The Effects of Monetary Policy Shocks on Inequality in Japan*

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Abstract

The impacts of monetary easing on inequality have been attracting increasing attention recently. In this paper, we use the micro-level data on Japanese households to study the distributional effects of monetary policy. We construct quarterly series of income and consumption inequality measures from 1981 to 2008, and estimate their response to a monetary policy shock. We find that monetary policy shocks do not have a statistically significant impact on inequality across Japanese households in a stable manner. When considering inequality across households whose head is employed, we find evidence that, before the 2000s, an expansionary monetary policy shock increased income inequality through a rise in earnings inequality. Such procyclical responses are, however, scarcely observed when the recent data are included in the sample period, or when earnings inequality across all households is considered. We also find that transmission of income inequality to consumption inequality is minor, including during the period when procyclicality of income inequality was pronounced. Using a two-sector dynamic general equilibrium model with attached labor inputs, we show that labor market flexibility is central to the dynamics of income inequality after monetary policy shocks. We also use the micro-level data on households' balance sheets and show that distributions of households' financial assets and liabilities do not play a significant role in the distributional effects of monetary policy.

1 Introduction

Does monetary policy implementation widen the income and consumption inequality across households? In recent years, this question has attracted increasing attention from both the general public and macroeconomists. In particular, the unconventional monetary policy measures undertaken by the central banks of major countries in the aftermath of the global financial crisis have sparked intense and diverse discussion and reaction regarding their consequences. For instance, Cohan (2014) argues that "Mr. Bernanke's extraordinary quantitative easing program, started in the wake of the financial crisis, has only widened the gulf between the haves and have-nots." By contrast, Krugman (2014) argues that "the belief that QE systematically favors the kinds of assets the wealthy own is wrong or at least overstated." Bernanke (2015) also states that "monetary policy is a blunt tool which certainly affects the distribution of income and wealth, although whether the net effect is to increase or reduce inequality is not clear."

Despite this growing interest, however, macroeconomists are still not in a position to fully answer the questions raised. In fact, empirical observations are mixed. A pioneering empirical paper by Coibion et al. (2017) shows that income and consumption inequality across U.S. households responds countercyclically to monetary policy shocks. Namely, inequality measures decline after an expansionary monetary policy shock. By contrast, the empirical work by Saiki and Frost (2014) argues that the opposite is true when using Japanese data. Domanski et al. (2016) examine the consequences of unconventional monetary policy measures on wealth inequality among households in selected countries, and argue that these measures may have widened wealth inequality, in particular through an upsurge in stock prices.

We address this question by examining the case for Japan. Our analysis consists of two separate parts. The first part documents how inequality measures respond to monetary policy shocks in Japan. We construct quarterly series of income and consumption inequality measures from 1981Q1 to 2008Q4 based on the micro-level data on households collected in the *Family Income and Expenditure Survey* (FIES) conducted by the Statistics Bureau of the Ministry of Internal Affairs and Communications. We then estimate the impulse response functions of these inequality measures to a shock to the short-term nominal interest rate using the local linear projection proposed by Jordà (2005). Our sample period covers both the period when unconventional monetary policy was undertaken – 1999Q1 to 2008Q4 – and the period when the conventional monetary policy was undertaken – 1999Q1 to 2008Q4. We therefore conduct two separate analyses taking into consideration the possible influence of regime shifts in monetary policy implementation, including changes in monetary policy instruments. When studying the effects of monetary policy shocks throughout the sample period, namely from 1981Q1 to 2008Q4, we use the shadow rate constructed by Ueno (2017) as the policy rate. We use the prevailing short-term nominal interest rate as the policy rate when studying the effects of monetary policy shocks during the period under the conventional monetary policy regime, namely from 1981Q1 to 1998Q4. In addition, because our micro-level data from the FIES are those on households whose head is employed, we construct a proxy measure of earnings inequality of households that includes households with and without a head who is employed, using the FIES as well as the aggregate data, and study how the series reacts to monetary policy shocks as well. Though households whose head is employed constitute the bulk of households in Japan, this additional exercise helps us draw a comprehensive picture of the distributional effects of monetary policy.[1]

The second part of our analysis sheds light on transmission mechanisms. It does so with the help of three distinct analysis. The first is a dynamic stochastic general equilibrium (DSGE) model that consists of two types of household and two goods sectors. From the model, we derive theoretical predictions regarding how labor market flexibility and distributions of households' financial assets and liabilities shape the size of distributional effects of monetary policy shocks. The other two analyses are inequality measures which we construct from alternative data sources: the industry-level time series of value-added, employees' earnings and hourly wages, published by the government; and the micro-level data on households' financial assets and liabilities collected in the *Survey of Household Finances* (SHF) conducted by Central Council for Financial Services Information (CCFSI).[2] These alternative inequality measures supplement our analysis based on the data from the FIES, containing as they do detailed information on labor markets, firms, and households' financial positions that are absent from the FIES.

Our empirical findings are summarized in three points: (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 on inequality across households whose head is employed; (ii) monetary policy shocks scarcely affect in-

[1] Among all households whose heads are aged from 25–59, which is the scope of households analyzed in this paper, households with a working head constitutes about 95% in 2010 according to the Japan Census.

[2] CCFSI is an organization that conducts financial services information activities in Japan for which the Bank of Japan has been working as the secretariat. The CCFSI's activities include providing financial and economic information to the public through various surveys and assistance in improving financial literacy education.

come 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; (iii) compared with the response of income inequality, the response of consumption inequality to monetary policy shocks is minor.

We show, using the DSGE model and two alternative data sources, that labor market flexibility plays the key role in generating a procyclical response of earnings inequality following monetary policy shocks as well as the gradual weakening of the responses over time. The Japanese labor market has witnessed a remarkable enhancement of its flexibility over the last two decades. Such a change is seen in the growing use of temporary workers by firms and an increase in the mobility of workers across firms. In the 1980s and early 1990s, firms increase their labor inputs typically by extending the working hours of existing employees. In the current years, they have been adjusting their labor inputs by hiring new workers, in particular temporary workers. These changes in labor markets affect the nature of transmission of the cross-firm or cross-industry heterogeneity of monetary policy effects to earnings inequality across households. As established by existing studies, such as Erceg and Levin (2006), Boivin et al. (2009), Gertler and Gilchrist (1994), and Peersman and Smets (2005), monetary policy shocks affect firms (or industries) differently, depending on characteristics of goods that firms produce, including goods' durability and price stickiness, or characteristics of firms themselves, such as firms' accessibility to financial markets. When labor market flexibility is low, the cross-firm heterogeneity of economic activity is easily translated into the cross-firm heterogeneity of earnings per employee, and earnings inequality across households. When labor market flexibility is high, however, the cross-firm heterogeneity is not translated to the cross-firm heterogeneity of earnings per employee, since wage differentials across firms do not hold long as workers are willing to supply their labor inputs more to the highest paying jobs.

Our paper follows the two strands of the literature on this topic. The first strand includes empirical works that explore the distributional effects of monetary policy shock, in particular on income inequality. These include Coibion et al. (2017), Saiki and Frost (2014), and Mumtaz and Theophilopoulou (2017). They estimate the responses of inequality measures of income, consumption, or both to monetary policy shocks by the standard methodology used in time series analysis. This strand also includes a number of works, such as Domanski et al. (2016) and O'Farrell et al. (2016), that assess effects of monetary policy shocks on asset values of households quantitatively, exploiting balance sheet information of households. The second strand in the literature includes theoretical works that study the distributional effects of monetary policy shocks using a variant of the DSGE model. These include McKay et al. (2016), Doepke et al. (2015), Gornemann et al. (2016), and Auclert (2019). These works typically employ a heterogenous agent model, à la Bewley, and simulate how a monetary policy shock alters income and consumption profiles of households with different asset sizes or employment status, changing inequality across households.

Compared with the existing studies, our study draws a broader picture of the distributional effects of monetary policy shocks in two dimensions. First, we focus on inequality measures of six variables; earnings, pre-tax income, disposable income, consumption, expenditure and financial positions, that are constructed in a coherent manner,[3] examining not only dynamics of each variable following monetary policy shocks but also the interaction between these dynamics. This contrasts with most of the existing studies that examine only a subset of these variables. For instance, our study differs from Saiki and Frost (2014), an empirically study regarding the distributional effects of monetary policy on Japanese households, not only in the sense that we study inequality measures constructed from micro-level household data rather than those based on semi-aggregate data which Saiki and Frost (2014) study, but also in terms of the scope of the coverages. Namely, we study inequality measures of six variables listed above, whereas Saiki and Frost (2014) study only an inequality measure of pre-tax income. As we show below, analysis on both earnings inequality and other income inequalities is essential for understanding the source of distributional effects of monetary policy in Japan, since heterogeneity in earnings across workers play a central role in shaping the aspects of the effects. Similarly, our study differs from Coibion et al. (2017) and Mumtaz and Theophilopoulou (2017) as we study inequality of financial assets and liabilities as well as that of income and consumption. Second, our data sample covers a fairly long span that includes periods of both conventional and unconventional monetary policy regimes. This enables us to study the distributional effects of monetary policy shocks across time and regimes. In addition to these two points, our paper is novel in the sense that it shows the quantitative importance of labor market flexibility in the distributional effects of monetary policy shocks, using the theoretical model and the data.

[3]Note that because households surveyed in the FIES and SHF are different from each other, we make adjustments to data constructed from the SHF so that characteristics of surveyed households of the SHF, which we use for our analysis, are the same as those of the FIES in terms of their ages and employment status.

The structure of this paper is as follows. Section 2 surveys existing studies and describes the channels through which monetary policy shocks affect inequality. Section 3 explains our data set and the estimation methodology. Section 4 documents our main empirical results, namely the responses of inequality measures to monetary policy shocks. Section 5 explores the transmission mechanisms of the distributional effects of monetary policy shocks, giving an account of our empirical results. Section 6 concludes.

2 Channels of distributional effects of monetary policy, and existing empirical studies

We start by reviewing the potential channels of the distributional effects of monetary policy shocks. We do this partly following a taxonomy established in existing studies, in particular Coibion et al. (2017) and Nakajima (2015). There are five main channels.

