The Nexus between Causal Macroeconomic Relations in Japan

George K Zestos[1] Yixiao Jiang[2] Hunter Simons[3]

Abstract

Japan achieved phenomenal economic growth after WWII. Starting in the early 1990s, however, the Japanese economy began experiencing a prolonged deflation-stagnation period widely known as the "Lost Decades". Based on data from the World Bank and the Federal Reserve Bank of Saint Louis, this paper employs an autoregressive distributed lags (ARDL) model to find evidence of a long run relation among the real GDP, real imports, the real exchange rate, and the public debt-to-GDP ratio for Japan. Once cointegration is established with the Bounds Test, Granger Causality tests are performed by employing an estimated Vector Autoregressive (VAR) model with the same variables. The empirical results support Granger causality in all directions. In particular, we found real imports and public debt-to-GDP ratio to directly cause real GDP. Interestingly, the real exchange rate causes real GDP indirectly via imports. The public debt had a negative effect on GDP but did not wreak havoc on the Japanese economy. The study also examines whether former Prime Minister Shinzō Abe's unprecedented macroeconomic policies and structural reforms launched in 2013, known as Abenomics, are pulling Japan out of its economic doldrums.

1. Corresponding Author: George K. Zestos Jean Monnet Chair Department of Economics. Christopher Newport University, 1 Avenue of the Arts, Newport News, VA, 23606, USA gzestos@cnu.edu
2. Assistant Professor, Department of Economics, Christopher Newport University
3. Research Assistant and CNU Summer Scholar, Christopher Newport University

1 Introduction: Japan, a reluctant trading partner

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.[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 occurred 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 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 its economy turned out to be exceptionally beneficial.[3] Japan was able to access advanced technology for all sectors of the economy including the military. As a result, Japan was gradually

transformed into the most powerful economic and military power in the Pacific. 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 against the Allied Forces. After WWII, the US assisted Japan in rebuilding its economy.

The post-WWII phenomenal growth in the Japanese economy was interrupted by a period of chronic stagnation and deflation, known as the "Lost Decades". Set against this background, this study has several objectives. First, it provided a comprehensive review of the economic causes of the Lost Decades as well as the major policy responses, with a focus on the stimulation plans of former Prime Minister Shinzō Abe. Second, an ARDL model was estimated to study the long run relationship among important macroeconomic variables; a variety of Granger causality tests were then performed to investigate the nexus among them. Finally, this paper critically assessed the success of Abenomics based on the estimated econometric model. Since public debt had a rather small impact on real GDP, the massive public debt in Japan should not be identified as the sole cause for the lost decades. Nevertheless, the Japanese government should be cautious in mounting public debt on the road to reform.

The rest of the paper is organized as follow. Section 2 discusses the major historical events and policy changes related to the Lost Decades. Section 3 reviews extant economic studies, both theoretical and empirical, that addressed the policy responses. Section 4 explains the employed methodology and data. Section 5 contains the empirical results and policy discussion. Section 6 concludes.

2 A Bubble Interrupts Expansion: Policy Responses

Following a period of rapid growth, a major bubble formed in Japan's real estate and stock markets, causing asset prices to skyrocket in the late 1980s. In 1989, the Nikkei stock

market index surpassed 38,000, a 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." A number of factors had 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 incredibly 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 monetary innovations were called "Zaitech"[4] which translates in English to "financial engineering", Zestos (2016)[5]

Prior to the formation of the asset bubble, the Japanese economy was internationally competitive in several industries, including electronics, machinery, and automobiles. This success resulted from the transformation of the traditional Japanese economy into a modern one, dominated by large corporations organized and strategically positioned for global competition. Japanese corporations recruited and trained many employees who became faithful and remained with the same companies for a lifetime. The tradition of lifetime employment prevailed in Japan for over a century and it was the outcome of cooperation between business management, labor, and the Japanese government. Furthermore, the Japanese government guided corporations to compete internationally. The Ministry of International Trade and Industry (MITI) was created in 1949 to coordinate trade policy along with other government agencies. 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. Consequently, the Bank of Japan (BOJ)[6] began raising interest rates, causing the Japanese economy to enter a prolonged period of deflation and stagnation (Hoshi and Kashyap, 2010). The BOJ was criticized

for not being more aggressive or announcing a target inflation rate. As a response to the stagnation-deflation problem, both the BOJ and the Japanese Treasury 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 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, below trend economic growth.

The crisis created many problems, including high unemployment among the young and middle-aged which 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 required increasing public deficits that gradually raised the public debt-to-GDP ratio to an unprecedented level.

The question arises: how could, after more than 20 years of stagnation and unprecedented increases in the public 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 the public debt[7]. The fact that Japan's public debt has not wreaked havoc is attributed to many factors; one such factor is a relatively high private saving rate compared to other developed countries. In addition, approximately 92% of the Japanese public debt is domestically owned. There is evidence of home bias among Japanese investors. Furthermore, because of the European Sovereign Debt Crisis, many international investors who preferred to invest in a safe-haven country, began purchasing short-term Japanese government bonds. As the Eurocrisis has waned, nonetheless, the purchase of government bonds by international investors has declined but investors still purchased yen for carry trade.

However, several unique factors characterize the Japanese economy. For example, although the real Japanese GDP growth rate was substantially reduced for many years, the Japanese economy still ranks the fourth in the world in terms of purchasing power parity (PPP) rates. Consequently, the Japanese enjoy high standard of living.[8] Furthermore, Japan is the largest creditor in the world. Despite such success, the Japanese government had been applying incorrect fiscal policy by increasing public consumption and decreasing public investment (see Akram, 2014).

2.1 Abenomics

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

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

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

The first two arrows employed monetary and fiscal policies. These two policies alone, however, would not have been sufficient to achieve the ultimate objectives of Abenomics unless complemented by the third arrow, the structural reforms. Such reforms included increasing labor force participation rate of female and older workers. In addition, an elaborate deregulation program of the economy was launched.

Abenomics aimed to resolve the deep-rooted deflation-stagnation problem of the Japanese economy that emerged after the 1991 financial crisis. Deflationary expectations created by the crisis had become self-fulfilling (Bojkova, 2017). Price expectations in Japan were, for a long time, backward-looking.[9] Low energy prices were an additional obstacle for the BOJ's efforts to reverse backward looking expectations of prices. Prices, however, started rising on November 2021.

