1	0.000130	0.0000877	1.48	0.1414
int	1	-9.9311	6.4531	-1.54	0.1260
inf	1	-8.7212	7.1149	-1.23	0.2223
USDI1	1	-4.4608	0.9446	-4.72	<.0001

Estimates of Autocorrelations			
Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	892.6	1.000000	| |********************|
1	40.6432	0.045534	| |* |
2	19.8604	0.022250	| | |
3	138.2	0.154825	| |*** |
4	95.2178	0.106675	| |** |

Preliminary MSE	881.7

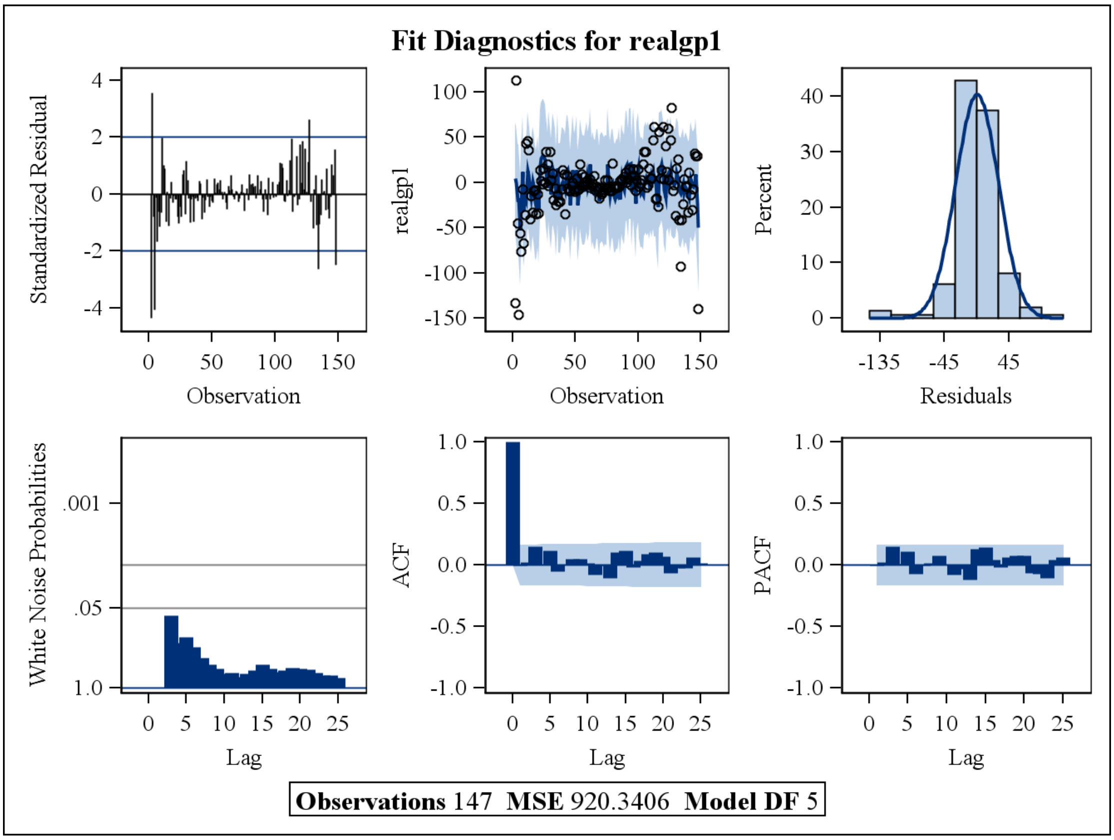
Estimates of Autoregressive Parameters			
Lag	Coefficient	Standard Error	t Value
1	-0.029730	0.085022	-0.35
4	-0.102072	0.085022	-1.20

Expected Autocorrelations	
Lag	Autocorr
0	1.0000
1	0.0300
2	0.0010
3	0.0031
4	0.1022

Yule-Walker Estimates			
SSE	128847.678	DFE	140
MSE	920.34056	Root MSE	30.33712
SBC	1448.20896	AIC	1427.27593
MAE	19.0145354	AICC	1428.08169
MAPE	498.710415	HQC	1435.78125
Durbin-Watson	1.8119	Transformed Regression R-Square	0.1770
		Total R-Square	0.1968

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-3.2590	2.9046	-1.12	0.2638
GGPS11	1	0.000127	0.0000870	1.45	0.1479
int	1	-9.4409	6.3222	-1.49	0.1376
inf	1	-8.7459	6.9593	-1.26	0.2109
USDI1	1	-4.4179	0.9512	-4.64	<.0001

Expected Autocorrelations	
Lag	Autocorr
0	1.0000
1	0.0300
2	0.0010
3	0.0031
4	0.1022



Fit Diagnostics for realgp1
Standardized Residual
Observation
realgp1
Observation
Percent
Residuals
White Noise Probabilities
Lag
ACF
Lag
PACF
Lag
Observations 147 MSE 920.3406 Model DF 5

A4 Gold Model 2: Revise model for 148 Regression Data for First Difference Gold Model (SAS)

The REG Procedure
Model: MODEL2
Dependent Variable: realgp1

Number of Observations Read	148
Number of Observations Used	147
Number of Observations with Missing Values	1

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	3	27825	9275.07466	10.00	<.0001
Error	143	132600	927.27275		
Corrected Total	146	160425			

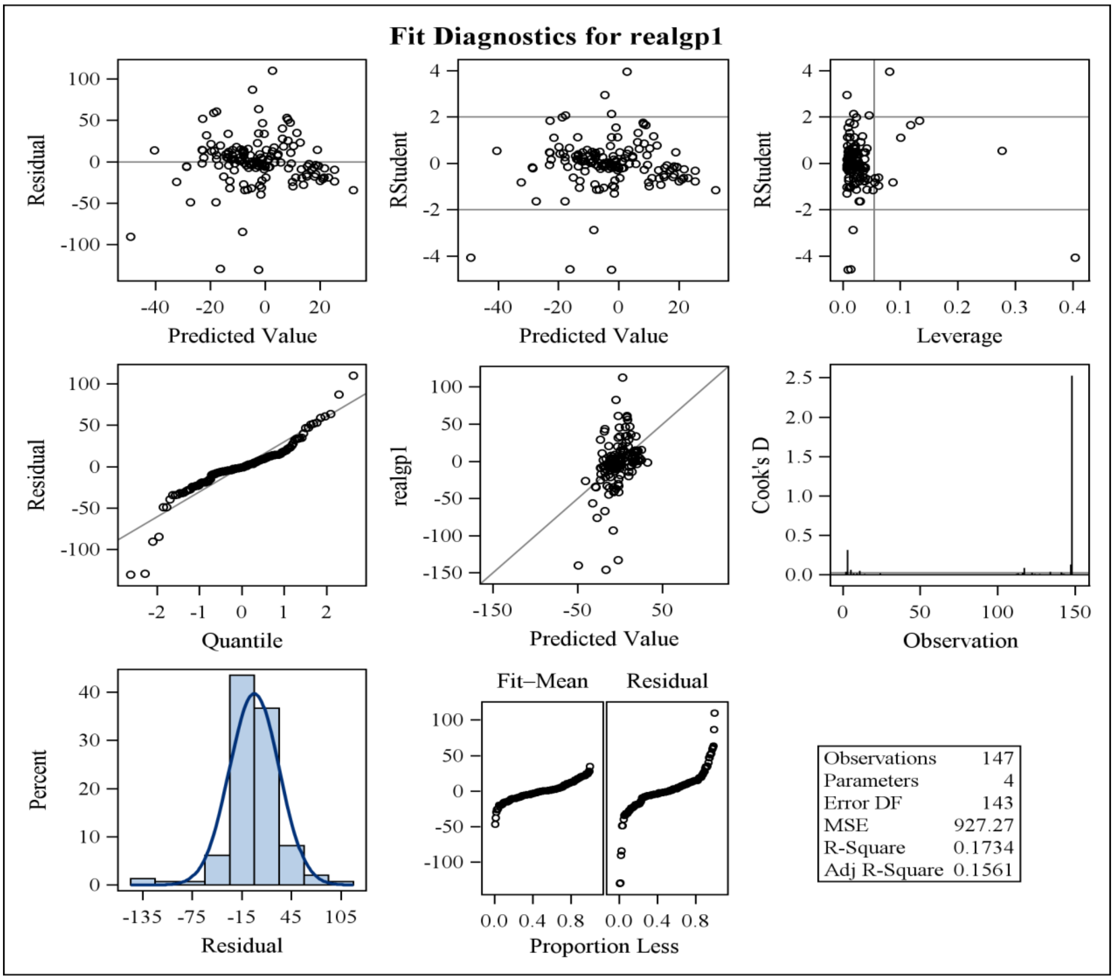
Root MSE	30.45115	**R-Square**	0.1734
Dependent Mean	-2.61578	**Adj R-Sq**	0.1561
Coeff Var	-1164.13179		

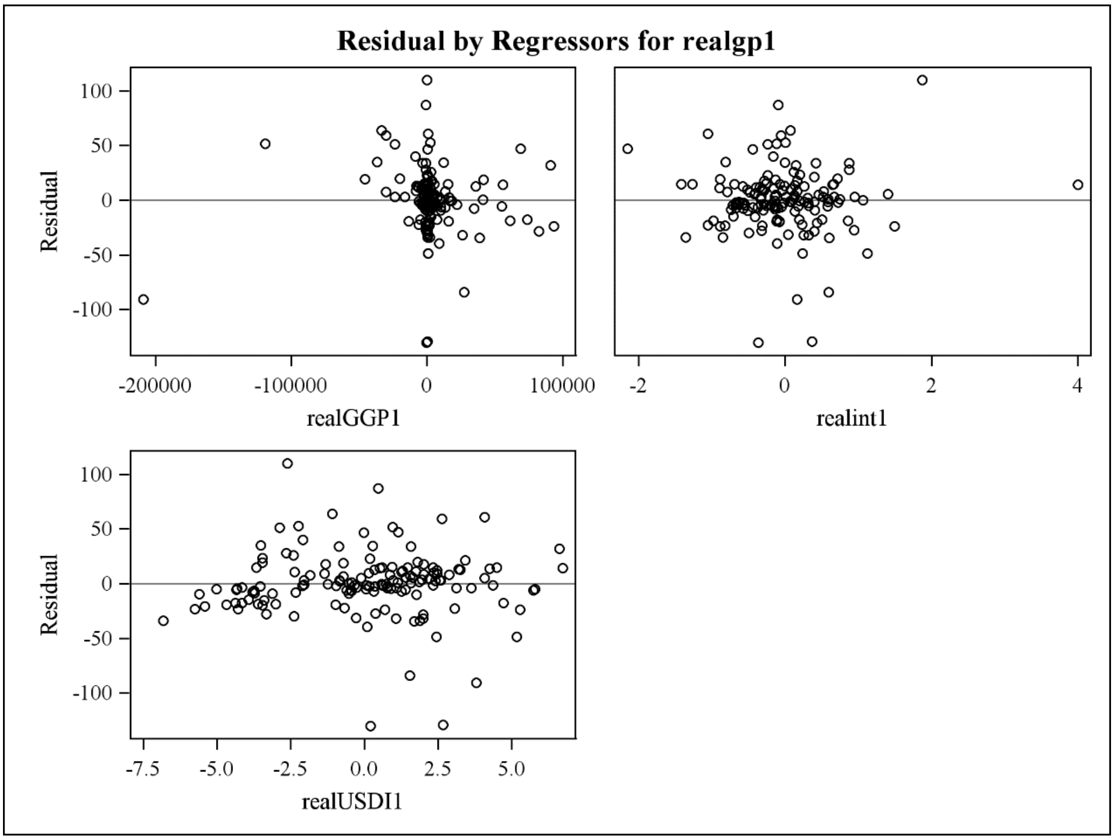
Parameter Estimates							
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Tolerance**	**Variance Inflation**
Intercept	1	-2.68731	2.53103	-1.06	0.2901	.	0
realGGP1	1	0.00013578	0.00008774	1.55	0.1239	0.99141	1.00867
realint1	1	-3.56551	3.83726	-0.93	0.3544	0.94534	1.05783
realUSDI1	1	-4.62086	0.93714	-4.93	<.0001	0.93761	1.06655