The earnings heterogeneity channel arises when the response of earnings to a monetary policy shock differs across workers. The degree of labor unionization, stickiness of nominal wage, or labor market flexibility are candidate explanations for this channel to operate. This channel can impact inequality in both ways, and its impact on earnings inequality measures needs to be determined empirically, both qualitatively and quantitatively. Mumtaz and Theophilopoulou (2017), using micro-level data on households in the U.K., show that this channel works countercyclically to a monetary policy shock. By contrast, as shown below, this channel works procyclically among Japanese households, at least in some parts of the sample period.

The job creation channel is a variant of the earnings heterogeneity channel. It comes with job creation and/or destruction following a monetary policy implementation. As discussed by Bernanke (2015), this channel is expected to generate a countercyclical response of labor income inequality, because an accommodative (contractionary) monetary policy shock creates (reduces) jobs and decreases (increases) the number of households with zero earnings.

The income composition channel arises when the income composition of different income types, such as labor and capital income and the government transfer, differs across households. Whether income inequality through this channel is cyclical or not depends on the characteristics of the income composition of households, and on how a monetary policy affects each category of income components. Under the premise that an expansionary monetary policy shock boosts capital income more than labor income, and that the share of capital income is higher among the rich, other things being equal, the distributional effects of monetary policy shocks through this channel become cyclical. This channel is, in particular, highlighted in Coibion et al. (2017). Coibion et al. (2017) report that, for low-income households, a contractionary monetary policy shock leads to a larger government transfer and lower earnings, making the response of their total income to the shock almost neutral.

The portfolio channel arises when the size and composition of asset portfolios differs across households. Suppose the poor hold their assets in cash, while the rich hold their assets in equity. An expansionary monetary policy shock is likely to dampen the capital income of the poor disproportionately. This is because the real value of cash typically falls following the shock whereas that of equity rises. Saiki and Frost (2014) argues that this channel was at work for Japan, when unconventional monetary policy was implemented in the aftermath of the global financial crisis.

The saving redistribution channel arises from the fact that a decline in the policy rate set by the central bank and a subsequent rise in inflation induces a transfer from lenders to borrowers. This channel has attracted increasing attention as a novel channel of monetary policy transmission.[4] Empirical studies, such as Doepke and Schneider (2006), agree that this channel tends to act as an instrument that transfers wealth between the young and the old. Its impact on inequality across the economy as a whole depends on the distribution of financial assets and liabilities among all households. The channel works countercyclically if the rich is a lender while the poor is a borrower, and works in the opposite direction if otherwise is the case.

3 Data and estimation methodology

3.1 Data

3.1.1 Family Income and Expenditures Survey

Following Lise et al. (2014), we construct inequality measures based on the Japanese household survey called *Family Income and Expenditures Survey* (hereafter FIES), which is compiled by the Statistics Bureau of the Ministry of Internal Affairs and Communications. The FIES is a monthly diary survey that collects data on the earnings, income and consumption expen-

[4] See, for example, Auclert (2019), Korinek and Simsek (2016), and Oda (2016).

diture of Japanese households.[5] The survey was first conducted in 1953 and has continued up to the present. However, we have access only to data for the period from January 1981 to December 2008 for research purposes. (See Appendix A for details.)

There are two similarities and one difference between the FIES and the Consumer Expenditure Survey used in Coibion et al. (2017). The similarities are that both sets of data are available on a higher frequency, and that both sets do not include households at the very top of income distribution. Consequently, analysis using the top 1% of income and consumption, such as that conducted in Piketty (2014), is not feasible in the current analysis. The difference is that each household is surveyed for no longer than six months in the FIES. As a result, data are not available for annual growth rates of earnings and consumption expenditures, often used in existing studies to estimate income dynamics and the size of idiosyncratic risks (e.g., Blundell et al. (2008)).

3.1.2 Scope of households in our baseline analysis

In order to obtain the longest and most consistent time series of inequality measures, we construct inequality measures from the subset of households surveyed in the FIES that meet the following conditions; (i) households are multiple-person,[6] (ii) the household head is employed during the survey period, and (iii) the household head is aged from 25–59.[7] In addition, as our procedure of sample selection, we drop those households that do not report figures and those that report non-positive values in disposable income, and we trim the top and bottom 0.25% of observations for earnings distributions in each year.

We drop households with a non-working head from our sample for the purpose of maintaining characteristics of sampled households consistent throughout the sample period. In the FIES, these households are often underrepresented, and the degree by which they are underrepresented varies over time. For example, in 2010, the proportion of households with a non-working head among households whose head is aged from 25–59 is 2.5% in the FIES, while the number is 5.2% in the Japan Census.

Due to this sample selection, our inequality measures do not fully capture the *job creation*

[5] The data on households' asset holdings and liabilities are available only after 2002 in the FIES. We therefore do not use these data for our analysis of wealth inequality.

[6] The FIES collects the data for single-person households, but only after 2002. As households' characteristics are often different between multiple-person households and single-person households, we choose to use only data on multiple-person households.

[7] We drop households whose head is aged above 60 because the mandatory retirement age is typically 60 in Japan.

channel of monetary policy shocks, i.e., changes in inequality arising from changes in relative number of households without a working head to those with a working head.[8] Because households with a working head have constituted the bulk of all households in Japan, we justifiably use inequality measures constructed from data on these households as our benchmark. We, however, gauge the quantitative impact of the *job creation channel* through the extensive margin of households' heads on inequality measures, in Section 4.3 below, by constructing a proxy measure of earnings inequality and studying how this series reacts to monetary policy shocks.

3.1.3 Time path of inequality measures

Figure 1 shows the quarterly series of inequality of earnings, pre-tax income, disposable income, expenditure, and consumption, respectively, in the three inequality measures, the variance of log, the Gini coefficient, and the P9010 ratios, which is the ratio of the upper bound value of the ninth decile to that of the first decile.

Developments of our inequality measures are similar to those of the annual series reported in Lise et al. (2014), in particular, in the following three points. First, the inequality measures grew at a positive rate over the sample period. Second, most of the measures, in particular, income inequality measures, grew at a quicker pace during the bubble boom period from the mid-1980 to the early 1990s, compared with the rest of the sample period. Third, as indicated by the observation that the discrepancy between earnings and pre-tax income inequality or that between pre-tax income and disposable income inequality is minimal, earnings inequality stands out as the dominant driver of income inequality measures over the sample period.

3.2 Estimation methodology

3.2.1 Local linear projection

We estimate the impulse responses of inequality measures to a shock to a monetary policy rule using the local linear projection (LLP) proposed by Jordà (2005), augmented with the use of factors à la Bernanke et al. (2005) and Boivin et al. (2009). Our methodology is essentially the same as a Factor-Augmented Local Projection (FALP) proposed by Aikman et al. (2016). Similar to discussions made in Aikman et al. (2016), we choose the LLP approach because this methodology is known as being robust to model mis-specifications such as a choice of

[8] It is important to stress that because we do not drop the data on households whose head has a job but non-head member does not have a job, our inequality measures based on the FIES do capture *job creation channel* through extensive margin of labor adjustments among non-head members of households.

explanatory variables and the number of lags. We use factors so as to extract a shock to a monetary policy rule in the data-rich environment.

We denote an inequality measure of interest, such as the variance of log of earnings, at period $t+h$ by Y_{t+h}, and a shock to the short-term nominal interest rate at period t by u_t^R. Following Jordà (2005), the impulse response to be estimated, which we denote as $\partial Y_{t+h}/\partial u_t^R$, is defined as follows.

$$\frac{\partial Y_{t+h}}{\partial u_t^R} \equiv \mathrm{E}\left(Y_{t+h}|u_t^R = 1; M_t\right) - \mathrm{E}\left(Y_{t+h}|u_t^R = 0; M_t\right), \text{ for } h = 0, ..., H. \tag{1}$$

Here, M_t is macroeconomic factors at period t and E is the expectation operator.

Following closely the procedure used in the example in Jordà (2005), we estimate the impulse response functions (1) by estimating the two equations. This first equation provides the relationship between the inequality measure at period $t+h$ and macroeconomic factors M_t, including the short-term nominal interest rate, at t that is described as follows.

$$\begin{aligned} Y_{t+h} - Y_t &= \alpha_h + \Pi_h(L)M_t + \epsilon_{t+h}, \text{ for } h = 0, ..., H, \qquad (2) \\ \text{where } \Pi_h(L)X_t &= \Pi_{h,0}X_t + \Pi_{h,1}X_{t-1} + ... + \Pi_{h,d_1}X_{t-d_1}, \\ \text{and } M_t &= \begin{bmatrix} \Delta TFP_t \\ F_t \\ \Delta R_t \end{bmatrix}. \end{aligned}$$

α_h is a parameter of the constant term and $\Pi_h(L)$ are coefficients of a lag polynomial of order d_1, and ϵ_{t+h} is an innovation to the equation. $\Pi_{h,s}$ for $s = 0, ..., d_1$ is a $1 \times (K+2)$ vector of parameters. M_t includes macroeconomic factors that drive inequality measures. We incorporate in M_t a quarterly growth rate of the measured TFP, denoted as ΔTFP_t and a $K \times 1$ vector of unobservable factors, denoted as F_t, and R_t, which is a level of the short-term interest rate. We include the measured TFP series, since existing studies that explore causes of the lost decades in Japan, including Hayashi and Prescott (2002), stress the importance of the TFP in accounting for dynamics of macroeconomic variables during the lost decades and beyond.[9] For the short-term interest rate R_t, we discuss our choice in Section 3.2.3.

The second equation is the law of motion of macroeconomic factors M_t that is described

[9]See Appendix A for the construction methodology of the measured TFP and unobservable factors.

as follows.

$$\begin{aligned} B_0 M_t &= \alpha + B_1 M_{t-1} + B_2 M_{t-2} + ... + B_{d_2} M_{t-d_2} + u_t, \\ \text{where } u_t &\equiv \begin{bmatrix} u_t^{TFP} \\ u_t^F \\ u_t^R \end{bmatrix}. \end{aligned} \tag{3}$$

Here, α is a $(K+2) \times 1$ vector of a constant term, and B_s for $s = 0, ..., d_2$ are $(K+2) \times (K+2)$ vector of parameters that govern the dynamics of macroeconomic factors, and u_t is a $(K+2) \times 1$ vector of structural shocks that are normally distributed with a diagonal variance-covariance matrix D. Using the parameters that appear in the equations (2) and (3), the impulse response function defined in the equation (1) is computed using the following relationship.

$$\frac{\partial Y_{t+h}}{\partial u_t^R} = \Pi_{h,0} (B_0)^{-1} \nu u_t^R \text{ for } h = 1, ..., H, \tag{4}$$

where ν is a $(K+2) \times 1$ vector whose elements are all zero except for a 1 for the $K+2$th element. Note that when identifying shocks to macroeconomic factors u_t, in the baseline setting, we impose the recursive structure of shocks with the ordering of variables that appear in the equation (3) so that a monetary policy shock is the least exogenous to the system (3). In other words, monetary policy shocks do not affect other factors ΔTFP_t and F_t contemporaneously. In Appendix C, as a sensitivity analysis, we report estimation results based on the setting where monetary policy shocks affect all of the other factors contemporaneously, or equivalently where u_t^R comes first in the ordering of shocks listed in u_t.