The aggressive BOJ monetary policy of QE 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 was to flatten and even invert the yield curve.[10] Despite the massive increase in liquidity, a new consumption tax contributed to a minor recession in 2014. It is suspected that excessive liquidity did not end up in the real economy and did not boost domestic production; instead, it was simply absorbed by the financial sector (Xing, 2016).

Abenomics could have been more effective if it were not preceded by an earthquake and tsunami that caused the tragic explosion (meltdown) of the Fukushima Daishi nuclear power plant on March 11, 13, and 15, 2011.[11] These natural disasters worked against Abenomics. Preliminary data regarding the performance of the Japanese economy during the launch of Abenomics indicated mixed results. The inflation rate never reached its target of 2%. There was, nevertheless, a modest increase in output (Hausman and Wieland, 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.[12] Recent unfavorable international economic developments, such as Brexit, exchange rate volatility, the breakdown of multilateral international trade negotiations, trade wars, and the Pandemic, have worked against Abenomics.[13]

2.2 Exchange Rate Developments

Under the Bretton Woods fixed exchange rate system, the nominal exchange rate in 1971 was set at 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 1985 Plaza Accord, the US, Germany, France, and Japan agreed to intervene in the foreign exchange markets by coordinating economic policies to prevent further dollar appreciation. The dynamics of real exchange rate in Japan is depicted in Figure 1 of Section 4.2. Following the Plaza Accord, the yen rapidly appreciated until 1988. After a couple of years of depreciation until 1990, the yen appreciated again until 1995. A stronger yen had a negative impact on the international competitiveness of Japan, since the country's export prices increased substantially. A nominal yen appreciation reduced the Japanese price level, thus leading to deflation.

Starting in 1995, the real yen began a long depreciation path, following a volatile upward trend. Long subintervals of substantial oscillations took place, indicating that the yen exchange rate was unstable. For example, during the period from 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 and spread to Europe, the yen appreciated. Such yen appreciation was explained because investors reduced demand for dollars and euros. Currency speculators and other financial investors during this period sought a safe haven and thus invested in yen. This led to the appreciation of the Japanese currency.

When the US Subprime Mortgage crisis and the Eurocrisis were mostly subdued by 2012, the demand for yen declined and the Japanese currency began depreciating again until 2015. A cheaper yen was expected to have restored the Japanese international competitiveness, especially in relation to the South East Asian countries that had seriously challenged the Japanese exports sector. In addition, monetary and fiscal policy under Abenomics, starting in 2013, reduced both short and long-term interest rates, driving them to zero-lower bound and even negative. Low interest rates discouraged investment in Japan, as a result, the yen depreciated. A yen depreciation, however, only mildly improved the Japanese trade balance.

3 Literature Review

3.1 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 and early 1990s financial crisis which peaked in 1991. Many studies 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 a large demand for financial and real estate assets (discussed in Section 2). Eventually, the bubble burst. Although bubble crises are not uncommon among countries, the prolonged stagnation-deflation of Japan is rare and unique. The yen appreciation after the Plaza Agreement in 1985 is considered a major factor of the prolonged deflation-stagnation problem.

Two alternative hypotheses provide explanations of the crisis; these are classified either as supply-side or 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 responses by the BOJ and

the Japanese government respectively, to cope with the crisis which created a liquidity trap.[14] The ultra-expansionary monetary policy triggered a liquidity trap that rendered monetary policy impotent. Furthermore, deficit spending led to the mounting public debt problem. A high public debt-to-GDP ratio required large interest payments which hindered economic development[15].

In a recent study, Nersisyan and Wray (2021) noted that while Japan has the highest public debt-to-GDP ratio in the world, the country has not been negatively affected because of its low interest rate. Furthermore, the two authors emphasized that the main reason Japan did not quickly recover from the stagnation is because its fiscal policy was not sufficiently effective during times of recessions. Thus, Japanese fiscal policy was characterized by stop-and-go steps reversing course from expansionary to contractionary prior to recoveries

Fukao (2013) observed that the Japanese capital-to-GDP ratio has been increasing since the mid-1970s. Therefore, he concluded that the rise in the capital-to-GDP ratio contributed to the decline of the marginal product of capital and subsequently to a decrease in the rate of return to capital. In addition, Fukao observed not only that the accumulation of information technology was low in comparison to capital accumulation, but it was lower for Small and Medium sized Enterprises (SMEs). Although large firms had started moving production facilities abroad to avoid the yen appreciation problem and the US tariffs, low accumulation of technology had a negative impact on the SMEs efficiency. Such a phenomenon resulted in a reduction in the productivity of the SMEs, which constitute a large share of the Japanese economy and thus played a role to the stagnation-deflation problem.[16]

Jiang et al. (2020) and Fokuda and Doita (2016) address the question of why the new QE policy launched by the BOJ in April 2013, which led to yen depreciation, did not trigger a significant increase in Japanese real exports and therefore to GDP. Two main reasons contributed to the slow increase in Japanese exports after the launch of the QE 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 starting in 2008. Since then, Japanese corporations began moving production abroad, thus an outward bound Foreign Direct Investment (FDI) increased substantially at the expense of exports.[17]

Unlike the liquidity trap explanation for the prolonged stagnation, Yoshino and Taghizadeh-Hesary (2015) attributed the Japanese lost decades to chronic structural problems of the economy, particularly to the aging population and the unwillingness to invest in SMEs startups due to Basel international banking regulations. Such rigidities resulted 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 investment and GDP. Subsequently, the authors concluded that only major structural corrections could help Japan out of the prolonged stagnation-deflation problem. Tyers (2012) attributes the Japanese slowdown to the emergence 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.

3.2 Economic Development and Trade Theories

Two opposite schools of thought have emerged from at least the 18th century regarding the effects of international trade on economic development. The first school includes authors who support free trade and recognize the beneficial effects of opening up 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. Several authors support the view that open trade policies are beneficial to countries

because 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 policy.

Opponents of free international trade, on the contrary, advocate protectionism as the optimal trade policy. Protectionists, also known as mercantilists, are firm believers that countries should trade if and only if they generate persistent trade surpluses.[18] Protectionists adopted the import substitution theory which requires a country to produce and consume domestic goods instead of relying on imports. The most known proponent of this theory is Raúl Prebich (1962).[19] The Balanced Growth theory was proposed by Nurkse (1961) according to this theory all sectors of an economy are supported and expanded proportionally. Such a theory that is almost forgotten can presently gain popularity and support in an environment dominated by trade wars and suspicions.

