Investigating the Nexus of Causal Macroeconomic Relations of Japan

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Abstract

Japan achieved phenomenal economic growth after WWII. Starting in the early 1990's, however, the Japanese economy began experiencing a prolonged deflation-stagnation period. The paper employs an ARDL Model to find evidence of long-run relation among the real GDP, imports, exchange rate, and public debt. Once cointegration is established, Granger Causality tests were performed using an estimated VAR Model with the same variables. The empirical results support Granger causality in all possible directions. In particular, we found real imports, public debt to cause the real GDP. Interestingly, the real exchange rate causes real GDP, but indirectly, via imports.

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Introduction: Japan, a reluctant trading partner

A few economists believe that Japan, because of its scarcity of natural resources, benefits more than most other countries from international trade relations. The Japanese, however, according to historical evidence, did not seek to open trade relations with the Western countries on their own. Japan's first contact with Western countries was anything but smooth. The exploitative colonial approach of the European traders and their persistent efforts to convert the Japanese to Catholicism led to much hostility among the Japanese people.[1] Unfair trading practices by the Europeans led the Japanese to expel the Portuguese, Spanish, and Dutch traders. Thus in 1639, Japan closed the borders to Western nations.

Japan's next official contact with the West came in 1851, more than two hundred years later, when the American Commodore Matthew Perry, authorized by US President Millard Fillmore, entered the Bay of Tokyo with four ships. Perry's aim was to open up trade relations with Japan, and he tried to accomplish this by bearing gifts for the emperor and other officials along with threats from the fire power of his ships. Trade relations were imposed upon the Japanese on March 31, 1854, when Commodore Perry returned to Tokyo with a larger squadron of ships. The Japanese, albeit angered and humiliated, reluctantly signed the Kanagawa Treaty.[2] This treaty gave the US steamships access to two Japanese coaling ports. In addition, the Japanese government agreed to assist stranded US ships and American seamen (whalers) at risk in Japanese waters. An official commercial treaty, the Harris Treaty, was signed by the United States and Japan a few years later in 1858.

Although Japan was forced to accept trade relations practically at gunpoint, opening up its economy turned out to be exceptionally beneficial.[3] Japan was able to have access to advanced technology for all sectors of the economy including for the military. As a result, Japan

was gradually transformed into the most powerful economic and military power in the Pacific.[4] Japan has undergone several stages of industrialization since the opening of its economy. However, much of its industrial base and infrastructure was destroyed during WWII, a period when Japan was at war with the Allied Forces. After WWII, the US assisted Japan in rebuilding its economy.

A Bubble Interrupts Expansion: Policy Responses

Following the period of the rapid growth, a major bubble formed in Japan's real estate and stock markets when asset prices skyrocketed in the late 1980s. In 1989, the Nikkei stock market index surpassed 38,000, an all-time record high. In 1991, however, the inevitable happened and the bubble burst. What followed was an unprecedented period of chronic stagnation and deflation branded as the "lost decades." Several factors have contributed to the formation of the Japanese asset bubble. Ultra-expansionary monetary policy kept interest rates exceptionally low for a very long time. Several corporations reported high profits based on capital gains, enabling them to borrow at very low interest rates and employ these funds for speculative investments. In addition, relatively high household savings were used to increase demand for equity and real estate assets. Such innovation was called "Zaitech,"[5] which in Japanese translates to "financial engineering."[6]

Prior to the formation of the asset bubble, the Japanese economy became internationally competitive in several industries, including electronics, machinery, and automobiles. Such a success was a consequence of the transformation of the traditional Japanese economy into a modern one, dominated by large corporations organized and strategically designed for global competition. Japanese corporations recruited and trained many employees who became faithful and remained a lifetime with the same companies. The tradition of lifetime employment

prevailed in Japan for over a century as the outcome of cooperation between business management, labor, and the Japanese government. Furthermore, the Japanese government guided corporations so they could compete in the international markets. The Ministry of International Trade and Industry (MITI) was created in 1949 to coordinate trade policy along with other government agencies. However, a successful export sector allowed Japan to purchase high quality capital and technology-intensive imports that played a favorable role in the growth of the economy.

In the late 1990s, Japan nevertheless experienced a major asset bubble. As the Bank of Japan (BOJ)[7] began raising interest rates, the Japanese economy entered into a prolonged period of deflation and stagnation (Hoshi and Kashyap, 2010). The BOJ was criticized for not being more aggressive and for not announcing sooner a target inflation rate. As a response to the stagnation-deflation problem, both the BOJ and the Japanese Treasury gradually contributed to the massive increase in government bonds. Such a massive increase in public debt led to a zero bound interest rate, a phenomenon that had never been explored before by other major central banks (Nakano and Okabe, 2012). Many economists, including Leigh (2010), Grabowiecki and Dabrowski (2017), and Krugman (1998), were convinced that a liquidity trap was responsible for the low economic growth, below trend, in spite the massive increases in monetary base.

The crisis created many problems; high unemployment among the young and middle-aged contributed to a higher income inequality. Lost government revenues due to stagnation affected the ability of the government to assist the aging population. Government efforts to cope with the crisis dictated increasing public deficits that gradually raised the public debt-to-GDP ratio to an unprecedented level. As a result, Japan’s public debt-to-GDP ratio increased to be the highest among all developed economies.

The question arises: how could it be that after more than 20 years of stagnation and unprecedented increases in the government debt-to-GDP ratio interest rates on government bonds did not rise? Such an increase would have been explained by rising default risk premia necessary to finance and refinance the public debt[8]. The fact that Japan's public debt has not wreaked havoc is attributable to many factors. A relatively high private savings rate in relation to other developed countries constitutes one such factor. In addition, most of the Japanese public debt, approximately 92%, is domestically owned. There is evidence of home bias among Japanese investors. However, because of the European Sovereign Debt Crisis, many international investors who wanted to invest in a safe haven country began purchasing short-term Japanese government bonds. Nevertheless, as the Eurocrisis has waned, the purchase of government bonds by international investors has also declined.

However, several unique factors characterize the Japanese economy. For example, although the Japanese real GDP growth rate was substantially reduced for many years, the Japanese economy still ranks fourth in the world in terms of Purchasing Power Parity (PPP) rates and the Japanese people enjoy a high standard of living.[9] Japan is the largest creditor in the world. Despite such success, the Japanese government, according to Akram (2014), was applying unsound fiscal policy by increasing public consumption and decreasing public investment.