3.2.2 Number of factors and lags

In estimating the impulse response function of a variable, we set the number of lags for the equations (2) d_1 for each of $h = 0, ..., H$, by the AIC. That is, the number of lags differs across variables and projection horizons h. For the lag in the equation (3), we set $d_2 = 2$. In computing the confidence interval of the impulse response functions, we compute standard errors of the impulse responses as in Newey and West (1987) and report 95% confidence interval, unless otherwise noted.

3.2.3 Sample period and the monetary policy instrument

In our baseline setting, the sample period runs from 1981Q1 to 1998Q4, and the monetary policy instrument R_t is the prevailing short-tem nominal interest rate, which was the main policy instrument of the Bank of Japan.[10] We choose this starting point because the micro-level data of the FIES is only available to us from 1981Q1. We choose this end point, taking into consideration the regime shifts in the monetary policy implementation in 1999Q1 and beyond.[11] For instance, the Bank of Japan switched to pursuing a zero lower interest rate policy in 1999Q1. Within a few years, it introduced Quantitative Easing and started to target the monetary base as well.

However, we are also interested in the distributional effects of monetary policy over the entire sample period, including the period when the unconventional monetary policy was undertaken. To this end, we employ the shadow rate of the short-term nominal interest rate in Japan estimated by Ueno (2017). The shadow rate is essentially equivalent to the prevailing short-term interest rate when it is positive, and is equivalent to what the short-term interest rate would be without the zero lower bound when it is negative. Shadow rates are increasingly used in studies of monetary policy implementation under the zero lower bound. For instance, Wu and Xia (2016) construct the shadow federal funds rate and estimate the impulse response of macroeconomic variables to a shock to the shadow rate. Similarly to a negative shock to the federal funds rate, they find that a negative shock to the shadow federal funds rate leads to an increase in production activity and a fall in the unemployment rate. Following existing studies, including Wu and Xia (2016), we study the effects of unconventional monetary policy by treating the shadow rate of the short-term interest rate as the policy rate from 1999Q1 and beyond.

Admittedly, one caveat regarding the use of the shadow rate is that the rates are not directly observable. They have to be constructed from information contained in the entire yield curve by imposing theoretical assumptions that are often differ across studies, and the rates documented in existing studies, including Ueno (2017) and Krippner (2015), do not coincide with each other. Our strategy is therefore to formulate an analysis using the series constructed by Ueno (2017) as the baseline analysis, and then conduct sensitivity analyses using two alternative measures of the monetary policy instrument, the shadow rate constructed by Krippner

[10] We use uncollateralized overnight call rate as the policy rate R_t. Because this series is available only from 1985Q3 and beyond, it is extended backward before 1985Q3 using the collateralized overnight call rate.

[11] Note that until 1998Q4, the Bank of Japan had continuously utilized the short-term interest rate in implementing monetary policy.

(2015), and the prevailing two-year government bond yield. Figure 2 shows the time path of these rates, and the estimation results of the sensitivity analysis are documented in Appendix C.

3.2.4 Effects of a monetary policy shock on macroeconomic variables

We begin by analyzing the effects of a monetary policy shock on the main macroeconomic variables estimated by the framework explained in the above section. Figure 3 shows the impulse response function of macroeconomic variables to a negative shock, which means an expansionary shock, to the short-term nominal interest rate, using the equation (2). For all of the panels, the point estimates of the impulse response functions based on the baseline sample period, which runs from 1981Q1 to 1998Q4, are shown by the black line with black circles together with dark areas that account for the 90% confidence interval. For the estimation results based on the sample period from 1981Q1 to 2008Q4, both the point estimates and confidence interval are depicted in dotted line.

The estimated response of macroeconomic variables to monetary policy shocks are in line with existing studies such as Bernanke et al. (2005). Namely, in response to a negative shock to the short-term interest rate, quantity variables, such as GDP, investment, and consumption, and price variables, such as inflation and stock, all increase, and aggregate labor income and capital income both go up as well. Estimation results are qualitatively unaffected by the choice of the sample period, though expansionary effects on macroeconomic variables are less pronounced when the sample period runs up to 2008Q4.

4 Effects of a monetary policy shock on inequality

This section documents estimation results based on four different settings regarding the estimation procedure: (i) The baseline estimation. This estimation uses inequality measures constructed from the micro-level data set of the FIES and the sample period covers from 1981Q1 to 1998Q4. In other words, the estimated responses are those of inequality measures across households whose head is employed, to shocks to the actual short-term nominal interest rate. (ii) Estimation based on the sample period that runs from 1981Q1 to 2008Q4. Inequality measures are the same as the baseline estimation, but monetary policy shocks are identified as shocks to the shadow rate. (iii) Estimation that uses what we call the adjusted Gini coefficient as the earnings inequality measure. This adjusted Gini coefficient captures earnings inequality across all households, including those without a working head. We do this to assess the entire impact of the *job creation channel* of expansionary monetary policy shocks. (iv) Estimation that uses inequality measures constructed from semi-aggregate data that runs from 2008Q4 to 2016Q2. To do this, we use the published time series of the mean of pre-tax income of households that belong to five different groups with different income levels. We first construct the income inequality measure from this semi-aggregate data following Saiki and Frost (2014), and estimate its response to a shock to the shadow rate as well as the central bank's balance sheet which is used as the policy instrument in Saiki and Frost (2014). Because our micro-level data set covers only until 2008Q4, this analysis supplements the first two exercises, using the most current data.

4.1 Estimation results: baseline

Figure 4 shows the impulse response function of inequality measures of earnings y_L, pre-tax income y, disposable income y_D, expenditure (total consumption expenditure) c_T, and consumption (non-durable consumption expenditure) c_{ND}, to a negative shock, which is an expansionary shock, to the short-term interest rate. Inequality measures include variance of log, Gini coefficient, and P9010. For the purpose of comparison, for each of the inequality measures, we plot point estimate of the impulse response function of earnings inequality (the line with circles) in all of the panels in the same row.

Three observations are noteworthy. First, the impact of an expansionary monetary policy shock on income inequalities is procyclical. For instance, the variance of log of disposable income y_D increases at the statistically significant level of 5% for more than three years out of five after the shock. The same observations hold for other two income variables y, and y_L, and other two inequality measures. Second, such a procyclical response arises mainly from the procyclical response of earnings y_L, suggesting the importance of the *heterogenous earnings channel*. This is seen from the fact that the gap of the impulse response function between earnings y_L and other income variables, y and y_D, is minimal, implying that the capital income and the government distributional policy play a minor role in terms of the distributional consequences of monetary policy shocks. Third, the transmission of income inequality to consumption and expenditure inequality is less than one-to-one. Moreover, the responses of these inequality to shocks are often mixed in terms of the sign across time horizons following the impact period. For instance, the expenditure inequality of the variance of log reacts positively at the impact period, but negatively at the 10-12th quarters after the impact period.

4.2 Estimation results: from 1981 to 2008

Figure 5 shows the impulse response function of the same set of inequality measures to a negative shock to the short-term interest rate extended by the shadow rate for the sample beyond 1999Q1, based on the sample period up to 2008Q4. For the purpose of comparison, in each panel, we depict by dotted lines the impulse response of the inequality measure of the same variable estimated under the baseline setting. The results differ from those shown in Figure 4, in particular for income inequality. For almost all of the income inequality measures, the estimated impact of a monetary policy shock becomes less pronounced.

To see those changes in more detail, we study how the estimated impulse response functions of earnings inequality vary with the sample period, by conducting rolling estimates of the equation (2). Figure 6 shows the results. The y-axis denotes the estimated size of the response to an expansionary monetary policy shock of the three inequality measures that is estimated using different sample periods from 1981Q1 to an end point that is specified on the x-axis. The size of the response is measured by the average of the impulse response functions over 20 quarters after a shock's impact period. Procyclical responses of inequality measures of earnings y_L to a monetary policy shock are obtained throughout the 1990s. The responses, however, gradually diminish after the mid-2000s and beyond, several years after the shift of the monetary policy regime. Although not conclusive, this result suggests that a change in the response of earnings inequality to a monetary policy shock is associated with a change in economic surroundings rather than that in the monetary policy implementation.

4.3 Estimation results when changes in extensive margin of household head are counted

Inequality measures used in the analysis above are those of households whose head is employed. The time paths of these measures therefore do not reflect changes of inequality across all households including households with a non-working head. By contrast, expansionary monetary policy shocks are expected to reduce the number of households whose head does not have a job and to mitigate an increase in earnings inequality arising from the *heterogenous earnings channel*through the *job creation channel*. The upper panel of Figure 7 shows the impulse response function, estimated using the equation (2), of the number of unemployed workers who are household heads, to an expansionary monetary policy shock.[12] This estimation sug-

[12] In estimating responses in Figure 7, we use the number of unemployed household heads, including those aged 60 and higher and 24 and younger, in the Labour Force Survey published by the Ministry of Internal Affairs and

gests the *job creation channel* is at work in Japan. The number of household heads without a job, and therefore with zero earnings, declines following an accommodative monetary policy shock, possibly reducing earnings inequality across all households.