Correlation of Estimates				
Variable	**Intercept**	**realGGP1**	**realint1**	**realUSDI1**
Intercept	1.0000	-0.1012	0.0615	-0.0400
realGGP1	-0.1012	1.0000	0.0013	-0.0904
realint1	0.0615	0.0013	1.0000	-0.2330
realUSDI1	-0.0400	-0.0904	-0.2330	1.0000

Test of First and Second Moment Specification		
DF	**Chi-Square**	**Pr > ChiSq**
9	10.13	0.3404

Durbin-Watson D	1.661
Number of Observations	147
1st Order Autocorrelation	0.074



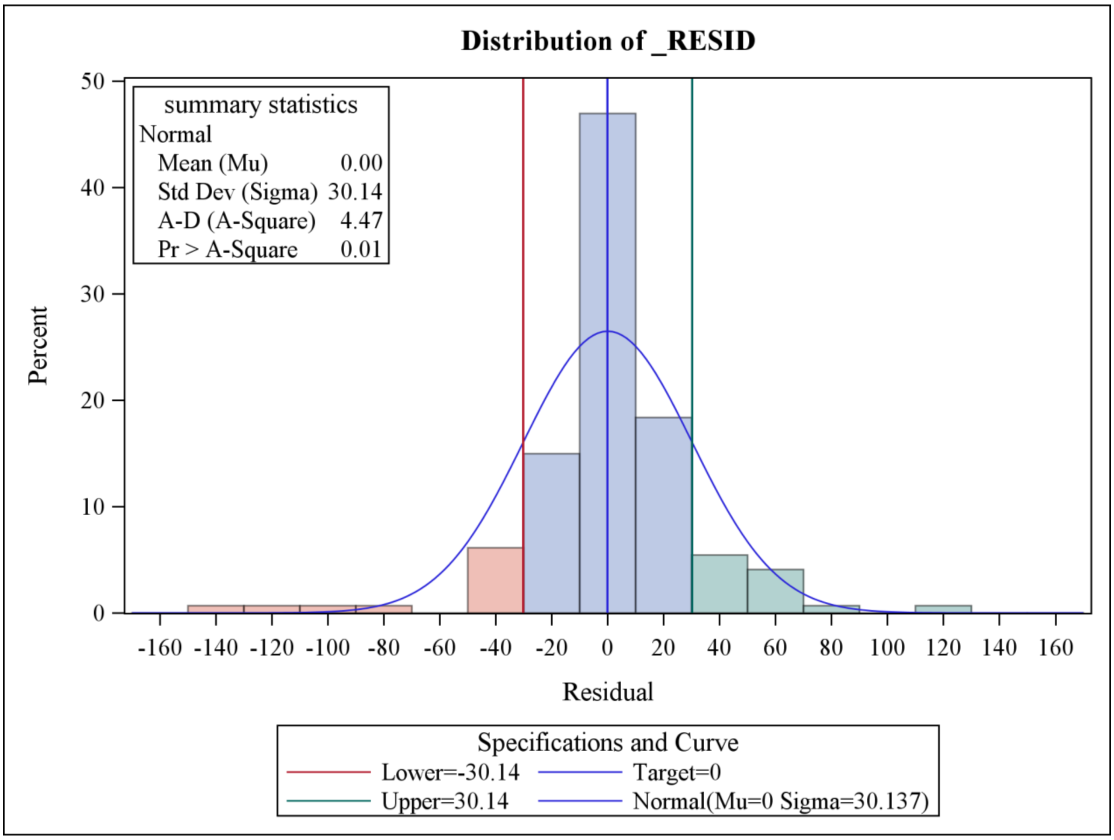


Residual by Regressors for realgp1
Residual
realGGP1
realint1
realUSDI1

A5 Gold Model 2: Anderson–Darling Test for Revise model for 148 Regression Data for First Difference Gold Model (SAS)

GOLD MODEL 2

RESIDUALS OF GOLD REGRESSED ON MACRO FACTORS (FIRST DIFFERENCE)



The CAPABILITY Procedure
Fitted Normal Distribution for _RESID (Residual)
Parameters for Normal Distribution

Parameter	Symbol	Estimate
Mean	Mu	0
Std Dev	Sigma	30.13668

Goodness-of-Fit Tests for Normal Distribution					
Test	**Statistic**		**DF**	**p Value**	
Kolmogorov-Smirnov	**D**	0.13865		**Pr > D**	<0.010
Cramer-von Mises	**W-Sq**	0.78470		**Pr > W-Sq**	<0.005
Anderson-Darling	**A-Sq**	4.46736		**Pr > A-Sq**	<0.005
Chi-Square	**Chi-Sq**	1032.32060	11	**Pr > Chi-Sq**	<0.001

Percent Outside Specifications for Normal Distribution			
Lower Limit		**Upper Limit**	
LSL	-30.140000	**USL**	30.140000
Obs Pct < LSL	8.843537	**Obs Pct > USL**	10.884354
Est Pct < LSL	15.862856	**Est Pct > USL**	15.862856

Quantiles for Normal Distribution		
	Quantile	
Percent	**Observed**	**Estimated**
1.0	-129.34740	-70.1084
5.0	-34.32840	-49.5704
10.0	-28.37081	-38.6217
25.0	-9.14113	-20.3269
50.0	-0.74875	0.0000
75.0	12.64189	20.3269
90.0	33.92251	38.6217
95.0	50.98576	49.5704
99.0	86.96797	70.1084

A6 Gold Model 2: Jarque–Bera Test for Revise model for 148 Regression Data for First Difference Gold Model (SAS)

GOLD MODEL 2

RESIDUALS OF GOLD REGRESSED ON MACRO FACTORS J-B TEST (FIRST DIFFERENCE)

The AUTOREG Procedure

Dependent Variable	realgp1

Ordinary Least Squares Estimates			
SSE	132600.003	**DFE**	143
MSE	927.27275	**Root MSE**	30.45115
SBC	1437.41465	**AIC**	1425.45292
MAE	19.2478292	**AICC**	1425.73461
MAPE	471.265458	**HQC**	1430.3131
Durbin-Watson	1.6608	**Total R-Square**	0.1734

Miscellaneous Statistics			
Statistic	**Value**	**Prob**	**Label**
Normal Test	190.1841	<.0001	Pr > ChiSq

Parameter Estimates					
Variable	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**
Intercept	1	-2.6873	2.5310	-1.06	0.2901
realGGP1	1	0.000136	0.0000877	1.55	0.1239
realint1	1	-3.5655	3.8373	-0.93	0.3544
realUSDI1	1	-4.6209	0.9371	-4.93	<.0001

Estimates of Autocorrelations			
Lag	**Covariance**	**Correlation**	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	902.0	1.000000	| |********************|
1	67.1377	0.074429	| |* |
2	24.6014	0.027273	| |* |
3	117.2	0.129941	| |*** |

Preliminary MSE	882.3

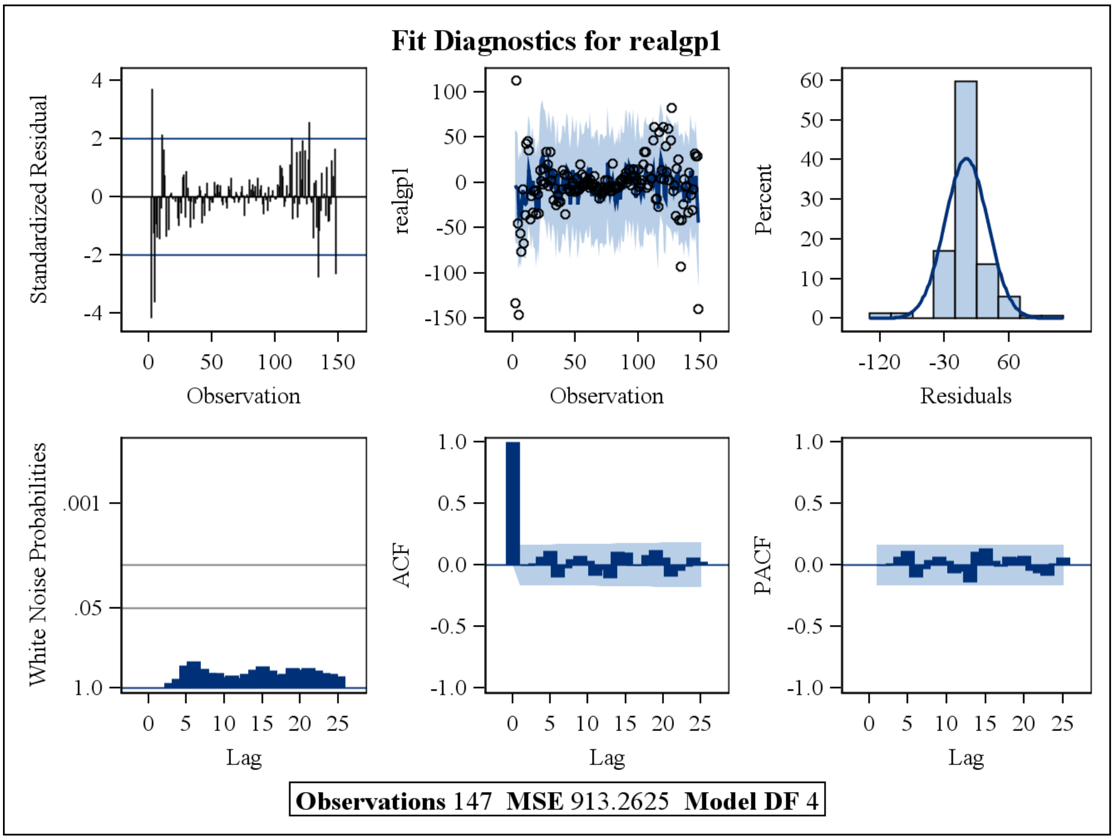
Estimates of Autoregressive Parameters			
Lag	**Coefficient**	**Standard Error**	**t Value**
1	-0.070938	0.083318	-0.85
3	-0.128007	0.083318	-1.54

Expected Autocorrelations	
Lag	**Autocorr**
0	1.0000
1	0.0728
2	0.0145
3	0.1290

Yule-Walker Estimates			
SSE	128770.011	**DFE**	141
MSE	913.26249	**Root MSE**	30.22023
SBC	1443.14212	**AIC**	1425.19952
MAE	18.9236732	**AICC**	1425.79952
MAPE	457.376073	**HQC**	1432.48979
Durbin-Watson	1.7973	**Transformed Regression R-Square**	0.1696
		Total R-Square	0.1973

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-2.9124	3.1122	-0.94	0.3510
realGGP1	1	0.000153	0.0000911	1.68	0.0956
realint1	1	-2.8120	3.7624	-0.75	0.4561
realUSDI1	1	-4.6359	0.9513	-4.87	<.0001

Expected Autocorrelations	
Lag	Autocorr
0	1.0000
1	0.0728
2	0.0145
3	0.1290



Appendix B Correlograms on the Level Basis

Table B a-1 Correlogram of GP_t on the Level Basis

Date: 04/26/18 Time: 21:52
Sample: 1980Q1 2016Q4
Included observations: 148

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.954	0.954	137.55	0.000
.|*******	.|. |	2	0.916	0.059	265.16	0.000
.|******|	*|. |	3	0.863	-0.185	379.08	0.000
.|******|	.|. |	4	0.810	-0.049	480.11	0.000
.|******|	.|* |	5	0.769	0.139	571.85	0.000
.|***** |	.|. |	6	0.726	-0.023	654.19	0.000
.|***** |	.|. |	7	0.694	0.048	729.98	0.000
.|***** |	.|. |	8	0.662	-0.005	799.40	0.000
.|***** |	.|. |	9	0.636	0.045	864.01	0.000
.|**** |	.|. |	10	0.612	0.004	924.26	0.000
.|**** |	*|. |	11	0.582	-0.078	979.21	0.000
.|**** |	.|. |	12	0.551	-0.061	1028.7	0.000
.|**** |	.|. |	13	0.513	-0.040	1072.0	0.000
.|*** |	.|. |	14	0.480	0.032	1110.2	0.000
.|*** |	*|. |	15	0.440	-0.089	1142.5	0.000
.|*** |	*|. |	16	0.398	-0.076	1169.1	0.000
.|*** |	.|. |	17	0.358	0.005	1190.9	0.000
.|** |	.|. |	18	0.321	0.028	1208.5	0.000
.|** |	.|. |	19	0.287	-0.030	1222.7	0.000
.|** |	*|. |	20	0.250	-0.085	1233.6	0.000
.|** |	.|. |	21	0.217	-0.000	1241.8	0.000
.|* |	.|. |	22	0.187	0.043	1248.0	0.000
.|* |	.|. |	23	0.161	0.030	1252.6	0.000
.|* |	.|. |	24	0.139	-0.012	1256.1	0.000
.|* |	.|. |	25	0.117	-0.021	1258.5	0.000
.|* |	.|. |	26	0.098	0.028	1260.3	0.000
.|* |	.|. |	27	0.076	-0.009	1261.3	0.000
.|. |	*|. |	28	0.051	-0.092	1261.8	0.000
.|. |	.|. |	29	0.028	-0.008	1262.0	0.000
.|. |	.|. |	30	0.000	-0.005	1262.0	0.000
.|. |	.|. |	31	-0.026	-0.020	1262.1	0.000
.|. |	.|. |	32	-0.052	-0.040	1262.6	0.000
*|. |	.|. |	33	-0.079	-0.047	1263.8	0.000