The impact of international trade on economic development has been widely studied. Helpman and Krugman (1989), Balassa (1978, 1985), Bhagwati and Srinivasan (1979), Feder (1983), Ben-David and Loewy (1998), Harbeler (1978), Tao and Zestos (1999), Frankel and Romer (1999), Zestos and Tao (2002), Awokuse (2014), and Krueger (1978) are just a few of the many theoretical and empirical studies in this literature. In a more recent study, Zestos et al. (2016) provide statistical evidence that persistent trade surpluses in the Northern Eurozone countries in relation to the Southern Eurozone members Granger caused public indebtedness to their trading partners in Southern Europe. The fiscal situation deteriorated such that five Eurozone members counties: Greece, Ireland, Portugal, Spain and Cyprus had to be jointly bailed out by the IMF and the EU to avoid bankruptcy.[20] In light of this literature, we present two

econometric models that allow the real GDP to be flexibly driven by imports, exchange rate, and the public debt-to-GDP ratio.

4 Methodology

4.1 The ARDL Model

The autoregressive distributed lags 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 was developed by Pesaran, et al. (2001). The ARDL model investigates evidence of cointegration among a set of time series variables expressed in levels using the Bounds Test. In addition, the Toda-Yamamoto (1995) Vector Autoregressive model (VAR) complements the ARDL model by testing for Granger econometric causality among a group of time series variables.[21] The ARDL-VAR methodology can be employed as long as the time series variables are not integrated of order two, I(2), or higher.

The conditional or unrestricted ARDL model in this study consists of four variables that are characterized by different orders of integration up to I(1), therefore the ability to accommodate flexible integration orders makes the ARDL-VAR framework applicable in this study. The dependent 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 numbers of yen per dollar, and the natural logarithm of the public debt-to-GDP ratio ($\ln PD_t$).

The three variables were selected after a careful screening among a group of possible alternatives. The two 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 all the one-period lagged variables in levels: $lnY_{t-1}, ln\,M_{t-1}, ln\,ER_{t-1}$, and $lnPD_{t-1}$, and a number of optimal lagged differences of all the variables of order r, s, k and p respectively. The ARDL model is presented in equation (1) below:

$$(1)\quad \Delta lnY_t = \alpha_0 + \alpha_1 lnY_{t-1} + \alpha_2 ln\,M_{t-1} + \alpha_3\, ln\,ER_{t-1} + a_4 lnPD_{t-1} + \sum_{i=1}^{r} \alpha_{1i}\Delta lnY_{t-i} + \sum_{i=0}^{s} \alpha_{2i}\Delta\, ln\,M_{t-i} + \sum_{i=0}^{k} \alpha_{3i}\Delta\, ln\,ER_{t-i} + \sum_{i=0}^{p} \alpha_{4i}\Delta\, ln\,PD_{t-i} + \varepsilon_t$$

where t=1, 2, 3…, and α_{ij} *'s* are parameters to be estimated and ε_t is the usual white noise error term. 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 Test proposed by Pesaran et al. (2001) where two sets of critical values are calculated: one assuming all regressors are I(0), and the other assuming that they are I(1). To be specific, the null and alternative hypotheses of the Bounds Test are stated respectively as H_0 $(No\ Cointegration)$: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$ and H_a: H_0, not true. If the computed Wald F-test statistic falls below the lower critical value bound or above the upper critical value bound it is concluded either to accept or reject the null hypothesis. However, if the Wald F-test statistic falls inside the critical bound values, the test is inconclusive.

4.2 Data and Variable Descriptions

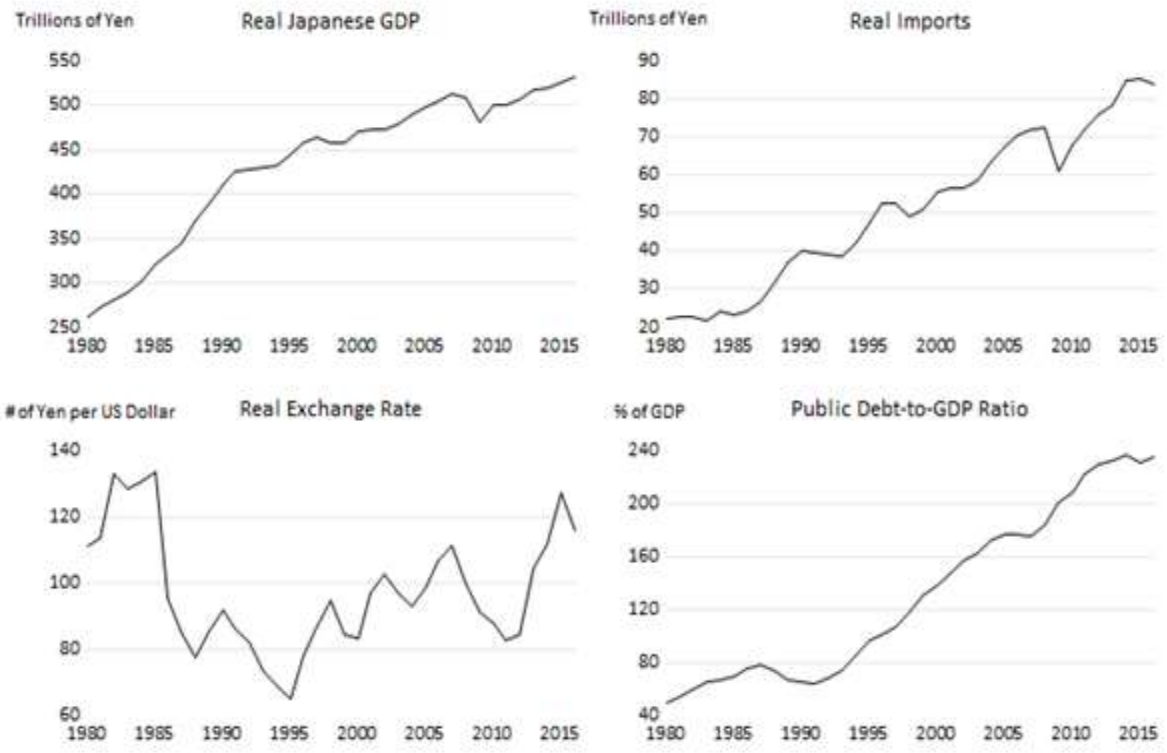

Figure 1: Time plots of the variables of this study

Figure 1 above depicts the time plots of the four variables employed in the study. In the upper part of Figure 1 the real Japanese GDP (Y) and the real imports (M) are presented, in the left and right; both variables are expressed in 2010 trillion of Japanese yen. The time plot shows Y has a positive trend, indicating that the Japanese economy has been growing almost throughout the sample period, 1980-2016. One or more structural breaks may be present in Y, including an intercept change in 2008-2009 corresponding to the US Subprime Mortgage Crisis. The time plot of the real imports (M) shows a similar pattern as that of the Y.