Abenomics

Upon his reelection as the Japanese Prime Minister in December 2012, Shinzo Abe, along with the newly appointed governor of the BOJ, Harunciko Kuroda, announced a set of new policies to revive the Japanese economy (Guillemete and Starsky, 2015). The three policies listed below are known as "The Three Arrows" or Abenomics:

1. Accommodative Monetary Policy

2. Fiscal Policy followed by consolidation
3. Structural Reforms to induce private investment and raise potential economic growth

The first arrow, Accommodative Monetary Policy, aimed to increase inflation to an annual target rate of 2% and overcome the chronic deflation problem. To achieve this objective, the BOJ launched the Quantitative and Qualitative Monetary Easing (QQME) program. The BOJ initially purchased an extraordinary large amount of long-term government bonds, quickly doubling its total holdings. The second arrow, Fiscal Policy followed by consolidation, dictates the application of fiscal policy to raise real GDP growth and thus reduce the public debt-to-GDP ratio.

The first two arrows pertain to monetary and fiscal policies. These two policies alone however, would not be sufficient to achieve the ultimate objectives of Abenomics unless they were accompanied by the third arrow, structural reforms. Such reforms include increasing the labor force participation rates of women and older workers. In addition, an elaborate deregulation program of the economy, which was considered necessary, was launched.

Abenomics aims to resolve the well-rooted deflation-stagnation problem of the Japanese economy that emerged after the 1991 financial crisis which created deflationary expectations. According to Bojkova (2017), such expectations had become self-fulfilling. Price expectations in Japan were, for a long time, backward-looking.[10] Low energy prices were and still are an additional obstacle for the BOJ's efforts to reverse backward looking expectations. Abenomics could have been more effective if it was not preceded by the earthquake, the tsunami, and the explosion (meltdown) of the Fukushima Daishi nuclear power plant during the tragic dates of March 11, 13, and 15, 2011. However Patrick (2014) and a few other authors expressed admiration for the extraordinary resilience of the Japanese people which prevailed and led to the economic recovery.

These natural disasters worked against Abenomics. Preliminary data regarding the performance of the Japanese economy after Abenomics indicate mixed results. The inflation rate never reached its target of 2%. There was, nevertheless, a modest increase in output (Hausman and Weiland, 2015). A reduction in unemployment from 4.2% in 2013 to 3% in October 2016 took place without a substantial increase in nominal or real wages.[11] Recent unfavorable international economic developments, such as Brexit, exchange rate volatility, breakdown of multilateral international trade negotiations, and trade wars, work against Abenomics.[12]

The aggressive BOJ monetary policy of QQME aimed to increase inflation by establishing negative short and long-term interest rates. To achieve this objective, the BOJ also switched to purchasing long-term government bonds instead of short-term bonds. The BOJ's aim is to flatten and even invert the yield curve.[13] Despite the massive increase in liquidity, a new consumption tax contributed to a minor recession in 2014. Excessive liquidity, according to Xing (2016), was not absorbed by the real economy and did not boost domestic production; instead, it was simply "recycled in the financial sector".

Exchange Rate Developments

Under the Bretton Woods fixed exchange rate system, the nominal exchange rate in 1971 was 308 yen per dollar. When Japan joined the floating exchange rate system in 1973, the yen appreciated substantially to 270 yen per dollar. In the Plaza agreement in 1985, the US, Germany, France and Japan agreed to intervene in the foreign exchange markets by coordinating economic policies to prevent further dollar appreciation. Subsequently, the yen rapidly appreciated till 1988. After a couple of years of depreciation till 1990, the real exchange of the yen continued with further appreciation till 1995. A stronger yen had a negative impact on the international competitiveness of Japan since the country's export prices increased substantially in terms of

dollars. A nominal yen appreciation reduced the Japanese price level, thus leading to deflation. The real exchange rate of the yen was also appreciating until 1995, a year in which it reversed trend.

Starting in 1995, the Japanese real exchange rate began a long depreciation path, following a fluctuating upward trend. Long subintervals of substantial oscillations took place, indicating that the exchange rate of the yen was very volatile. For example, during the period 2007 to 2015, the yen completed a half cycle consisting of both appreciation and depreciation. From 2007 to 2012, a period during which the US Subprime Mortgage Crisis began to spread to Europe, the yen appreciated. This yen appreciation was explained since investors reduced demand for dollars and euros. Currency speculators and other financial investors during this period sought a safe haven, thus were investing in yen. This led to the appreciation of the Japanese currency. When the US subprime mortgage crisis and the Eurocrisis were subdued in 2012, demand for yen declined and the Japanese currency began depreciating again until 2015, see Figure 3. A cheaper yen was expected to have restored Japanese international competitiveness, especially in relation to the South East Asian countries that had seriously challenged the Japanese export sector.

Monetary and fiscal policy under Abenomics, starting in 2013, reduced both short and long-term interest rates, driving them below the zero lower bound. Low interest rates discouraged investment in Japan, as a result the yen depreciated. A depreciated yen improved the Japanese trade balance.

Trade and Economic Development

Trade and exchange rate policies have received much attention by many authors who employed various models to explain economic development. Two opposite schools of thought have emerged from at least as far back as the 18th century regarding the effects of international trade on economic development. The first school includes those authors who support free trade

and recognize the beneficial effect of opening national economies to the world via trade, Foreign Direct Investment (FDI), and capital flows. Starting with Adam Smith and David Ricardo, free trade proponents convinced many that free trade is the optimal policy for countries to follow.

Opponents of free international trade support the view that protectionism is the optimal trade policy. Protectionists, also known as mercantilists, are firm believers that countries should trade if and only if they can generate persistent trade surpluses. This policy nevertheless is self-defeating, as it is not possible for all countries to simultaneously generate trade surpluses during the same period.

Several authors support the view that open trade policies are beneficial to economies because the expansion of production to meet foreign demand allows firms to move along their long run average cost curve, enabling them to achieve economies of scale and become internationally competitive. Thus the export-led growth (ELG) hypothesis was formulated and has emerged as the dominant trade theory.

