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Keywords
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Comments
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Abstract

This paper assesses the effects of the most recent monetary policy behavior of the Bank of Japan (BOJ) (in particular, zero interest rate policy and negative interest rate policy) and Japanese tax policy on income inequality in this country during the period of 2002Q1 to 2017Q3. The vector error correction model that develops in this research, shows that increase in money stock (m1) through quantitative easing (QE) and quantitative and qualitative easing (QQE) policies of the BOJ significantly increases the income inequality. On the contrary, Japanese tax policy was effective in reducing the income inequality. Variance decomposition results show after ten periods almost 87.15% of the forecast error variance of the inequality is accounted for by its own innovations and 3.76% of the forecast error variance can be explained by exogenous shocks to monetary policy shock—the money stock (M1). The short-term interest rate also accounts for the increase in inequality by 0.47%. On the other hand, the total tax and real gross domestic product contributed in reducing the inequality measure, respectively, by 6.65% and 1.96% after 10 periods.

Keywords: income inequality, monetary policy, tax policy, Japanese economy

JEL Classification: D63, E52, H24

Contents

1. INTRODUCTION AND THE LITERATURE SURVEY

Growing inequality, especially in advanced economies has attracted much attention from policy makers and academics (Yellen 2014; Bernanke 2015; Draghi 2016). Equality is considered a significant value in most societies akin to fairness. Regardless of ideology, culture, and religion, individuals acknowledge inequality as unfavorable (Dabla-Norris et al. 2015). Not only can it become a cause for instability within society, studies have shown it can hinder economic growth.

Recent empirical works found that high levels of inequality are harmful for the pace and sustainability of growth (Ostry, Berg, and Tsangarides 2014). Also, Cingano (2014) strengthened the finding by demonstrating through an econometric analysis on Organisation for Economic Co-operation and Development (OECD) countries and concluding that income inequality has a negative and statistically significant impact on subsequent growth. The analysis shows that the income distribution itself matters for gross domestic product (GDP) growth. Specifically, if the income share of the top 20% increases, then GDP growth declines over the medium term. In contrast, an increase in the income share of the bottom 20% is associated with higher GDP growth (Dabla-Norris et al. 2015). Others have argued that increasing inequality may have been a critical contributing factor to the global financial crisis (GFC henceforth). Rajan (2010) argues that increasing inequality led to political pressure for more housing credit, which intensified the falsified lending in the financial sector. Ranciere and Kumhof (2011) present that, in the United States, the Great Depression of 1929 and the GFC of 2008 were both anticipated by a rapid rise in income and wealth inequality and by a sharp rise in debt-to-income ratios among low-income households.

In the case of Japan, it is unguarded from the gradual increase in inequality, which is also observed in other OECD countries in the recent years (Hoeller et al. 2013). The concerns over income inequality that have grown between the Japanese population and the wide notion that “all Japanese are middle class” has become a concept of the past (Aoyagi, Ganelli, and Murayama 2015). In their study, they calculated the evidence of increasing income inequality in Japan, showing that the Gini coefficient of Japan has continuously increased over the last 3 decades. Beginning from the lowest among the G7 countries in the 1980s, it has recently converged to roughly the G7 average of 0.5. Japan’s pace of rising inequality has been exceptionally high.

Different scholars have found several reasons for the causes of income inequality, including (i) technology (Bound and Johnson 1992), (ii) demographics (Karahan and Ozkan 2013), (iii) globalization (Feenstra and Hanson 2008; and Furceri et al. 2016), and (iv) structure of labor market (Jaumotte and Buitron 2015). Acemoglu and Johnson (2012) and Stiglitz (2015) raised expansionary monetary policy as a possible contributing factor for income inequality. However, the results of the effect of monetary policy on inequality have been ambiguous and sometimes even contradictory. The opinions are often divided among scholars from the results being insignificant to significant and expansionary monetary policy increasing the inequality to reducing inequality.

In the recent study by O’Farrell, Rawdanowicz, and Inaba (2016), the effect of monetary policy on inequality was only limited. They have taken an impact of monetary policy on income and wealth via changes in returns on assets, debt interest payments, and asset prices, rather than through its impact on employment and inflation, in selected developed countries and, at the same time, addressing if high inequality has a negative impact on effectiveness of monetary policy.

The effects of monetary policy on income and wealth inequality through financial channels were found to be complex and ambiguous, only giving a limited effect on inequality. The cross-country difference in size and distribution of income and wealth components were accountable for the ambiguity of the results. As for the second objective, higher inequality did not seem to significantly affect the effectiveness of monetary policy, particularly in boosting private consumption through wealth effects.

Similarly, Inui, Sudo, and Yamada (2017) have published their view that both conventional and unconventional monetary policy shocks do not have statistically significant impacts on inequality across Japanese households in a stable manner. Their results show that

(i) expansionary monetary policy shocks increase income inequality in a statistically significant manner, mainly through the responses of earnings inequality, when using the data from 1981Q1 to 1998Q4 of inequality across households whose head is employed;

(ii) monetary policy shocks scarcely affected income inequality, however, when extending the end point of the sample period to 2008Q4, or when studying earnings inequality across households that include those whose head is not employed as well. Weakening of the distributional effects of monetary policy shocks over time has occurred gradually from around the early 2000s; and

(iii) compared with the response of income inequality, that of consumption inequality to monetary policy shocks is minor (Inui, Sudo, and Yamada 2017).

Outcomes of various researches demonstrated significant impacts of the monetary policy on inequality. Fuceri, Loungani, and Zdzienicka (2016), for example, have displayed results that the expansionary monetary policy reduces income inequality. They used data on top income shares (top 1%, 5%, and 10%) from the World Top Income Databases, the share of wage income in GDP from OECD, and Gini coefficient in 32 advanced and emerging countries. What is unique about their study is that they have incorporated the forecast error of the policy rates. This is implemented to overcome the problem of “policy foresight” (Forni and Gambetti 2010) and to eliminate the chance of capturing the potentially endogenous response of monetary policy to the condition of the economy. The monetary policy shock effects on inequality are observed through impulse response functions directly from local projections introduced by Jorda (2005). Results showed that an unexpected decline of 100 basis points in the policy rate reduces inequality by approximately 1.25% in the short-term and 2.25% in the medium term. According to their calculations, the effect of policy rates is economically significant as there was a high persistence and limited variation in the Gini. The effect is larger for countries with higher labor share of income and smaller redistribution policies. Likewise, Coibion et al. (2012) advocated the significance of the effect and that the expansionary (contractionary) monetary policy reduced (increases) inequality in the United States (US) from 1980 to 2008. Under their study, the contractionary monetary policy had significant long-term effects on inequality in consumption, income, expenditure, and labor earnings in a statistically significant manner. In their work, the transmission channels are thoroughly examined. Earning heterogeneity channel and income composition channel were especially strong in their outcome. After contractionary monetary policy shocks, higher earnings for high-income earners are observed but lower earnings for low-income earners, demonstrating earning heterogeneity channel. Income composition channel also played a major role as aggregate financial income rose sharply while business income declined after contractionary monetary policy shocks and the top 1% of the income distribution received approximately 30% of their income from financial income. The income

composition of the low-income earners mostly consists of labor income, thus, creating a wider disparity between the income of the top and bottom layers of income distribution. Another research proposing the significance of the monetary policy effect on inequality is by Saiki and Frost (2014). To identify the response of monetary policy shocks to income inequality empirically, a vector auto regression framework and impulse response functions are used. The result makes apparent that the increase in monetary base positively affects the Gini.