*|. |	*|. |	34	-0.108	-0.071	1266.1	0.000
*|. |	.|. |	35	-0.135	-0.003	1269.7	0.000
*|. |	.|. |	36	-0.159	0.002	1274.7	0.000

Table B a-2 Correlogram of GGP_t on the Level Basis

Date: 04/26/18 Time: 21:54

Sample: 1980Q1 2016Q4

Included observations: 148

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.972	0.972	142.55	0.000
.|*******	*****|. |	2	0.907	-0.660	267.60	0.000
.|******|	.|. |	3	0.823	0.039	371.18	0.000
.|***** |	.|* |	4	0.734	0.110	454.13	0.000
.|***** |	.|* |	5	0.651	0.101	520.02	0.000
.|**** |	.|. |	6	0.584	0.073	573.27	0.000
.|**** |	.|. |	7	0.533	0.037	617.92	0.000
.|**** |	.|. |	8	0.497	0.006	657.05	0.000
.|*** |	.|. |	9	0.472	-0.017	692.58	0.000
.|*** |	.|. |	10	0.452	-0.036	725.37	0.000
.|*** |	.|. |	11	0.431	-0.039	755.44	0.000
.|*** |	.|. |	12	0.406	-0.011	782.35	0.000
.|*** |	.|. |	13	0.377	0.018	805.74	0.000
.|** |	.|. |	14	0.346	0.028	825.58	0.000
.|** |	.|. |	15	0.316	0.031	842.25	0.000
.|** |	.|. |	16	0.290	0.021	856.41	0.000
.|** |	.|. |	17	0.271	0.016	868.81	0.000
.|** |	.|. |	18	0.258	0.024	880.18	0.000
.|** |	.|. |	19	0.253	0.029	891.16	0.000
.|** |	.|. |	20	0.253	0.031	902.29	0.000
.|** |	.|. |	21	0.258	0.020	913.91	0.000
.|** |	.|. |	22	0.264	-0.004	926.16	0.000
.|** |	.|. |	23	0.267	-0.028	938.85	0.000
.|** |	.|. |	24	0.265	-0.045	951.45	0.000
.|** |	.|. |	25	0.255	-0.053	963.23	0.000
.|** |	.|. |	26	0.237	-0.047	973.41	0.000
.|* |	.|. |	27	0.209	-0.028	981.46	0.000
.|* |	.|. |	28	0.177	0.003	987.29	0.000
.|* |	.|. |	29	0.145	0.034	991.23	0.000
.|* |	.|. |	30	0.119	0.053	993.88	0.000
.|* |	.|. |	31	0.101	0.052	995.83	0.000
.|* |	.|. |	32	0.096	0.021	997.59	0.000
.|* |	.|. |	33	0.100	-0.010	999.52	0.000
.|* |	.|. |	34	0.110	-0.023	1001.9	0.000
.|* |	.|. |	35	0.120	-0.019	1004.7	0.000
.|* |	.|. |	36	0.126	0.013	1007.8	0.000

Table B a-3 Correlogram of INT_t on the Level Basis

Date: 04/26/18 Time: 21:55
Sample: 1980Q1 2016Q4
Included observations: 148

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.957	0.957	138.32	0.000
.|*******	.|* |	2	0.926	0.115	268.58	0.000
.|******|	.|. |	3	0.897	0.031	391.67	0.000
.|******|	.|. |	4	0.863	-0.061	506.48	0.000
.|******|	.|. |	5	0.838	0.069	615.40	0.000
.|******|	*|. |	6	0.806	-0.072	716.91	0.000
.|******|	*|. |	7	0.771	-0.067	810.40	0.000
.|***** |	.|* |	8	0.749	0.119	899.28	0.000
.|***** |	.|. |	9	0.725	0.016	983.28	0.000
.|***** |	.|. |	10	0.703	0.003	1062.8	0.000
.|***** |	*|. |	11	0.675	-0.096	1136.5	0.000
.|***** |	.|. |	12	0.651	0.056	1205.8	0.000
.|**** |	*|. |	13	0.622	-0.099	1269.4	0.000
.|**** |	.|. |	14	0.597	0.025	1328.5	0.000
.|**** |	*|. |	15	0.568	-0.068	1382.3	0.000
.|**** |	.|. |	16	0.535	-0.037	1430.5	0.000
.|**** |	.|. |	17	0.508	0.020	1474.3	0.000
.|*** |	.|. |	18	0.478	-0.047	1513.4	0.000
.|*** |	.|. |	19	0.450	0.006	1548.3	0.000
.|*** |	.|. |	20	0.427	0.024	1580.0	0.000
.|*** |	.|. |	21	0.405	0.048	1608.7	0.000
.|*** |	.|* |	22	0.393	0.080	1635.9	0.000
.|*** |	.|. |	23	0.379	-0.000	1661.4	0.000
.|*** |	.|. |	24	0.370	0.072	1685.9	0.000
.|*** |	.|. |	25	0.358	-0.043	1709.1	0.000
.|** |	.|. |	26	0.346	-0.012	1730.8	0.000
.|** |	.|* |	27	0.342	0.097	1752.3	0.000
.|** |	.|. |	28	0.334	-0.017	1773.0	0.000
.|** |	*|. |	29	0.316	-0.137	1791.6	0.000
.|** |	*|. |	30	0.289	-0.158	1807.3	0.000
.|** |	.|* |	31	0.270	0.081	1821.2	0.000
.|** |	.|* |	32	0.261	0.088	1834.2	0.000
.|** |	.|* |	33	0.261	0.159	1847.4	0.000
.|** |	*|. |	34	0.249	-0.139	1859.5	0.000
.|** |	.|. |	35	0.236	-0.039	1870.4	0.000
.|** |	*|. |	36	0.223	-0.077	1880.2	0.000

Table B a-4 Correlogram of INF_t on the Level Basis

Date: 04/26/18 Time: 21:55
Sample: 1980Q1 2016Q4
Included observations: 148

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|**** |	.|**** |	1	0.547	0.547	45.180	0.000
.|** |	.|. |	2	0.338	0.055	62.529	0.000
.|*** |	.|** |	3	0.394	0.270	86.253	0.000
.|** |	.|. |	4	0.284	-0.051	98.687	0.000
.|** |	.|* |	5	0.272	0.137	110.20	0.000
.|** |	.|. |	6	0.276	0.024	122.11	0.000
.|* |	*|. |	7	0.152	-0.080	125.76	0.000
.|* |	.|. |	8	0.091	-0.052	127.07	0.000
.|* |	.|. |	9	0.086	-0.021	128.24	0.000
.|* |	.|. |	10	0.089	0.049	129.52	0.000
.|. |	.|. |	11	0.054	-0.040	130.00	0.000
.|* |	.|* |	12	0.082	0.085	131.08	0.000
.|* |	.|. |	13	0.114	0.059	133.23	0.000
.|* |	.|* |	14	0.128	0.086	135.92	0.000
.|. |	*|. |	15	0.056	-0.109	136.44	0.000
.|. |	.|. |	16	0.033	-0.013	136.63	0.000
.|. |	.|. |	17	0.065	0.009	137.34	0.000
.|. |	.|. |	18	0.034	-0.039	137.53	0.000
.|. |	.|. |	19	0.006	-0.041	137.54	0.000
.|. |	.|. |	20	0.045	0.048	137.89	0.000
.|. |	.|. |	21	-0.000	-0.019	137.89	0.000
.|. |	.|* |	22	0.066	0.148	138.66	0.000
.|. |	.|. |	23	0.066	-0.051	139.44	0.000
.|. |	.|* |	24	0.061	0.086	140.12	0.000
.|. |	*|. |	25	0.040	-0.083	140.41	0.000
.|. |	.|. |	26	0.021	-0.014	140.49	0.000
.|* |	.|. |	27	0.094	0.071	142.12	0.000
.|* |	.|. |	28	0.142	0.065	145.87	0.000
.|* |	.|. |	29	0.113	0.033	148.25	0.000
.|. |	*|. |	30	0.069	-0.073	149.13	0.000
.|. |	.|. |	31	0.053	0.019	149.66	0.000
.|. |	.|. |	32	0.057	-0.016	150.29	0.000
.|* |	.|* |	33	0.106	0.103	152.44	0.000
.|* |	.|. |	34	0.111	-0.041	154.86	0.000
.|. |	.|. |	35	0.070	0.020	155.82	0.000
.|* |	.|. |	36	0.107	0.051	158.08	0.000

Table B a-5 Correlogram of $\mathbf{USDI}_t$ on the Level Basis

Date: 04/26/18 Time: 21:56

Sample: 1980Q1 2016Q4

Included observations: 148

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|*******</td><td>.|*******</td><td>1</td><td>0.960</td><td>0.960</td><td>139.18</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>**|. |</td><td>2</td><td>0.900</td><td>-0.278</td><td>262.29</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>.|. |</td><td>3</td><td>0.837</td><td>0.003</td><td>369.65</td><td>0.000</td></tr>
<tr><td>.|******|</td><td>*|. |</td><td>4</td><td>0.764</td><td>-0.184</td><td>459.67</td><td>0.000</td></tr>
<tr><td>.|***** |</td><td>.|. |</td><td>5</td><td>0.686</td><td>-0.037</td><td>532.75</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>6</td><td>0.611</td><td>0.003</td><td>591.11</td><td>0.000</td></tr>
<tr><td>.|**** |</td><td>.|. |</td><td>7</td><td>0.536</td><td>-0.059</td><td>636.28</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>*|. |</td><td>8</td><td>0.457</td><td>-0.077</td><td>669.44</td><td>0.000</td></tr>
<tr><td>.|*** |</td><td>.|* |</td><td>9</td><td>0.389</td><td>0.097</td><td>693.60</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>10</td><td>0.330</td><td>0.002</td><td>711.09</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|. |</td><td>11</td><td>0.276</td><td>0.010</td><td>723.41</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>*|. |</td><td>12</td><td>0.221</td><td>-0.110</td><td>731.39</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>13</td><td>0.167</td><td>-0.054</td><td>735.98</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|. |</td><td>14</td><td>0.117</td><td>-0.001</td><td>738.23</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>*|. |</td><td>15</td><td>0.058</td><td>-0.179</td><td>738.80</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>16</td><td>0.002</td><td>0.035</td><td>738.80</td><td>0.000</td></tr>
<tr><td>.|. |</td><td>.|. |</td><td>17</td><td>-0.044</td><td>0.041</td><td>739.13</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>18</td><td>-0.092</td><td>-0.094</td><td>740.57</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>.|. |</td><td>19</td><td>-0.143</td><td>-0.048</td><td>744.08</td><td>0.000</td></tr>
<tr><td>*|. |</td><td>*|. |</td><td>20</td><td>-0.193</td><td>-0.089</td><td>750.52</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>21</td><td>-0.238</td><td>0.005</td><td>760.41</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>22</td><td>-0.276</td><td>0.045</td><td>773.86</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>23</td><td>-0.301</td><td>0.066</td><td>789.92</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>24</td><td>-0.318</td><td>-0.041</td><td>808.01</td><td>0.000</td></tr>
<tr><td>**|. |</td><td>.|. |</td><td>25</td><td>-0.332</td><td>-0.020</td><td>827.88</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>*|. |</td><td>26</td><td>-0.346</td><td>-0.098</td><td>849.71</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>27</td><td>-0.362</td><td>-0.057</td><td>873.73</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>28</td><td>-0.370</td><td>0.020</td><td>899.09</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>29</td><td>-0.376</td><td>-0.038</td><td>925.52</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>30</td><td>-0.382</td><td>-0.010</td><td>952.94</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>31</td><td>-0.383</td><td>-0.005</td><td>980.82</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>*|. |</td><td>32</td><td>-0.389</td><td>-0.098</td><td>1009.8</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>*|. |</td><td>33</td><td>-0.402</td><td>-0.089</td><td>1040.9</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>34</td><td>-0.411</td><td>-0.001</td><td>1073.9</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>.|. |</td><td>35</td><td>-0.417</td><td>-0.062</td><td>1108.1</td><td>0.000</td></tr>
<tr><td>***|. |</td><td>*|. |</td><td>36</td><td>-0.427</td><td>-0.085</td><td>1144.3</td><td>0.000</td></tr>
</table>