In the lower part of Figure 1, the real exchange rate of the yen (ER) and the public debt-to-GDP ratio (lnPD) are presented. The real exchange rate is expressed as the numbers of yen per US dollar[22]. The real exchange rate is the nominal exchange rate adjusted for the relative price levels of the US and Japan. The nominal exchange rate fluctuated substantially since Japan

abandoned the fixed exchange rate regime in 1973. As a result, the lnER oscillated substantially as well. The data for the first three variables comes from the World Bank.

The last variable, public debt, depicted in the bottom-right of Figure 1 is measured as the public debt-to-GDP ratio (PD). Data for PD comes from the Economic Database (FRED) of the Federal Reserve Bank of Saint Louis. The PD is a crucial macroeconomic indicator of 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 for a few years near 1990, the PD has kept rising. In 2016, Japan's PD was the highest among all developed countries as it is shown in Figure 1A in the Appendix. However, the high Debt-to-GDP ratio has not yet affected the default risk premium of the government bonds. Despite the stripping by the Credit Rating Agencies (CRAs) the AAA-rated status of the Japanese government bonds in 1998, the 10-year government bond yield has remained lower than two percent[23].

5 EMPIRICAL RESULTS

5.1 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 first performed. However, these two commonly used tests have been criticized for being unreliable in small samples, such as the Japanese sample in this study. The criticism of these two tests is serious, as they tend to over 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 the natural logarithms of output (lnY_t), imports (lnM_t), and real exchange rate ($lnER_t$) are integrated either of order I(0) or of I(1), so we were able to employ them in the estimation of the ARDL model. However, the natural logarithm of public debt ($lnPD_t$) was found to be I(1) only when the test is carried out with a constant. When the test is carried out with a constant and a trend, the $lnPD_t$ was not stationary in the first differences and hence could not be employed in the ARDL model. From the graph of lnPD in Figure 1, it is clear that lnPD has a trend and thus the unit root test result cannot be ignored[24].

Perron (1989) pointed out structural change and unit root tests are closely related. Thus, researchers should bear in mind that conventional unit root tests are biased towards accepting a false unit root null when the data is trended and has structural breaks.[25] 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 employed a modified version of the augmented Dickey-Fuller test proposed by Perron (1989) and also by Carrion-i-Silvestre, Kim and Perron (2009). The test allows each variable to have multiple structural breaks in both the trend and the intercept. The break dates were left unspecified and were determined empirical by the data via the Carrion-i-Silvestre, Kim and Perron (2009) unit root test procedure. The break dates and unit root test results for all four variables are reported in Table 1 below. Specifically, we found lnY_t and $lnPD_t$ are non-stationary in levels but stationary in the first differences, while $lnER_t$ and lnM_t are stationary in levels. That is, after accounting for structural break(s), none of the time series is I(2), therefore the requirement of ARDL model is met.

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

Variable	Break year	Integration order
Output (lnY_t)	2009	I(1)
Imports (lnM_t)	1987,2008	I(0)

Public debt ($lnPD_t$)	1991	I(1)
Exchange rate ($lnER_t$)	1985,1995,2008	I(0)

Moreover, the unit root tests identify one structural break for lnY in 2009, which coincides with the end of the US Subprime Mortgage Crisis. The US Subprime Mortgage Crisis during 2008-2009 also caused structural breaks in imports and the real exchange rate. 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 Accord and the 1995 reversal of the real exchanges rate trend, respectively.

5.2 The Estimated ARDL Model

The estimated ARDL model is reported in Table 2 below. This model is referred to as (5, 5, 3, 0). The numbers inside the parenthesis refer to the lagged values included in the model for both the dependent and independent variables. The model also includes a dummy variable capturing a structural break for the last two years of the US Subprime Mortgage Crisis. The dummy variable takes the value of one for 2008 and 2009 and zero elsewhere. As indicated in Pesaran et. al (2001), including a break dummy does not affect the cointegration test. The sample of the time series data set spans the period 1980 - 2016, a total of 37 observations. Below the dependent 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 highly significant as expected. The Durbin Watson (DW) statistic is 2.10, which indicates that serial correlation is unlikely to be present in the estimated model. In addition, to reaffirm that the model was free from serial correlation, the Breush-Godfrey Lagrange Multiplier (LM) test was performed as well. The estimated ARDL model passes the test at 5% level of significance. The results of the Breush-Godfrey serial correlation test are reported in Table 3 adjacent to Table 2.

Based on the above estimated ARDL model, the Bounds Test for cointegration was

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**
LnER	0.0105
$lnER_{t-1}$	-0.0119
$lnER_{t-2}$	0.0304
$lnER_{t-3}$	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

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 strong statistical evidence of cointegration.

Table 4 Critical Values for Bounds Test

Estimated Statistics		
Model	F-Statistic	DF
k=3	31.83	32
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 presented below describes an explicit long run relation of the included variables,

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

According to the estimated cointegration equation, the real Japanese GDP is positively related to the real imports. This is a plausible result: an increase of real Japanese imports contributes to an increase in Japanese real exports and thus increasing GDP. This happens because imports consisted mainly of high technology capital goods. It can be predicted that when M increases by a certain percentage, Y will increase by about half of that percentage.[26] This is the case because the elasticity of Y with respect to imports, $E_{Y.M}$, is 0.49.

The elasticity of Y with respect to the real exchange rate, $E_{Y.ER}$, is 0.16 implying that when the yen depreciates by 100 percent, Y, 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 to economic growth. High levels of PD require large annual interest payments to service it. The elasticity of Y with respect to PD, $E_{Y.PD}$, is -0.20, which is relatively low. Such a low value of output-PD elasticity, nevertheless, is

not very surprising because Japan has endured many years without a major collapse of its economy. Therefore, the high PD was not very detrimental to the Japanese economy.