In this paper, we shed light on the effect of expansionary monetary policy, in particular, quantitative easing (QE) and quantitative and qualitative easing QQE through zero interest rate monetary policy and negative interest rate policy on income inequality across Japan from an empirical point of view. In addition, we also look at the effect of tax policy on income inequality. The effect of tax policy has been clear as it is used as "the primary tool for governments to affect income distribution" (Bastagli, Coady, and Gupta 2012). Both tax policies and spending policies have the power to alter the distribution of income over the short and medium term. However, the redistributive effects of fiscal policies have been shown less effective in recent past. Our findings show that an increase in monetary stock contributed to an increase in inequality in Japan, demonstrating that an implemented expansionary monetary policy contributed to increasing inequality and, as for the tax policy, it reduced inequality in Japan.

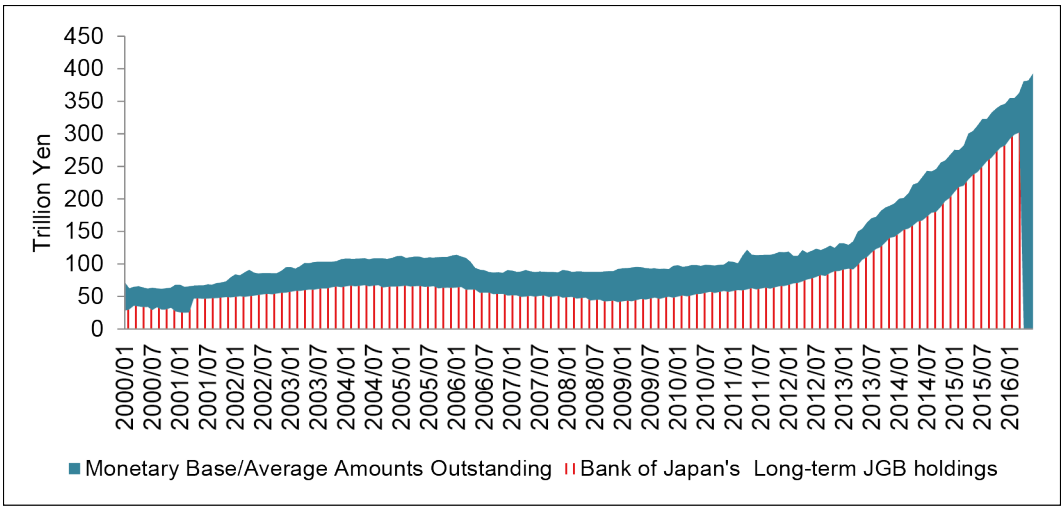
2. RECENT MONETARY POLICY OF THE BANK OF JAPAN AND INCOME INEQUALITY TRENDS

As for the most recent monetary policy behavior of the Bank of Japan (BOJ, henceforth), on 4 April 2013, they announced the purchase of Japanese government bonds (JGBs, henceforth). Haruhiko Kuroda made this decision when he first became the governor of the BOJ (Yoshino, Taghizadeh-Hesary, and Miyamoto 2017). Figure 1 shows the expansion of the monetary base and JGB holdings by the BOJ. Since 2013, there has been a massive increase in the amount of monetary base through the implementation of QQE[1] in part of the three arrows introduced by Prime Minister Abe.

Table 1 depicts the monetary base and government bond purchase data comparison of April 2013 and May 2016. From April 2013 until May 2016, the monetary base of Japan rose from ¥155 trillion to ¥387 trillion, with an average annual increase of about ¥80 trillion. In the same period, in April 2013, assets of the BOJ amounted to ¥175 trillion and, by May 2016, they had enlarged to ¥426 trillion, an increase of almost 2.5 times in 3 years. In the same period, JGBs, which were the major purchase of the BOJ, rose from ¥98 trillion to ¥319 trillion. In other words, the major part of the asset is the purchase of long-term government bonds (Yoshino, Taghizadeh-Hesary, and Tawk 2017).

[1] At the Monetary Policy Meeting held on 20 and 21 September 2016, the bank decided to introduce a new policy framework of QQE with yield curve control by strengthening the two previous policy frameworks of QQE and QQE with a Negative Interest Rate. The new policy framework consists of two major components: the first is "yield curve control" in which the bank controls short-term and long-term interest rates through market operations; and the second is an "inflation-overshooting commitment" in which the bank commits itself to expanding the monetary base until the year-on-year rate of increase in the observed consumer price index exceeds the price stability target of 2% and stays above the target in a stable manner. https://www.boj.or.jp/en/announcements/education/oshiete/seisaku/b27.htm/ (accessed 23 January 2018).

Figure 1: Expansion in the Monetary Base and Japanese Government Bond Holdings (January 2000–June 2016)



JGB = Japanese government bond.

Notes: Monetary base is average amounts outstanding in each month. Bank of Japan's long-term JGB holding data were available up to March 2016.

Source: Bank of Japan. Time-series database. https://www.stat-search.boj.or.jp/index_en.html (accessed 30 July 2016).

Table 1: Monetary Base and Japanese Government Bond Purchase Data (comparison of April 2013 with May 2016)

(¥ trillion)

	April 2013 (Actual)	May 2016 (Actual)	Average Annual Increase
Monetary Base	155	387	About ¥80 trillion
JGB	98	319	About ¥80 trillion
CP	1.4	2.3	Outstanding balance maintained
Corporate Bonds	2.9	3.2	Outstanding balance maintained
ETFs	1.7	8.0	About ¥3 trillion
J-REITs	0.13	0.31	About ¥90 billion
Total Assets of the BoJ	175	426	–

BoJ = Bank of Japan, CP = commercial paper, ETFs = exchange-traded funds, J-REITs = Japan real estate investment trusts, JGB = Japanese government bond.

Source: Bank of Japan. Time-series database. https://www.stat-search.boj.or.jp/index_en.html (accessed 30 July 2016).