Table B b-1 Correlogram of ΔGP_t on the 1st Difference Basis

Date: 04/26/18 Time: 21:59
Sample: 1980Q1 2016Q4
Included observations: 147

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|* |	.|* |	1	0.133	0.133	2.6435	0.104
.|. |	.|. |	2	0.070	0.054	3.3912	0.183
.|* |	.|* |	3	0.119	0.105	5.5511	0.136
.|* |	.|* |	4	0.111	0.083	7.4413	0.114
.|* |	.|* |	5	0.203	0.175	13.783	0.017
*|. |	*|. |	6	-0.071	-0.141	14.575	0.024
.|. |	.|. |	7	0.021	0.011	14.647	0.041
.|. |	.|. |	8	0.029	-0.014	14.782	0.064
.|. |	.|. |	9	0.050	0.040	15.183	0.086
.|. |	.|. |	10	0.021	-0.013	15.252	0.123
*|. |	.|. |	11	-0.075	-0.045	16.168	0.135
.|. |	.|. |	12	0.035	0.025	16.367	0.175
.|. |	.|. |	13	0.015	0.006	16.402	0.228
.|* |	.|* |	14	0.195	0.208	22.683	0.066
.|* |	.|. |	15	0.099	0.070	24.299	0.060
.|. |	.|. |	16	-0.040	-0.062	24.573	0.078
.|. |	*|. |	17	-0.020	-0.100	24.643	0.103
.|. |	.|. |	18	0.029	-0.000	24.789	0.131
.|* |	.|. |	19	0.099	0.034	26.462	0.118
.|. |	.|. |	20	0.006	0.032	26.468	0.151
*|. |	*|. |	21	-0.103	-0.089	28.305	0.132
*|. |	*|. |	22	-0.083	-0.103	29.520	0.131
.|. |	*|. |	23	-0.062	-0.087	30.192	0.144
.|. |	.|. |	24	-0.033	-0.006	30.391	0.172
.|. |	.|. |	25	-0.051	0.057	30.854	0.194
.|. |	.|. |	26	-0.036	0.046	31.089	0.225
.|. |	.|* |	27	0.057	0.077	31.681	0.244
.|. |	*|. |	28	-0.029	-0.100	31.833	0.281
.|. |	.|. |	29	0.014	-0.011	31.872	0.326
.|. |	.|. |	30	-0.016	0.004	31.920	0.371
.|. |	.|. |	31	-0.031	0.021	32.106	0.412
.|. |	.|. |	32	0.073	0.062	33.133	0.412
.|* |	.|. |	33	0.078	0.060	34.292	0.406
.|. |	*|. |	34	0.013	-0.067	34.323	0.452
.|. |	.|. |	35	-0.046	-0.040	34.744	0.480
.|. |	.|. |	36	-0.028	0.023	34.898	0.521

Table B b-2 Correlogram of ΔGGP_t on the 1st Difference Basis

Date: 04/26/18 Time: 22:00
Sample: 1980Q1 2016Q4
Included observations: 147

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|***** |	.|***** |	1	0.692	0.692	71.778	0.000
.|** |	**|. |	2	0.349	-0.247	90.224	0.000
.|. |	**|. |	3	0.024	-0.217	90.315	0.000
**|. |	*|. |	4	-0.228	-0.164	98.264	0.000
***|. |	*|. |	5	-0.366	-0.099	118.89	0.000
***|. |	.|. |	6	-0.381	-0.046	141.41	0.000
**|. |	.|. |	7	-0.295	-0.010	155.07	0.000
*|. |	.|. |	8	-0.148	0.019	158.50	0.000
.|. |	.|. |	9	0.011	0.022	158.52	0.000
.|* |	.|. |	10	0.119	-0.019	160.79	0.000
.|* |	.|. |	11	0.152	-0.044	164.50	0.000
.|* |	.|. |	12	0.120	-0.038	166.86	0.000
.|. |	.|. |	13	0.050	-0.031	167.27	0.000
.|. |	.|. |	14	-0.023	-0.014	167.36	0.000
*|. |	.|. |	15	-0.081	-0.020	168.44	0.000
*|. |	.|. |	16	-0.122	-0.050	170.92	0.000
*|. |	*|. |	17	-0.146	-0.071	174.51	0.000
*|. |	*|. |	18	-0.155	-0.083	178.61	0.000
*|. |	*|. |	19	-0.143	-0.066	182.13	0.000
*|. |	.|. |	20	-0.100	-0.023	183.85	0.000
.|. |	.|. |	21	-0.024	0.018	183.95	0.000
.|. |	.|. |	22	0.071	0.047	184.83	0.000
.|* |	.|. |	23	0.164	0.058	189.57	0.000
.|** |	.|. |	24	0.230	0.053	198.95	0.000
.|** |	.|. |	25	0.244	0.033	209.66	0.000
.|* |	.|. |	26	0.194	-0.002	216.46	0.000
.|* |	.|. |	27	0.085	-0.033	217.77	0.000
.|. |	.|. |	28	-0.056	-0.055	218.34	0.000
*|. |	.|. |	29	-0.186	-0.058	224.78	0.000
**|. |	.|. |	30	-0.255	-0.025	236.98	0.000
**|. |	.|. |	31	-0.242	-0.002	248.04	0.000
*|. |	.|. |	32	-0.162	-0.004	253.02	0.000
.|. |	.|. |	33	-0.050	-0.016	253.49	0.000
.|. |	.|. |	34	0.038	-0.062	253.77	0.000
.|. |	*|. |	35	0.073	-0.082	254.83	0.000
.|. |	.|. |	36	0.064	-0.057	255.64	0.000

Table B b-3 Correlogram of ΔINT_t on the 1st Difference Basis

Date: 04/26/18 Time: 22:01

Sample: 1980Q1 2016Q4

Included observations: 147

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*|. |	*|. |	1	-0.170	-0.170	4.3371	0.037
*|. |	*|. |	2	-0.073	-0.105	5.1412	0.076
.|* |	.|* |	3	0.106	0.078	6.8594	0.077
*|. |	*|. |	4	-0.130	-0.109	9.4523	0.051
.|. |	.|. |	5	0.047	0.022	9.7869	0.082
.|. |	.|. |	6	0.016	0.001	9.8280	0.132
*|. |	*|. |	7	-0.166	-0.146	14.139	0.049
.|. |	*|. |	8	-0.015	-0.090	14.173	0.077
.|. |	.|. |	9	-0.010	-0.051	14.188	0.116
.|* |	.|* |	10	0.096	0.109	15.674	0.109
.|. |	.|. |	11	-0.063	-0.064	16.304	0.130
.|* |	.|* |	12	0.104	0.111	18.052	0.114
.|. |	.|. |	13	-0.059	-0.060	18.623	0.135
.|. |	.|. |	14	0.051	0.066	19.058	0.163
.|. |	.|. |	15	0.006	-0.045	19.064	0.211
*|. |	*|. |	16	-0.105	-0.081	20.910	0.182
.|. |	.|. |	17	0.013	-0.017	20.937	0.229
.|. |	.|. |	18	0.011	0.002	20.956	0.282
*|. |	.|. |	19	-0.089	-0.051	22.306	0.269
.|. |	*|. |	20	-0.001	-0.074	22.306	0.324
*|. |	*|. |	21	-0.114	-0.117	24.563	0.267
.|. |	.|. |	22	0.035	-0.033	24.783	0.308
.|. |	*|. |	23	-0.059	-0.111	25.400	0.330
.|. |	.|. |	24	0.061	0.011	26.057	0.350
.|. |	.|. |	25	0.008	-0.007	26.068	0.404
*|. |	*|. |	26	-0.067	-0.069	26.889	0.415
.|* |	.|. |	27	0.080	0.015	28.068	0.407
.|* |	.|* |	28	0.122	0.120	30.790	0.326
.|* |	.|* |	29	0.090	0.177	32.297	0.307
*|. |	*|. |	30	-0.086	-0.076	33.681	0.294
*|. |	*|. |	31	-0.100	-0.081	35.564	0.262
.|. |	*|. |	32	-0.011	-0.093	35.588	0.303
.|. |	.|. |	33	-0.053	-0.038	36.123	0.325
.|. |	.|. |	34	0.040	-0.018	36.438	0.356
.|. |	.|. |	35	-0.007	0.043	36.447	0.401
.|. |	.|. |	36	0.007	0.068	36.458	0.447

Table B b-4 Correlogram of ΔINF_t on the 1st Difference Basis

Date: 04/26/18 Time: 22:03

Sample: 1980Q1 2016Q4

Included observations: 147

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|. |	**|. |	1	-0.288	-0.288	12.415	0.000
**|. |	***|. |	2	-0.259	-0.372	22.537	0.000
.|* |	.|. |	3	0.160	-0.062	26.443	0.000
*|. |	**|. |	4	-0.127	-0.230	28.933	0.000
.|. |	*|. |	5	0.020	-0.086	28.994	0.000
.|* |	.|. |	6	0.125	0.011	31.409	0.000
.|. |	.|. |	7	-0.014	0.069	31.439	0.000
.|. |	.|. |	8	-0.030	0.048	31.580	0.000
.|. |	.|. |	9	-0.046	-0.024	31.912	0.000
.|. |	.|. |	10	0.034	0.033	32.096	0.000
.|. |	.|. |	11	0.003	0.000	32.097	0.001
.|. |	.|. |	12	0.008	0.023	32.107	0.001
.|. |	*|. |	13	-0.040	-0.070	32.373	0.002
.|* |	.|* |	14	0.122	0.133	34.813	0.002
*|. |	.|. |	15	-0.066	0.006	35.543	0.002
*|. |	.|. |	16	-0.096	-0.043	37.093	0.002
.|* |	.|. |	17	0.110	0.014	39.133	0.002
.|. |	.|. |	18	-0.000	0.030	39.133	0.003
*|. |	.|. |	19	-0.088	-0.055	40.445	0.003
.|* |	.|. |	20	0.107	0.032	42.425	0.002
*|. |	*|. |	21	-0.147	-0.169	46.165	0.001
.|* |	.|* |	22	0.104	0.079	48.073	0.001
.|. |	*|. |	23	-0.017	-0.084	48.124	0.002
.|. |	.|* |	24	0.051	0.134	48.588	0.002
.|. |	.|* |	25	0.058	0.091	49.192	0.003
*|. |	.|. |	26	-0.189	-0.060	55.639	0.001
.|. |	.|. |	27	0.027	-0.026	55.775	0.001
.|. |	.|. |	28	0.072	-0.051	56.721	0.001
.|. |	.|* |	29	0.024	0.082	56.826	0.002
.|. |	.|. |	30	-0.034	-0.057	57.039	0.002
.|. |	.|. |	31	-0.021	-0.014	57.127	0.003
.|. |	*|. |	32	-0.050	-0.131	57.610	0.004
.|. |	.|. |	33	0.036	0.062	57.861	0.005
.|. |	.|. |	34	0.057	-0.023	58.499	0.006
*|. |	.|. |	35	-0.096	-0.061	60.294	0.005
.|. |	.|. |	36	0.042	-0.038	60.647	0.006

