Proceedings of the 2nd International Conference on Business and Policy Studies
DOI: 10.54254/2754-1169/16/20231026

Relationship Between Real GDP, CPI and M2 During the "Lost Decades" and Abenomics Era

--Based on Vector Autoregression Model and Cointegration Analysis

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Abstract: The "lost decades" and its solutions, especially Abenomics are famous topics when discussing about Japan's economy. This paper mainly focused on the relationship between CPI, M2 and real GDP of Japan in both short and long run using VAR model and cointegration analysis, and find out that: (1) Changes in money issuance and gross output in the short run have a positive effect on the increase in the price index; (2) The increase in monetary issuance and price level does not directly bring about an increase in output, but rather affects the demand and reduces the GDP growth rate; (3) The real GDP performance in the long run shows changes in the same direction as CPI, M2 and the time trend. CPI has a positive effect on disequilibrium, while changes in M2 have the effect of eliminating the disequilibrium.

Keywords: lost decades, Abenomics, GDP, CPI, VAR model.

1. Introduction

When discussing about Japan's economic development process, the "lost decades" is a topic that is difficult to avoid. To some scholars, the "Plaza Accord" is the main reason that caused the economic recession. In 1985, in order to deal with the increasing problems of fiscal deficit and trade deficit, the United States together with Japan, the Federal Republic of Germany, the United Kingdom and France signed the "Plaza Accord". As a result, the yen appreciated significantly against the dollar.

Having an export-led economy, the rise in the exchange rate had serious adverse effects on Japan. The Japanese government tried to expand the money supply to prevent a recession, which resulted in a severe real estate bubble. 1989 witnessed the bubble burst and an economic crisis broke out. It is discussed by more researches that other causes have been further sapping the vitality of the Japanese economy [1]. Faced with the severe challenges of economic globalization and an aging population, a series of macro policy failures have exacerbated the economic stagnation [2].

In order to bring the Japanese economy out of the downturn and rebuild the international status of Japan, Shinzo Abe, upon his re-election as Prime Minister, immediately proposed his economic goals, or Abenomics. In 2013, the Cabinet Office of Japan and the Bank of Japan issued a joint statement specifying a 2% inflation target [3]. To achieve this goal, aggressive monetary policy, flexible fiscal policy and stimulating private investment are used as the "three arrows" [4].

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In the current study, many scholars have evaluated the recessionary period and the Abe economics period from various aspects [5]. This study utilizes important macroeconomic data of Japan from 1994 to 2017 and analyzes the short-run and long-run intrinsic linkages using vector autoregressive models and cointegration analysis, aiming to explore the patterns and give an evaluation of the future trends.

2. Methodology

2.1. Research Design

There are many research methods available to study the macroeconomic performance of a country over time.

For the researched factors, Gross Domestic Product (GDP) is generally taken as an important indicator of the level of a country's economy, and this is especially true for real GDP, which excludes the inflation factor. According to the theory of the monetarism, inflation is essentially a monetary phenomenon, so the supply of M2 not only affects the price level but also indirectly affects GDP. The change of GDP is inseparable from the income level of residents, and at the same time, the income level of residents will have an impact on CPI, so GDP will indirectly have an impact on CPI.

Chen's study in 2009 and Xiao and Chen's study in 2018 both constructed vector autoregressive models and performed cointegration analysis to study the relationship of macroeconomic data in China [6-7]. In this paper, the macroeconomic data of Japan will be studied with reference to the above paper.

2.2. Data Resources

The data the research uses is from Federal Research Economic Data (FRED), a trusted online database created and maintained by the research department of the Federal Reserve Bank of St. Louis. This paper selects the seasonal adjusted real GDP, CPI and M2 data of Japan from the first quarter of 1994 to the fourth quarter of 2017 according to FRED for regression analysis. M2 and CPI are transferred into quarterly data using the first observation rule. For the research, 92 observations are available. The series are as below.