Contrary to the ELG hypothesis is the import substitution theory for international trade. The import substitution approach to trade supports protectionism by simply having the country produce and consume domestic goods in place of foreign imports. The most famous proponent of import substitution is Raúl Prebich (1962), who was influential in convincing many countries to adopt import substitution.[14] The contributions of Helpman and Krugman (1985), Ballasa (1978, 1985), Bhagwati and Srinivasan (1979), Feder (1983), Ben-David and Loewy (1998), Tao and Zestos (1999), Zestos and Tao (2002), Awokuse (2014) is a very short list of empirical studies on trade and economic development.

The two polar policies of trade and economic development, ELG and import substitution theory, divided developing countries into two distinct groups for many years. The first group includes the South East Asian countries and a few other nations that embraced the ELG model.

Japan is definitely among this group. The second group includes mainly the Latin American countries, which predominantly adopted import substitution. A third approach to trade and economic development is the "balanced growth" approach supported by Nurkse (1962). This theory promotes the simultaneous expansion of all sectors of the economy.[15] Below we present our econometric models employed for this empirical study.

Methodology

The Autoregressive Distributed Lag Model (ARDL) is employed to investigate Granger causal relations of the Japanese real GDP with real imports, real exchange rate, and public debt. The model is an important contribution by Pesaran, Shin, and Smith, (2001) in applied econometrics. The ARDL model investigates evidence of cointegration among a set of time series variables in levels using the Bounds Test. The Toda-Yamamoto (1995) Vector Autoregressive Model (VAR) complements the ARDL model by testing for Granger econometric causality among a set of time series variables. Several authors support the view that the combination of the ARDL-VAR models is superior to the method proposed by Granger (1969). It is also superior to the (Johansen, 1991, 1995) cointegration test, which is used in conjunction with Vector Error Correction (VEC) model to test for Granger Causality.

The ARDL-VAR combination models can be employed as long as the time series variables are not integrated on order two, I(2), or higher. The method can be used even if the variables are integrated on order zero, I(0), order one, I(1), or a combination of I(0) and I(1).

The conditional or unrestricted ARDL model in this study consists of four variables. The four variables are characterized by different integration orders up to I(1), therefore the ability to accommodate flexible integration orders makes the ARDL-VAR framework applicable in this study. The dependent left-hand side variable of the single equation ARDL model is the natural logarithm of the real Japanese GDP, denoted as $\ln Y_t$. The three right-hand side variables are: the

natural logarithm of real imports ($\ln M_t$), the natural logarithm of the real exchange rate ($\ln ER_t$) expressed as (#yen/1dollar), and the natural logarithm of the public debt-to-GDP ratio ($\ln PD_t$). The three variables are selected after a careful screening among a group of possible other variables. The two most important criteria for this selection were the required dynamic properties of the time series variables for the ARDL model and the plausibility of the empirical results of the estimated model. The ARDL model also includes as right-hand side variables a number of optimal lagged differences of all the variables of order r, s, k and p, as well as all the one-period lagged variables in levels: $lnY_{t-1}, ln\,M_{t-1}, ln\,ER_{t-1}$, and $lnPD_{t-1}$. The optimum numbers of lagged differences are determined according to the Schwarz Information Criterion (SIC)[16]. The ARDL model is presented in equation (1) below:

$$(1)\qquad \Delta lnY_t = \alpha_0 + \sum_{i=1}^{r} \alpha_{1i}\Delta lnY_{t-i} + \sum_{i=0}^{s} \alpha_{2i}\Delta\, ln\, M_{t-i} + \sum_{i=0}^{k} \alpha_{3i}\Delta\, ln\, ER_{t-i} + \sum_{i=0}^{p} \alpha_{4i}\Delta\, ln\, PD_{t-i} + \alpha_5 lnY_{t-1} + \alpha_6\, ln\, M_{t-1} + \alpha_7\, ln\, ER_{t-1} + a_8 lnPD_{t-1} + \varepsilon_t$$

where t=1, 2, 3…, and $\alpha_{ij}'s$ are parameters to be estimated and ε_t is the usual white noise error of the classical regression model. Furthermore, Δ denotes the first difference of the variables.

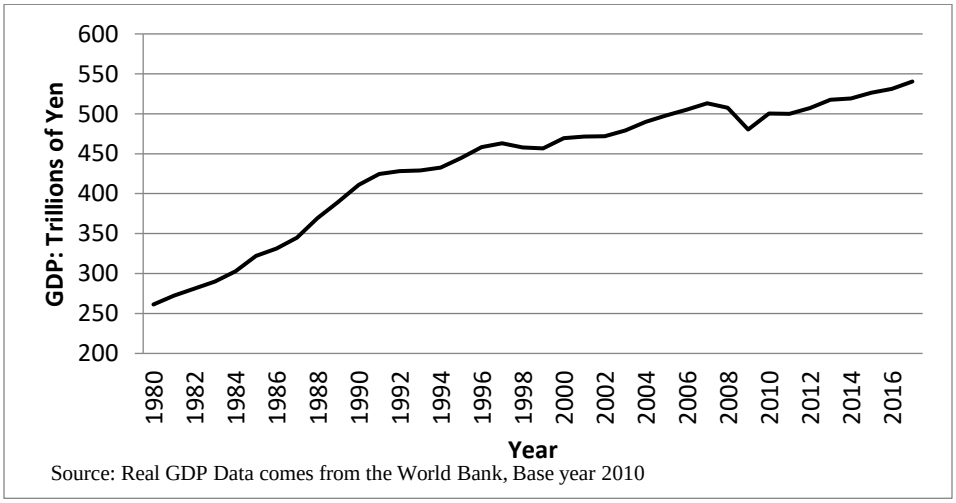
Based on the estimated ARDL model of equation (1), the existence of a long-run relationship can be tested by examining the joint significance of the coefficients of the one-period lagged variables. We employ the Bounds Testing procedure proposed by Pesaran, Shin, and Smith, (2001) where two sets of critical values are calculated: one assumes all regressors are I(0), and the other assumes that they are I(1). To be specific, the null and alternative hypotheses of the Bounds Test for cointegration H_0 and H_a are stated respectively as H_0: $\alpha_5 = \alpha_6 = \alpha_7 = \alpha_8 = 0$ and H_a: $H_0\ not\ correct$. If the computed Wald or F-test statistic falls below the lower critical value bound and above the upper critical value bounds, we can conclusively either accept

or reject the null, respectively. However, if the Wald or F-test statistic falls inside the critical value bounds, the decision is inconclusive.