Another form of the same estimated ARDL model, known as the Long Run Error Correction Model (ECM), is presented below in Table 5. The main feature of this version of the ARDL is that it includes the one-period lagged Error Correction term (EC_{t-1}) of the cointegrating equation as an additional right-hand side variable. According to this estimated model, the coefficient of the EC_{t-1} is negative, large in absolute value, and highly significant. This implies that if the cointegrated variables deviate from their long run equilibrium values, they will adjust rather quickly to return to their long run equilibrium values. 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

Sample: 1980-2016	
Dependent Variable	Independent Variables
$\ln Y_t$	$\Delta\ln M_t$, $\Delta\ln ER_t$, $\Delta\ln PD_t$
$\Delta\ln Y_{t-1}$	-0.2664***
$\Delta\ln Y_{t-2}$	-0.3415***
$\Delta\ln Y_{t-3}$	0.1898**
$\Delta\ln Y_{t-4}$	-0.4015***
$\Delta\ln M_t$	0.2679***
$\Delta\ln M_{t-1}$	0.0102
$\Delta\ln M_{t-2}$	0.0747***
$\Delta\ln M_{t-3}$	0.0624**
$\Delta\ln M_{t-4}$	0.0767***
$\Delta\ln ER$	0.0105
$\Delta\ln ER_{t-1}$	-0.0693***
$\Delta\ln ER_{t-2}$	-0.0389***
Break0809	-0.0199***

EC_{t-1}	-0.4207***

*, **, *** represent the levels of significance

5.3 Granger Causality Tests within the framework of two estimated econometric models

Evidence of cointegration from the Bounds Test led us investigate Granger Causality from the three right-hand side variables to $\ln Y_t$. 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 which is 2 in our case. Within the framework of the estimated VAR model, which is reported in Table 2A in the Appendix, we performed Granger causality tests. 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 results of the Maximum Likelihood test for serial correlation are reported in Table 3A in the Appendix. The inverse roots of the AR characteristic polynomials remain within the unit circle, so the model is characterized by dynamic stability. Results of the Inverse Roots of the Polynomial are reported in Figure 2A also in the Appendix.

Table 6 Granger Causality tests within the estimated VAR model

Equation	Excluded Variables	χ^2	df	P-values
lnY_t	lnM_t	5.0504	2	0.0800
	$lnER_t$	0.9178	2	0.6320
	$lnPD_t$	14.8177	2	0.0006
	All	**25.1975**	**6**	**0.0003**
lnM_t	lnY_t	1.1637	2	0.5588
	$lnER_t$	5.7849	2	0.0554
	$lnPD_t$	13.8579	2	0.0010
	All	**24.8536**	**6**	**0.0004**
$lnER_t$	lnY_t	24.5039	2	0.0000
	lnM_t	21.0530	2	0.0000
	$lnPD_t$	0.5813	2	0.7478
	All	**39.2529**	**6**	**0.0000**
$lnPD_t$	lnY_t	4.5623	2	0.1022
	lnM_t	3.7244	2	0.1553
	$lnER_t$	1.4864	2	0.4756
	All	**23.5951**	**6**	**0.0006**

Note: the VAR was estimated with two lagged differences.

In Table 6 above, we report the results of the Granger Causality test. A test for each of the four endogenous variables of the VAR model was performed by employing the EViews block exogeneity test. Such tests allowed the investigation of whether the three right-hand side variables in each equation of the VAR model jointly Granger cause the left-hand side variable. These tests employed the 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. Four different joint tests were performed, one for each of the left-hand side variables lnY, lnM, lnER and lnPD, these variables appear in the first column of Table 6. In the second column the three right-hand side variables appear for everyone of the four tests. EViews automatically performs a Granger Causality t-test for each

individual right-hand side variable. The significance of each test is denoted by the p-value reported in the last column.

According to the first panel of Table 6, 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 near 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 the $\ln M_t$. Such indirect Granger causality is evident from the second panel in Table 6 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, $\ln ER_t$ and $\ln PD_t$, each Granger causes $\ln M_t$. Perhaps surprisingly, $\ln Y_t$ does not cause $\ln M_t$.

The empirical results strongly indicate that the Japanese GDP is affected by the foreign sector and public debt. The high Public debt played a crucial role in prolonging the recession but has not wreaked havoc on the economy. The remaining variables, $\ln ER_t$ and $\ln PD_t$, are each jointly Granger-caused by the excluded three right-hand side variables. This implies that there is evidence of strong Granger causality among all the variables in the VAR model. It is evident from the empirical results of this study that imports turned out to be the most important variable Granger causing lnY. Such evidence is supported also by comparing the time plot of imports and exports in Figure 2 below.

It can be seen from Figure 2 that Japan generated both trade deficits and surpluses during the 1980-2016 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 and raw materials (including oil) that strengthened its ability to increase the quantity of high-quality exports (Thorbecke, 2015). It is interesting to note that Japan for many years became also an exporter of high-tech intensive capital goods to several Asian countries completing a trade cycle in the global economy.