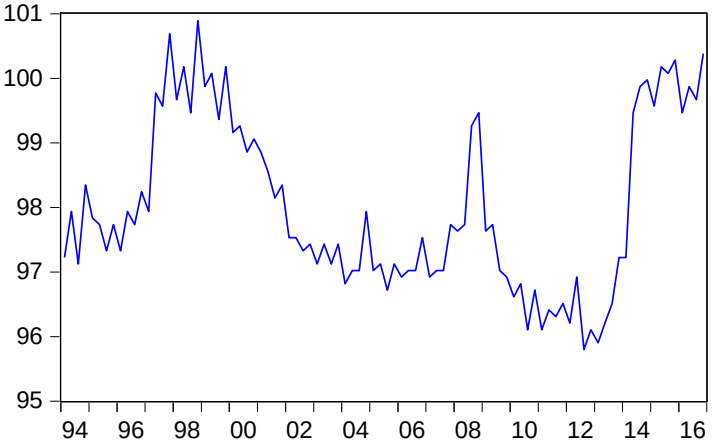

Figure 1: Japan CPI.

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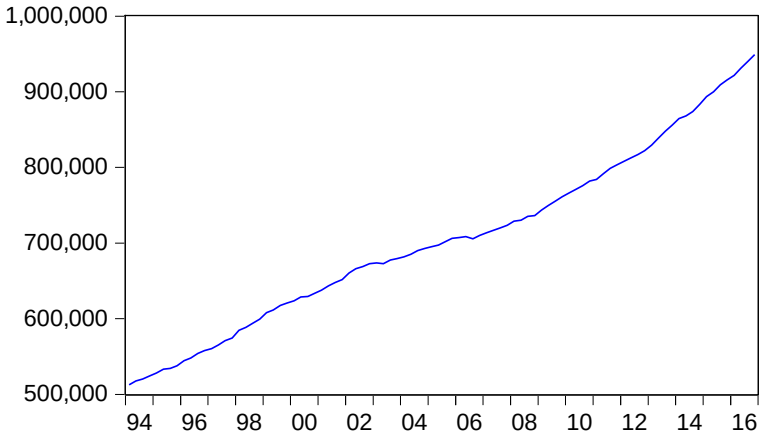

Figure 2: Japan M2.

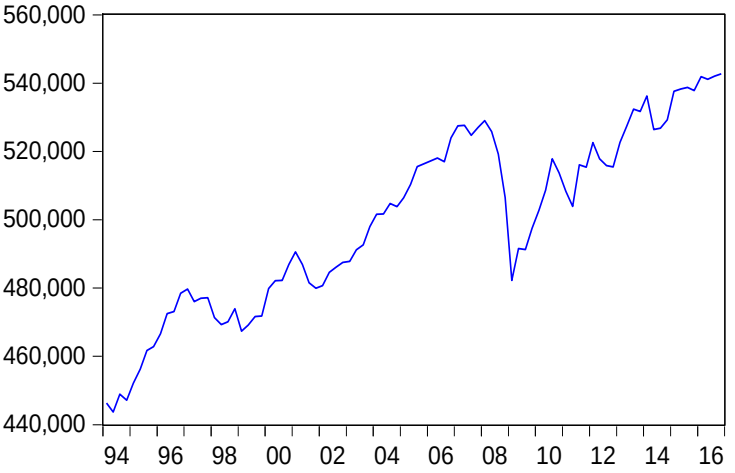

Figure 3: Japan Real GDP.

2.3. Vector Autoregression Model and Impulse Response Function

Data Pre-processing. Vector autoregression model is frequently used to study on the interaction between different factors, while it demands the series to be stationary. To avoid serial correlation and spurious regression, ADF test is taken as the basic rule of unit-root test.

Table 1: Unit-root test of each series.

Variable	Form	ADF Test	1%	5%	10%	P-value
CPI	None	0.271536	-2.59181	-1.94457	-1.61432	0.7625
GDP	None	1.946495	-2.59062	-1.9444	-1.61442	0.987322618
M2	None	4.012844	-2.5912	-1.94449	-1.61437	1
d(CPI)	None	-3.5107	-2.59181	-1.94457	-1.61432	0.0006
d(GDP)	None	-7.94295	-2.59091	-1.94444	-1.61439	0
d(M2)	Trend and intercept	-4.0927	-4.06445	-3.46109	-3.15678	0.0092

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It can be observed from above that CPI and GDP are able to be considered as processes integrated of order 1, while the 1st order differential of M2 (d(M2)) has constants and linear trend.