Table B b-5 Correlogram of $\Delta \mathbf{USDI}_t$ on the 1st Difference Basis

Date: 04/26/18 Time: 22:01
Sample: 1980Q1 2016Q4
Included observations: 147

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|** |	.|** |	1	0.326	0.326	15.987	0.000
.|. |	*|. |	2	0.035	-0.080	16.174	0.000
.|* |	.|* |	3	0.119	0.149	18.328	0.000
.|* |	.|. |	4	0.078	-0.011	19.267	0.001
.|. |	.|. |	5	-0.016	-0.035	19.305	0.002
.|. |	.|. |	6	0.038	0.055	19.527	0.003
.|. |	.|. |	7	0.042	-0.002	19.804	0.006
*|. |	*|. |	8	-0.067	-0.082	20.511	0.009
*|. |	.|. |	9	-0.068	-0.023	21.251	0.012
.|. |	.|. |	10	-0.046	-0.038	21.586	0.017
.|. |	.|. |	11	0.003	0.049	21.587	0.028
.|. |	.|. |	12	0.003	-0.001	21.589	0.042
.|. |	.|. |	13	-0.056	-0.061	22.110	0.054
.|* |	.|* |	14	0.122	0.192	24.573	0.039
.|. |	*|. |	15	-0.013	-0.152	24.601	0.056
*|. |	.|. |	16	-0.116	-0.040	26.848	0.043
.|. |	.|. |	17	0.020	0.060	26.916	0.059
.|. |	.|. |	18	0.061	-0.001	27.544	0.069
.|. |	.|. |	19	0.010	0.042	27.560	0.092
.|. |	*|. |	20	-0.045	-0.082	27.913	0.111
*|. |	*|. |	21	-0.073	-0.082	28.838	0.118
*|. |	*|. |	22	-0.203	-0.148	36.029	0.030
*|. |	.|. |	23	-0.140	-0.022	39.509	0.017
*|. |	.|. |	24	-0.066	-0.020	40.292	0.020
.|. |	.|. |	25	-0.034	0.022	40.500	0.026
.|. |	.|. |	26	-0.013	0.004	40.532	0.035
*|. |	.|. |	27	-0.072	-0.029	41.480	0.037
.|. |	.|. |	28	-0.022	-0.001	41.565	0.048
.|. |	.|. |	29	-0.043	-0.056	41.908	0.057
*|. |	.|. |	30	-0.088	-0.049	43.371	0.054
.|. |	.|. |	31	0.014	0.032	43.406	0.069
.|* |	.|. |	32	0.105	0.073	45.525	0.057
.|. |	.|. |	33	0.025	-0.023	45.648	0.070
.|. |	.|. |	34	-0.002	0.039	45.649	0.087
.|. |	.|. |	35	0.034	-0.023	45.875	0.103
.|. |	.|. |	36	0.018	0.042	45.936	0.124

Appendix C Dickey-Fuller Unit Root Tests on the Level Basis

Table C a-1 Dickey-Fuller Unit Root Tests on GP_t

Null Hypothesis: REALGP has a unit root

Exogenous: None

Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.331101	0.1690
Test critical values:	1% level	-2.580897	
	5% level	-1.943027	
	10% level	-1.615260	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALGP)

Method: Least Squares

Date: 04/26/18 Time: 22:05

Sample (adjusted): 1980Q3 2016Q4

Included observations: 146 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REALGP(-1)	-0.008818	0.006625	-1.331101	0.1853
D(REALGP(-1))	0.146336	0.082548	1.772740	0.0784

R-squared	0.031817	Mean dependent var	-1.724026
Adjusted R-squared	0.025093	S.D. dependent var	31.44322
S.E. of regression	31.04620	Akaike info criterion	9.722434
Sum squared resid	138796.8	Schwarz criterion	9.763305
Log likelihood	-707.7377	Hannan-Quinn criter.	9.739041
Durbin-Watson stat	1.488689		

Table 2A-2 Dickey-Fuller Unit Root Tests on $\mathbf{GGP}_t$

Null Hypothesis: REALGP has a unit root

Exogenous: None

Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.331101	0.1690
Test critical values:	1% level	-2.580897	
	5% level	-1.943027	
	10% level	-1.615260	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALGP)

Method: Least Squares

Date: 04/26/18 Time: 22:31

Sample (adjusted): 1980Q3 2016Q4

Included observations: 146 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REALGP(-1)	-0.008818	0.006625	-1.331101	0.1853
D(REALGP(-1))	0.146336	0.082548	1.772740	0.0784

R-squared	0.031817	Mean dependent var	-1.724026
Adjusted R-squared	0.025093	S.D. dependent var	31.44322
S.E. of regression	31.04620	Akaike info criterion	9.722434
Sum squared resid	138796.8	Schwarz criterion	9.763305
Log likelihood	-707.7377	Hannan-Quinn criter.	9.739041
Durbin-Watson stat	1.488689		

Table C a-2 Dickey-Fuller Unit Root Tests on GGP_t

Null Hypothesis: REALGGP has a unit root

Exogenous: None

Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.501720	0.1244
Test critical values:	1% level	-2.581233	
	5% level	-1.943074	
	10% level	-1.615231	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALGGP)

Method: Least Squares

Date: 04/26/18 Time: 22:06

Sample (adjusted): 1981Q2 2016Q4

Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REALGGP(-1)	-0.002494	0.001660	-1.501720	0.1355
D(REALGGP(-1))	3.293908	0.075587	43.57789	0.0000
D(REALGGP(-2))	-4.400826	0.217114	-20.26970	0.0000
D(REALGGP(-3))	2.871451	0.237520	12.08930	0.0000
D(REALGGP(-4))	-0.801810	0.106909	-7.499961	0.0000

R-squared	0.992658	Mean dependent var	3095.680
Adjusted R-squared	0.992445	S.D. dependent var	29247.65
S.E. of regression	2542.175	Akaike info criterion	18.55377
Sum squared resid	8.92E+08	Schwarz criterion	18.65736
Log likelihood	-1321.594	Hannan-Quinn criter.	18.59586
Durbin-Watson stat	2.068103		

Table C a-3 Dickey-Fuller Unit Root Tests on INT_t

Null Hypothesis: REALINT has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.051283	0.2636
Test critical values:	1% level	-2.580788	
	5% level	-1.943012	
	10% level	-1.615270	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALINT)

Method: Least Squares

Date: 04/26/18 Time: 22:07

Sample (adjusted): 1980Q2 2016Q4

Included observations: 147 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REALINT(-1)	-0.008056	0.007663	-1.051283	0.2949

R-squared	0.004840	Mean dependent var	-0.034938
Adjusted R-squared	0.004840	S.D. dependent var	0.675481
S.E. of regression	0.673844	Akaike info criterion	2.055143
Sum squared resid	66.29360	Schwarz criterion	2.075486
Log likelihood	-150.0530	Hannan-Quinn criter.	2.063409
Durbin-Watson stat	2.330304		

Table C a-4 Dickey-Fuller Unit Root Tests on INF_t

Null Hypothesis: INF has a unit root

Exogenous: None

Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.156904	0.0018
Test critical values:	1% level	-2.581233	
	5% level	-1.943074	
	10% level	-1.615231	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(INF)

Method: Least Squares

Date: 04/26/18 Time: 22:07

Sample (adjusted): 1981Q2 2016Q4

Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(-1)	-0.149175	0.047254	-3.156904	0.0020
D(INF(-1))	-0.371745	0.083938	-4.428830	0.0000
D(INF(-2))	-0.462973	0.088583	-5.226434	0.0000
D(INF(-3))	-0.167129	0.085051	-1.965041	0.0514
D(INF(-4))	-0.241565	0.077436	-3.119562	0.0022

R-squared	0.321581	Mean dependent var	-0.014081
Adjusted R-squared	0.301916	S.D. dependent var	0.588281
S.E. of regression	0.491517	Akaike info criterion	1.451698
Sum squared resid	33.33924	Schwarz criterion	1.555294
Log likelihood	-98.79638	Hannan-Quinn criter.	1.493794
Durbin-Watson stat	2.057441		

Table C a-5 Dickey-Fuller Unit Root Tests on USDI_t

Null Hypothesis: REALUSDI has a unit root

Exogenous: None

Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.088186	0.7092
Test critical values:	1% level	-2.580897	
	5% level	-1.943027	
	10% level	-1.615260	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALUSDI)

Method: Least Squares

Date: 04/26/18 Time: 22:08

Sample (adjusted): 1980Q3 2016Q4

Included observations: 146 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REALUSDI(-1)	0.000224	0.002542	0.088186	0.9299
D(REALUSDI(-1))	0.330900	0.079271	4.174284	0.0001

R-squared	0.107209	Mean dependent var	0.099336
Adjusted R-squared	0.101009	S.D. dependent var	2.786929
S.E. of regression	2.642430	Akaike info criterion	4.794879
Sum squared resid	1005.471	Schwarz criterion	4.835751
Log likelihood	-348.0262	Hannan-Quinn criter.	4.811486
Durbin-Watson stat	1.926993		

Table C b-1 Dickey-Fuller Unit Root Tests on ΔGP_t

Null Hypothesis: D(REALGP) has a unit root

Exogenous: None

Lag Length: 1 (Automatic - based on AIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.400394	0.0000
Test critical values:	1% level	-2.580788	
	5% level	-1.943012	
	10% level	-1.615270	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALGP,2)

Method: Least Squares

Date: 04/29/18 Time: 21:41

Sample (adjusted): 4 150

Included observations: 147 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REALGP(-1))	-1.321530	0.178576	-7.400394	0.0000
D(REALGP(-1),2)	-0.535393	0.134062	-3.993625	0.0001

R-squared	0.729930	Mean dependent var	-5.188271
Adjusted R-squared	0.728068	S.D. dependent var	102.1489
S.E. of regression	53.26771	Akaike info criterion	10.80205
Sum squared resid	411430.0	Schwarz criterion	10.84274
Log likelihood	-791.9506	Hannan-Quinn criter.	10.81858
Durbin-Watson stat	1.869390		

Table C b-2 Dickey-Fuller Unit Root Tests on ΔGGP_t

Null Hypothesis: D(REALGGP) has a unit root

Exogenous: None

Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.936594	0.0001
Test critical values:	1% level	-2.581233	
	5% level	-1.943074	
	10% level	-1.615231	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALGGP,2)

Method: Least Squares

Date: 04/26/18 Time: 22:11

Sample (adjusted): 1981Q2 2016Q4

Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REALGGP(-1))	-0.066638	0.016928	-3.936594	0.0001
D(REALGGP(-1),2)	2.386930	0.072598	32.87861	0.0000
D(REALGGP(-2),2)	-2.132672	0.132283	-16.12200	0.0000
D(REALGGP(-3),2)	0.886315	0.091310	9.706669	0.0000

R-squared	0.969489	Mean dependent var	-1464.427
Adjusted R-squared	0.968830	S.D. dependent var	14464.03
S.E. of regression	2553.627	Akaike info criterion	18.55599
Sum squared resid	9.06E+08	Schwarz criterion	18.63887
Log likelihood	-1322.753	Hannan-Quinn criter.	18.58967
Durbin-Watson stat	2.121036		

Table C b-3 Dickey-Fuller Unit Root Tests on $\Delta \mathrm{INT}_t$

Null Hypothesis: D(REALINT) has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-14.26541	0.0000
Test critical values:	1% level	-2.580897	
	5% level	-1.943027	
	10% level	-1.615260	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALINT,2)

Method: Least Squares

Date: 04/26/18 Time: 22:10

Sample (adjusted): 1980Q3 2016Q4

Included observations: 146 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REALINT(-1))	-1.167042	0.081809	-14.26541	0.0000

R-squared	0.583928	Mean dependent var	0.003631
Adjusted R-squared	0.583928	S.D. dependent var	1.036351
S.E. of regression	0.668484	Akaike info criterion	2.039217
Sum squared resid	64.79629	Schwarz criterion	2.059653
Log likelihood	-147.8629	Hannan-Quinn criter.	2.047521
Durbin-Watson stat	1.961511		

Table C b-4 Dickey-Fuller Unit Root Tests on $\Delta \mathrm{INF}_t$

Null Hypothesis: D(INF) has a unit root

Exogenous: None

Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.721557	0.0000
Test critical values:	1% level	-2.581233	
	5% level	-1.943074	
	10% level	-1.615231	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(INF,2)