When compared with other countries and other regions of the world, the extremity of Japan's recent monetary easing becomes distinct. In Table 2, the monetary base/GDP ratios of Japan are compared with those of the US and the euro zone. In July 2016, the ratio was 80% in Japan, while 21% in the US, and 20% in the euro zone (Yoshino, Taghizadeh-Hesary, and Miyamoto 2017).

As for the income inequality in Japan, the indicator we used in this empirical survey is the average households' income of top 10% (rich) over average households' income of bottom 10% (poor). Figure 2 illustrates the trend of this indicator during 2002Q1–2017Q3. As demonstrated in Figure 2, the index of inequality shows a drastic upward trend, especially during the last decade, meaning increasing income inequality. This ratio was 10.14 when the BOJ had first implemented the QE policy, which was removed in March 2006 as the inflation rate turned positive and the economy seemed

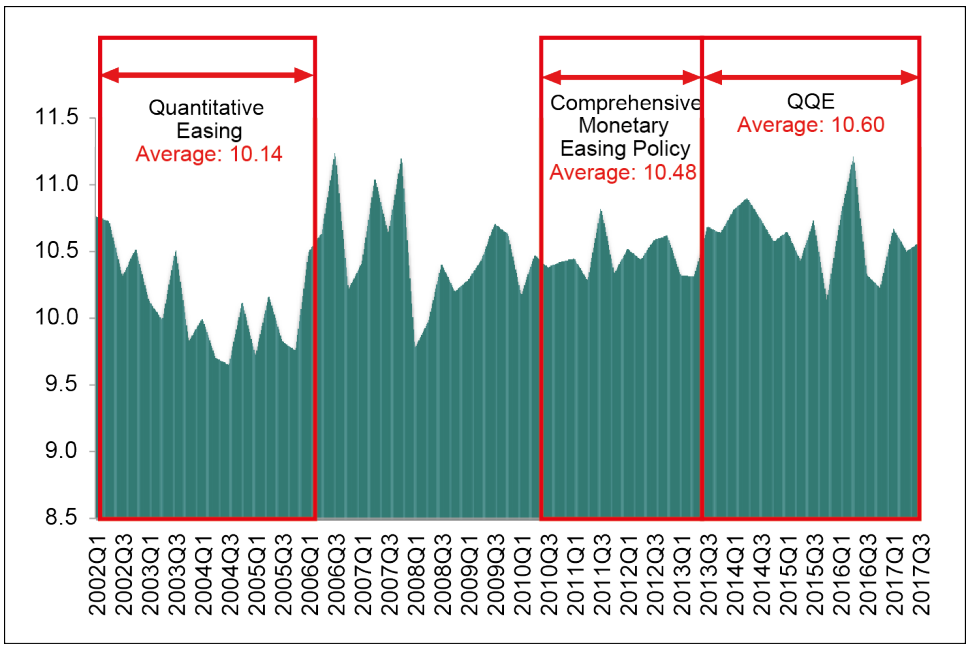
to be recovering. However, when the GFC hit in 2008 and the economy went into a tailspin, the BOJ lowered its interest rate to almost zero. In 2010, they executed the Comprehensive Monetary Easing Policy and the ratio increased to 10.48. In 2013, Prime Minister Abe took power for the second time and released his Abenomics' three arrows,[2] which included QQE and was executed as a remedy to combat the prolonged deflation in Japan. The inequality during this period marked the highest. During this period the inequality ratio reached 10.60; this phase covers the negative interest rate from 29 January 2016.[3]

Table 2: Monetary Base/Gross Domestic Product Ratio for Japan, the United States, and Eurozone
(%)

	Dec 2000	Dec 2012		July 2016	
	Monetary Base/GDP	Monthly QE Volume/GDP	Monetary Base/GDP	Monthly QE Volume/GDP	Monetary Base/GDP
Japan	15	0.2	29	1.3	80
US	6	0.5	16	–	21
Eurozone	7	–	17	0.8	20

GDP = gross domestic product, QE = quantitative easing, US = United States.
Source: International Monetary Fund, International Financial Statistics (2016).

Figure 2: Average Household Income of Top 10% (Rich) over Average Household Income of Bottom 10% (Poor) 2002Q1–2017Q3



Source: Statistics Japan (https://www.e-stat.go.jp).

[2] For more information on Abenomics' three arrows, see: Yoshino and Taghizadeh-Hesary (2014, 2015a, and 2017).

[3] At its monetary policy meeting on 29 January 2016, the BOJ policy board introduced QQE with a negative interest rate to achieve the price stability target of 2% at the earliest possible time.

3. THEORETICAL BACKGROUND AND THE MODEL

3.1 Channels for Transmission of Monetary Policy to Inequality

In order to capture the distributional effects of monetary policy on inequality, we will need to review the potential transmission channels. Coibion et al. (2012); Nakajima (2015); and Inui, Sudo, and Yamada (2017) introduce four major channels, in which monetary policy affects the income inequality:

1. *Earnings heterogeneity channel.* Proceeds when the response of earnings to monetary policy shock differs across different households' income groups. This channel is affected by the level of labor unionization, stickiness of nominal wage, or labor market flexibility. According to research by Mumtaz and Theophilopoulou (2016), this channel works countercyclically to a monetary policy shock. However, this channel works procyclically among Japanese households, according to Inui, Sudo, and Yamada's study (2017). Under the assumption that the high-income households have more capital income and less wage income when expansionary monetary policy is implemented, their capital income increases. However, because of the stickiness of nominal wage, the income of the poor, which is mostly wage income, will not change. Thus, this contributes to widening income inequality across households.
2. *The job creation channel.* Arises with job creation and job destruction, which resulted from the implementation of monetary policy. This channel generates a countercyclical response of labor income inequality since contractionary monetary policy shock creates jobs, reduces the unemployment rate, and decreases the number of households with no income (Bernanke 2015), therefore, contributing to the narrowing down of income inequality.
3. *The portfolio channel.* Becomes apparent when the size and composition of asset portfolios differs across households. Also, under the assumption of the rich holding most of their assets in financial assets and the poor in cash, income inequality widens as the result of monetary easing. This situation occurs due to equity prices elevating, resulting in an increase in income of the richer households, and the result of inflation depreciates cash, in which case the disparity of the rich and poor widens.
4. *The savings redistribution channel.* Emerges from the fact that a decline in the policy rate set by the central bank and the rising inflation leads to transfer from lenders to borrowers. According to the Quantitative Theory of Money (MV=PY), when expansionary monetary policy is implemented, the price level increases. This means that inflation is present. Due to the Taylor Rule, the interest rate eventually increases, and, as a result, inequality increases as borrowers (the low-income households) will need to pay higher interest to lenders (high-income households).