In order to quantitatively assess the effect arising from changes in the extensive margin of household heads, we construct an alternative Gini coefficient of earnings, which we denote as G^*, that is defined as follows.

$$G^* \equiv \frac{\sum_{i=1}^{\tilde{N}} \sum_{j=1}^{\tilde{N}} |x_i - x_j|}{2\tilde{N} \sum_{i=1}^{\tilde{N}} x_i} = G \frac{N}{\tilde{N}} + \frac{\tilde{N} - N}{\tilde{N}}, \tag{5}$$

where

$$G \equiv \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} |x_i - x_j|}{2N \sum_{i=1}^{N} x_i}. \tag{6}$$

Here, the equation (6) is the standard formula of the Gini coefficient. In this specific case, x_i is earnings of the household i for $i = 1, ..., N$, whose head is employed. $\tilde{N}$ is the number of total households including those whose head does not have a job. We assume that earnings for those households is zero. Using the number of household heads who are employed and the number of those who do not have a job from the aggregate statistics named Labour Force Survey, for N and $\tilde{N} - N$, respectively, we compute an inequality measure of earnings across all of the households. For G, we use the Gini coefficient of equivalized earnings.

The lower panel of Figure 7 shows two impulse response functions of the adjusted Gini coefficient of earnings G^* to an expansionary shock to a monetary policy, based on sample periods that run up to 1998Q4 and up to 2008Q4, respectively. The distributional effects of a monetary policy shock are insignificant even in the former sample period.

Admittedly, some caveats apply to our adjusted Gini coefficient G^*, as a measure of income inequality. This measure, for instance, does not capture changes in income distribution arising from capital income and the government transfer.[13] However, the result of this exercise, combined with the estimated response functions of unemployed household heads, suggests the possibility that a decline in earnings inequality due to the *job creation channel* counters a rise in earnings inequality stemming from the *heterogenous earnings channel* after an expansionary

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Communications. Ideally, we should use the subset of those households aged 25-59 so as to maintain consistency of population of households based on which the inequality measures studied in the rest of the paper are constructed. Such a series is, however, not available in the survey. Similarly, the number of employed household heads is also not available.

[13] In addition, because the relevant data are not available, we use the number of household heads of all ages instead of those aged from 25–59.

monetary policy shock.

4.4 Estimation results: from 2008 to 2016

The limitation of the estimation exercises above is that these are based on the sample period before 2009, due to the unavailability of the micro-level data of the FIES. In order to study whether the distributional effects of a monetary policy shock have recently changed, we follow Saiki and Frost (2014) and construct an alternative inequality measure of pre-tax income y from the semi-aggregate income series of households included in the FIES. The FIES publishes time series of pre-tax income y of households, including those whose head is not employed, by five different income quantiles from January 2002 to the present. We use as our pre-tax income inequality measure the difference of averaged income y of households of the highest income quantile, the 80–100th, and that of the lowest income quantile, the 0–20th, and estimate the response of the measure to a monetary policy shock. It is notable, however, that, although this analysis delivers useful information regarding the most recent relationship between monetary policy shocks and inequality measures, there are some limitations as well. First, we are only able to study pre-tax income y, since the FIES does not publish other income and consumption series by households' income levels. Second, this pre-tax income inequality measure does not capture changes in inequality within each of the two different income groups. Lastly, the population of sampled households in this measure does not accord precisely with the scope of households specified in Section 3.1.2.

To check robustness, in estimating the impulse response functions of the pre-tax income inequality measures to a monetary policy shock, we formulate two separate exercises using different estimation procedures; the VAR used in Saiki and Frost (2014), and the LLP based on the equation (2). The VAR in Saiki and Frost (2014) consists of five variables, including real GDP, inflation, assets held by the Bank of Japan, stock prices, and the pre-tax income inequality measure. A monetary policy shock is identified as a shock to the assets held by the Bank of Japan by the Cholesky decomposition with this ordering of the variables.[14] In both estimations, the sample period runs from 2008Q4 to 2016Q2.

Figure 8 shows the impulse response function of pre-tax income inequality to a shock to the measure of the monetary policy adopted in Saiki and Frost (2014) in the upper panel, and that

[14] To consider the effects of the Great East Japan earthquake of March 11th, 2011 in Japan, following Saiki and Frost (2014), we introduce two exogenous dummy variables, which they call "earthquake" and "earthquake response" in their paper. Each of the two dummy variables takes unity for the period from 2011Q2 to 2011Q3, and from 2011Q4 to 2012Q1, and takes zero if otherwise, respectively.

to a shock to the shadow rate of Ueno (2017) in the lower panel. Though point estimates are positive and in line with what Saiki and Frost (2014) document, both estimation results agree that responses of pre-tax income inequality to a monetary policy shock are not statistically significant. This result therefore confirms that estimation results obtained in Figure 5 are robust to the extension of the data sample.[15]

5 Accounting for estimation results

Why did the once-prevailing distributional effects of monetary policy diminish during the 2000s? And why didn't consumption inequality increase as much as income inequality in the period before the 2000s? What role did financial assets and liabilities play in the distributional effects of monetary transmission?

To address to these questions, we conduct three analyses. The first one is a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model that consists of two production sectors and two types of households. The DSGE model is used to illustrate how the distributional effects of a monetary policy shock change with the structure of the economy in a way we observed in the empirical exercises above, rather than providing a quantitative model that closely matches with all of our empirical observations. From this view point, our model is absent from some of the channels, such as the *job creation channel* and the *income composition channel*, since, as indicated by Figure 4 and 5, the *heterogenous earnings channel* appears as the central to the distributional effects of monetary policy in Japan. We discuss, based on the model, that two elements, the labor market flexibility and the distribution of households' financial assets and liabilities, have potential to shape responses of income and consumption inequality to monetary policy shocks in an important manner. The other two analyses include two types of alternative data set, industry-level aggregate data sets that contain time series of labor market variables and goods production, and the micro-level data on a household's financial assets and liabilities. These data sets complement the data collected in the FIES. We use those data sets as well as inequality measures constructed from the FIES to check whether the model's predictions accord with the data.

[15]Note that Saiki and Frost (2014) show that an expansionary shock to their monetary policy measure leads to an increase in the pre-tax income inequality measure in a statistically significant manner when the sample period runs from 2008Q4 to 2014Q1.

5.1 A model with two types of households

5.1.1 Setting

Two households There are two types of an infinitely-lived household, X and Z, each of which has two types of members; one member that supplies its labor inputs to one of the two sectors exclusively, and another member that can split its labor inputs, supplying its labor inputs to both sectors. We refer to these as attached and mobile labor inputs, respectively. Households receive utility from consumption C_t, and disutility from working hours of the first type of member denoted as N_t, and those of the second type of member denoted as H_t. The expected utility function (7) is described in the following manner.

$$U_{s,t} \equiv \mathrm{E}_t \left[\sum_{q=0}^{\infty} \beta^q \left(\log \left(C_{s,t+q} - bC_{s,t+q-1} \right) - \theta \frac{N_{s,t+q}^{1+\eta}}{1+\eta} - \phi \frac{H_{s,t+q}^{1+\delta}}{1+\delta} \right) \right], \tag{7}$$

for $s = X$ and Z. Here, $\beta \in (0, 1)$ is the discount factor, $b > 0$ captures the degree of habit formation, η, $\delta > 0$ are the inverse of the Frisch labor-supply elasticity, and θ and $\phi > 0$ are the weighting assigned to attached and mobile labor inputs, respectively.

The budget constraint for each of the households is given by

$$C_{s,t} + \frac{B_{s,t}}{P_t} \leq \left[\begin{array}{l} \frac{W_{s,t}}{P_t} N_{s,t} + \frac{W_t}{P_t} H_{s,t} \\ + \left(\frac{\Pi_{X,t} + \Pi_{Z,t}}{P_t} \right) \gamma_{\Pi,s} \\ + \left(\frac{R_{X,t} K_X + R_{Z,t} K_Z}{P_t} \right) \gamma_{K,s} \\ + R_{t-1} \frac{B_{s,t-1}}{P_t} + \kappa_B \left(\frac{B_{s,t}}{P_t} \right)^2 \end{array} \right], \text{ for } s = X \text{ and } Z, \tag{8}$$

where P_t is the aggregate price index that corresponds to the consumption composite, $B_{s,t}$ is the nominal bond holding, and $W_{s,t}$ and W_t are the nominal wages paid to the attached labor inputs of the household s, for $s = X$ and Z, and the mobile labor inputs, respectively. Notice that the nominal wage for attached labor inputs $W_{s,t}$ differs across household types, and that of mobile labor inputs W_t is common across household types. $\Pi_{X,t} + \Pi_{Z,t}$ is the nominal dividend from the two sectors; $\gamma_{\Pi,s} \in [0, 1]$ is the share of dividends held by the household s; $R_{X,t}$ and $R_{Z,t}$ are the nominal rental costs of the capital stock used in the two sectors, K_X and K_Z; $\gamma_{K,s} \in [0, 1]$ is the share of capital stock held by the household s; R_{t-1} is the nominal return to bonds holding; and $\kappa_B > 0$ is the parameter that governs the adjustment costs of bond holding. For simplicity, we assume that the shares of dividend and capital income are not tradable and constant over time.

Firms' goods production The economy consists of two sectors, X and Z and each sector has final goods firms and a continuum of intermediate goods firms. Perfectly competitive final goods firms use a continuum of intermediate goods $i \in (0,1)$ for the sector X and $j \in (0,1)$ for the sector Z, and produce the gross output $\tilde{X}_t$ and $\tilde{Z}_t$ that are used for constructing the consumption basket C_t. The gross output are produced using the following production technology;

$$\tilde{X}_t = \left[\int_0^1 x_t (i)^{1-\varepsilon^{-1}} di \right]^{\frac{\varepsilon}{\varepsilon-1}} \text{ and } \tilde{Z}_t = \left[\int_0^1 z_t (j)^{1-\varepsilon^{-1}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $\varepsilon \in (1, \infty)$ denotes the elasticity of substitution between differentiated products and $x_t (i)$ and $z_t (j)$ are products of intermediate goods firms in the two sectors.