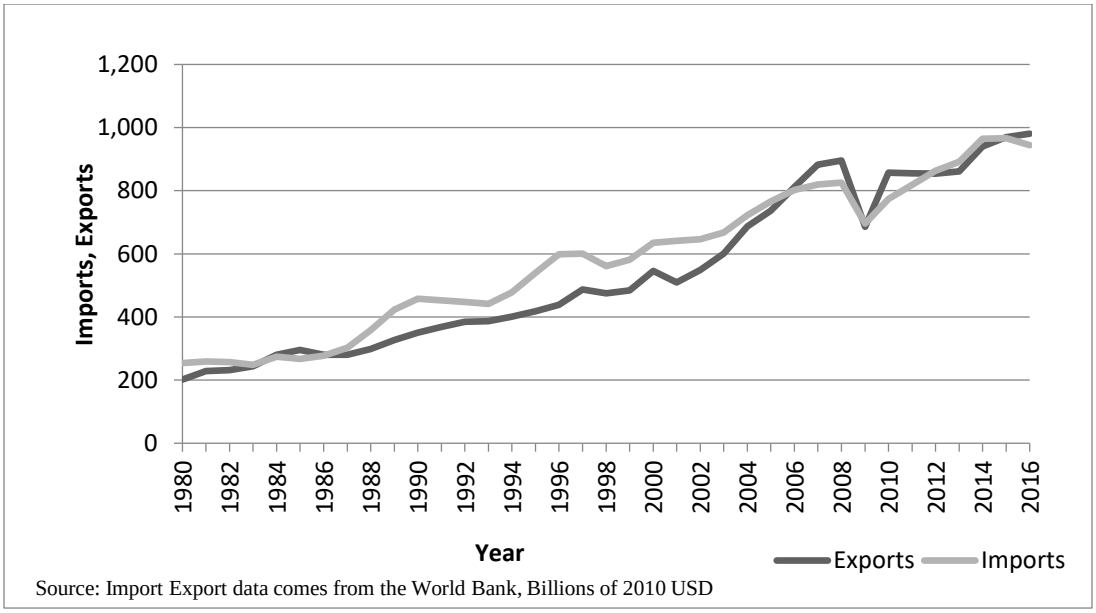

Fig. 2 Real Japanese Imports and Exports

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. Although Japan was forced to open its economy to the world some 160 years ago, it presently enjoys the status of one of the most developed countries. Public debt also affected real Japanese GDP but has not wreaked havoc on the Japanese economy. Although

Japan's mounting public debt did not abruptly destabilize the economy, it is highly likely to have played a negative role to its chronic stagnation-deflation problem. Abenomics policies, launched in 2013, kept the default risk premium for the Japanese public debt exceptionally low. Nonetheless, Abenomics seems to be working despite the recent adverse domestic and international developments and the recent resignation of Prime Minister Shinzō Abe. Low and even negative interest rates along with fiscal consolidation and structural reforms are making public debt financing possible. Japan is the largest creditor country in the world and accumulated the largest international investment position. It has also evolved to be the second largest country in terms of holdings of foreign currency reserves, next only to China. As a result, Japan can keep distancing itself from financial crises and from credit events while leveling off and even reducing its public debt to GDP ratio.

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Sources of Data: 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 numbers of yen per US dollar, adjusted by the price levels of the two countries. The data for the three variables comes from the World Bank. The last variable, public debt (PD), is measured as the public debt to GDP ratio: PD = Public Debt/Y. Data for PD come from the Economic Database (FRED) of the Saint Louis Federal Reserve Bank.

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[1] Milestones 1830-1860 – Office of the Historian. Retrieved from https://history.state.gov/milestones/1830-1860/opening-to-japan.
[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] See, for example, J. Colombo (2012).
[5] A term very familiar in the US from the US Subprime Mortgage Crisis of 2007-2009.
[6] This is the name of the Central Bank of Japan.
[7] See Horioka, Nomoto and Terada-Hagiwara (2014)
[8] According to our calculations, in the 1960's the Japanese GDP grew 14.4%, in the 1970's 5.05%, in the 1990's 4.90% and only 1.07% from 1990 to 2016.

[9] 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.

[10] The US Federal Reserve also had launched such policy for this reason QE sometimes is referred to as Qualitative and Quantitative easing (QQE).

[11] Patrick (2014) and a few other authors expressed admiration for the extraordinary resilience of the Japanese people which prevailed and led to fast economic recovery despite the massive destruction including the killing of 20,000 people.

[12] Japan is similar to the rest of the world regarding suppressing labor costs to enable national firms become internationally competitive, thus, trade union membership declined along with labor income as a percentage of GDP.

[13] A few events nevertheless fall outside our sample period, but Abenomics is still applicable

[14] Several references of these two broad theories are provided by Tyers (2012). Such macroeconomic models differ from the econometric study of this paper.

[15]This increased income inequality (Harada, 2012).

[16] German policy for SMEs is exactly the opposite to the Japanese, Germany subsidizes SMEs for many years, as they constitute the backbone of the German economy. Germany, like Japan, benefits much from its foreign sector.

[17] Fokuda and Doita (2016) constructed a model that includes firms that can produce in the tradable sector in the home country or transfer production abroad.

[18] This policy, nevertheless, is a self-defeating, as it is not possible for all countries to generate trade surpluses simultaneously.

[19] Prebich was an Argentine economist and a very influential head of the UN Commission on Latin America.

[20] The bailouts came on condition that bailout recipient countries adopt fiscal austerity and neoliberal pro-business policies. Austerity policies in the midst of the recession prolonged the Eurocrisis.

[21] Several authors support the view that the combination of the ARDL-VAR models is superior to the method proposed by the Johansen (1991, 1995) cointegration test, which is used in conjunction with Vector Error Correction (VEC) model to test for Granger Causality.

[22] $ER_{¥//\$} = NE_{¥/\$} * (P_{US}/P_J)$, where $NE_{¥/\$}$ is the number of Yen per dollar (nominal exchange rate) and P_{US}/P_J is the ratio of the US price levels over the Japanese price level.

[23] http://www.bondeconomics.com/2015/04/higher-debt-to-gdp-ratio-and-lower-bond.html

[24] The results of the unit root tests are reported in Tables 1A and 1B in the Appendix.

[25] This observation has motivated development of an extensive literature in unit root tests that remain valid in the presence of structural break(s). See Hansen (2001) for an overview.

[26] 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 variables.

