Taylor and McCallum Rule during the Unprecedented Monetary Easing Era: The Recent Japanese Case

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Abstract

The Taylor and McCallum rules have been examined a lot in many studies. After these frameworks were presented, deflation has been prevailing and market interest rates have been low, almost zero, or negative in the world. Japan is a typical example. Unconventional monetary policy based on monetary base instead of based on interest rates, has been conducting. This study examines whether or not the Taylor and McCallum rule fit well in Japan. The empirical results show that the McCallum rule fits for recent Japanese cases, but the Taylor rule does not.

Keywords: Japan, McCallum rule, quantitative easing, Taylor rule

JEL classification: E31, E43, E44

1. Introduction

Japan experienced rapid economic growth in the 1980s which other countries could not enjoy. Asset and real estate prices rose from the mid-1980s. In 1985, the Plaza Accord was signed by the Group of five or G5 countries at that time, and the Japanese yen appreciated largely. Preventing appreciation of the US dollar was acknowledged unofficially. Usually appreciation of the yen leads to a loss in international competitiveness for Japan, and the appreciation reduces the exports instead of increasing imports. However, exports did not decrease drastically in spite of the appreciation. Consumer prices did not rise greatly from globalization, and cheap goods and services were imported from abroad. Stock and land prices rose greatly, and it was called a bubble economy. However, this bubble economy burst during the early 1990s, and the Japanese economy fell into a serious recession.

In February 1999, the Japanese central bank, the Bank of Japan (BOJ) implemented a new, the zero interest rate policy. The BOJ cut interest rates at an unprecedented low level. Following an era of zero interest rate policy, the BOJ implemented a quantitative easing (QE) policy, a more aggressive expansion policy in March 2001. In March 2006, however, the BOJ stopped its quantitative easing policy as serious deflation was not ongoing at that time.

After the Lehman shock in 2008, Japanese yen appreciated, which damaged the Japanese economy seriously. In 2010, the BOJ adopted the comprehensive monetary easing. One main policy was an asset purchase such as the government bonds and private assets.

A political regime change occurred at the end of 2012. After the election, a bold new dimension policy called *Abenomics* (Abe is the new prime minister) was implemented. The BOJ cooperated with Japanese government and conducted an unprecedented aggressive monetary and fiscal policies.

This paper applies the Taylor McCallum rules to recent Japanese situations. The Taylor rule usually means that central banks gaze on inflation and output gap in determining policy interest rate. The Taylor rule has been used and cited in many studies in both academic and practical fields. The McCallum Rule is another monetary policy guideline that was provided by McCallum. The McCallum Rule denotes a formula to describe inflation and the amount of their monetary base relationship.

Recently, many economists have said that monetary policy should be implemented based on rules. The Taylor rule and McCallum rule have been discussed most among such rules. The two rules have been focuses in academic fields and in

real-world scenarios. However, few studies have examined the case of Japan. Also, unprecedented monetary easing policy was conducted or is being conducted in developed economies, so it would be necessary to examine the suitability of these rules for the recent cases.

In this paper, Section 2 shows recent academic studies. Section 3 provides the Taylor rule and the McCallum rule that apply to Japan's recent economic conditions. Section 4 shows the results of the regression analyses and examines them. Finally, a brief summary of this study is performed..

2. Theoretical Aspects

The Taylor rule has been cited often including augmented versions. Bernanke (2004) showed that when asset prices are added, they confer forward-looking information. Darius (2014) found that the nonlinear Taylor rule fits better than linear ones.

Many studies have been provided to analyze recent ones, however, the empirical results are not conclusive. Drager and Lamia (2018) demonstrated that disagreement on the interest rate is mainly from disagreement on inflation and showed that the disagreement is influenced by central bank transparency. Hudson and Vespignani (2018) showed that Australia's interest rate deviation from the Taylor Rule can be explained by international factors and domestic factors which account for 41.9% and 22.5%, respectively. Boehm and House (2019) found that, under the Taylor rule, the central bank is systematically under-reaching to estimated inflation and the output gap. Engel, Lee, Liu, and Wu (2019) showed that monetary shocks and liquidity shocks make nominal interest rates in the Taylor rule. Nebot, Garcia-Solanes, and Beyaert (2019) showed that the ECB only responds to inflation departures if they are over the official 2% inflation target.