The demand functions for the differentiated products produced by firm i and j are derived from the optimization behavior of the final goods firms, and they are represented by

$$x_t (i) = \left[\frac{P_{X,t} (i)}{P_{X,t}} \right]^{-\varepsilon} \tilde{X}_t \text{ and } z_t (j) = \left[\frac{P_{Z,t} (j)}{P_{Z,t}} \right]^{-\varepsilon} \tilde{Z}_t, \tag{9}$$

where $\{P_{X,t} (i)\}$ and $\{P_{Z,t} (j)\}$ for i, $j \in [0,1]$ are the nominal price of the differentiated products, and $P_{X,t}$ and $P_{Z,t}$ are the price indices of the two final goods that are expressed as

$$P_{X,t} = \left[\int_0^1 P_{X,t} (i)^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}} \text{ and } P_{Z,t} = \left[\int_0^1 P_{Z,t} (j)^{1-\varepsilon} dj \right]^{\frac{1}{1-\varepsilon}}.$$

Each intermediate goods firm produces goods from two types of labor inputs and the sector-specific capital stock, with the Cobb-Douglas production technology described below.

$$x_t (i) = A N_{X,t} (i)^{\alpha\mu} U_{X,t} (i)^{\alpha(1-\mu)} K_{X,t} (i)^{1-\alpha}, \tag{10}$$

$$z_t (j) = A N_{Z,t} (j)^{\alpha\mu} U_{Z,t} (j)^{\alpha(1-\mu)} K_{Z,t} (j)^{1-\alpha}. \tag{11}$$

Here, A is the technology level that is common to the two sectors; $N_{X,t} (i)$ and $N_{Z,t} (j)$, $U_{X,t} (i)$ and $U_{Z,t} (j)$, and $K_{X,t} (i)$ and $K_{Z,t} (j)$, are the attached labor inputs, mobile labor inputs, and sector specific capital inputs used by the firm i and j; and α and $\mu \in [0,1]$ are the parameters that govern the production technology.

Firms' price setting Differentiated firms i and j are monopolistic competitors in the products market. A firm i in the sector X sets the price for its products $P_{X,t}(i)$ in reference to the demand given by the equation (9). It can reset the prices solving the following problem:

$$\max_{P_{X,t}(i)} \mathrm{E}_t \left[\sum_{q=0}^{\infty} \beta^{t+q} \frac{\Lambda_{t+q}}{\Lambda_t} \frac{\Pi_{t+q,X}(i)}{P_{t+q}} \right] \tag{12}$$

$$\text{s.t. } \Pi_{t+q,X}(i) = P_{X,t+q}(i)\, x_{t+q}(i) - MC_{X,t+q}(i)\, x_{t+q}(i) - \frac{\kappa_X}{2} \left(\frac{P_{X,t+q}(i)}{P_{X,t+q-1}(i)} - 1 \right)^2 P_{X,t+q} X_{t+q}, \tag{13}$$

where Λ_{t+q} is the Lagrange multiplier associated with budget constraint (8) of the household in the period $t+q$, $MC_{X,t+q}(i)$ is the nominal marginal cost derived from the production function (10), that is given as follows.

$$MC_{X,t} = \frac{\bar{\phi}_{MC} W_{X,t}^{\alpha\mu} W_t^{\alpha(1-\mu)} R_{X,t}^{1-\alpha}}{A}, \text{where } \bar{\phi}_{MC} \equiv (\alpha\mu)^{-\alpha\mu} (\alpha(1-\mu))^{-\alpha(1-\mu)} (1-\alpha)^{\alpha-1}. \tag{14}$$

$\kappa_X > 0$ is the parameter associated with price adjustment. A firm j faces a similar problem with the parameter $\kappa_Z > 0$. Note that we assume the symmetric equilibrium where all of the differentiated goods prices $P_{X,t+q}(i)$ and $P_{Z,t+q}(j)$ set by intermediate goods firms are identical, so that $P_{X,t+q}(i) = P_{X,t+q}$ and $P_{Z,t+q}(j) = P_{Z,t+q}$.

Aggregation There are agents named aggregators that purchase each of the value-added of two goods, which we denote as X_t and Z_t and defined below, and construct the composite of consumption goods from the two goods, using the following technology, and sell the goods to households in a competitive manner.

$$C_t = X_t^{\rho} Z_t^{1-\rho}, \tag{15}$$

where $\rho \in [0,1]$is the technology parameter associated with the aggregation. Note that the cost minimization problem of aggregators given the aggregation technology (15) implies that the aggregate price index is expressed as

$$P_t = \rho^{-\rho} (1-\rho)^{\rho-1} P_{X,t}^{\rho} P_{Z,t}^{1-\rho}. \tag{16}$$

Note also that using this price index, the demand for each of the two goods can be shown as follows.

$$X_t = \rho \left(\frac{P_t}{P_{X,t}} \right) C_t \text{ and } Z_t = (1-\rho) \left(\frac{P_t}{P_{Z,t}} \right) C_t. \tag{17}$$

The government The central bank adjusts the nominal interest rate so as to stabilize the growth rates of the price index P_t.

$$\log R_t = \rho_n \log R_{t-1} + (1-\rho_n) \varphi \log \pi_t + \epsilon_{R,t}, \tag{18}$$

where π_t is P_t / P_{t-1}, and $\rho_n \in [0, 1)$ and $\varphi > 0$ are the parameters and $\epsilon_{R,t}$ is an innovation to the monetary policy rule.

Resource constraint The resource constraints for three production inputs are given as follows.

$$\int_0^1 N_{X,t}(i)\, di = N_{X,t} \text{ and } \int_0^1 N_{Z,t}(j)\, dj = N_{Z,t}, \tag{19}$$

$$\int_0^1 U_{X,t}(i)\, di + \int_0^1 U_{Z,t}(j)\, dj = H_{X,t} + H_{Z,t}, \tag{20}$$

$$\int_0^1 K_{X,t}(i)\, di = K_X \text{ and } \int_0^1 K_{Z,t}(j)\, dj = K_Z. \tag{21}$$

Note that two terms in the left hand side of the equation (20) stands for the amount of labor inputs by mobile workers to sector X and Z, while those in the right hand side of the equation stands for the amount of labor input supplied by mobile workers in household X and Z. We hereafter denote the total labor inputs of mobile workers in the two sectors by $U_{X,t}$ and $U_{Z,t}$.

The resource constraints for the gross output produced by final goods producers $\tilde{X}_t$ and $\tilde{Z}_t$ are given as follows.

$$\begin{aligned} \tilde{X}_t &= X_t + \frac{\kappa_X}{2} \left(\frac{P_{X,t}}{P_{X,t-1}} - 1 \right)^2 X_t \text{ and} \\ \tilde{Z}_t &= Z_t + \frac{\kappa_Z}{2} \left(\frac{P_{Z,t}}{P_{Z,t-1}} - 1 \right)^2 Z_t. \end{aligned}$$

For the consumption composite, the sum of consumption of the two types of households equals the total amount of consumption composite produced by the aggregators, less costs associated with nominal bond holding paid by the two households.

$$C_{X,t} + C_{Z,t} = C_t - \kappa_B \left(\frac{B_{X,t}}{P_t} \right)^2 - \kappa_B \left(\frac{B_{Z,t}}{P_t} \right)^2.$$

Finally, the total supply of the nominal bond in the aggregate is assumed to be zero.

$$B_{X,t} + B_{Z,t} = 0.$$

5.1.2 Response of income and consumption inequality to an expansionary monetary policy shock

In this section, we derive theoretical predictions from the model about the distributional effects of monetary policy, focusing on the role of labor market flexibility and the distribution of financial assets and liabilities. To this end, we log-linearize the model around the non-stochastic steady state, and compute the model's equilibrium time path after a negative shock to $\epsilon_{R,t}$ in the equation (18) around the steady state. Table 1 shows the values of our model parameters which we use in our baseline simulation. Most of the parameter values are standard and taken from existing studies.

Baseline simulation Throughout the simulation, we assume that $\rho > 1 - \rho$ and $\kappa_X > \kappa_Z$. Because model parameters associated with two households and two sectors are symmetric in other aspects, the first assumption implies that household X receives higher earnings than does household Z at the steady state, and therefore enjoys a higher level of consumption than does household Z.[16] In other words, both earnings and consumption inequality across households are present at the steady state. In addition, this assumption implies that the value-added of sector X is larger than that of Z at the steady state. The second assumption implies that a monetary policy affects the two goods sectors differently around the steady state. This is because the price of goods X, $P_{X,t}$ is adjusted at a slower pace than that of goods Z, $P_{Z,t}$, in the wake of a monetary policy shock. When an expansionary monetary policy shock is considered, this assumption further implies that goods X attract a larger demand than goods Z, because goods X becomes cheaper than goods Z. This substitution effect across goods stemming from the difference in the degree of price stickiness is studied by earlier works such

[16]Suppose $\rho = 0.5$, on the contrary, then monetary policy shocks *increase* inequality across sectors and households regardless of the sign of the shock $\epsilon_{R,t}$. This prediction is at odds with the data. Our empirical exercises, for instance those shown in Figure 4, indicate that earnings inequality increases in response to an expansionary monetary policy shock and *decreases* in response to a contractionary monetary policy shock.

as Ohanian et al. (1995) and Barsky et al. (2007).[17]

Figure 9 shows the impulse response function to an expansionary monetary policy shock of the aggregate variables, the GDP, which is the consumption composite C_t in our model, the inflation rate π_t, the value-added produced by the two sectors X_t and Z_t, the relative price of goods $P_{X,t}/P_{Z,t}$, earnings of the two households y_L, which is $W_{s,t}N_{s,t} + W_t H_{s,t}$ for $s = X$ and Z in the model, and the consumption of the two households $C_{s,t}$ for $s = X$ and Z, together with earnings and consumption inequality measures across the two households, which we define below.

$$\begin{aligned} \text{Earnings inequality:} \qquad & \left| \log \left[\left(W_{X,t}N_{X,t} + W_t H_{X,t} \right) / \left(W_{Z,t}N_{Z,t} + W_t H_{Z,t} \right) \right] \right|, \\ \text{Consumption inequality:} \qquad & \left| \log \left(C_{X,t}/C_{Z,t} \right) \right|. \end{aligned}$$

The aggregate economy expands as a consequence of an expansionary monetary policy shock, with heterogenous impacts on the value-added of the two sectors as well as those on earnings and consumption across households. The cross-sector heterogeneity arises from the difference in price stickiness between $P_{X,t}$ and $P_{Z,t}$.. Because the goods price of sector X becomes relatively cheaper in the short-run, the demand towards goods X_t becomes larger than the demand for goods Z_t, as suggested by the equation (17). The heterogeneity across sectors in terms of goods production and value-added is translated to the difference across the two households through the *heterogenous earnings channel*. As shown in the production functions (10) and (11), because intermediate goods firm i, facing a greater demand, employs a larger amount of attached labor inputs $N_{X,t}(i)$, the nominal wage for those labor inputs $W_{X,t}$ increases disproportionately compared to other wages $W_{Z,t}$ and W_t. This leads to higher earnings of household X than household Z. Earnings through mobile labor inputs $W_t H_{X,t}$ and $W_t H_{Z,t}$, to some degree, help equalize the difference in earnings across households, but this does not fully offset the transmission of cross-sector inequality of value-added to cross-household earnings inequality. Reflecting an increase in earnings inequality across households, consumption inequality also widens, though with a smaller magnitude.