Appendix to: **The Nexus between Causal Macroeconomic Relations in Japan**

George K Zestos Yixiao Jiang Ryan D Patnode

Figure 1A: General government gross debt as a percentage of GDP in 2016

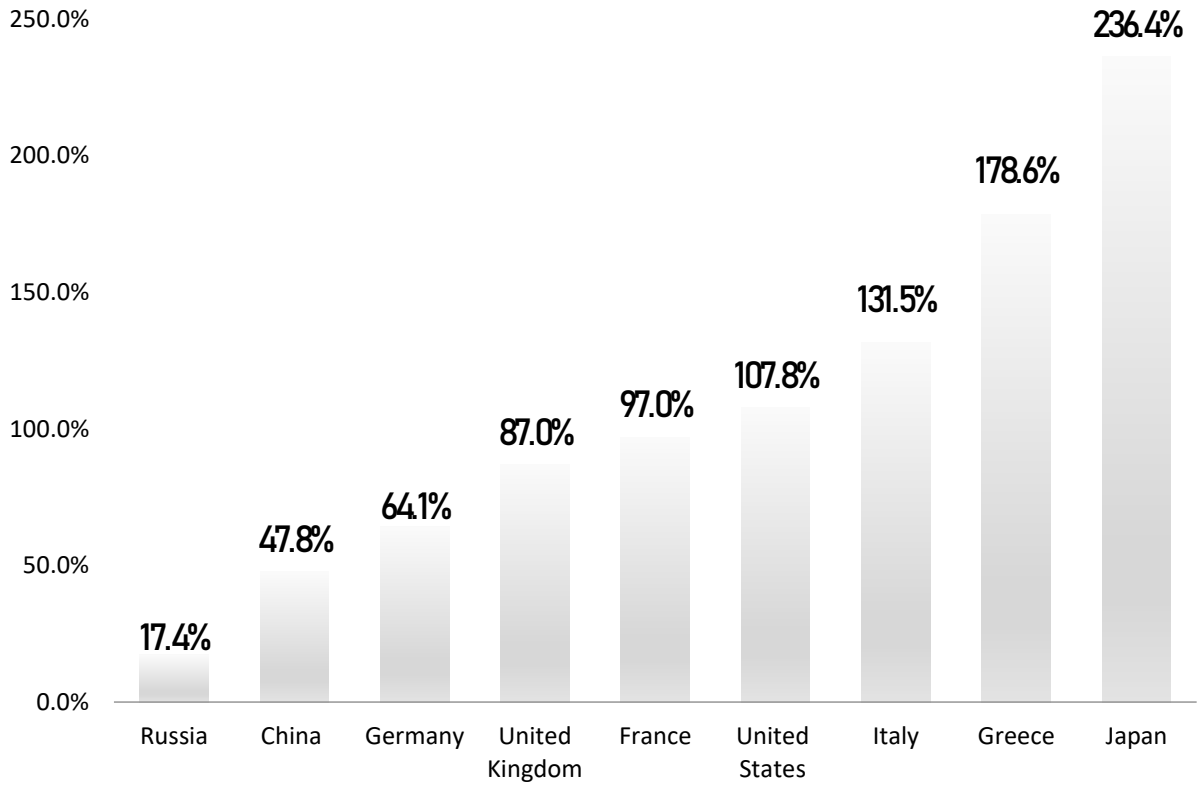

Table 1A Unit Root Tests (Part 1)

Japan 1980-2016 Data source: World bank Units: Yen

Levels – I(0)

		ADF Test			DF-GLS Test			PP Test	
Variable		Constant	Constant & Trend	Lags	Constant	Constant & Trend	Lags	Constant	Constant & Trend
LnY	AIC	-4.64***	-1.89	0,0	-0.16	-1.10	1,1	-4.39***	-1.86
	SIC	-4.64***	-1.89	0,0	-0.02	-0.94	0,0		
lnM	AIC	-3.26**	-2.16	9,0	0.42	1.73	0,0	-1.32	-1.52
	SIC	-7.09	-2.16	0,0	0.42	1.73	0,0		
lnER	AIC	-2.60	-2.47	1,1	-1.12	-1.40	3,3	-1.89	-1.56
	SIC	-2.60	-2.47	1,1	-1.12	-2.17	3,1		
lnPD	AIC	-0.70	-0.31	1,1	-0.03	-3.22**	1,1	-2.25	-1.83
	SIC	-0.70	-0.31	1,1	-0.03	-3.22**	1,1		

First Differences – I(1)

		ADF Test			DF-GLS Test			PP Test	
Variable		Constant	Constant & Trend	Lags	Constant	Constant & Trend	Lags	Constant	Constant & Trend
LnY	AIC	-3.68***	-4.73**	0,0	-3.46***	-4.87**	0,0	-3.69**	-4.73***
	SIC	-3.68***	-4.73***	0,0	-3.46***	-4.87**	0,0		
lnM	AIC	-4.41***	-4.55**	2,4	-4.16***	-4.64***	2,2	-4.48***	-5.50***
	SIC	-4.61***	-4.76***	0,2	-4.60	-4.73***	0,0		
lnER	AIC	-4.23***	-4.55***	2,2	-4.16***	-5.24***	0,2	-4.12***	-4.92***
	SIC	-4.35***	-4.38***	0,0	-4.16***	-5.24***	0,2		
lnPD	AIC	-2.67*	-2.62	0,0	-2.38**	-2.59	0,0	-2.79**	-2.75
	SIC	-2.67*	-2.62	0,0	-2.38**	-2.59	0,0		

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

Table 1B Unit Root Tests (Part 2): NG-Perron

Japan 1980-2016 Data source: World bank Units: Yen													
Variables		**Levels – I(0)**											
		CONSTANT						CONSTANT&TREND					
		MZa	MZt	MSB	MPT	lag	NOTE	MZa	MZt	MSB	MPT	lag	NOTE
lnY	AIC	-.04	-.03	.66	27.84	1		-2.55	-.99	.39	30.94	1	
	SIC	.85	1.19	1.40	125.12	0		-.52	-.33	.63	80.93	0	
lnER	AIC	-2.60	-1.13	.43	9.37	3		-3.79	-1.28	.34	22.69	3	
	SIC	-2.60	-1.13	.43	9.37	3		-9.57	-2.12	.22	9.80	1	
lnM	SIC	.92	.76	.82	48.8	0		-9.70	-2.20	.22	9.39	0	
	AIC	.92	.76	.82	48.8	0		-9.70	-2.20	.22	9.39	0	
lnPD	AIC	-.32	-.17*	.52	18.89	1		-23.76**	-3.41**	.14**	4.05**	1	
	SIC	-.32	-.17	.52	18.89	1		-23.76**	-3.41**	.14**	4.05**	1	
Variables		**First Differences – I(1)**											
		CONSTANT						CONSTANT&TREND					
		MZa	MZt	MSB	MPT	lag	NOTE	MZa	MZt	MSB	MPT	lag	NOTE
lnY	AIC	-13.3**	-2.56**	.19**	1.93**	0		-16.97*	-2.90*	.17*	5.44**	0	
	SIC	-13.3**	-2.56**	.19**	1.93**	0		-16.97*	-2.90*	.17*	5.44**	0	
lnER	AIC	-15.7***	-2.8***	.18**	1.7***	0		-18965***	-97.4***	.01***	.01***	2	
	SIC	-15.7***	-2.8***	.18**	1.7***	0		-18965***	-97.4***	.01***	.01***	2	
lnM	AIC	-17.0***	-2.9***	.17***	1.5***			-17.01***	-2.89*	.17*	5.45**		
	SIC	-17.0***	-2.9***	.17***	1.5***			-17.01***	-2.89*	.17*	5.45**		
lnPD	AIC	-8.47**	-2.01**	.24*	3.08**	0		-9.37	-2.16	.23	9.72	0	
	SIC	-8.37**	-2.01**	.24*	3.08**	0		-9.37	-2.16	.23	9.72	0	