Data and Variable Descriptions

Real Japanese Gross Domestic Product (Y) and Real imports (M) are measured in real 2010 Japanese currency units. The real exchange rate (ER) is expressed as the number of yen per US dollar[17]. The data for the three variables come from the World Bank. The last variable, public debt (PD), is measured as the public debt to Y ratio: PD = Public Debt/Y. Data for PD come from the Economic Database (FRED) of the Saint Louis Federal Reserve Bank.

Figure 1 below shows the real Japanese Gross Domestic Product (Y). It is shown in this Figure, Y has a positive trend, indicating that the Japanese economy has been growing almost throughout the sample period, 1980-2016. It is unclear from the Figure whether one or several structural breaks may be present in Y. There is clearly a level shift in the years 2008-2009 corresponding to the international financial crisis.



Source: Real GDP Data comes from the World Bank, Base year 2010

F**ig. 1** Real Japanese GDP

The first right-hand side variable is Japanese real imports (M). According to Figure 2 below, M has been continuously increasing since 1980, with a major exception in the years 2008 and 2009 during the international financial crisis.

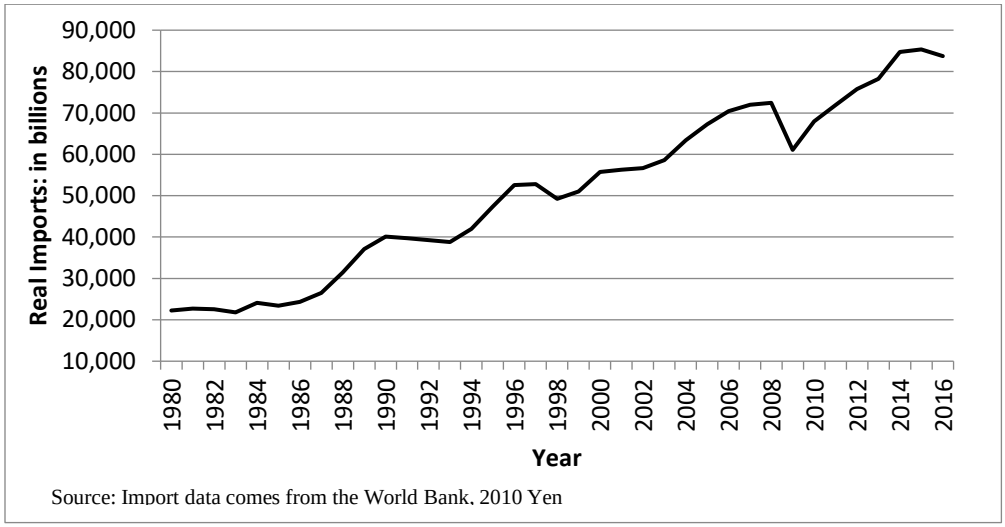


Fig. 2 Real Imports

The second right-hand side variable is the Real Exchange Rate (ER), which is presented in Figure 3 below. Real exchange rate is an important but volatile macroeconomic variable; in this respect the Japanese exchange rate is not an exception. The real exchange rate is the nominal exchange rate adjusted for the relative price levels of the US and Japan. The nominal exchange rate of the yen per dollar fluctuated within a wide range when Japan abandoned the fixed exchange rate regime in 1973. As a result, the ER oscillated substantially as well.

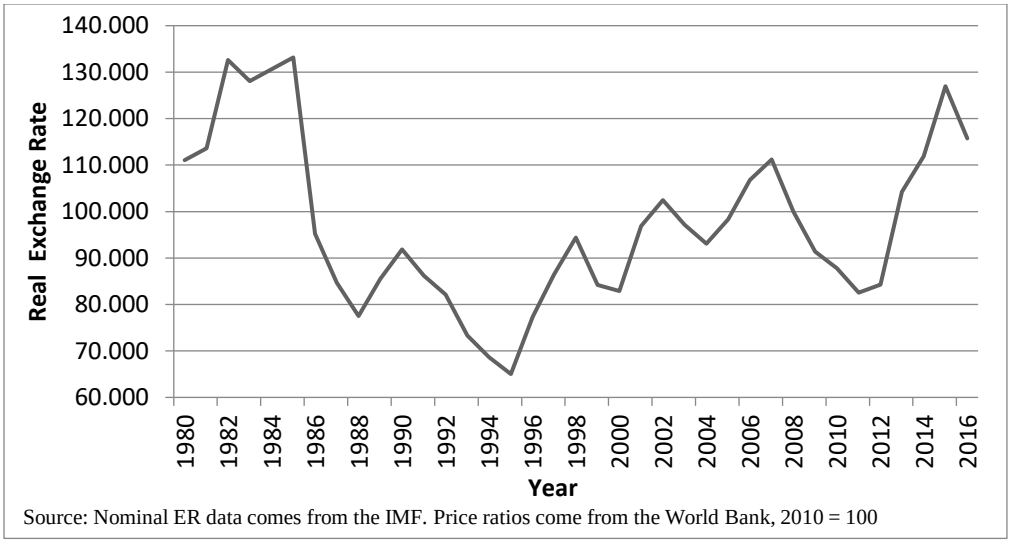
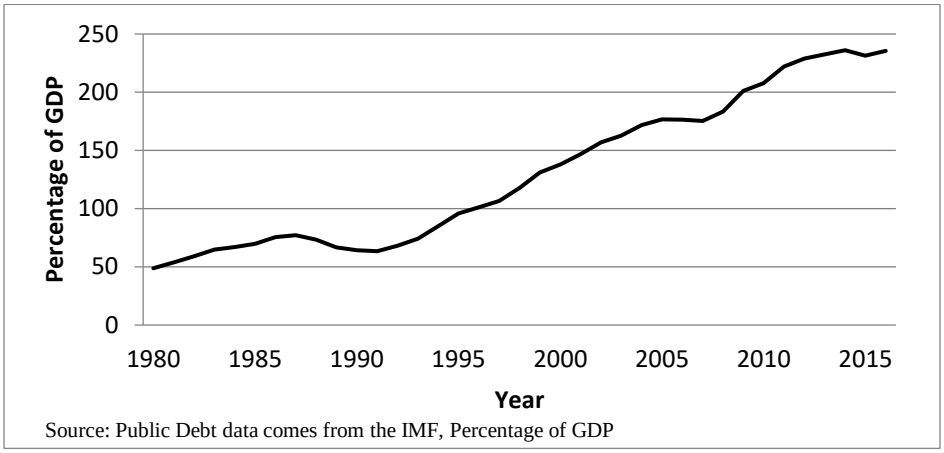