In order to detrend d(M2), an OLS regression with d(m2) as the explained variable and a t, the time trend and a constant as explanatory variables is conducted.

The resident of the regression is set as dm2x, and the plot is as follow. According to the unit-root test result, dm2x is a stationary series of data.

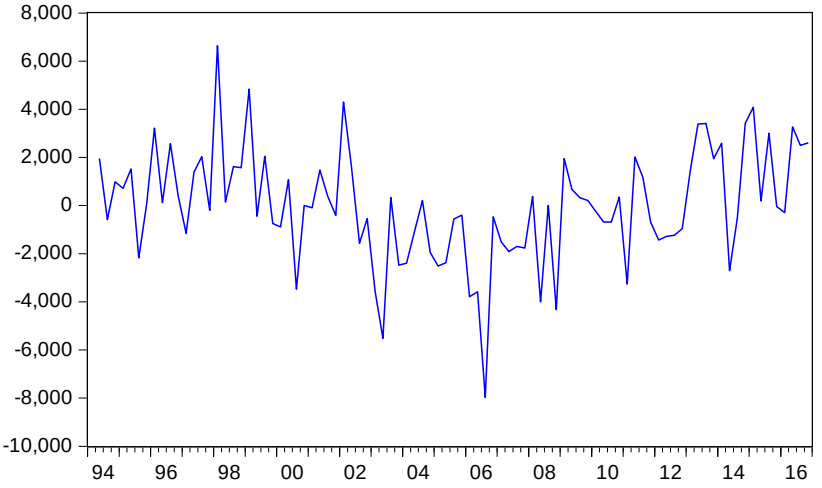

Figure 4: Detrended M2: DM2X.

Select the d(RGDP), d(CPI) and dm2x to set up a vector autoregression model, let the name be VAR1. Conduct the VAR lag order selection criteria with the max lag number be 8 (2years). It can be known that 2 is the optimal choice of lag intervals. In the following part, further research is based on this VAR (2) model.

Unit-root Test.

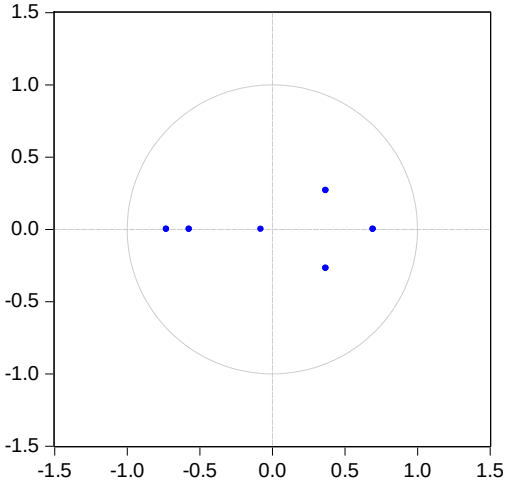

Figure 5: VAR1 unit root.

According to the plot above, all of the magnitude of roots are smaller than 1, falling inside the unit circle. This indicates that the is valid.

Granger Causality Test. The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another ones.

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Table 2: Granger causality test of VAR1.

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 09/07/22 Time: 09:43
Sample: 1994Q1 2016Q4
Included observations: 89

Dependent variable: D(CPI)

Excluded	Chi-sq	df	Prob.
D(RGDP)	3.217622	2	0.2001
DM2X	0.499061	2	0.7792
All	3.983263	4	0.4083

Dependent variable: D(RGDP)

Excluded	Chi-sq	df	Prob.
D(CPI)	9.625761	2	0.0081
DM2X	4.296898	2	0.1167
All	13.84730	4	0.0078

Dependent variable: DM2X

Excluded	Chi-sq	df	Prob.
D(CPI)	2.073089	2	0.3547
D(RGDP)	3.658136	2	0.1606
All	5.261860	4	0.2615

It can be seen from the chart that there is 1 significant Granger causality between d(CPI) and d(RGDP). This indicates that the 1st order differential of CPI can forecast d(RGDP) to some extent.

Impulse Response Function and the Result. The impulse response function reflects the dynamic impact on the other variables in the VAR model when one variable is subject to an exogenous shock. Generate the impulse response function of VAR1.