In Japan. As the top 20% of Japanese hold 15.4% of their assets in stocks and bonds, which is 5 times as much as the second top quintile, the possibility of the *earnings heterogeneity channel* and *the portfolio channel* is suggested. In the economic severity, the unconventional monetary policy was put in place, which resulted in higher asset prices. Higher asset prices benefited the high-income households, who held a larger amount of overall savings in securities, and, thus, benefited from greater capital income, hence, increasing the income inequality among the households.

3.2 Impact of Tax Policy on Inequality

In this section, we glance at the impacts of fiscal policy, especially putting emphasis on the tax policy, on inequality. In the research by Bastagli, Coady, and Gupta (2012), fiscal policy is defined as "the primary tool for governments to affect income distribution." And its three main objectives are described as "to support macroeconomic stability, provide public goods and correct market failures, and redistribute income." Both tax policies and spending policies have the power to modify the distribution of income over the short and medium term.

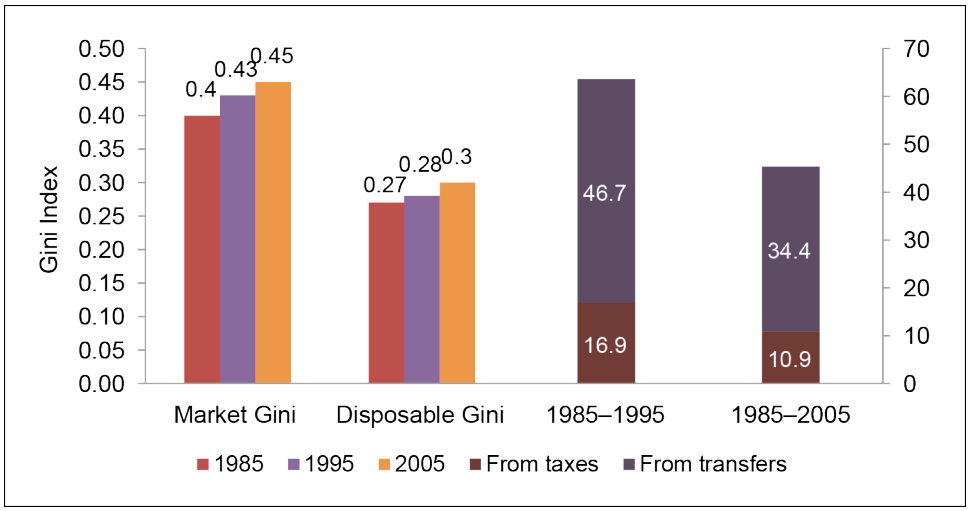
Various researchers found the outcome through regression-based studies, that greater reliance on income taxes and higher spending on welfare reduces inequality (Niehues 2010; Martínez-Vázquez, Vulovic and Moreno-Dodson 2012; Muinelo-Gallo and Roca-Sagalés 2013; and Woo et al. 2013). The bulk of these studies provides evidence that direct taxes, such as income tax, corporate tax, wealth tax, etc., are more redistributive than indirect taxes, like sales tax and service tax, and social protection spending lowers inequality.

However, recently, a reduction in the social benefits and less progressive taxation has resulted in a decrease in the redistributive impact of fiscal policy. During the course of the mid-1980s and mid-1990s, the Gini coefficient for income before taxes and transfers increased by 3.1%, while the Gini for income after taxes and transfers increased by only 1.1% (Figure 3) (Gupta 2014). Therefore, fiscal policy counteracted about two-thirds of the increase in market income inequality over the decade. Over the successive period, mid-1990s to mid-2000s, market income inequality boosted by another 2.2%, while disposable income inequality rose by 1.8 % (Figure 3). Thus, while market income inequality increased by less than over the previous decade, income inequality after taxes and transfers actually increased by more. Therefore, during the 2 decades from the mid-1980s to the mid-2000s, fiscal policy reduced less than half of the increase. Fiscal reforms in many economies since the mid-1990s are accountable for the decline in the redistributive power of fiscal policy (Gupta 2014). These reforms reduced the generosity of unemployment and social assistance benefits, as well as income tax rates, particularly for high-income earners (OECD 2011).

Without the policy changes, the absolute distributive impact of fiscal policy would have been higher than observed in Figure 3 below since the progressive tax and benefit systems redistribute income even more when market inequality rises (as unemployment rises and government transfers are given, or rising income of top earners are taxed more by the progressive tax system).

The main reasons for the reduction in the distributive impact of fiscal policy were the cost and efficiency. As for means tested social benefits, it provided disincentives for low-skilled workers to look for job opportunities (OECD 2011b). Progressive income tax can have disincentives for higher-income individuals. However, recent research has argued that the efficiency cost of progressive taxation may be much less than previously thought (Bastagli, Coady, and Gupta 2012). As opposed to productivity boosting, increases in top incomes were achieved at the expense of lower-income groups, showing no correlation between the rising top incomes and per capita GDP growth (Stantcheva et al. 2011). On the grounds of that, more progressive taxation on high-income groups was called for (Tanzi 2011).

Figure 3: Diminishing Fiscal Redistribution (1985–2005)



Source: Caminada, Goudswaard, and Wang (2012).

As previously stated, tax policies intend on reducing inequality, and, generally, they have a diminishing effect on inequality. For example, the inheritance tax in Japan is very high, up to 55% (Table 3). Moreover, after the revision of the inheritance tax in January of 2015, the total deduction was calculated by adding ¥10 million per heir to the basic deduction of ¥70 million. However, after being revised, the basic deduction declined to ¥42 million and only ¥7 million per heir. This can be seen as the attempt to mitigate Japan's widening income inequality since the major cause for inequality in Japan is explained by inheritance.

Table 3: Bracket of Taxable Inheritance in Japan (January 2015)
(%)

Bracket of Taxable Inheritance	Tax Rate
Up to 10 million	10
10 million–30 million	15
30 million–50 million	20
50 million–100 million	30
100 million–200 million	40
200 million–300 million	45
300 million–600 million	50
Over 300 million	55

Source: Ministry of Finance (2018).http://www.mof.go.jp/tax_policy/summary/property/e01.htm (accessed 31 January 2018).