Fig. 3 Real Exchage Rate

Lastly, the third right-hand side variable is the public debt-to-GDP ratio (PD) shown below in Figure 4. The PD is a very important macroeconomic variable, as it is a crucial indicator regarding the long-term fiscal stability of a country. For Japan, the PD constitutes an exceptionally interesting and unique case study. In 1980, the Japanese PD stood close to 50 percent; it more than quadrupled by 2016. With the exception of a few years near 1990, the PD of Japan has kept rising. Japan's PD is the highest among all developed countries. It is followed by the PD of Greece and Italy, two European countries that have been experiencing serious fiscal crises. See Figure 1 in Appendix. However, the high Debt-to-GDP ratio has not yet affected the default risk premium of the Japanese government bonds. Despite the credit rating agencies downgraded the AAA-rated Japanese government bonds in 1998, the 10-year Japanese government bond yield has remained lower than 2 percent[18].



Source: Public Debt data comes from the IMF, Percentage of GDP

Fig. 4 Japanese Public Debt

Causes of the "Lost Japanese Decades"

Several explanations are provided for the prolonged stagnation-deflation period of Japan. Almost all studies begin with the late 1980s early 1990s financial crisis which peaked in 1991. The vast majority of authors attribute the origin of the crisis to the formation of a bubble created by an excessive increase in money supply and liberal credit policies that induced an extraordinary large demand for financial and real estate assets. The bubble eventually led to a bust. Although bubble crises are not uncommon among countries, the prolonged stagnation-deflation of Japan is rare and unique.

According to many authors the Japanese crisis has its roots in the 1985 Plaza Agreement: Representatives of the US, Japan, Germany and France, met in the Plaza Hotel in New York City and agreed to intervene in the foreign exchange market to halt further appreciation of the US dollar. Such a massive intervention led to the real appreciation of the yen during 1985-1988. After a two-year (1988-1990) depreciation, the yen started appreciating until 1995, a year during which the exchange rate reversed trend. This appreciation is considered a main factor of the prolonged deflation-stagnation problem of Japan.

Two alternative hypotheses provide explanations of the crisis, these are classified as supply-side and demand-side theories. The supply side theories mainly focus on the decrease of labor productivity and the declining labor force due to an aging population. Demand-side theories focus on the real yen appreciation effects on the real economy after the Plaza agreement. These theories also analyze the monetary and fiscal policy response by the BOJ and the Japanese government respectively, to cope with the crisis which created a liquidity trap. Numerous references of these two broad theories are provided by Tyers (2012). Ultra expansionary monetary policy created a liquidity trap that rendered monetary policy impotent. Furthermore, continuous deficit spending led to the mounting public debt problem. High public-debt-to-GDP-Ratio requires large interest payments which hinders economic development. Consequently, high unemployment among the youth increased income inequality (Harada, 2012).

Fukao (2013) observed the Japanese capital-to-GDP ratio has been increasing since the mid-1970s. Therefore, he concluded that the rise in capital-to-GDP ratio must have contributed to the decline of the marginal product of capital and subsequently a decrease in the rate of return to capital. Fukao suggested that accumulation of information technology was low in comparison to capital accumulation, and it was lower for small and medium sized enterprises (SME). Because large firms started moving production facilities abroad to go around the yen appreciation problem, this had a negative impact on the SMEs. Such a phenomenon resulted in a reduction in the productivity of the SMEs, which constitute a large share of the Japanese economy and thus became intrinsic to the stagnation-deflation problem.

Fokuda and Doita (2016) address the question of why the new QQME policy, launched by the BOJ in April 2013, that depreciated the yen did not result in significant increase in Japanese exports. Two main reasons contributed to the slow increase in Japanese exports after the launch of the QQME policy. The first pertains to the slowdown of the global economy that

resulted in reduction in the external demand for Japanese exports. The second reason is the appreciation of the yen during the global financial crisis of 2008. Since that time, Japanese corporations began increasingly moving production abroad, thus outward bound FDI increased substantially. Fokuda and Doita (2016) constructed a model that includes firms that can produce in the tradable sector in the home country or transfer production to the foreign country. The main concern of the authors is to consider what magnitude of the exchange rate change will induce firms to produce domestically or move production operations abroad. The model shows that a small change in the exchange rate has no substantial effect in the decision of firms. The authors found exports increase when exchange-rate depreciation is accompanied by increased external demand and vice versa; exports decrease when yen appreciation is accompanied by weak international demand conditions.

Unlike the liquidity trap explanation for the prolonged stagnation, Yoshino and Taghizadeh-Hesary (2015) attribute the Japanese lost decade(s) to chronic structural problems of the Japanese economy. Particularly, they point out the aging population and the unwillingness of firms to invest in startups of SMEs due to Basel international banking regulations. Such rigidities of the economy result in a vertical IS curve, indicating that investment is totally insensitive to interest rate changes. Therefore, a zero bound interest rate had no effect on GDP. Subsequently, the authors concluded that only major structural change could help Japan out of the prolonged stagnation-deflation problem.

Lastly, another explanation of the Japanese slowdown is the rising of China as a major world exporting economy. The rise of China coincides with the beginning of the Japanese economic stagnation-deflation period. This occurred in 1985 after the Plaza agreement when the yen started appreciating (Tyers, 2012).