Compared to the Taylor rule, there are not many existing studies for the McCallum rule (McCallum, 1994). Stark and Croushore (1996) showed that the McCallum rule should be augmented by the GDP growth rate. Gallmeyer.Hollifield, and Zin (2005) confirmed that the policy rule used for rationalizing the empirical unfitness of the expectations hypothesis applies to the term structure of interest rates. Damette and Parent (2016) found that over the period, 1921-1933, the Fed followed the McCallum rule partially, however, it does not correct the deviation from this target. Jung (2018) found that McCallum's rule does not fit well compared with the Taylor rule under low interest rates. However, there is little research that examines recent Japanese cases by adopting the two rules. Examining the two rules should be conducted much more.

3. Empirical Aspects

3.1 Taylor Rule's Estimated Equation

Equation (1) is regressed as the basic Taylor rule.

$$i_t = \alpha + \beta\pi_t + \gamma y_t + \varepsilon_t \tag{1}$$

where i_t is the money market rate (overnight interest rate). $\pi_t = (p_t - p^*)$, p_t is consumer price index rate and $p^* = 2\%$, which was set by the BOJ as a price stability target in 2013 in terms of the year-on-year rate of change in the consumer price index. y_t denotes the output gap. t denotes time. As argued by Taylor (1993), central banks sometimes should conduct policies based on a simple rule. The simplification is important at time.

Some papers indicate that exchange rates should be included as an explanation variable. Kurihara (2017) showed that exchange rate should be included in the equation. Also, stock prices and other asset prices are sometimes included in the Taylor rule. Although exclusion of some variables in conducting monetary policy may result in departures from the policy rule, simple rule is employed in this analysis.

Many studies have examined the inflation gap. Rajendra (2013) demonstrated that the interest rate of Nepal is related positively with the inflation gap. Also, for the output gap, Ebru, Kivicim, and Ozan (2013) examined Kalman filter model. This paper focuses on McCallum's rule in addition to the Taylor rule.

3.2 McCallum Rule's Estimated Equation

The typical McCallum rule can be expressed as equation (2).

$$\Delta b_t = \Delta x^* - \Delta va_t + 0.5(\Delta x^* - \Delta x_{t-1}). \tag{2}$$

Δb_t is the change in the log of the monetary base (i.e., the growth rate of the base between periods t−1 and t; t denotes time). The first term, Δx^*, is specified as $p^* + \Delta y^*$ where Δy^* is the long-run growth rate of real GDP. The second term on the right-hand side of the equation (2), Δva_t, is the base velocity growth over the previous 16 quarters. The final term on the right-hand side of the equation (2) is adjusted upward (i.e., monetary policy is expanded) when Δx_{t-1} falls short of Δx^*. Values other than 0.5 could be possible for the coefficient attached to $\Delta x^* − \Delta x_{t-1}$ and variants of (2).

3.3 Data and Empirical Methods

To estimate these two rules prescribed as equation (1) and (2), quarterly data are used. The output gap data is from the BOJ's data. Other variables data are from the International Financial Statistics (IMF). The sample data is from 2000Q1 to the most recent, 2018Q4.

Empirical methods used here are ordinary least squares (OLS) and robust estimation. OLS estimates for regression are sensitive to the results that do not take the pattern of the other ones. In this analysis, as the sample size is not so large, this robust estimation is used along with the OLS.

4. Empirical Results

4.1 Validity of the Taylor Rule

First, unit root tests are performed, and a Dickey-Fuller test for each variable is conducted. The results are displayed in Table 1.

Table 1. Unit root tests (Dickey-Fuller test)

	t-Statistic	Probability
POLICY_INTEREST_RATE	-3.071	0.032
CONSUMER_PRICE	-9.313	0.000
GROWTH_RATE	-4.430	0.000
MB (monetary base)	-3.632	0.007

All of the variables have no unit roots at 5% level. Empirical analyses are performed using the rates of the variables, so Unit roots cannot be taken into account. The empirical results of the Taylor rule are in Table 2, and the results of the McCallum rule are Table 3.