[17] Notice that the two assumptions together imply that a sector that produces a larger value-added at the steady state faces a higher demand increase upon an expansionary monetary policy shock. As we show below, this implication is consistent with our empirical observation about the response of inequality of value-added across industries reported in Section 5.2.

Labor market flexibility We investigate what determine the dynamics of inequality measures following monetary policy shocks by conducting two sets of alternative model simulations. First, we study what role the degree of labor market flexibility plays. To do this, we compute the equilibrium responses of inequality measures using a model calibrated with three different values of the parameter μ. This parameter governs the share of attached labor inputs in the production function. If this parameter takes unity, then a household cannot supply its labor inputs to a sector to which the household is not attached, even when the sector offers a higher wage. If this parameter is zero, by contrast, wages are equalized across sectors, and households' earnings are equalized as well so far as working hours are the same.

Figure 10 shows the impulse response of earnings and consumption inequality, together with that of other variables, with different values of μ, 0.4, 0.6, and 0.8. With a higher value of μ, goods production is more dependent on attached labor inputs $N_{X,t}$ and $N_{Z,t}$ than mobile labor inputs $U_{X,t}$ and $U_{Z,t}$. Consequently, the heterogeneity of value-added, X_t and Z_t is easily translated into the heterogeneity of earnings per labor inputs, which we define as the difference between the two terms, $(W_{X,t}N_{X,t} + W_tU_{X,t})\,(N_{X,t} + U_{X,t})^{-1}$ and $(W_{Z,t}N_{Z,t} + W_tU_{Z,t})\,(N_{Z,t} + U_{Z,t})^{-1}$, since the production share of attached labor inputs is high. This also implies that the heterogeneity of households' earnings, which is the difference between earnings of the two households $W_{X,t}N_{X,t} + W_tH_{X,t}$ and $W_{Z,t}N_{Z,t} + W_tH_{Z,t}$, becomes more responsive to the heterogeneity of value-added, since the share of earnings arising from attached labor inputs is higher. With a lower value of μ, the same story holds in the opposite direction. The heterogeneity of value-added is hardly reflected in the heterogeneity of earnings per labor input or that of households' earnings.

This mechanism can be shown analytically. Suppose $\mu = 1$, and $\kappa_Z = 0$, for simplicity, then earnings inequality across households can be, using the equation the equations (14) and (17), expressed as

$$\log\left[\frac{(W_{X,t}N_{X,t})}{(W_{Z,t}N_{Z,t})}\right] = \log\left[\frac{MC_{X,t}\tilde{X}_t}{MC_{Z,t}\tilde{Z}_t}\right] \approx \log\left[\frac{MC_{X,t}}{P_{X,t}}\frac{\varepsilon}{\varepsilon-1}\right] + \log\left[\frac{\rho}{1-\rho}\right].$$

Note that in the second equality, the second term on the right hand side of the equation is unchanged after monetary policy shocks. The steady state value of the first term on the same side is zero, but it deviates from zero around the steady state, depending on the degree of price stickiness. When goods price of X $P_{X,t}$ is adjusted at a slower pace compared to its nominal marginal cost $MC_{X,t}$, the first term takes a positive value in response to an expansionary monetary policy shock, leading an earnings inequality across households to widen. By contrast, when $\mu = 0$, the first inequality does not hold. Provided that households are symmetric, the term on the left hand side of the equation always equals to zero.

The exercise above suggests that the degree of labor market flexibility is important to the distributional effects of monetary policy shocks. When labor inputs are mobile across firms, the heterogeneity across firms in terms of goods production and value-added, is straightforwardly translated into earnings inequality across households. This is because households supply labor inputs to a firm that offers a higher wage, which in turn reduces wage differentials across firms. By contrast, when labor inputs are attached to a specific firm, it is likely that the heterogeneity of demand size across firms is easily translated into that of earnings across households, because households cannot choose to work for a firm that offers a higher wage, leaving wage differential across firms unchanged.

Distribution of financial assets Second, we study how wealth and capital income affect the transmission from earnings to consumption inequality by analyzing the role of the parameter $\gamma_{K,X}$ or equivalently $1 - \gamma_{K,Z}$. This parameter specifies the share of household X's capital stock holding. Under the baseline parameterization, we set $\gamma_{K,Z} = \gamma_{K,X} = 0.5$ so that capital income arising from the two sectors, $R_{X,t}K_X + R_{Z,t}K_Z$, is equally distributed across the two households. If we set $\gamma_{K,Z} > (<)\ \gamma_{K,X}$, this implies that household X receives a smaller (larger) amount of capital income than household Z in the current period and beyond. Because a household determines its time path of consumption with reference to its total income stream, a change in the share of capital stock holding should lead to a change in the dynamics of consumption inequality following monetary policy shocks.

Figure 11 shows impulse response functions of earnings and consumption inequality, again together with other relevant variables, with different values for $\gamma_{K,X}$, 0.4, 0.5, and 0.6. The distribution of capital stock holding substantially affects the dynamics of both earnings and consumption inequality following monetary policy shocks. With a smaller share of capital stock holding $\gamma_{K,X}$, household X becomes less wealthy and therefore supplies more labor inputs to the goods producing sectors due to the negative wealth effect. By contrast, household Z, with a larger share of capital stock holding $\gamma_{K,Z}$, works less, further boosting earnings inequality across households. These changes in the response of labor inputs are, however, not sufficiently sizable to overturn the effects on consumption inequality arising from the difference in the present and future stream of capital income. Household Z consumes a greater amount of goods, as it now receives a larger share of capital income today and future, and household X consumes less. Consequently, the dispersion of consumption level across households is reduced.

The exercise suggests that the distribution of financial assets and liabilities has the potential to mitigate the translation of earnings inequality to consumption inequality. For instance, suppose a household that confronts a larger increase in earnings has a fewer amount of financial assets. A change in consumption inequality across households then should become minor compared with a change in earnings inequality. Using alternative data sources, we explore below whether the distributions of Japanese households' assets and liabilities are consistent with this prediction.

5.2 Monetary policy shocks and earnings inequality

Provided that the cross-firm or cross-industry heterogeneity of monetary policy effects are present, our theoretical model predicts that whether or not they result in earnings inequality across households depends on the degree of labor market flexibility. In this section, using the industry-level data sets of labor market and firm variables, we show that the data are in fact consistent with this prediction.

We start by briefly describing the nature of labor markets in Japan and their developments. Existing studies agree that a low flexibility of labor inputs adjustments through the extensive margins (adjustments with heads) has been a notable feature that characterizes Japanese labor markets. For instance, Braun et al. (2006) examine business cycle characteristics of labor market variables for the U.S. and Japan over the period from 1960 to 2002. They show that in Japan, variations in the extensive margin are about 60% of those of the intensive margin (hours of work per employee), whereas the number is 245% in the U.S. They then argue that in Japan labor inputs adjustments by a firm are made through working hours of existing workers, rather than through the hiring or firing of workers.

Since around the mid-1990s, however, labor markets in Japan has gone through important changes gradually. First, temporary workers have started to play a larger role in labor markets. Unlike regular workers, the period of employment for these workers is typically fixed, and limited to a short period of time, allowing firms to arrange more flexible labor inputs adjustments through the extensive margin. The upper panel of Figure 12 shows the time path of the proportion of employees who work as temporary workers over the total number of employees. The proportion exhibits a secular increase over the years, indicating that firms are becoming less dependent on adjustments through the intensive margin, and more dependent on adjustments through the extensive margin. In addition, partly due to an increase in temporary workers, there has been an enhancement in the degree of labor market mobility. The lower panel of Figure 12 shows the time path of labor turnover ratio, which indicates that workers tend recently to be more flexible in switching to jobs that offer a more favorable term, compared to the old days. These changes suggest that the degree of labor market flexibility, that was once low, has been changed such that the cross-firm or cross-industry heterogeneity of value-added is less likely to be translated into the heterogeneity of earnings per employee and earnings per labor input. This is because workers supply labor inputs to a firm that pays higher until earnings differential diminishes. Consequently, the cross-firm heterogeneity is no longer translated into earnings inequality across households. In the next subsection, we empirically show that this is indeed the case.

5.2.1 Responses of inequality measures across industries

Because the FIES does not collect detailed data on firms and workers in which we are interested, we conduct additional exercises using the industry-level data sets that contain such information, and study how the cross-industry heterogeneity of value-added is translated to that of earnings per employee and that of earnings per labor input. For this purpose, we construct an inequality measure across industries of the value-added and earnings per employee from the corresponding data on industry groups in the Financial Statements Statistics of Corporations (FSSC) published by the Ministry of Finance. The FSSC reports the data of 37 industries and each industry consists of four groups categorized by the size of capital. We therefore construct inequality measures across 37×4 industry groups of the FSSC.[18] We also construct inequality measures across industries of earnings per working hours from the corresponding data of 35 industries in the Monthly Labour Survey (MLS) by the Ministry of Health, Labour and Welfare.[19] We then estimate the response of these inequality measures to an expansionary shock to the short-term interest rate R_t, using the LLP specified in the equation (2).

The left panels of Figure 13 show the results of the estimation based on the sample period

[18]The FSSC reports the data series by size of capital: (1) less than 50 million yen, (2) 50 million yen to 100 million yen, (3) 100 million yen to 1 billion yen, (4) more than 1 billion yen.