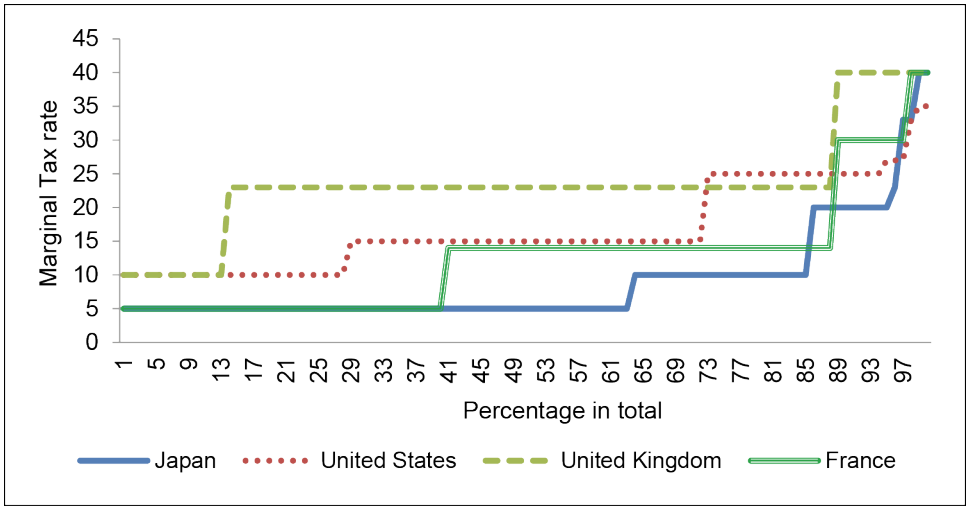
Japan's income tax is also effective in combating the growing inequality. As seen in Table 4 below, the income tax for low-income households is very low, gradually rising as income rises, and elevates quickly for high-income households. This is unique compared with other advanced countries, like the US, the United Kingdom, and France (Figure 4). The well-established tax system in Japan is one of the major reasons that inequality has not widened as much as other advanced countries.

Table 4: Individual Income Tax Rates in Japan (January 2017)
(%)

Brackets of Taxable Income		Tax Rates
–	Or under 1,950,000 yen	5
Over 1,950,000 yen	Or under 3,300,000 yen	10
Over 3,300,000 yen	Or under 6,950,000 yen	20
Over 6,950,000 yen	Or under 9,000,000 yen	23
Over 9,000,000 yen	Or under 18,000,000 yen	33
Over 18,000,000 yen	Or under 40,000,000 yen	40
Over 40,000,000 yen	–	45

Source: JETRO (2018). https://www.jetro.go.jp/en/invest/setting_up/section3/page7.html (accessed 20 April 2018).

Figure 4: International Comparison of Tax Percentages Based on the Final Tax Rate per Income Bracket



Source: Ministry of Finance of Japan. Available at https://www.mof.go.jp/tax_policy/summary/itn_comparison/j02.htm#a01 (accessed 21 January 2018).

The tax policy's effectiveness in reducing the inequality in Japan will be examined empirically in section 4.

3.3 Model Development

Here, we provide a simple theoretical model in order to show the impact of monetary policy and tax policy on income inequality. First, the two distinct income groups are presented in the form of their income and tax. Then, the relationship between the macroeconomic factors and inequality are depicted.

$$E_H = w_H L_H + r_D D_H + \pi P_S S_R \quad (1)$$

$$\mathrm{E}_L = w_L L_L + r_D D_L \quad (2)$$

In equations (1) and (2), we are considering the earning of two income groups, which are the high-income group and low-income group, denoted as E_H and E_L, respectively. The rich receive the wage income $w_H L_H$, where w_H is the wage rate per hour, for the high-income group and L_H shows how many hours they work. The second source of

income for the high-income group is the interest income from their deposit, $r_D D_H$, where r_D denotes the deposit interest rate and D_H denotes amount of deposits of the high-income group. The high-income group is also investing in the capital market, so they receive dividends from the stock market as their third income source ($\pi P_S S_H$) where π shows the dividend (as percentage), P_S shows the price of stock, and S_H the number of shares the high-income group is holding. The low-income group also receives labor income $w_L L_L$, and also interest from their deposit $r_D D_L$. w_L, L_L *and* D_L are, respectively, the wage rate per hour, for the low-income group, how many hours the low-income group works, and deposits of the low-income group. The difference in their income emanates from the wage income, deposit income, and also whether they can invest in the capital market or not.

$$P_S = \frac{\pi_1}{1+r} + \frac{\pi_2}{(1+r)^2} + \frac{\pi_3}{(1+r)^3} + \cdots\cdots + \frac{P_S^{t+n}}{(1+r)^n} \quad (3)$$

Equation (3) shows the relationship between the stock price, P_S , and dividends, π_1 , π_2, π_3…. The present stock price depends on the present discount value of dividend and future expected price of stocks. So we have to discount the dividend by $1 + r$, $(1 + r)^2, (1 + r)^3$and $(1 + r)^n$.

$$M \uparrow \rightarrow \mathrm{r} \downarrow \text{ and } r_D \downarrow \rightarrow r_D D \downarrow \quad (4)$$

$$M \uparrow \rightarrow \mathrm{r} \downarrow \; P_S \uparrow \quad (5)$$

Equation 4 shows the impact of money supply on deposits. If the money supply goes up, $M \uparrow$, the interest rate declines, $\mathrm{r} \downarrow$, and that will reduce the deposit rate of interest, $r_D \downarrow$. As far as their asset return is concerned, the deposit interest rate will go down and their money in deposit will be reduced, $r_D D \downarrow$. Also, if the monetary policy works well, the interest rate goes down, which leads stock prices to recover and future prices of the stocks increase because of monetary easing (Equation 5). Then, the total return from the capital market investment goes up for the higher-income group. However, for the lower-income group, they are only putting their money in their deposit, so when the deposit interest rate goes down, their total asset does not increase. Rich people are affected strongly from easing monetary policy, and lower-income or poor people are outside of those influences, which will diversify the income distribution.

Next, we add taxes to equations 1 and 2; results are found in equation 6 and 7, stated as below:

$$E_H = (1 - t_w^H) w_H L_H + (1 - t_C^H)\,(r_D D_H + \pi P_S S_H) \quad (6)$$

$$\mathrm{E}_L = (1 - t_w^L) w_L L_L + (1 - t_C^L) r_D D_L \quad (7)$$

Where t_w^H denotes wage income tax for high-income group and t_w^L denotes the wage income tax for low-income group and t_C^H denotes tax on capital. As it is clear in terms of tax, there are two kinds of tax, which are wage income tax and tax on capital.