Table 2. Taylor rule

	OLS	OLS	Robust Least Squares
C	0.330***	0.047***	0.016**
	(17.191)	(2.777)	(2.204)
CONSUMER_PRICE	0.005	0.015	-0.007
	(0.112)	(0.764)	(-0.390)
OUTPUT_GAP	0.045***	0.013**	-0.015***
	(3.737)	(2.518)	(-3.249)
POLICY_INTEREST_RATE(-1)		0.863***	
		(18.873)	
Adjusted R-squared	0.157	0.879	
Adjust Rw-squared			0.181
F-statistic	8.408	150.204	
Prob(F-statistic)	0.000	0.000	
Rn-squared statistic			
Prob(Rn-squared stat.)			0.0001

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.

Table 3. McCallum rule

	OLS	OLS	Robust Least Squares
C	11.945***	0.613	11.184***
	(7.244)	(0.838)	(7.171)
GROWTH_RATE	1.471**	0.103	1.498**
	(2.013)	(0.404)	(2.168)
MB(-1)		0.942***	
		(24.321)	
Adjusted R-squared	0.037	0.887	
			0.079
F-statistic	4.055**	313.157	
Prob(F-statistic)	0.047	0.000	
Rn-squared statistic			4.701
Prob(Rn-squared stat.)			0.000

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.

Most of the results are conclusive, however, the consumer price in the Taylor rule is not significant. The reasons seem to be the deflation that has continued for a long time and hit the Japanese economy. It would be necessary to take zero or low interest rates into account. On the other hand, the McCallum rule fits well with the Japanese economy for this sample period. Again, low interest rates and unprecedented monetary easing would affect this result. During negative interest rate era, the monetary base may be a more important policy rule than interest rates. This may fit the reality. Also, VAR analysis is performed using four variables. The regression results are in Table 4 (Appendix), and the impulse response is in Figure 1.

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

Figure 1. Impulse response

The results are clear. The effects of the shock of monetary base and policy interest rate on consumer price and on growth rate appear a few years later. Finally, the real data' deviation from the McCallum rule and the Taylor rule is calculated. The deviation is the theoretical value calculated by the right side of the equations (3) and (4) minus the real value. Case 1 is the case of McCallum rule, and Case 2 is the case of Taylor rule. Using these variables, the equations are performed.

$$case1_t = \alpha1 case1_t + \varepsilon_t \qquad (3)$$

$$\text{case2}_t = \alpha2\text{case2}_{t-1} + \varepsilon_t \tag{4}$$

The results of equations (3) and (4) are in Table 5.

Table 5. Shock from the deviation from the two rules

	Case1	Case2
Case1(-1)	0.962***	
	(32.043)	
Case2(-1)		0.535***
		(5.630)
Adjusted R-squared	0.875	0.227

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.

Using the coefficients of α1 and α2the duration of the shock effect is calculated. The case of the half is employed, and the calculations $0.962^{x1} = 0.5$ and $0.535^{x2} = 0.5$. x1 and x2 denote time period. The result for the case of the McCallum rule is 17.872, and the Taylor rule's case is 1.108. The deviation from the theoretical value lasts longer for the case of McCallum rule than the Taylor rule.

Finally, VAR analysis is employed for these variables of case 1 and case 2. The regression analyses are in Table 6, Table 7 (Appendix), Figure 2, and Figure 3.
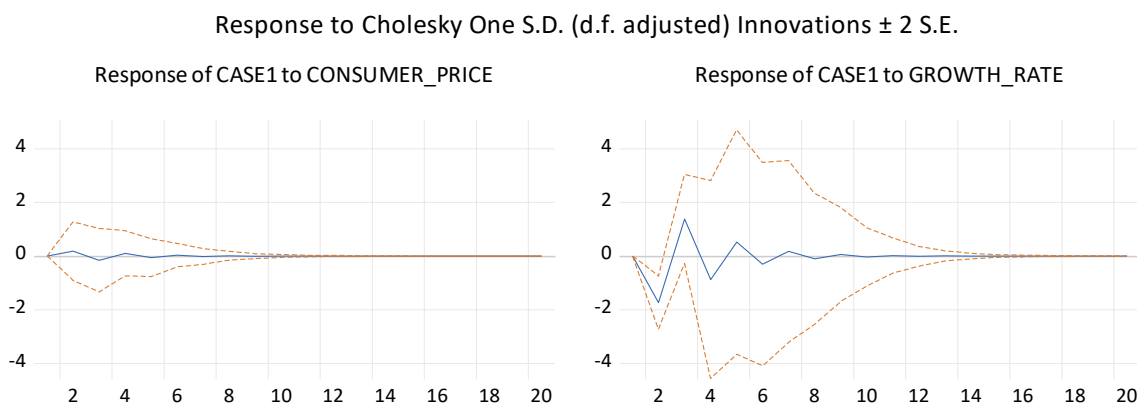