[19]The earnings per employee is calculated by dividing "Salaries and wages" of an industry group by "Number of employees" of the same group reported in FSSC. The earnings per working hour is calculated by dividing "Total cash earnings" per employee by "Total hours worked" per employee reported in MLS.

running from 1981Q1 to 1998Q4. An expansionary monetary policy shock leads to a rise in inequality across industries in terms of value-added, earnings per employee, and earnings per working hours. Apparently, the cross-industry heterogeneity of value-added is translated into that of earnings per employee and per working hours. In order to see the effects of higher labor market flexibility, we estimate the response of these inequality measures to a monetary policy shock, now using the sample period from 1981Q1 to 2008Q4, which includes a period when labor market flexibility was already high. The right panels of Figure 13 show the estimation results. The procyclical responses of inequality in terms of value-added is still observed in this setting. In contrast to the results documented in the left panel of the figure, however, this response of inequality is not translated into inequality in terms of earnings per employee and of earnings per working hour. This weakening of translation of inequality from value-added to earnings accords well with the model's prediction shown in Figure 9 and 10, and supports the view that a change in labor market flexibility alters responses of earnings inequality to a monetary policy shock.[20]

5.3 Transmission of income inequality to consumption inequality and the role of financial assets

5.3.1 Responses of the MPC by household's income quantiles

As Figure 4 shows, we find that the transmission of monetary policy shocks to consumption inequality is slightly procyclical or insignificant, even when earnings inequality exhibits a significant procyclical response to these shocks. In this section, we explore the reasons for this. We first show that the response of consumption inequality is insignificant, not because the responses of "mean" of consumption of households are all weak, but because the response of "mean" of consumption of low-income households is substantially large compared with that of high-income households. We then ask if households' financial positions are responsible for these observations, using the micro-level data on financial positions.

To this end, we divide the households surveyed in the FIES into five subgroups depending on their income quantiles, and construct time series of the mean of disposable income y_D and consumption c_{ND} of households in each group. We then compute the response of the mean of the two series y_D and c_{ND} to an expansionary monetary policy shock, using the

[20]For the sensitivity analysis, we conduct the same estimation exercise using inequality measures across 37 industries using the data of the FSSC for the sample period from 1981Q1 to 1998Q4 and that from 1981Q1 to 2008Q4. The results are qualitatively the same as those shown in Figure 13.

estimation equation (2) for these five groups. In addition, we compute a measure of the MPC by subtracting the response of disposable income y_D from that of consumption c_{ND}.

Figure 14 shows the response of mean of consumption c_{ND} and MPC, following a monetary policy shock, for households that fall in the 80–100% income quantile and those that fall in the 0–20% income quantile in the upper and lower panel, respectively. Consumption responses to a monetary policy shock are positive for both groups of households and comparable across these groups. MPC conditional on monetary policy shocks is greater for households of a low-income quantile compared with those of a high-income quantile. It appears that the greater response of MPC in low-income households is a cause of the moderate translation of earnings inequality to consumption inequality.

5.3.2 Distributional effects via financial asset holdings

Why is the MPC conditional on monetary policy shocks higher for households in the low income quantile? We consider two possible explanations. The first explanation rests on the distribution of financial assets and liabilities across households at the time of arrival of a monetary policy shock. Our simulation exercise in Figure 11 shows the distribution is relevant to the response of consumption inequality to a monetary policy shock. The cyclical response of consumption inequality is attenuated when household Z holds a greater share of financial assets. Existing empirical studies, such as Doepke and Schneider (2006), Domanski et al. (2016), and O'Farrell et al. (2016), also underscore the importance of the heterogeneity of households' financial positions on the distributional effects of monetary policy, as the heterogeneity of the distributions acts as a source of the *portfolio channel* and the *savings distribution channel*.[21] The second explanation is a difference in consumption behavior across households with different income level. If the MPC is higher by nature for low-income households for any reason, then it can serve as an explanation for the minor response of consumption inequality. For instance, Jappelli and Pistaferri (2014) argue that if households falling in a lower income quantile are more liquidity-constrained than those in a higher income quantile, the MPC of those households tends to be higher. Also, Carroll and Kimball (1996) discuss that a precautional motive

[21] Our discussion here is not inconsistent with our empirical observation that the most of cyclical dynamics of income inequality is attributed to those of earnings inequality shown in Figure 4. It is notable that the FIES does not count the capital gains or losses as a part of capital income. Even when there is a rise in the value of a household's asset due to monetary expansion and the household increases its consumption accordingly through *the portfolio channel*, so far as the household does not sell the asset, other things being equal, it leads to an increase in its MPC. Similarly, the FIES does not count a change in the real value of household's debt possibly by changes in inflation rate as a change in income as well. If the household increases its consumption as a result through the *savings distribution channel*, it observationally results in an increase in its MPC.

explains the higher MPC for the poor and lower MPC for the rich.

Our strategy is to exploit micro-level data on households' financial positions collected in the Survey of Household Finances (SHF), and examine if these are distributed in a way that is consistent with the MPC of low-income households being higher than that of high-income households, so that the response of consumption inequality is mitigated compared with the response of earnings. The SHF is conducted annually by the Central Council for Financial Services Information (CCFSI), and contains information of the amount of financial assets by class, deposits, insurance, stocks, bonds, and debts, and the characteristics of the households, including households' total income, and household's head age.

Existing studies mentioned above typically consider the assets composition between risky and safe assets, in particular, stocks vs deposits and cash, and the size of financial debt as the key driving forces of inequality measures across households. We therefore start our analysis by looking at the distribution of financial positions along these lines. We divide the households surveyed in the SHF into five subgroups depending on their income quantiles, and construct time series of the mean of stock holding and financial liabilities for each households group. Figure 14 shows the time path of these series in average values of five years. The size of stock holdings, cash, and financial liabilities are normalized by income size of each household group. The panel suggests, at least qualitatively, that there is room for both the *portfolio channel* and the *savings distribution channel* to operate among Japanese households and to affect how MPC and consumption inequality react to an expansionary shock to a monetary policy. Throughout the sample period, the rich tend to hold a larger proportion of their assets in the form of stocks compared with the poor, and the poor tend to have a larger financial debts than the rich.

Because the *portfolio channel* and the *savings distribution channel* are expected to drive inequality in the opposite direction, we next gauge quantitatively the distributional effects of expansionary monetary policy shocks stemming from changes in households' financial assets and liabilities. To do this, we compute the total change in the real value of net financial assets for each of the five household groups i, which we denote by $\Delta w_{i,t}/w_{i,t}$, using the following equation.

$$\frac{\Delta w_{i,t}}{w_{i,t}} = \left(\frac{e_{i,t}}{w_{i,t}}\right)\left(\frac{\Delta e_{i,t}}{e_{i,t}}\right) + \left(\frac{d_{i,t}}{w_{i,t}}\right)\left(\frac{\Delta d_{i,t}}{d_{i,t}}\right), \tag{22}$$

Here, $w_{i,t}$ is the real value of net financial assets, $e_{i,t}$ is the real value of stock holding, $d_{i,t}$ is the real value of cash and deposits less the size of financial liabilities in period t for a household group i.[22]. We compute these values $w_{i,t}$, $e_{i,t}$, and $d_{i,t}$ for each household group i by taking five year averages from the 1980s to the present. We construct a change in the values $\Delta e_{i,t}/e_{it}$ and $\Delta d_{i,t}/d_{i,t}$ from the cumulative sum over the five-year horizons of impulse response functions of stock price and the price level to an expansionary monetary policy shock documented in Figure 3.

The upper panel of Figure 16 shows the response of the real value of financial assets $\Delta w_{i,t}/w_{i,t}$ derived from equation (22) for households of income quantile of the 0–20% and of the 80–100%. The difference of the response of the real value of financial assets between the two household groups, which we use as our measure of a change in financial assets inequality, is also shown in the same panel. When focusing on point estimates exclusively, the responses of households in the 80–100% income quantile are higher than those of households in the 0–20% income quantile, suggesting that effects of the *portfolio channel* dominate those of the *savings distribution channel*. Both responses are, however, not statistically significant. One reason behind this result is that while the rich has a large portion of its financial assets in the form of equities, it also has a sizable portion of its assets in the form of inflation sensitive assets. The middle panel of the figure shows the response of the same variables $\Delta w_{i,t}/w_{i,t}$ for the two groups and the difference between the two, when we use the impulse response of stock price and the price level at two years after the impact period as our measure of $\Delta e_{i,t}/e_{it}$ and $\Delta d_{i,t}/d_{i,t}$, respectively. Here, we therefore implicitly assume that households sell all of their equities at the period when the response of stock price statistically significantly deviates from zero, so that the difference of wealth response across the two household groups is the most pronounced. In this setting, the response of the real value of financial assets were significantly positive for both groups. The response of the difference between the two groups is, however, again not statistically significant.

In addition to the exercises using the equation (22), we formulate one other estimation exercise. We construct two inequality measures for households' net financial assets, using the average series of the five household groups classified according to households' income, variance of log and P9010, and estimate the response of these net financial assets inequality measures to an expansionary monetary policy shock based on the equation (2).[23] The estimation results are reported in the bottom panel of Figure 16. For the two sample periods,

[22]In computing a change in the real value of financial assets using the equation (22), we categorize financial assets that are not stock, such as bonds and insurance, as cash and deposits $d_{i,t}$

[23]Because the data of the SHF are reported on the yearly basis, we obtain a quarterly series from the annual series using linear interpolation for the purpose of this estimation exercise.

estimated responses of net financial assets inequalities are not statistically significant.

Those empirical results indicate that financial assets and liabilities do not play a part in the distributional effects of monetary policy at least in a statistically significant manner. They also suggest that the higher MPC of low-income households in Figure 14 is not likely to arise from the distribution of households' financial position, and is likely to come from other factors such as liquidity constraints, precautionary savings, and/or real assets that are not analyzed in the current paper.

6 Conclusion

In this paper, we use the micro-level data on households in Japan to study how monetary policy shocks are transmitted to inequality. We construct quarterly series of inequality measures of income and consumption from 1981Q1 to 2008Q4 from the micro-level data, and estimate their response to monetary policy shocks. We find that, when considering inequality across households whose head is employed exclusively, an expansionary monetary policy shock increased income inequality through a rise in earnings inequality, in the period before the 2000s. Such procyclical responses are, however, scarcely observed when the most current data is included in the sample period, or when earnings inequality across all households is considered. Regarding the transmission from income inequality to consumption inequality, we find that the transmission is minor even during the period before the 2000s, namely the period when procyclicality of income inequality following monetary policy shocks was pronounced. These observations suggest that the distributional effects of monetary policy shocks were once present, but they are not stable over time, and possibly statistically insignificant, so far as the effects on all households at present time are concerned.

We show, using a simple dynamic general equilibrium model, that labor market flexibility is central to the dynamics of income inequality after monetary policy shocks in Japan. Given monetary policy shocks have heterogeneous impacts on economic activity in different parts of the economy, the distributional effects of monetary policy shocks depend crucially on how labor markets react to the shocks. When labor markets are segmented and mobility across firms is limited, then heterogeneous impacts on various firms are easily translated into earnings inequality across workers. By contrast, when labor markets enjoy high flexibility, the heterogeneous impacts on production do not cause large distributional effects across workers. The increasing flexibility of labor markets in Japan is consistent with our empirical observations regarding the response of earnings inequality to monetary policy shocks.