Next, in order to capture the impact of monetary policy on each income-group's income, we get the first order conditions of E_H in Equation 6 and E_L in Equation 7 with respect to M, or the money supply; The results of first order conditions are found in equations 8 and 9:

$$\frac{\partial E_H}{\partial \mathrm{M}} = (1 - t_w^H)(\frac{\partial w_H}{\partial \mathrm{M}} L_H + w_H \frac{\partial L_H}{\partial \mathrm{M}}) + (1 - t_C^H)\left\{\frac{\partial r_D}{\partial \mathrm{M}} D_H + r_D \frac{\partial D_H}{\partial \mathrm{M}} + \pi P_S \frac{\partial S_H}{\partial \mathrm{M}} + \frac{\partial \pi}{\partial M} P_S S_H + \pi \frac{\partial P_S}{\partial M} S_H\right\} \quad (6)$$

$$\frac{\partial E_L}{\partial \mathrm{M}} = (1 - t_w^L)(\frac{\partial w_L}{\partial \mathrm{M}} L_L + w_L \frac{\partial L_L}{\partial \mathrm{M}}) + (1 - t_C^L)(\frac{\partial r_D}{\partial M} D_L + r_D \frac{\partial D_L}{\partial M}) \quad (7)$$

Therefore, $\frac{\partial E_H}{\partial M} / \frac{\partial E_L}{\partial M} > 1$, which means the money supply will increase the earning of the high-income group more, compared with the low-income, which means increasing the income inequality among the different income groups. According to our model, good monetary policy has the power to widen the income distribution.

On the other hand, if the tax ratios are progressive, the higher-income group needs to pay much higher wage-taxes, while the poor only need to pay a small amount of tax, equalizing the income between the rich and the poor. Rich people will have to pay more capital income. This shows that, based on our model, the tax policy could be in favor of reducing the income inequality.

In the next step, in order to find the empirical model, we write $\frac{E_H}{E_L}$ as in Equation (8):

$$\frac{E_H}{E_L} = \frac{(1-t_w^H) w_H l_H + (1-t_C^H)(r_D D_H + \pi P_S S_H)}{(1-t_w^L) w_L l_L + (1-t_C^L) r_D D_H} \quad (8)$$

Equations 9–15 shows that each of the variables in Equation 8 are functions of certain variables:

$$w = p \frac{\partial Y}{\partial L} = f(P, Y) \quad (9)$$

$$P_S = g(r, M, Y) \quad (10)$$

$$r_D = r_D(r, M, Y) \quad (11)$$

$$L = L(r, M, Y) \quad (12)$$

$$\pi = \pi(r, M, Y) \quad (13)$$

$$D = D(r, M, Y) \quad (14)$$

$$S_H = S_H(P_S, r, M, Y) \quad (15)$$

Equation 9 shows that wage rate is a function of price level and GDP (income level). Equation 10 shows that the price of stock is a function of interest rate, money supply, and GDP (income level). Equation 11 shows that deposit interest rate is a function of interest rate, money supply, and GDP (income level). Equation 12 shows that labor supply is a function of interest rate, money supply, and GDP (output level). Dividend is shown in Equation 13, which is a function of interest rate, money supply, and the GDP (output level). In Equation 14, deposits are mentioned as a function of interest rate, money supply, and GDP (income level). As in Equation 15, the number of shares are a function of price of stock, interest rate, money supply, and GDP (income level).

Then we write the linearized $\frac{E_H}{E_L}$ as in Equation (10), according to Equation 9–15, by considering that each variable is a function of other variables:

$$\frac{E_H}{E_M} = \alpha_0 + \alpha_1 Y + \alpha_2 M + \alpha_3 t + \alpha_4 r \ldots \quad (16)$$

Equation 16 shows that the $\frac{\mathrm{E_H}}{\mathrm{E_L}}$, which is the indicator of inequality in this survey, is a function of r or interest rate, M or money supply, Y or GDP. The variables we used for the empirical survey and their definitions are summarized in Table 5:

Table 5: Model Variables

Variable	Description	Source
r	Short-term interest rate (call-rate, overnight rate) of Japan	Bank of Japan, Time series database
t	Total government tax receipts of Japan, seasonally adjusted X-21 census over GDP	Ministry of Finance, Japan
Y	Real gross domestic product (GDP) of Japan, expenditure approach, real term, seasonally adjusted, X-21 census	Nikkei needs
M	Money stock average amount outstanding (M1) of Japan, seasonally adjusted over GDP	Bank of Japan
$\frac{E_H}{E_L}$	Average household earning of the top 10% (rich) over average household earning of the10% bottom (poor) of Japan	Statistics Japan

Notes: Tax, GDP, and money stock are all seasonally adjusted.

4. EMPIRICAL ANALYSIS

Although the Gini index might be a better definition for representing the level of inequality in a country, due to the lack of data for Japan, in this paper, the definition of inequality is the average household earning of top 10% (rich) over the average household earning of the bottom 10% (poor) as our inequality measure, and the original data were collected from *FIES,* conducted by Statistics Japan.

4.1 Data Analysis

4.4.1 Unit Root Tests

In order to evaluate the stationarity of all series, we performed unit root tests on all variables at levels and first differences. The results are summarized in Table 6. Our results imply that all variables are non-stationary in level except for $\frac{E_H}{E_L}$. These variables include the short-term interest rate, total tax, real GDP, and money stock (M1), all in their logarithmic forms. These results demonstrate that the short-term interest rate, total tax, real GDP, and money stock (M1) each contain a unit root. However, in the first differences, we were able to reject the null hypothesis of presence of unit root for those variables.

Table 6: Unit Root Test

	Augmented Dickey-Fuller (ADF)			
Variable	Levels (t-statistic)	P-value	First Differences (t-statistic)	P-value
r	–2.52	0.11*	–5.20**	0.00*
t	–1.61	0.47*	10.94**	0.00*
Y	–1.18	0.68*	–6.79**	0.00*
M	–0.07	0.95*	–7.00**	0.00*
$\frac{E_H}{E_L}$	–5.27**	0.00*	–9.64**	0.00*

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

** indicate rejection of the null hypothesis for the presence of unit root at 1% using Augmented Dickey Fuller.

Notes: r indicates short-term interest rate (call-rate, overnight rate) of Japan; t is total government tax receipts of Japan, seasonally adjusted X-21 census over GDP; Y is real gross domestic product (GDP) of Japan, expenditure approach, real term, seasonally adjusted, X-21 census; M is money stock average amount outstanding (M1) of Japan, seasonally adjusted over GDP; $\frac{E_H}{E_L}$ is household average earning of top 10% rich over average earning of 10% bottom of Japan.

Source: Author's compilation.

Since four of the variables were non-stationary at level and stationary at first differences, they are integrated of order 1 or I (1). Due to the non-stationary series, the next step is to apply a cointegration analysis to examine whether the series are cointegrated, meaning that long-term relationships are present among these variables or not.

4.1.2 Cointegration Analysis

One of the main issues in VAR/VEC models is lag order selection. Ivanov and Kilian (2005) presented six criteria for lag order selection, which are the Schwarz Information Criterion (SIC), the Hannan–Quinn Criterion (HQC), the Akaike Information Criterion (AIC), the general-to-specific sequential likelihood ratio (LR) test, a small-sample correction to LR (SLR), and the Lagrange multiplier (LM) test. In this research, we used AIC standards, which suggested two lags.