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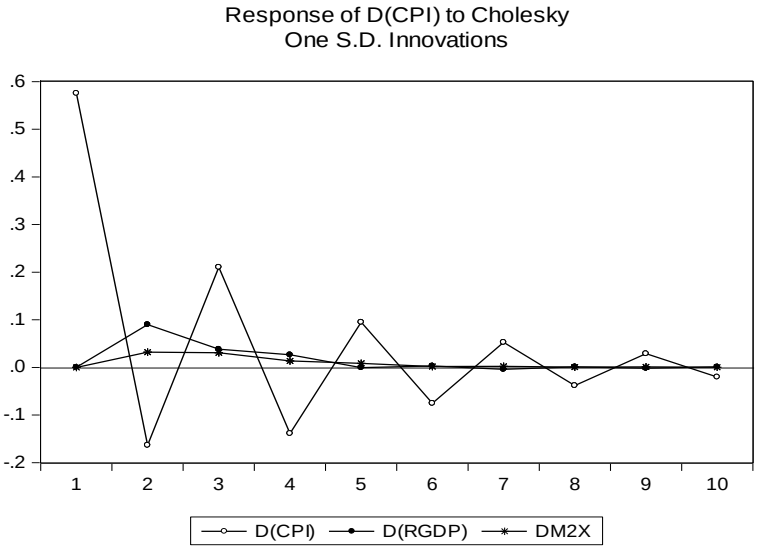

Figure 6: Impulse response of D(CPI).

Compared to M2, the impact of the first-order differential of real GDP has a greater impact on the amount of change in CPI, both shocks are positive and act as 0 in the current period, and then begin to decline after rising to a maximum in the second period. This indicates that the pulling effect of M2 and real GDP on CPI is significant in the short term and decays in the long term. It shows that changes in money issuance and gross output in the short run have a positive effect on the increase in the price index.

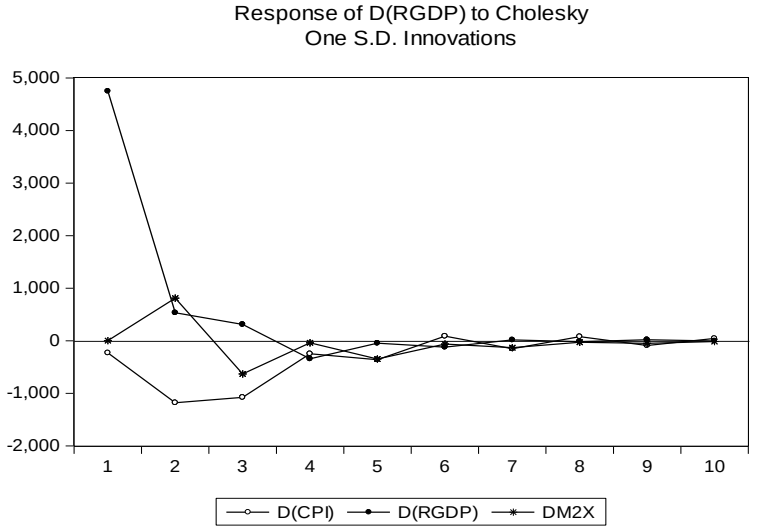

Figure 7: Impulse response of D(RGDP).

For the first-order differential of real GDP, the shock of M2 changes has a positive effect in the short term, but turns negative in the 3rd period and beyond, and then gradually decays; while the shock of CPI changes has a negative effect, and the absolute value of the effect is greater than that of M2, and the negative effect is greatest in the 1st period, and then also decays. It can be considered that the main reason is that the increase in monetary issuance and price level does not directly bring about an increase in output, but rather affects the demand and reduces the GDP growth rate.

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2.4. Cointegration Analysis and Vector Error Correction Model

Cointegration Analysis. Cointegration is a technique to analyze correlation between time series processes in long term. For this method, all the series need to be integrated of the same order.

Resulting from that the 3 original series are non-stational and the 1st order differentials are stational or with a time trend, this analysis is possible to perform.

Set up a new VAR model with original series. Conduct the VAR lag order selection criteria with the max lag number be 8.According to the chart, reset the model with the optimal lag interval 5, let the name be VAR2.