Table 1C: Estimated VAR model

	LNY	LNM	LNREERZ	LNDEBT
lnY_{t-1}	0.361948	0.203225	-3.121108	1.112650
	(0.23243)	(0.87437)	(1.26900)	(0.52926)
	[1.55722]	[0.23242]	[-2.45951]	[2.10227]
lnY_{t-2}	0.583456	0.101794	1.217896	-0.991845
	(0.23275)	(0.87558)	(1.27075)	(0.52999)
	[2.50676]	[0.11626]	[0.95841]	[-1.87143]
lnM_{t-1}	0.071160	0.583850	1.426085	-0.194795
	(0.06897)	(0.25945)	(0.37655)	(0.15705)
	[1.03176]	[2.25033]	[3.78725]	[-1.24035]
lnM_{t-2}	-0.142069	-0.031029	-0.538616	0.299441
	(0.06975)	(0.26239)	(0.38081)	(0.15883)
	[-2.03683]	[-0.11826]	[-1.41440]	[1.88535]
$lnER_{t-1}$	-0.022992	-0.186100	0.755157	0.079028
	(0.03240)	(0.12188)	(0.17689)	(0.07378)
	[-0.70963]	[-1.52690]	[4.26908]	[1.07120]
$lnER_{t-2}$	-0.000827	-0.048729	-0.173628	-0.018078
	(0.03109)	(0.11694)	(0.16972)	(0.07079)
	[-0.02661]	[-0.41670]	[-1.02302]	[-0.25539]
$lnPD_{t-1}$	-0.199583	-0.094446	-0.170931	1.817406
	(0.06431)	(0.24193)	(0.35112)	(0.14644)
	[-3.10335]	[-0.39038]	[-0.48682]	[12.4104]
$lnPD_{t-2}$	0.239385	0.338305	0.114757	-0.929401
	(0.06663)	(0.25064)	(0.36377)	(0.15172)
	[3.59286]	[1.34975]	[0.31547]	[-6.12592]
BREAK0809	-0.042270	-0.072743	-0.087520	0.038162
	(0.01088)	(0.04093)	(0.05941)	(0.02478)
	[-3.88471]	[-1.77713]	[-1.47322]	[1.54021]
C	4.029282	3.767170	38.36957	-7.119215
	(1.59144)	(5.98669)	(8.68866)	(3.62379)
	[2.53185]	[0.62926]	[4.41605]	[-1.96458]
R-squared	0.996357	0.990467	0.897123	0.997461
Adj. R-squared	0.995045	0.987035	0.860087	0.996547

Determinant resid covariance (dof adj.)	4.49E-13
Log likelihood	322.4642
Akaike information criterion	-16.14081
Schwarz criterion	-14.36327
Number of coefficients	40

Figure 2A: Testing for dynamic stability for the VAR model

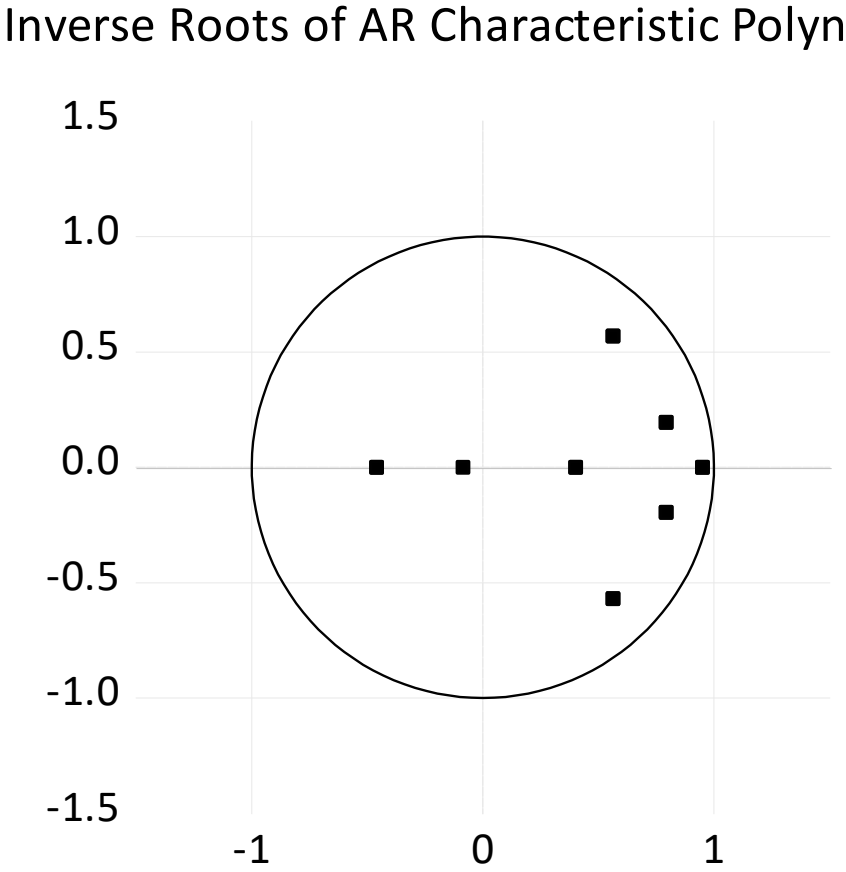

Table 2 VAR Residual Serial Correlation LM Test

	Dependent variable: output	
Lags	LM Statistic	Probability
1	25.45	0.065
2	36.32	0.301

Source: 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, adjusted by the price levels of the two countries. The data for the three variables come from the World Bank. The last variable, public debt (PD), is measured as the public debt to GDP ratio: PD = Public Debt/Y. Data for PD come from the Economic Database (FRED) of the Saint Louis Federal Reserve Bank.