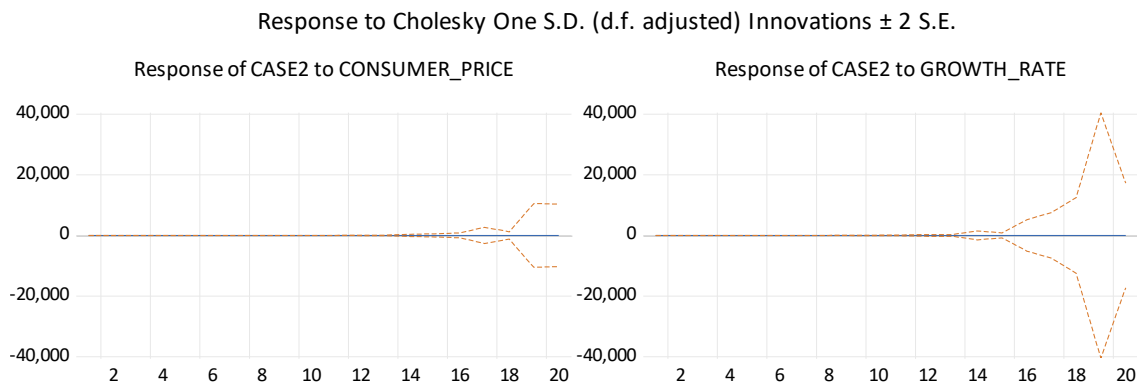Figure 2. Impulse response of the McCallum rule

Figure 3. Impulse response of the Taylor rule

The empirical results show that the McCallum rule fits well for recent Japanese cases. The relationship between monetary policy and economic growth rate is strongly related, and the shock appears for both cases and continues for some time.

5. Conclusions

The Taylor and McCallum rules have been examined a lot in many studies. After these frameworks were presented, deflation has been prevailing and interest rates have become low, zero, or sometimes negative in the world. Japan is a typical example. Unconventional monetary policy based on monetary base instead of based on interest rates, has been conducting. This paper examines whether or not the Taylor and McCallum rule fit well. The empirical results show that the McCallum rule fits for recent Japanese cases, but the Taylor rule does not. The relationship between the monetary policy and economic growth could be found.

Most empirical results seem to be robust, however, there is some room for further study. Simplicity in this study sometimes outperform the critical opinion, but other cases should be analyzed. This study only examined recent Japanese case. There is some possibility that vital variables may be omitted in this study. Also, as the ECB and the BOJ now conduct the negative interest rate policy and interest rates are almost zero in many developed economies. In newly developing economies, consumer prices have not risen so much recently. Finally, different empirical methods may be neccesary. Only OLS and Robust estimations could not be sufficient. Further research would be necessary for the field of monetary policy rule.