EMPIRICAL RESULTS

Unit Root Tests

Prior to proceeding with the estimation of the econometric model, the dynamic properties of the four time series variables were investigated by carrying out four different unit root tests for each variable. The Augmented Dickey Fuller (1979, ADF) and the Phillips-Perron (1988, PP) tests were performed. However, these two commonly used tests have been criticized for being unreliable with small size samples, such as the Japanese sample in this study. The criticism of these two tests is serious, as it is claimed that they too frequently tend to reject a correct null hypothesis and accept a false one. To investigate the validity of this claim, we employed two other unit root tests: the Dickey-Fuller Generalized Least Squares (DF-GLS) test introduced by Elliott et al., (1996) and the NG-Perron test, (2001). According to these unit root tests, output (lnY_t), imports (lnM_t), and real exchange rate ($lnER_t$) are integrated either of order I(0) or order of I(1), so they can be used in the estimation of the ARDL model. However, public debt ($lnPD_t$) is found to be I(1) only when the test is carried out with a constant only. When the test is carried out with a constant and a trend, $lnPD_t$ is not stationary in the first difference and hence cannot be used in the ARDL model.

As Perron (1989) points out, structural change and unit root tests are closely related. Therefore, researchers should bear in mind that conventional unit root tests are biased towards accepting a false unit root null hypothesis when the data are trended and have structural breaks[19]. Since the graphs reported in the previous section plausibly suggest the existence of structural breaks, it is important to perform unit root tests which explicitly allow the presence of multiple structural breaks.

Specifically, we employ a modified version of the augmented Dicker-Fuller test proposed by Perron (1989) and Carrion-i-Silvestre, Kim and Perron (2009). When implementing the test,

we allow each variable to have multiple structural breaks in both the trend and the level. The break dates were left unspecified and were generated by the model. The break dates and unit root test results for all four variables are reported in Table 1 below. Specifically, we find $\ln Y_t$ and $\ln PD_t$ are non-stationary in levels but stationary in the first differences, while $\ln ER_t$ and $\ln M_t$ are stationary in levels. That is, after accounting for the existence of structural breaks, none of the time series is I(2), so the requirement of ARDL model is met. Since the four variables have different integration orders, employing the ARDL model in the present context seems to be a preferable choice than the VECM and VAR that require all series have identical integration orders.

Table 1 Carrion-i-Silvestre, Kim and Perron (2009) Unit Root Tests with Structural Breaks

Variable	Break year	Integration order
Output ($\ln Y_t$)	2009	I(1)
Imports ($\ln M_t$)	1987,2008	I(0)
Public debt ($\ln PD_t$)	1991	I(1)
Exchange rate ($\ln ER_t$)	1985,1995,2008	I(0)

Moreover, the unit root tests identify one structural break for output in 2009, which coincides with the global financial crisis. The global financial crisis during 2008-2009 also causes a structural break in imports and the real exchange rate, respectively. Since the crisis has huge impact on the variables, we include a dummy variable indicating the structural break for 2008-2009 in the estimated ARDL model. As shown in Pesaran, Shin, and Smith (2001), including a break dummy will not affect the performance of the cointegration test. The real exchange rate is found to have two other structural breaks, one in 1985 and the other in 1995, which coincide with the Plaza agreement and the 1995 reversal of the real exchanges rate, respectively.

The Estimated ARDL Model

The estimated ARDL model is reported in Table 2 below. This ARDL is referred to as Model (5, 5, 3, 0). The numbers inside the parenthesis refer to the lagged differences included in the model for both the dependent and the explanatory variables in the same order as the variables entered the equation of the ARDL model. The model also includes a two-year structural break for the global financial crisis of 2008-2009. The sample of the time series data set spans the period from 1980 to 2016, a total of 37 observations. Below the independent variable, lnY, are the three right-hand side variables: lnM_t, $lnER_t$, and $lnPD_t$. According to the estimated model, several coefficients are statistically significant. The coefficient of the break turned out to be negative and significant. The Durbin Watson (DW) statistic in the estimated model is 2.10, which indicates that serial correlation is unlikely. In addition, to reaffirm that the model is free from serial correlation, the Lagrange Multiplier test (LM) was performed as well. According to the LM Breush-Godfrey test for serial correlation, the estimated ARDL model passes this test of no serial correlation at a 5% level of significance. The results of the Breush-Godfrey serial correlation test are reported in Table 3 adjacent to Table 2.

Table 2 Estimated Conditional Unrestricted ARDL Model

Model ARDL(5,5,3,0)	
Sample: 1980-2016	
Dependent Variable	lnY
Independent Variables	lnM, lnER, lnPD
C	7.8137***
lnY_{t-1}	0.3129**
lnY_{t-2}	-0.0751
lnY_{t-3}	0.1517
lnY_{t-4}	-0.2116*
lnY_{t-5}	0.4015***
lnM_{t}	0.2679***
lnM_{t-1}	-0.0513
lnM_{t-2}	0.0645
lnM_{t-3}	-0.0122
lnM_{t-4}	0.0143
lnM_{t-5}	-0.0768**
Lnreerz	0.0105
$lnreerz_{t-1}$	-0.0119
$lnreerz_{t-2}$	0.0304
$lnreerz_{t-3}$	0.0389**
lnPD	-0.0867***
Break0809	-0.0199***
D.W.	2.1033

*, **, *** represent the significance levels of .10, .05, .01 respectively.

Table 3 - Breusch-Godfrey Serial Correlation LM Test - χ^2 Test

Lags	P-Values
1	0.5762
2	0.2247
3	0.3687
4	0.4165
5	0.2894

Based on the above estimated ARDL model, the Bounds Test for cointegration was performed and is reported in Table 4 below. The test statistic of the Bounds Test is 31.83, which is exceptionally high. This value exceeds the upper bound critical values provided by Pesaran et

al., (2001) at any conceivable level of significance. Therefore there is statistical evidence of cointegration.