In the next step, in order to identify the cointegrating vectors among the short-term interest rate, total tax, real GDP, money stock (M1) and $\frac{E_H}{E_L}$, we conduct a cointegration analysis using Johansen's cointegration test by assuming a linear deterministic trend and in two cases, with intercept and with intercept and trend. The results of the cointegration rank test of trace are shown in Table 7.

As we can see from Table 7, the results reject the null hypothesis of non-cointegrating variables with 2 cointegrating equations at 5% significance level for intercept and 3 cointegrating equations at 5% significance level for intercept and trend. This means that variables are cointegrated, and there is a long-term association among variables, thus, they move together in the long term. Therefore, we should run a vector error correction model (VECM).

Table 7: Johansen Cointegration Test (Trace)

	Intercept		
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.**
r=0*	0.62	106.47	0.00
r<=1*	0.50	59.08	0.00
r<=2	0.33	24.83	0.17
r<=3	0.10	5.40	0.77
r<=4	0.00	0.22	0.64
Johansen Cointegration Test (Trace) with Intercept			
	Intercept and Trend		
Hypothesized no. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.**
r=0*	0.63	128.13	0.00
r<=1*	0.52	79.82	0.00
r<=2*	0.40	43.78	0.04
r<=3	0.25	18.85	0.29
r<=4	0.09	4.45	0.68

Note: Trace test indicates 2 cointegrating equations at the 5% level and trace test with intercept indicates 3 cointegrating equations at the 5% level.

Source: Author's compilation.

4.2 Empirical Work

4.2.1 Vector Error Correction Model (VECM)

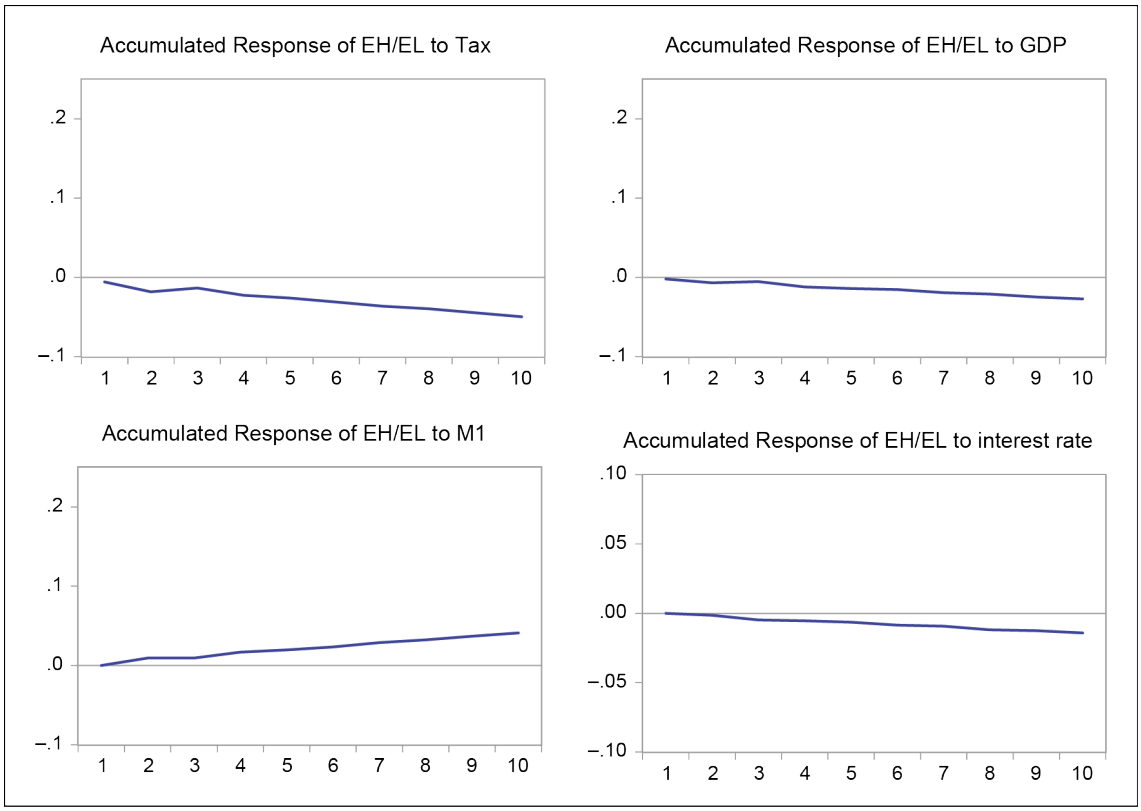
We estimate Model (16) in a VECM setting, including the five variables: the short-term interest rate, total tax, real GDP, money stock (M1) and $\frac{E_H}{E_L}$. We define all variables in their logarithmic forms. The VECM is defined as:

$$\mathrm{D}V_t = A(L)V_r + \Pi V_{t-1} + \varepsilon \tag{16}$$

$$\textit{where } \mathrm{V} = \left(\frac{E_H}{E_L}, \mathrm{t}, \mathrm{Y}, \mathrm{M}, \mathrm{r}\right) \tag{17}$$

Where D is the first differences, L is the lag operator, and ε is an error term. Π can be written as Π= ab,′ where a and b are Π × r matrices, and Π is the number of variables in V. A is a loading matrix defining the adjustment speed of the variables in V to the long-run equilibrium designated by the cointegrating relationship and b is a vector of the cointegrating relationship (Yoshino et al. 2014). The rank of Π is expressed by r. As mentioned in the previous subsection, the AIC standard suggested two lags for these series.

Figure 5: Accumulated Response to Cholesky One S. D. Innovations



Note: $\frac{E_H}{E_L}$ indicates household average earning of top 10% rich over average earning of 10% bottom of Japan.

Source: Authors's compilation.

From the impulse response function results (Figure 5), we can see the sign of association between the independent variables, which are the short-term interest rate, total tax, real GDP, money stock (M1), and the dependent variable, which is $\frac{E_H}{E_L}$ in our model. As total tax, real GDP, and the short-term interest rates increase, our inequality measure declines. Since the interest rate declines during monetary easing, in our case, the effect would be the opposite. As for money stock (M1), when it increases, $\frac{E_H}{E_L}$ also increases. The Impulse response results are in favor of our hypothesis that money supply or monetary policy and lower interest rates in Japan increased the income inequality while the tax policy was in favor of reducing the income inequality.