Run the Johanson cointegration test with lag intervals be 4. Knowing that the M2 has linear trend after getting the 1st order differential, select the 4th assumption.

Table 3: Johanson cointegration test of VAR2.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.306324	47.20839	42.91525	0.0175
At most 1	0.126942	15.38806	25.87211	0.5424
At most 2	0.040286	3.577480	12.51798	0.8020

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.306324	31.82033	25.82321	0.0071
At most 1	0.126942	11.81058	19.38704	0.4330
At most 2	0.040286	3.577480	12.51798	0.8020

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

It can be seen with both methods of G test and maximum eigenvalue, there are 1 cointegrating relationship detected.

Vector Error Correction Model. Vector Error Correction Model describes a short-run dynamics by VAR model and a long-run equilibrium by error correcting equations. Set up a VECM, with 4 period of lag intervals, and 1 cointegrating relationship. Select the 4th condition of trend specification according to the cointegration test. According to the result, the normalized the function is as below.

$$Z_t = RGDP_{t-1} - 5212.745CPI_{t-1} - 0.104749M2_{t-1} - 682.6823@trend + 116517.8 \quad (1)$$

The VECM function is as follow.

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$$\begin{pmatrix} \Delta RGDP \\ \Delta CPI \\ \Delta M2 \end{pmatrix} = \begin{pmatrix} -0.104887890813 \\ 3.11959277732e-05 \\ -0.0829113303597 \end{pmatrix} (Z_{t-1}) + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix} \quad (2)$$

Run a hypothesis test with the adjustment coefficients. The null hypothesis is as follow.

$$H_0: A(1,1) = A(2,1) = A(3,1) = 0 \quad (3)$$

The output is as below.

Table 4: Hypothesis test result.

H_0	A(1)=0	A(2)=0	A(3)=0
P-value	0.183998	0.000046	0.009689

Conclusin of Cointegration Analysis. From the results of the analysis above, it can be seen that the real GDP performance in the long run shows changes in the same direction as CPI, M2 and the time trend, which is also consistent with a common understanding of economic theory. By looking at the VECM model, it shows that the changes in CPI and M2 have a statistically significant effect on the previous period's deviated equilibrium state. In particular, CPI has a positive effect on disequilibrium, while changes in M2 have the effect of eliminating the disequilibrium in the prior period on a larger scale. In general, this VECM system moves toward the elimination of disequilibrium.

3. Conclusion

This paper focuses on the relationship between macroeconomic data for Japan from 1994 to 2017. As can be seen, the relationship between the various data series remains consistent with our understanding of the underlying economic logic. In order to obtain sufficient sample data, both the decline period and the Abe economics period are included in the scope of this study. The specific evaluation of each period should be studied and discussed in stages. In addition, the yen has experienced an unprecedented depreciation trend this year, which lead to unprecedented social tension. With the assassination of Prime Minister Abe, the specific utility of Abe's economics needs to be further discussed.

References

[1] *Hoshi, T., & Kashyap, A. (2011). Why did Japan stop growing?. NIRA report.*

[2] *Li, C. (2014). Was the "Plaza Accord" the Cause of Japan's "Lost Decade"? –Explanation of An Economic History Mystery. Fujian Tribune (03),5-9.*

[3] *Yi, X. (2013). Theoretical analysis of the effect and impact of "Abenomics". Studies of International Finance (06),14-23.*

[4] *Ito Takatoshi.(2021).An Assessment of Abenomics: Evolution and Achievements. Asian Economic Policy Review(2). doi:10.1111/AEPR.12353.*

[5] *Ito, T., Iwata, K., McKenzie, C. and Urata, S. (2018), Did Abenomics Succeed?: Editors' Overview. Asian Economic Policy Review, 13: 1-22. https://doi.org/10.1111/aepr.12215.*

[6] *Xiao, J., & Chen, F. (2018). Analysis of Factors Influencing Consumer Price Index (CPI) in China - Based on Var Model. Times Finance (29),6-7+10.*

[7] *Chen, X. (2009). Relationship between CPI, CDP and M2. Economic Research Guide (04),52-53.*