Table 4 Critical Values for Bounds Test

Estimated Statistics		
Model	F-Statistic	DF
	31.834	32
k=3		
Significance Level	I(0) Bound	I(1) Bound
10%	2.676	3.586
5%	3.272	4.306
1%	4.614	5.966

Note k, denotes the number of independent variables in the model

The estimated unconditional ARDL model reported in Table 2 has also generated the cointegration equation of the four variables. The cointegration equation describes an explicit equation form long run relation of the variables and is based on the time series data of the four variables and the estimated ARDL model. The cointegration equation is shown below.

$$(2) \quad \ln Y_t = 18.5735 + 0.4907 \ln M_t + 0.1614 \ln ER_t - 0.2061 \ln Debt_t$$
$$\text{p-value} \quad (0.00) \quad (0.00) \quad (0.01) \quad (0.00)$$

According to the estimated cointegration equation, the real Japanese Y is positively related to the real imports. This is a plausible result: an increase of Japanese imports contributes to an increase in Japanese exports because imports consist mainly of high technology capital goods. From the cointegration equation, it can be predicted that when M increases by a certain percentage, Y_t will increase by about half of the increase in M_t.[20] In this case, the elasticity of Y with respect to $E_{Y.M}$ is 0.49. The elasticity of Y with respect to exchange rate, $E_{Y.ER}$, is 0.16 implying that when the Yen depreciates by 100 percent, Y_t will increase by approximately 16 percent. Lastly, the relationship of Y with respect to PD is negative, unlike the other two

variables. Such a relationship is plausible because a high PD is a deterrent factor of economic growth. High levels of PD require large annual interest payments to service the public debt. The elasticity of Y with respect to PD ($E_{Y.PD}$) is -0.20, which is relatively low. Such a finding, nevertheless, is not very surprising, as Japan has endured many years without a major collapse of its economy, therefore the high public Japanese debt was not very detrimental to the Japanese economy. This has happened despite the massive public debt accumulation during the last few decades.

Another format of the same estimated ARDL model, known as the Estimated Long Run Error Correction Model (ECM), is presented below in Table 5. The main feature of this version of the ARDL model is that it includes as one of its right-hand side variables, the one-period lagged error correction term (EC_{t-1}) of the cointegrating equation. According to this estimated model, the EC_{t-1} coefficient is negative, relatively large in absolute value and highly significant. This implies that if the cointegrated variables deviate from their long run equilibrium values, they will adjust to return to their long run equilibrium values rather quickly. Specifically, the model predicts that 42.07 percent of the adjustment will take place within the first year.

Table 5 Estimated Long Run ECM of the ARDL Model

Model ARDL(5,5,3,0)	
Sample: 1980-2016	
Dependent Variable	Independent Variables
lnY_t	lnM_t, $lnER_t$, $lnPD_t$
ΔlnY_{t-1}	-0.2664***
ΔlnY_{t-2}	-0.3415***
ΔlnY_{t-3}	0.1898**
ΔlnY_{t-4}	-0.4015***
ΔlnM_t	0.2679***
ΔlnM_{t-1}	0.0102
ΔlnM_{t-2}	0.0747***
ΔlnM_{t-3}	0.0624**
ΔlnM_{t-4}	0.0767***
$\Delta lnER$	0.0105
$\Delta lnER_{t-1}$	-0.0693***
$\Delta lnER_{t-2}$	-0.0389***
Break0809	-0.0199***
EC_{t-1}	-0.4207***
*, **, *** represent the levels of significance	

Granger Causality Tests within the framework of two estimated econometric Model

Evidence of cointegration from the Bounds Test led us to investigate Granger Causality from the three right-hand side variables to lnY_t. Toda and Yamamoto (1995) complement the ARDL model by showing that in a set of time series variables of differing integrating order, the standard asymptotic theory is valid if the order of integration does not exceed the length of the VAR model. In such a case, the VAR model can be estimated in levels with two lags. Within the framework of the estimated VAR model, Granger Causality Tests were performed. The

estimated VAR model is reported in Table 2 the Appendix. Prior to performing the Granger Causality tests, the estimated VAR model was tested for dynamic stability and for serial correlation. There is no evidence of serial correlation at 95% confidence level. The inverse roots of the AR characteristic polynomials remain within the unit circle, so the model is characterized by dynamic stability. Results of these two tests are found in Table 3 and Figure 3 in the Appendix. In Table 7 below, we report the Granger Causality test.

Table 7 Granger Causality tests within the estimated VAR model for $\mathbf{lnY_t}$

Excluded	χ^2	df	Probability	Excluded	χ^2	df	Probability
Dependent Variable		$\mathbf{lnY_t}$		Dependent Variable		$\mathbf{lnM_t}$	
lnM_t	15.2631	2	0.0005	lnY_t	13.7802	2	0.0010
$lnER_t$	2.0561	2	0.3577	$lnER_t$	9.3047	2	0.0095
$lnPD_t$	8.0233	2	0.0181	$lnPD_t$	13.8171	2	0.0010
All	**30.5006**	**6**	**0.0000**	**All**	**31.1507**	**6**	**0.0002**
		$\mathbf{lnER_t}$		Dependent Variable		$\mathbf{lnPD_t}$	
Dependent Variable							
lnY_t	2.9553	2	0.2282	lnY_t	6.1464	2	0.0463
lnM_t	9.1167	2	0.0105	lnM_t	10.4416	2	0.0054
$lnPD_t$	2.0136	2	0.3654	$lnER_t$	0.3806	2	0.8267
All	**18.4669**	**6**	**0.0052**	**All**	**20.0228**	**6**	**0.0027**

Note: the VAR was estimated with two lagged differences

We performed a test for each of the four endogenous variables of the VAR model using the block exogeneity test in EViews. Such tests allowed us to investigate whether the three right-hand side variables in each equation jointly Granger caused the left-hand side variable. These tests employed a χ^2 distribution. In addition, a t-test was also performed for each right-hand side variable to examine whether each of the three right-hand side variables separately Granger caused the left-hand side variable. Consequently, the Granger causality results are reported for each of the four left-hand side variables.

According to the top-left panel of Table 7, the three right-hand side variables, $\ln M_t$, $\ln ER_t$ and $\ln PD_t$, jointly Granger cause $\ln Y_t$ at any conceivable level of significance, as the p-value is almost zero. Regarding the individual t-tests, $\ln M_t$ and $\ln PD_t$ are statistically significant according to the reported p-values and therefore Granger cause $\ln Y_t$ individually. Interestingly, the exchange rate, although not individually Granger causing $\ln Y_t$, affects $\ln Y_t$ indirectly via its influence on $\ln M_t$. Our claim regarding the indirect Granger causality is evident from the top-right panel in Table 7 wherein the dependent variable is $\ln M_t$. The three independent variables $\ln Y_t$, $\ln ER_t$ and $\ln PD_t$, jointly Granger cause $\ln M_t$ according to the χ^2 test. As for the individual t-statistic, the $\ln ER_t$ causes $\ln M_t$; Similarly, $\ln Y_t$ and $\ln PD_t$, each Granger causes $\ln M_t$.