4.2.2 Variance Decomposition Analysis

In the VAR/VEC framework, variance decomposition is interpreted as the portion of the total variance of an observed variable that is due to the various structural shocks (Yoshino et al. 2014). Variance decomposition clarifies which one of the macroeconomic factors provides explanatory power for a variation in our inequality measure over different periods (Lutkepohl 2005).

The result of the forecast error variance decomposition (FEVD) for the $\frac{E_H}{E_L}$ is shown in Table 8. The variance decomposition makes it possible to determine the magnitude of each variable in creating fluctuations in other variables. Results show that after ten periods, firstly, almost 87.15% of forecast error variance of the $\frac{E_H}{E_L}$ is accounted for by

its own innovations, in other words, the lagged inequality made the current and will make the future Inequality. Secondly, 3.76% of the forecast error variance can be explained by exogenous shocks to monetary policy shock—the money stock (M1). The short-term interest rate also accounts for the increase in inequality by 0.47%. On the other hand, the total tax and real GDP contributed in reducing the inequality measure, respectively, by 6.65% and 1.96% after ten periods.

Table 8: Forecast Error Variance Decomposition (FEVD) of $\frac{E_H}{E_L}$

Period	S.E.	r	t	Y	M	$\frac{E_H}{E_L}$
1	0.05	0.00	1.47	0.17	0.00	98.36
2	0.06	0.09	7.59	1.13	3.37	87.82
3	0.07	0.42	6.58	0.95	2.60	89.45
4	0.07	0.36	7.61	2.07	3.58	86.37
5	0.08	0.36	7.53	2.06	3.59	86.45
6	0.08	0.42	7.03	1.79	3.38	87.37
7	0.08	0.40	7.13	2.02	3.74	86.70
8	0.08	0.48	6.73	1.91	3.66	87.22
9	0.08	0.46	6.69	2.02	3.73	87.11
10	0.08	0.47	6.65	1.96	3.76	87.15

Notes: S.E. is the standard error; r indicates short-term interest rate (call-rate, overnight rate) of Japan; t is total government tax receipts of Japan, seasonally adjusted X-21 census over GDP; Y is real gross domestic product (GDP) of Japan, expenditure approach, real term, seasonally adjusted, X-21 census; M is money stock average amount outstanding (M1) of Japan, seasonally adjusted over GDP; $\frac{E_H}{E_L}$ is household average earning of top 10% rich over average earning of 10% bottom of Japan.

5. CONCLUSION

In this paper, we used our original calculation of inequality measure from Statistic Japan to study how monetary policy shocks and tax policy affected inequality in Japan. We constructed a quarterly series of inequality measures of income by calculating average household earning of the top 10% over average household earning of the bottom 10% from 2002Q1 to 2017Q3 and estimated their response to monetary shocks and the tax policy implemented. We found that the zero and negative interest rate policy of the Bank of Japan increased income inequality through a rise in the price of the financial assets that just benefited the rich income groups, which resulted in widening the income gap among different income groups.

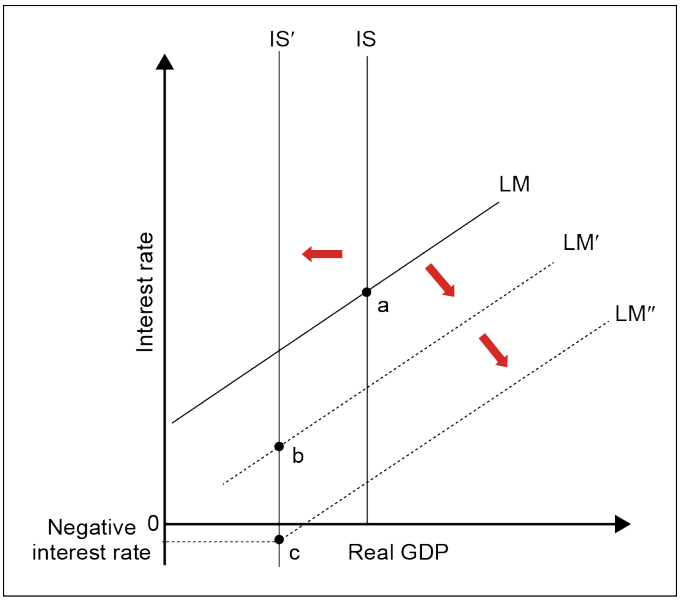
Further breaking down our results, the largest factor affecting inequality was inequality itself (lagged inequality), accounting for 87.15% of forecast error variance of our inequality measure. Our outcome shows that inequality creates inequality and that there is a low level of social mobility present. An additional factor that played a role in increasing inequality was the Money supply (M1) and short-term interest rate, for 4.23% totally. On the contrary, tax policy and real GDP were effective in reducing inequality, accounting, respectively, for 6.65% and 1.96%.

The Japanese economy has been in a stagnant situation, often described as the –lost decade," and monetary policy could not promote the economic growth or create jobs. Only those households holding financial assets and investing in the capital market,

which are the high-income households, are gaining benefit, contributing to the rise of the inequality Yoshino and Taghizadeh-Hesary (2017b).

One theory to explain the ineffectiveness of the monetary policy is mentioned by Yoshino and Taghizadeh-Hesary (2015b) and Yoshino, Taghizadeh-Hesary, and Miyamoto (2017). The Investment-Saving curve (IS) became vertical therefore, even when the lower interest rate is implemented by the monetary policy (LM). Private investment does not grow despite very low interest rates, and, as a consequence of low return, not many new technologies appear in Japan. Depressed investment in Japan means that the economy is not able to recover (Yoshino and Taghizadeh-Hesary 2016). Corporate restructuring to reduce idle capacity and input new investments was not pursued, with greater importance placed on monetary policy instead of accelerating corporate restructuring (Yoshino and Taghizadeh-Hesary 2014).

Figure 6: Ineffectiveness of Monetary Policy in Japan



Source: Modified version of the figure from Yoshino and Sakakibara (2002).

Under the unconventional monetary policy, while the high-income households gain from the appreciating price of the financial assets, low-income households, which do not hold significant financial assets, are unable to see the rise in their income.

Although this unconventional monetary policy in Japan has been taken as the last measure to combat the long-lasting stagnation, it may bring about an unwanted side effect. With inequality already rising, following with this policy will not achieve a desirable result to the Japanese economy and, furthermore, to the nation itself.

On the bright side, the implemented tax policy was successful in reducing inequality, as there is a progressive income tax system existing in Japan, as shown in Figure 4, besides other types of taxes (inheritance tax, sales tax, capital tax, etc.).

Beyond its pertinence for Japan, this study paves a way for other countries tackling economic turmoil and initiating unconventional measures. Its extensive history of unconventional monetary policy has the potential to enlighten other regions of the world in terms of the monetary policy's future and, hence, for future growth.

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