Method: Least Squares

Date: 04/26/18 Time: 22:12

Sample (adjusted): 1981Q2 2016Q4

Included observations: 143 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	-2.390183	0.245864	-9.721557	0.0000
D(INF(-1),2)	0.936259	0.203154	4.608623	0.0000
D(INF(-2),2)	0.419441	0.140234	2.991016	0.0033
D(INF(-3),2)	0.240494	0.079893	3.010186	0.0031

R-squared	0.718977	Mean dependent var	0.002432
Adjusted R-squared	0.712912	S.D. dependent var	0.946465
S.E. of regression	0.507121	Akaike info criterion	1.507441
Sum squared resid	35.74692	Schwarz criterion	1.590317
Log likelihood	-103.7820	Hannan-Quinn criter.	1.541118
Durbin-Watson stat	2.048176		

Table C b-5 Dickey-Fuller Unit Root Tests on $\Delta USDI_t$

Null Hypothesis: D(REALUSDI) has a unit root

Exogenous: None

Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.473929	0.0000
Test critical values:	1% level	-2.580897	
	5% level	-1.943027	
	10% level	-1.615260	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(REALUSDI,2)

Method: Least Squares

Date: 04/26/18 Time: 22:13

Sample (adjusted): 1980Q3 2016Q4

Included observations: 146 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REALUSDI(-1))	-0.668793	0.078924	-8.473929	0.0000

R-squared	0.331165	Mean dependent var	0.024557
Adjusted R-squared	0.331165	S.D. dependent var	3.219978
S.E. of regression	2.633374	Akaike info criterion	4.781235
Sum squared resid	1005.525	Schwarz criterion	4.801670
Log likelihood	-348.0301	Hannan-Quinn criter.	4.789538
Durbin-Watson stat	1.927004		

Appendix D Engle-Granger Co-integration Test for Gold Model OLS

The REG Procedure

Model: MODEL1

Dependent Variable: realgp1

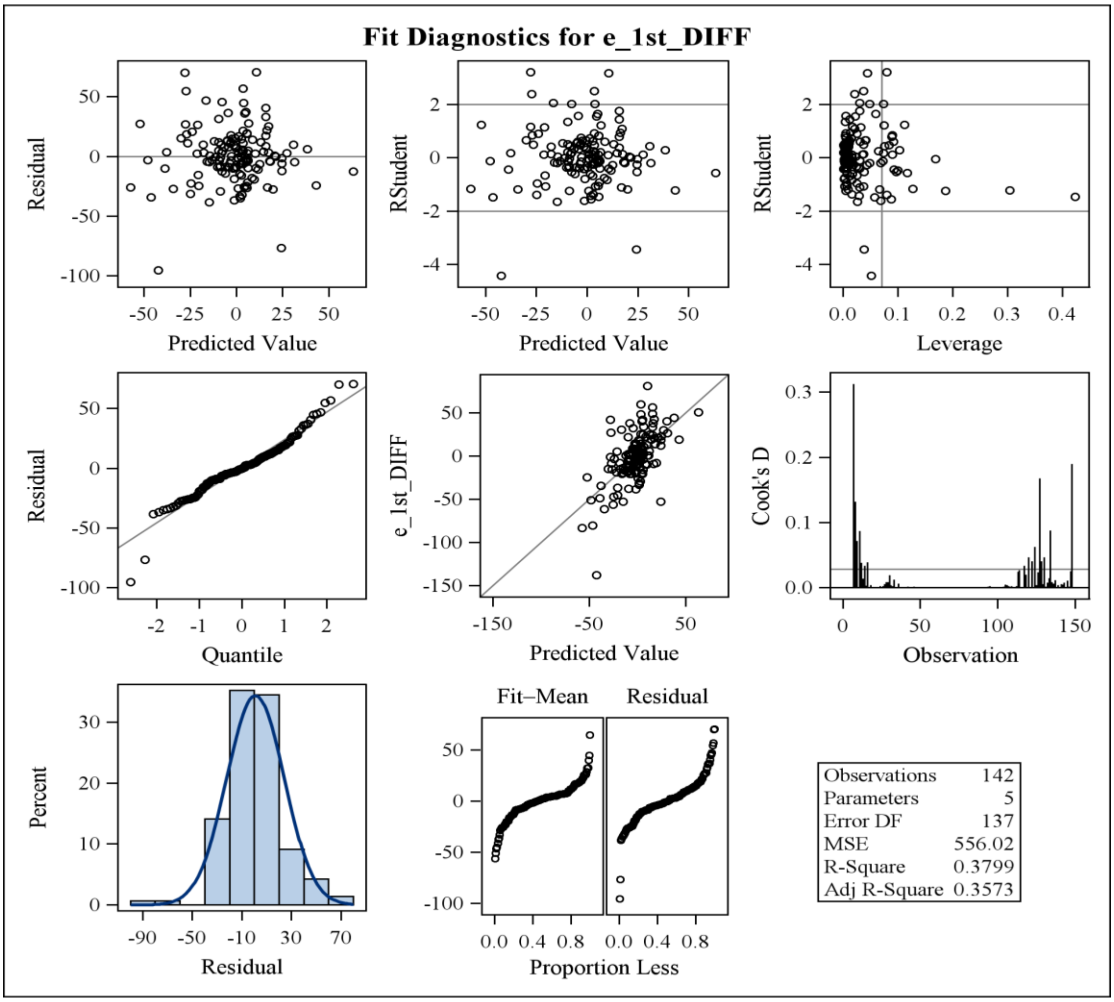
Number of Observations Read	148
Number of Observations Used	142
Number of Observations with Missing Values	6

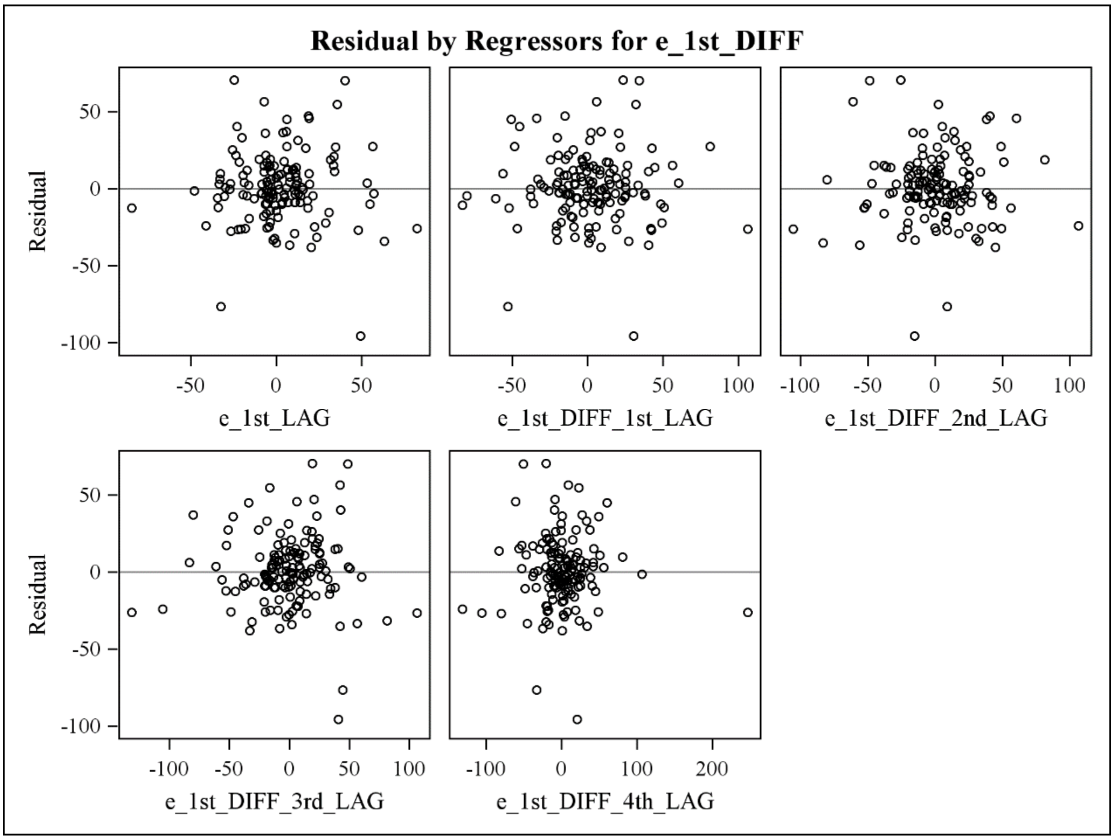
Note: No intercept in model. R-Square is redefined.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	46670	9334.09210	16.79	<.0001
Error	137	76175	556.02257		
Uncorrected Total	142	122846			

Root MSE	23.58013	**R-Square**	0.3799
Dependent Mean	-0.47596	**Adj R-Sq**	0.3573
Coeff Var	-4954.26676		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-0.56661	0.13569	-4.18	<.0001
Realggp1	1	-0.23959	0.13077	-1.83	0.0691
Realint1	1	-0.15804	0.12156	-1.30	0.1958
Inf1	1	-0.18849	0.09981	-1.89	0.0611
Realusdi1	1	-0.08977	0.07073	-1.27	0.2065


Fit Diagnostics for e_1st_DIFF
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
e_1st_DIFF
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 142
Parameters 5
Error DF 137
MSE 556.02
R-Square 0.3799
Adj R-Square 0.3573


Residual by Regressors for e_1st_DIFF
Residual
e_1st_LAG
e_1st_DIFF_1st_LAG
e_1st_DIFF_2nd_LAG
Residual
e_1st_DIFF_3rd_LAG
e_1st_DIFF_4th_LAG

Appendix E

E1 Newey-West Standard Errors Method for OLS

The MODEL Procedure

Model Summary	
Model Variables	5
Endogenous	1
Exogenous	4
Parameters	5
Equations	1
Number of Statements	1

Model Variables	realgp1 realGGP1 realint1 inf1 realUSDI1
Parameters	b0 b1 b2 b3 b4
Equations	realgp1

The Equation to Estimate is	
realgp1 =	F(b0(1), b1(realGGP1), b2(realint1), b3(inf1), b4(realUSDI1))
Instruments	1 realGGP1 realint1 inf1 realUSDI1

NOTE: At GMM Iteration 0 convergence assumed because OBJECTIVE=2.228819E-31 is almost zero (<1E-12).

The MODEL Procedure

GMM Estimation Summary

Data Set Options	
DATA=	MYLIB2.GOLD

Minimization Summary	
Parameters Estimated	5
Kernel Used	BARTLETT
l(n)	5

Minimization Summary	
Method	Gauss
Iterations	0

Final Convergence Criteria	
R	1
PPC	0
RPC	.
Object	.
Trace(S)	892.5962
Objective Value	2.23E-31

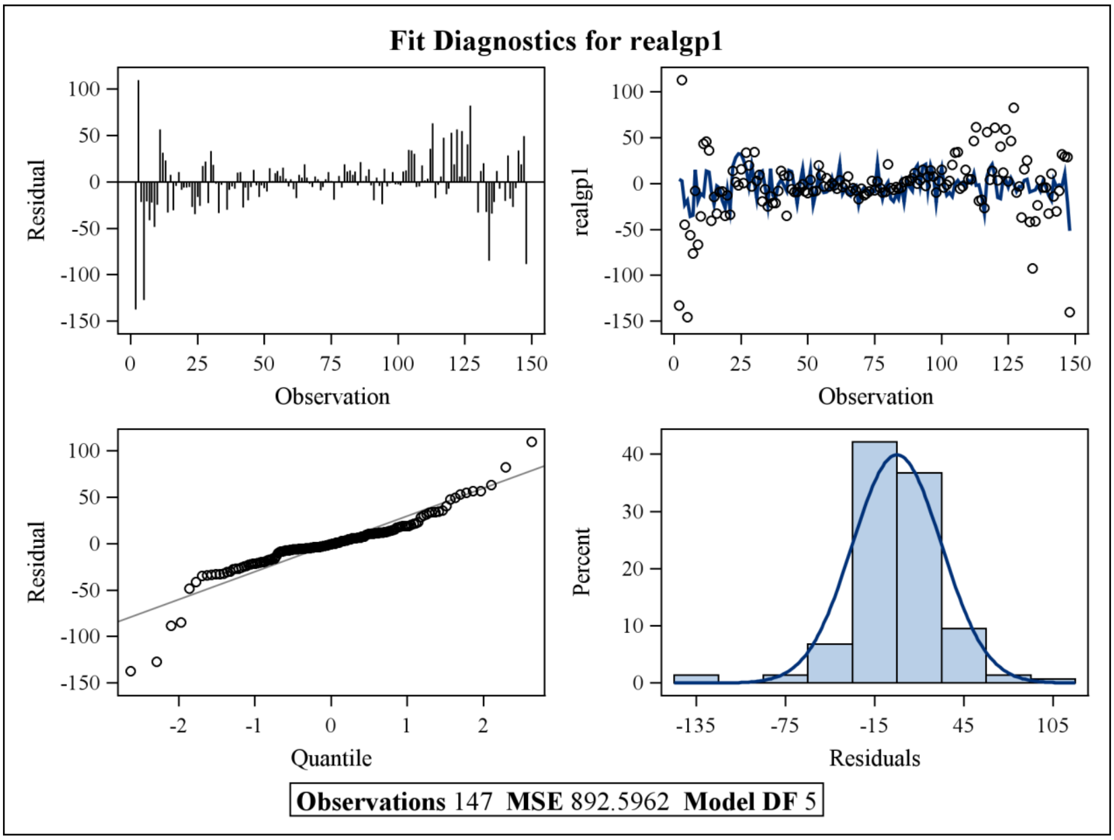
Observations Processed	
Read	148
Solved	148
Used	147
Missing	1