Liberally interpreted, these results show that output is caused by the foreign sector and public debt regardless of the fact that the high indebtedness did not wreak havoc on the economy. Public debt, nonetheless, most likely played a crucial role in prolonging the recession. The remaining variables $\ln M_t$, $\ln ER_t$, and $\ln PD_t$, are each jointly Granger-caused by the excluded three right-hand side variables. This implies that there is evidence of Granger causality among all the variables in the VAR model.

In Figure 5, it can be seen that Japan generated both deficits and surpluses during this period. Nevertheless, the deficit years exceeded the surplus years. For a large interval of about twenty consecutive years, Japan generated only deficits. However, this cannot be characterized as a weakness; on the contrary, it should be considered a strength, as large shares of Japanese imports were capital goods that strengthened its ability to increase the quantity of high quality exports (Thorbecke, 2015).

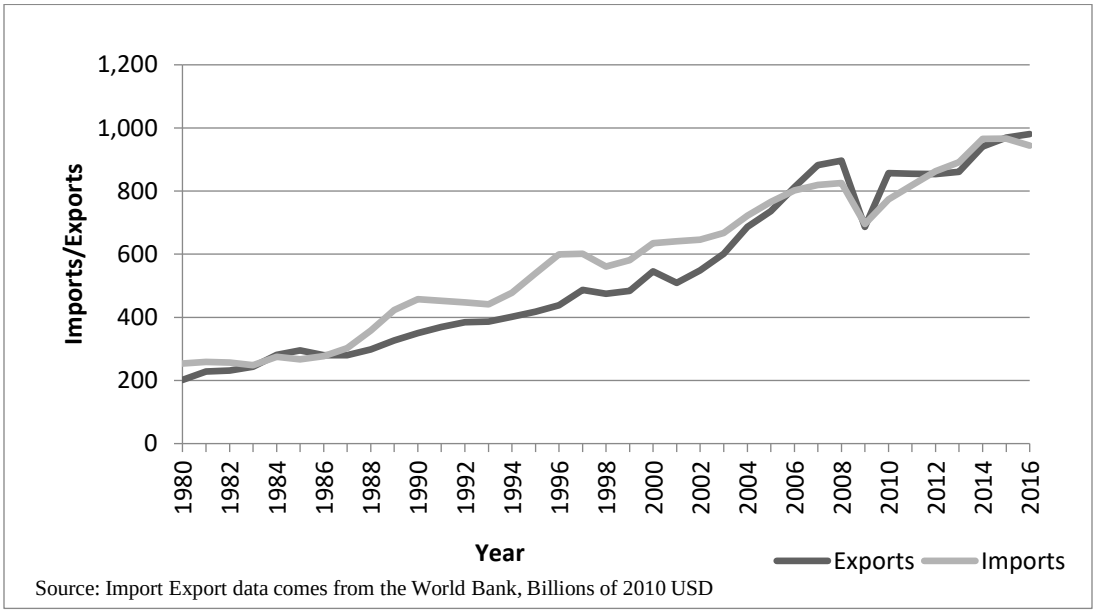


Fig. 5 Japanese Imports and Exports

Concluding Comments

The study investigates Granger causal relations of Japanese real GDP vis-à-vis three macroeconomic variables: real imports, real exchange rate, and public debt. According to the empirical results, these variables are found to jointly Granger cause real Japanese GDP. This is an important empirical result. Despite the fact that Japan was forced to open up its economy to the world some 160 years ago, Japan now enjoys the status of one of the most developed countries. Public debt was also one of the determinants of the real Japanese GDP. According to the estimated ARDL model and the Granger causality tests, public debt has not wreaked havoc. Although it did not abruptly destabilize the economy, it is likely to have contributed to Japan's stagnation. Abenomic policies launched in 2013 kept the default risk premium for the Japanese public debt very low. Nonetheless, Abenomics seems to be working despite the recent adverse domestic and international developments. Low and even negative interest rates along with fiscal consolidation and structural reforms are making public debt refinancing possible. As Japan is the

largest creditor country in the world and accumulates the largest international investment position, it has also evolved to be the second largest country in terms of holdings of foreign currency reserves. As a result, Japan is able to keep distancing itself from financial crises or credit events while gradually reducing its public debt to GDP ratio.

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[1] Milestones 1830-1860 – Office of the Historian
[2] https://www.archives.gov/exhibits/featured-documents/treaty-of-kanagawa
[3] Such benefits do not of course reflect cultural preferences derived from isolationism.
[4] Ibid 2
[5] J. Colombo (2012)
[6] A term very familiar in the US from the US Subprime Mortgage Crisis of 2007-2009.
[7] This is the name of the Central Bank of Japan.
[8] See Horioka, Nomoto and Terada-Hagiwara (2014)
[9] According to own calculations, in the 1960's GDP grew 14.4%, in the 1970's 5.05%, in the 1990's 4.90% and only 1.07% from 1990 to 2016
[10] Governor Haruchinko Kurodova of The Bank of Japan also characterized inflationary expectations in Japan as backward looking, implying past deflation would continue in the future despite very aggressive expansionary monetary policy.
[11] Japan is similar to the rest of the world regarding suppressing labor costs to enable national firms to become internationally competitive, as trade union membership declined along with labor income as percentage of GDP.
[12] Most of these events nevertheless fall outside our sample period, but Abenomics is still applicable
[13] The US Federal Reserve also had launched such policy.
[14] Prebich was an Argentine economist and a very influential head of the UN Commission on Latin America.
[15] For more detailed information on the earlier contributions to trade and development see Zestos and Tao (2002).
[16] The SIC always chooses the most parsimonious model and such model is preferable in this study as our sample size is a relatively small with 37 observations. We restricted the maximum optimum lags to be 3 in each of the four variables.
[17] $ER_{¥/\$} = NE_{¥/\$} * (P_{US}/P_J)$
[18] http://www.bondeconomics.com/2015/04/higher-debt-to-gdp-ratio-and-lower-bond.html
[19] This observation has motivated development of a large literature in unit root tests that remain valid in the presence of structural breaks. See Hansen (2001) for an overview.
[20] Such an inference can be made because all the variables in this equation are expressed in terms of their natural logarithms. Therefore the coefficients are the elasticities of Y in reference to the respective variable.