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Appendix

Table 4. VAR analysis

	MB	POLICY_INTEREST RATE	CONSUMER PRICE	GROWTH RATE
MB(-1)	1.529***	-0.003**	0.003	-0.004
	(12.186)	(-2.016)	(0.331)	(-0.124)
MB(-2)	-0.690***	0.006*	0.005	0.053
	(-3.003)	(1.800)	(0.256)	(0.739)
MB(-3)	0.035	-0.002	0.002	-0.108
	(0.156)	(-0.723)	(0.133)	(-1.605)
MB(-4)	0.072	-0.001	-0.007	0.081**
	(0.584)	(-0.550)	(-0.673)	(2.075)
POLICY_INTEREST_RATE(-1)	0.472	0.950***	1.262	0.238
	(0.058)	(7.581)	(1.688)	(0.092)
POLICY_INTEREST_RATE(-2)	-5.658	0.326*	-0.919	0.742
	(-0.519)	(1.945)	(-0.919)	(0.215)
POLICY_INTEREST_RATE(-3)	16.458	-0.369*	1.048	0.793
	(1.507)	(-2.199)	(1.045)	(0.229)
POLICY_INTEREST_RATE(-4)	-8.553**	-0.085	-1.349*	-1.667
	(-2.054)	(-0.682)	(-1.810)	(-0.649)
CONSUMER_PRICE(-1)	0.413	-0.024	-0.152	0.456
	(0.303)	(-1.179)	(-1.223)	(1.059)
CONSUMER_PRICE(-2)	-0.272	-0.025	-0.124	0.325
	(-0.198)	(-1.194)	(-0.983)	(0.747)
CONSUMER_PRICE(-3)	-1.791	0.016	-0.077	0.899**
	(-1.369)	(0.828)	(-0.648)	(2.172)
CONSUMER_PRICE(-4)	0.046	0.007	0.197	0.711
	(0.034)	(0.362)	(1.611)	(1.680)
GROWTH_RATE(-1)	1.038**	0.006	0.011	0.762
	(2.791)	(1.123)	(0.345)	(6.468)
GROWTH_RATE(-2)	-1.451**	0.000	0.037	0.069
	(-2.789)	(0.110)	(0.810)	(0.434)
GROWTH_RATE(-3)	0.581	-0.010	-0.029	-0.291
	(1.089)	(-0.125)	(-0.608)	(-1.726)
GROWTH_RATE(-4)	-0.182	0.009	-0.002	-0.065
	(-0.455)	(1.618)	(-0.079)	(-0.519)
Adj. R-squared	0.919	0.859	0.054	0.648
F-statistic	57.740	31.220	1.286	10.104
Akaike AIC	5.909	-2.437	1.134	3.609
Schwarz SC	6.415	-1.931	1.640	4.115

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.

Table 6. VAR analyses of the shock from the McCallum rule

	Case1	CONSUMER_PRICE	GROWTH_RATE
Case1(-1)	1.437***	0.005	0.012
	(14.381)	(0.648)	(0.387)
Case1(-2)	-0.527***	-0.003	-0.003
	(-5.267)	(-0.367)	(-0.097)
CONSUMER_PRICE	-0.141	-0.086	0.369
(-1)	(-0.012)	(-0.743)	(0.883)
CONSUMER_PRICE	0.359	-0.067	0.093
(-2)	(0.286)	(-0.586)	(0.224)
GROWTH_RATE	1.393***	0.036	0.942***
(-1)	(3.961)	(1.121)	(8.075)
GROWTH_RATE	-1.285***	-0.000	-0.250**
(-2)	(-3.602)	(-0.010)	(-2.116)
Adj. R-squared	0.910	-0.020	0.588
F-statistic	135.344	0.732	19.835
Akaike AIC	5.870	1.108	3.663
Schwarz SC	6.079	1.316	3.872

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.

Table 7. VAR analyses of the shock from the Taylor rule

	Case2	CONSUMER_PRICE	GROWTH_RATE
Case2(-1)	0.7127	0.293	-2.599**
	(1.657)	(1.052)	(-2.737)
Case2(-2)	0.219	-0.267	2.169**
	(0.500)	(-0.941)	(2.492)
CONSUMER_PRICE	1.157	0.347	-3.405**
(-1)	(1.759)	(0.814)	(-2.343)
CONSUMER_PRICE	0.392	-0.459	3.305**
(-2)	(0.594)	(-1.071)	(2.266)
GROWTH_RATE	-0.045	0.035	0.905***
(-1)	(-0.910)	(1.090)	(8.794)
GROWTH_RATE	-0.002	0.003	-0.227**
(-2)	(-0.053)	(0.094)	(-2.091)
Adj. R-squared	0.481	-0.017	0.631
F-statistic	13.215	0.776	23.565
Akaike AIC	1.968	1.104	3.553
Schwarz SC	2.176	1.313	2.259

Note. Parentheses are t-statistics. ***, **, and * denotes significant at 1%, 5%, and 10% respectively.