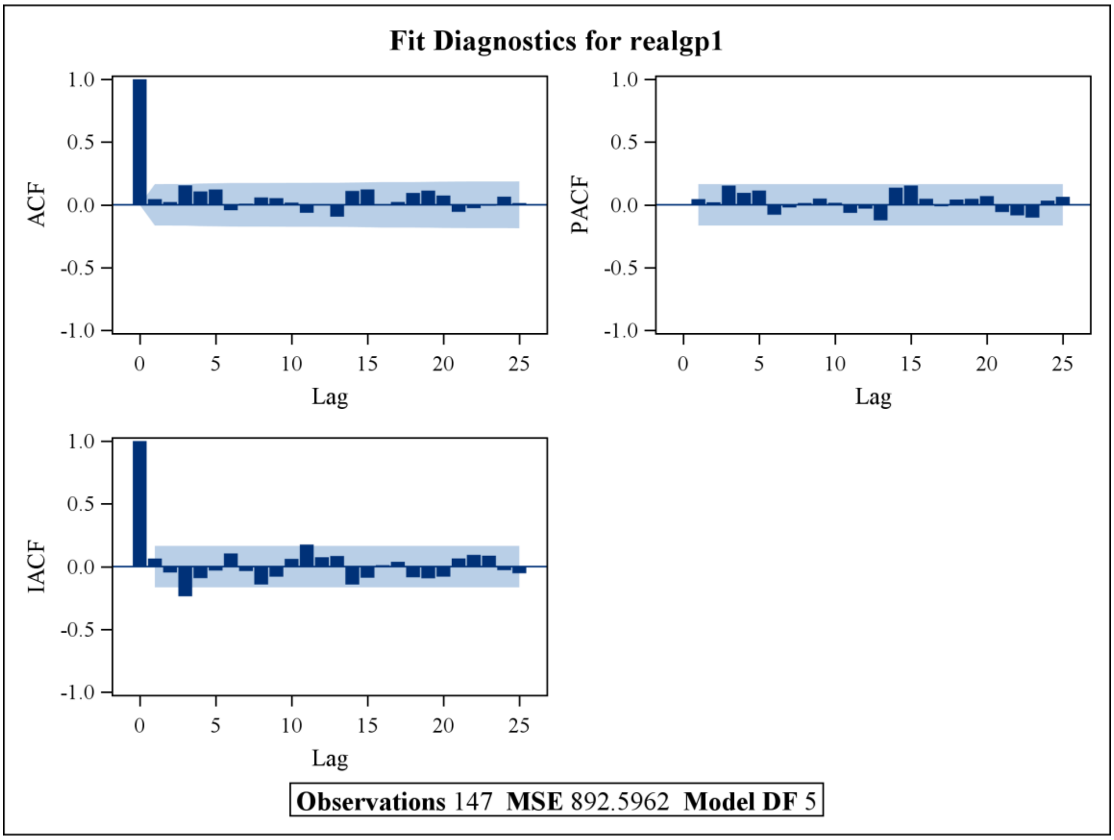
Nonlinear GMM Summary of Residual Errors							
Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
realgp1	5	142	131212	892.6	29.8763	0.1821	0.1591

Nonlinear GMM Parameter Estimates				
Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
b0	-3.09734	2.8959	-1.07	0.2866
b1	0.00013	0.000133	0.97	0.3321
b2	-9.93113	9.7437	-1.02	0.3098
b3	-8.72124	8.8287	-0.99	0.3249
b4	-4.4608	1.1484	-3.88	0.0002

Number of Observations		Statistics for System	
Used	147	**Objective**	2.229E-31
Missing	1	**Objective*N**	3.276E-29

GMM Test Statistics			
Test	**DF**	**Statistic**	**Prob**
Overidentifying Restrictions	0	0.00	.




Fit Diagnostics for realgp1
ACF
PACF
IACF
Lag
Observations 147 MSE 892.5962 Model DF 5

E2 Revise of Gold Model with Newey-West Standard Errors Method for OLS

The MODEL Procedure
Model Summary

Model Variables	4
Endogenous	1
Exogenous	3
Parameters	4
Equations	1
Number of Statements	1

Model Variables	realgp1 realGGP1 realint1 realUSDI1
Parameters	b0 b1 b2 b3
Equations	realgp1

The Equation to Estimate is	
realgp1 =	F(b0(1), b1(realGGP1), b2(realint1), b3(realUSDI1))
Instruments	1 realGGP1 realint1 realUSDI1

NOTE: At GMM Iteration 0 convergence assumed because OBJECTIVE=3.495204E-32 is almost zero (<1E-12).

Data Set Options	
DATA=	MYLIB.GOLD

Minimization Summary	
Parameters Estimated	4
Kernel Used	BARTLETT
l(n)	4
Method	Gauss
Iterations	0

Final Convergence Criteria	
R	1
PPC	0
RPC	.
Object	.
Trace(S)	902.0408
Objective Value	3.5E-32

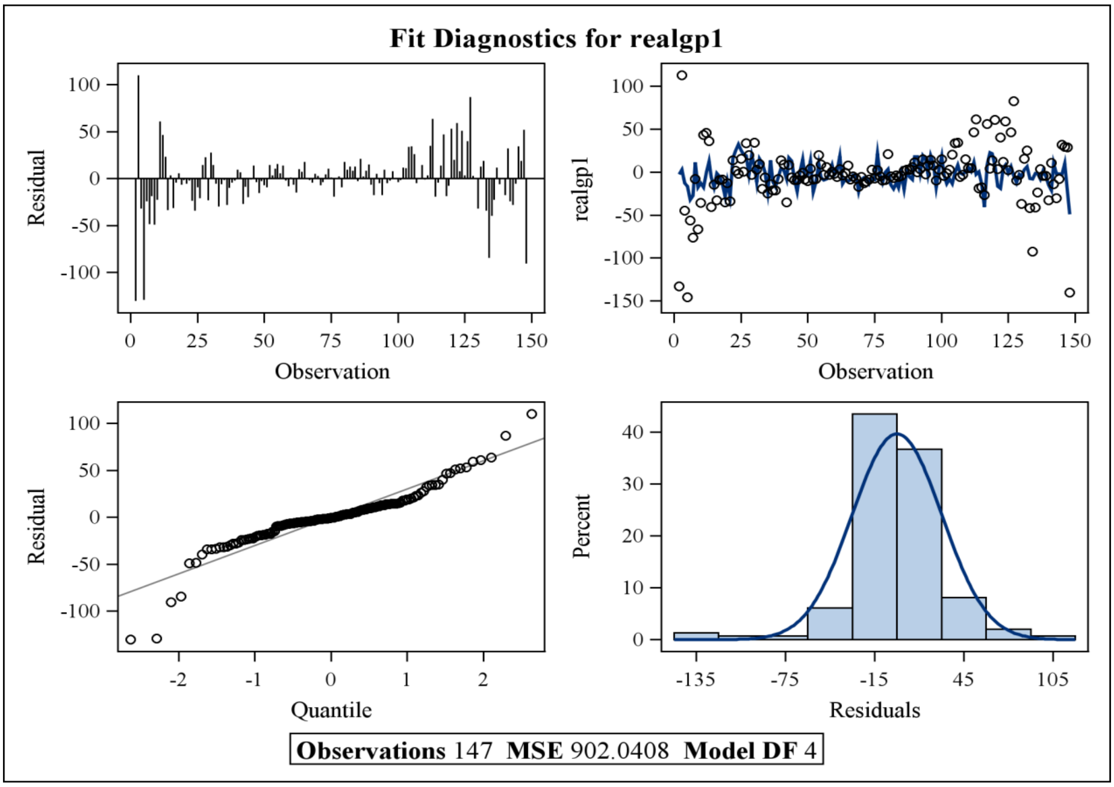
Observations Processed	
Read	148
Solved	148
Used	147
Missing	1

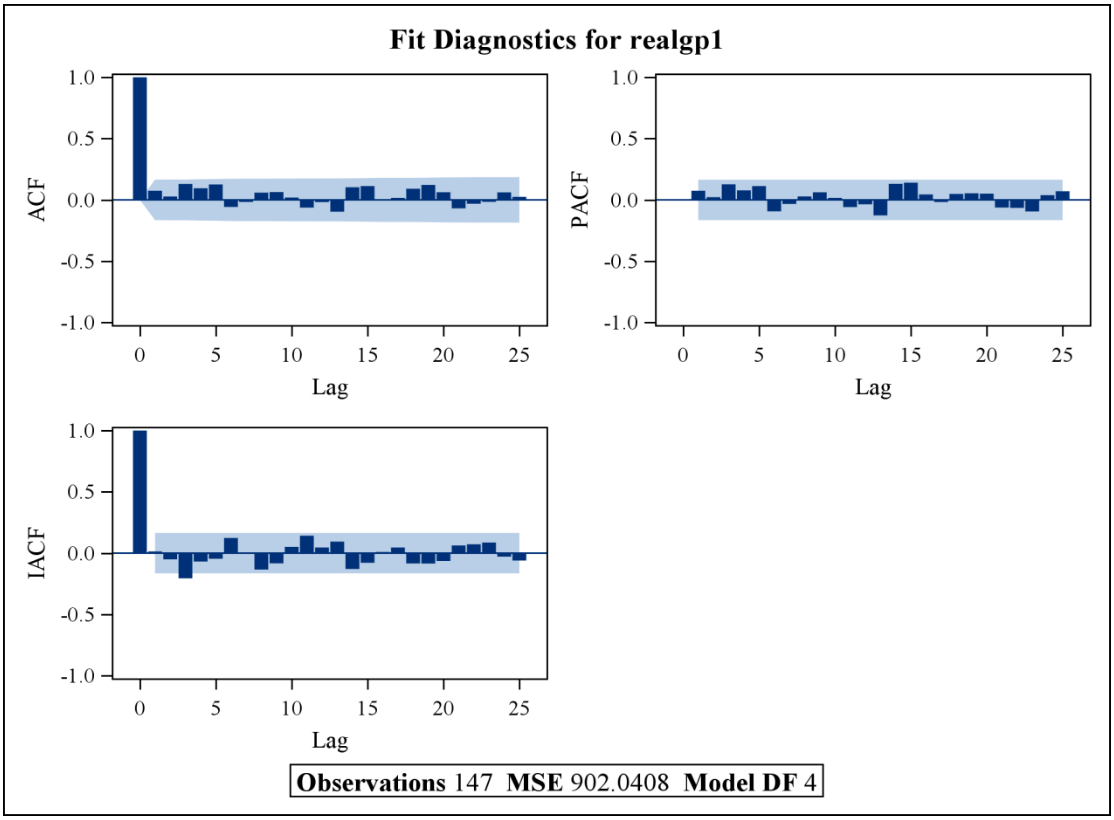
Nonlinear GMM Summary of Residual Errors							
Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
realgp1	4	143	132600	902.0	30.0340	0.1734	0.1561

Nonlinear GMM Parameter Estimates				
Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
b0	-2.68731	2.8131	-0.96	0.3411
b1	0.000136	0.000139	0.97	0.3313
b2	-3.56551	4.7070	-0.76	0.4500
b3	-4.62086	1.1359	-4.07	<.0001

Number of Observations		Statistics for System	
Used	147	Objective	3.495E-32
Missing	1	Objective*N	5.138E-30

GMM Test Statistics			
Test	**DF**	**Statistic**	**Prob**
Overidentifying Restrictions	0	0.00	.





Appendix F Descriptive Statistics for Variables and Residuals

The MEANS Procedure

Variable	Label	N	Mean	Maximum	Minimum	Range	Std Dev	Coeff of Variation
realgp1		147	-2.6158	112.7	-145.7	258.4	33.1482	-1267.2
realGGP1		147	3017.1	93582.1	-208863	302446	28848.1	956.2
realint1		147	-0.0349	4.0018	-2.1522	6.1539	0.6755	-1933.4
inf1		147	-0.0218	1.6000	-3.8300	5.4300	0.5996	-2754.6
realUSDI1		147	0.1001	6.7400	-6.8200	13.5600	2.7772	2773.4
_RESID	Residual	147	-396E-17	109.8	-137.5	247.3	29.9785	-7.56E17

The MEANS Procedure for Revise Model

f	Label	N	Mean	Maximum	Minimum	Range	Std Dev	Coeff of Variation
realgp1		146	0.2721	240.5	-142.5	383.0	38.9700	14322.7
realGGP1		145	1.2569	240.5	-141.9	382.4	37.2374	2962.6
realint1		144	1.0382	240.5	-141.9	382.4	37.2738	3590.2
realUSDI1		143	1.1516	240.5	-141.9	382.4	37.3798	3245.8
_RESID	Residual	147	-145E-17	110.0	-130.4	240.5	30.1367	-2.08E18

Appendix G Data Set on the Level Basis

DATA	REALGP	REALGGP	REALINT	INF	REALUSDI
01/01/80	799.78	8822.39	8.19	3.95	82.84
04/01/80	666.97	8636.74	7.83	3.37	83.05
07/01/80	779.67	8745.69	9.70	1.88	80.44
10/01/80	734.74	9103.59	10.03	2.80	82.44
01/01/81	589.08	9653.27	10.39	2.77	85.12
04/01/81	532.65	10345.15	11.89	2.09	90.41
07/01/81	456.72	11142.32	12.14	2.78	95.59
10/01/81	449.00	11992.92	12.99	1.63	91.98
01/01/82	382.23	12833.54	14.12	0.89	94.43
04/01/82	346.41	13620.14	13.06	1.45	97.50
07/01/82	389.64	14321.05	12.01	1.74	101.59
10/01/82	435.37	14939.48	11.57	0.31	101.57
01/01/83	471.38	15529.79	11.77	0.07	98.11
04/01/83	431.07	16163.83	10.41	1.16	100.00
07/01/83	416.41	16916.11	11.36	0.98	102.56
10/01/83	383.52	17789.90	11.41	1.00	102.29
01/01/84	374.37	18719.75	10.86	1.42	103.19
04/01/84	365.92	19643.63	12.27	0.94	104.60
07/01/84	330.98	20519.09	12.12	0.87	110.35
10/01/84	318.18	21392.79	11.49	0.86	112.68
01/01/85	284.19	22396.88	11.34	0.92	118.47
04/01/85	297.79	23688.28	10.72	0.91	114.94
07/01/85	299.59	25423.86	10.41	0.62	109.19
10/01/85	297.68	27485.97	9.56	1.02	102.37
01/01/86	313.37	29466.90	9.05	0.52	96.77
04/01/86	313.50	30986.96	9.49	-0.49	91.36
07/01/86	346.87	31702.94	8.22	0.61	87.69
10/01/86	366.76	31567.80	7.98	0.70	87.89
01/01/87	363.35	30915.98	7.16	1.21	83.61
04/01/87	397.31	30108.54	8.04	1.13	80.97
07/01/87	400.04	29472.80	8.70	1.06	82.44
10/01/87	409.69	29172.03	9.28	0.93	78.10
01/01/88	390.09	29171.35	8.78	0.78	75.72
04/01/88	383.88	29410.50	8.66	1.15	75.25
07/01/88	359.07	29834.29	8.74	1.22	79.61
10/01/88	345.16	30368.87	8.42	1.09	76.28
01/01/89	323.83	30911.27	8.55	1.14	78.06
04/01/89	302.57	31370.14	7.87	1.62	81.70
07/01/89	294.76	31658.93	8.19	0.78	82.07
10/01/89	308.74	31693.07	7.87	1.02	80.73

DATA	REALGP	REALGGP	REALINT	INF	REALUSDI
01/01/90	317.37	31412.82	7.47	1.72	80.02
04/01/90	282.22	30763.50	8.41	0.99	80.40
07/01/90	290.40	29696.82	7.67	1.73	76.68
10/01/90	284.11	28456.12	7.59	1.70	73.23
01/01/91	275.07	27590.72	8.18	0.75	73.84
04/01/91	265.98	27638.00	8.32	0.59	78.09
07/01/91	262.00	29106.94	8.03	0.76	77.83
10/01/91	261.43	31931.31	7.62	0.83	74.43
01/01/92	252.98	35378.31	7.60	0.68	75.22
04/01/92	242.59	38685.78	7.51	0.77	75.54
07/01/92	246.65	41166.51	7.22	0.76	72.42
10/01/92	238.17	42457.39	7.14	0.88	76.92
01/01/93	230.31	42579.95	7.00	0.73	78.89
04/01/93	250.29	41624.26	6.69	0.72	76.52
07/01/93	259.30	39659.42	6.43	0.46	77.46
10/01/93	255.85	37040.95	6.01	0.83	79.11
01/01/94	261.96	34457.55	6.66	0.50	79.65
04/01/94	258.69	32555.29	7.38	0.57	78.70
07/01/94	259.11	31930.77	7.24	0.93	76.37
10/01/94	256.89	32752.90	7.99	0.58	75.95
01/01/95	251.37	34628.90	7.55	0.73	75.52
04/01/95	254.95	37137.91	6.84	0.82	71.59
07/01/95	251.40	39941.91	6.93	0.50	73.94
10/01/95	250.57	43002.55	6.45	0.54	75.51
01/01/96	258.04	46621.19	6.16	0.89	77.52
04/01/96	249.39	51155.12	6.75	0.86	78.66
07/01/96	244.51	56947.83	7.01	0.58	78.75
10/01/96	237.27	63475.13	6.36	0.87	79.53
01/01/97	220.06	69259.17	6.82	0.61	83.61
04/01/97	214.40	72915.85	7.34	0.23	84.59
07/01/97	201.27	73239.84	6.67	0.50	85.86
10/01/97	190.34	71074.02	6.34	0.54	86.96
01/01/98	181.58	69587.97	6.46	0.21	89.16
04/01/98	184.37	72050.45	6.31	0.33	90.42
07/01/98	176.82	81540.95	5.98	0.51	92.28
10/01/98	179.13	97668.15	5.86	0.47	87.61
01/01/99	174.08	116041.42	6.05	0.37	88.35
04/01/99	164.50	132346.57	6.18	0.75	90.76
07/01/99	155.03	142685.02	6.59	0.74	90.24
10/01/99	175.75	145596.65	6.75	0.74	88.92
01/01/00	170.58	142792.34	6.72	0.99	91.39
04/01/00	163.52	136362.37	6.99	0.78	94.65
07/01/00	159.85	128265.85	6.70	0.91	96.67

DATA	REALGP	REALGGP	REALINT	INF	REALUSDI
10/01/00	154.37	120656.13	6.69	0.71	99.88
01/01/01	149.81	115920.10	6.12	0.96	100.05
04/01/01	151.26	116234.33	6.52	0.70	103.47
07/01/01	154.34	123652.40	6.83	0.28	102.65
10/01/01	156.98	137322.17	6.99	-0.07	103.52
01/01/02	162.90	152964.64	6.30	0.32	105.86
04/01/02	174.07	166374.55	5.92	0.79	102.13
07/01/02	174.14	173759.39	5.81	0.54	97.97
10/01/02	177.34	174243.97	5.69	0.59	97.86
01/01/03	192.02	170578.83	4.97	1.03	93.54
04/01/03	189.49	165815.30	5.47	-0.16	89.16
07/01/03	196.91	162714.38	4.95	0.75	89.31
10/01/03	211.23	162202.94	5.28	0.38	84.29
01/01/04	218.77	163110.60	4.61	0.85	82.18
04/01/04	209.00	164060.15	5.14	0.79	85.07
07/01/04	211.92	163774.81	5.00	0.64	83.84
10/01/04	226.64	161808.03	4.42	1.07	79.69
01/01/05	222.15	158649.89	4.81	0.51	79.35
04/01/05	220.68	154825.90	4.47	0.68	81.82
07/01/05	223.66	150830.02	3.58	1.51	83.57
10/01/05	244.01	147674.14	4.45	0.93	85.16
01/01/06	277.77	146806.54	4.87	0.52	84.30
04/01/06	311.88	149608.89	4.99	0.90	81.90
07/01/06	305.99	157259.13	4.74	0.94	81.96
10/01/06	303.07	167085.42	5.80	-0.41	81.44
01/01/07	318.04	172324.47	4.38	0.98	82.04
04/01/07	322.72	166207.05	4.45	1.13	80.00
07/01/07	327.08	142554.60	5.12	0.63	77.95
10/01/07	373.54	105916.02	4.30	1.23	74.44
01/01/08	434.66	72596.58	4.38	1.08	73.36
04/01/08	415.84	59351.72	4.30	1.30	72.39
07/01/08	398.24	81380.87	4.11	1.54	75.51
10/01/08	371.65	137142.88	8.11	-2.29	82.25
01/01/09	427.73	205994.16	5.96	-0.69	83.40
04/01/09	431.92	267178.48	4.98	0.53	80.40
07/01/09	445.80	301882.18	4.41	0.86	76.61
10/01/09	506.67	304210.22	4.42	0.78	74.37
01/01/10	510.23	284447.94	5.13	0.16	76.19
04/01/10	550.74	254278.81	5.08	-0.04	78.82
07/01/10	562.90	224175.14	4.29	0.29	76.99
10/01/10	622.12	200383.04	4.05	0.81	74.11
01/01/11	624.32	184104.54	4.06	1.07	73.27
04/01/11	670.68	175488.72	3.90	1.14	71.19

DATA	REALGP	REALGGP	REALINT	INF	REALUSDI
07/01/11	753.04	174826.70	3.81	0.65	71.66
10/01/11	743.46	182749.11	3.48	0.45	74.27
01/01/12	740.42	199643.69	3.34	0.56	74.85
04/01/12	703.43	225852.54	3.59	0.21	75.92
07/01/12	718.76	261771.23	3.01	0.45	76.26
10/01/12	744.18	303475.20	2.88	0.66	75.56
01/01/13	702.45	342098.51	3.48	0.40	77.25
04/01/13	609.75	369463.06	4.08	-0.12	78.80
07/01/13	568.53	378413.49	3.97	0.54	78.90
10/01/13	544.93	372186.34	4.20	0.39	78.23
01/01/14	548.66	366098.14	3.80	0.64	79.54
04/01/14	544.13	376124.97	3.75	0.47	78.95
07/01/14	540.02	417456.74	3.86	0.26	80.53
10/01/14	506.98	491318.50	4.06	-0.18	85.26
01/01/15	517.47	582463.33	4.21	-0.64	91.89
04/01/15	503.45	676045.40	3.32	0.58	92.59
07/01/15	472.96	758483.58	3.72	0.37	94.58
10/01/15	465.03	813695.27	3.90	0.09	95.97
01/01/16	496.88	825779.13	3.90	0.03	96.26
04/01/16	526.22	780195.85	3.01	0.58	92.80
07/01/16	555.16	661198.94	2.90	0.44	93.76
10/01/16	415.26	452335.50	3.06	0.75	97.56
max	799.78	825779.13	14.12	3.95	118.47
min	149.81	8636.74	2.64	-2.29	71.19
average	357.22	139581.66	6.77	0.79	85.53