In addition, we use the micro-level data on households' financial assets and liabilities to study the distributional effects of monetary policy through changes in asset values. We find that financial assets and liabilities of Japanese households are distributed in a way that both the *portfolio channel* and *saving redistribution channel* can work at least qualitatively. However, the estimated effects of expansionary monetary policy shocks on the difference across households in terms of the value of net assets is not significantly different from zero, throughout the sample period, indicating hat the two channels are not quantitatively important in shaping the distributional effects of monetary policy.

Lastly, it is also important to distinguish the two sides of the same coin. A higher flexibility of labor markets has two different implications for developments in inequality. First, as the current paper highlights, an increase in the participation of temporary workers and an enhanced mobility of workers in labor markets helps isolate variations in goods production across firms, from being straightforwardly translated into variations in earnings across workers. Consequently, it makes dynamics of income inequality almost neutral to monetary policy shocks. Second, by contrast, as observed in existing studies, the use of temporary workers is typically associated with structural and long-lived dispersions in wage profile across workers within a firm, which has the potential to widen earnings inequality across households. Given the fact that inequality measures in Japan from the 1980s onwards exhibit a secular positive trend as shown in Figure 1, a detailed analysis of structural developments in inequality is essential for gaining a better understanding of the quantitative aspects of inequality. This is, however, left for future research.

A Appendix: Japanese Data [NOT FOR PUBLICATION]

This appendix documents the data sources, including two micro-level data, the FIES and SHF, and the construction methodology of the time series of inequality measures used in Section 4 and 5.

A.1 The Family Income and Expenditures Survey

A.1.1 About the FIES

The Family Income and Expenditure Survey (FIES) is a cross-sectional household survey conducted monthly by the Japanese Ministry of Internal Affairs and Communications. The FIES is a primary source of the private consumption series in the System of National Accounts (SNA). It is also used for the construction of the Consumption Price Index (CPI). Using this data, Lise et al. (2014) documents developments in inequality in Japan.

The survey unit is a household and the universe for the survey includes all Japanese households with the exception of (*i*) institutional households; (*ii*) students living alone; (*iii*) households in which the household business is a restaurant, or boarding house which shares the same dwelling; (*iv*) households with boarders who share meals (even if this is not the main source of income); (*v*) households with four or more live-in employees; (*vi*) households where the head is absent for more than three months in the year; and (*vii*) foreigners. Multiple-person households are surveyed for six consecutive months, while single-person households are surveyed for three consecutive months, but only after 2002. One-sixth of the households are rotated out and replaced by new households every month. Approximately 8,000 multiple-person households are surveyed every month, meaning that approximately 16,000 households are surveyed every year.

The survey contains rich information on the earnings of household members, household consumption expenditures, and households' characteristics such as household members' ages, gender, occupation, industry of employment, marital status, and region of residence; however, detailed information on monthly income is collected only if the household head is employed, but not if the household head is non-employed, self-employed, executive, free lancer, farmer, forester, or fisher. The household head is defined as the primary earner in the household. The data is collected by a combination of survey questions and a household diary in which households are requested to fill in daily expenditures. There is neither bottom nor top coding of income and consumption records.

A.1.2 Variables of interest

We are interested in analyzing the inequality measures of five variables, earnings y_L, pre-tax income y, disposable income y_D, non-durable consumption c_{ND}, and total consumption expenditures c_T. We refer to the last two variables simply as consumption and expenditure. We define each variable following Lise et al. (2014). Earnings y_L is defined as the sum of earnings of all household members, namely household head, spouse, and other household members. As noted in the main text, however, when earnings are zero, we drop the household from our sample. Pre-tax income (y) is computed by adding asset income and private transfers to the earnings (y_L). We subtract reported tax payments from the pre-tax income and add public transfers to obtain disposable income (y_D). The nondurable expenditure (c_{ND}) includes food (1), repair and maintenance (2.2), fuel, light and water charges (3), domestic utensils (4.4), domestic nondurable goods (4.5), domestic services (4.6), clothing and footwear (5), medical care (6), transportation and communication (7) (excluding purchase of vehicles (7.2.1) and bicycles (7.2.2)), education (8), culture and recreation (9) (excluding recreation durable goods (9.1)), and other consumption expenditures (10) (excluding remittance (10.4)).[24] We add semidurable and durable expenditures to c_{ND} to compute total consumption c_T.

A.1.3 Construction methodology of quarterly series of inequality measures

Since the FIES is surveyed monthly, we construct a quarterly series of inequality measures using the data on households who are interviewed for three consecutive months within the quarter. We make two adjustments to the series. First, in order to control for differences in inequality measures arising from the size and composition of households, we equivalize raw numbers using the OECD equivalent scale, and compute inequality measures across households based on these equivalized figures.[25] Second, we apply seasonal adjustments to the data. Our earnings series exhibits a strong seasonality due to bonuses that are paid twice a year, one in summer (June or July), and one in winter (December). When constructing quarterly series, therefore, we compute the total bonus payments for each household and distribute one-sixth of the bonus payments to regular monthly earnings, and apply the X12 ARIMA filter to the series.

[24] Numbers in parentheses are the item codes in the FIES.

[25] The OECD scale gives a unit weight to the first adult, 0.7 to all other adults, and 0.5 to children aged 16 and younger.

A.2 The Survey of Household Finances

A.2.1 About the SHF

The SHF is a cross-sectional household survey conducted by the Central Council for Financial Services Information. Beginning in 1953, the survey, originally named the "Public Opinion Survey on Household Financial Assets and Liabilities" was renamed the SHF in 2007. The survey unit is a household and the universe for the survey includes all Japanese households that meet the following conditions; (*i*) households are multiple-person, and (*ii*) the household head is aged 20 or over 8,000 multiple-person households are surveyed once a year.[26] Sample households are selected each year.

The survey contains rich information on the amount of financial assets and liabilities by class, and selection of financial products such as stocks, bonds, deposits, insurance, and debt. The survey also details various characteristics of households such as income, expenditure, borrowing, education, and so forth.

A.2.2 Adjustments to variables of interest

Our interest is to assess the distributional effects of expansionary monetary policy shocks via changes in the value of households' financial assets and liabilities. We construct the time-series data on financial assets, stock holdings and financial liabilities by households' income quantiles. In order to maintain the consistency with our analysis using the FIES data, we use only the data on households whose heads are aged from 25 to 59. We also drop households whose earnings are zero from our sample, for the same reason. Financial assets are defined as the total amount of financial products (excluding cash-in-hand, but including foreign currency-denominated financial products), as in the SHF. Stock holdings include employee stock ownership plans and foreign currency-denominated stocks (in yen terms). We define financial liabilities as the total outstanding balance borrowed, which includes housing loans and educational loans.

[26]Note that not all households surveyed respond. In the 2015 survey, for example, 3,474 multiple-person households responded.

A.3 Macroeconomic variables

A.3.1 Unobservable macroeconomic factors

In estimating the two equations (2) and (3), we use K unobserved macroeconomic factors that are extracted from a balanced panel that includes a quarterly series of 59 variables from 1981Q1 to 2008Q4. The list of variables included in the panel is given in Table 2. All of the variables are transformed to stationary series by the methodology reported in the table. From the balanced panel, we extract the time series of a set of unobservable factors $\tilde{F}_t$ as the first K principal components. We set the number of unobservable factor K to equal two in our baseline specification. For a sensitivity analysis, which we report in Appendix C, we estimate impulse response functions in a setting where K is set to 3 instead of 2.

A.3.2 Total factor productivity

As in Hayashi and Prescott (2002), our measured TFP series, TFP_t, is computed from the logarithm of output growth less the weighted average of the logarithm of labor input and capital input growth. The time series of output and capital inputs are taken from the System of National Accounts, and that of labor input is obtained from the number of employees based on the Labour Force Survey, multiplied by hours worked per employee based on the Monthly Labour Survey. There are two differences between our TFP series and that of Hayashi and Prescott (2002): (*i*) the output series that is used for constructing our TFP series is the GDP series, while the output series used for constructing their TFP is GNP less government capital consumption; and (*ii*) households' residential and foreign assets are not included in our capital stock series, while these two components are included by Hayashi and Prescott (2002).

B Appendix: Model [NOT FOR PUBLICATION]

This appendix lists the equilibrium conditions facing households, firms, and the government in the two-sector agents model discussed above.

B.1 Equilibrium conditions of households' utility maximization

- Eular equation of households;

$$\begin{pmatrix} (C_{s,t} - bC_{s,t-1})^{-\sigma} \\ -\beta b_s (C_{s,t+1} - bC_{s,t})^{-\sigma} \end{pmatrix} = \beta \left\{ \frac{R_t}{\mathrm{E}_t \pi_{t+1}} \right\} \times \begin{pmatrix} (C_{s,t+1} - bC_{s,t})^{-\sigma} \\ -\beta b (C_{s,t+2} - bC_{s,t+1})^{-\sigma} \end{pmatrix}, \text{ for } s = X \text{ and } Z.$$

- Consumption-leisure decision with attached labor inputs $N_{s,t}$ and mobile labor inputs $H_{s,t}$;

$$\theta N_{s,t}^{\eta} = \left(\frac{W_{s,t}}{P_t} \right) \times \begin{pmatrix} (C_{s,t} - bC_{s,t-1})^{-\sigma} \\ -\beta b (C_{s,t+1} - bC_{s,t})^{-\sigma} \end{pmatrix},$$

$$\theta H_{s,t}^{\delta} = \left(\frac{W_t}{P_t} \right) \times \begin{pmatrix} (C_{s,t} - bC_{s,t-1})^{-\sigma} \\ -\beta b (C_{s,t+1} - bC_{s,t})^{-\sigma} \end{pmatrix}, \text{ for } s = X \text{ and } Z.$$

B.2 Equilibrium conditions of firms' profit maximization

[27]

- Production of the two intermediate goods producers;

$$\begin{aligned} \tilde{X}_t &= A N_{X,t}^{\alpha\mu} U_{X,t}^{\alpha(1-\mu)} K_X^{1-\alpha}, \text{ and} \\ \tilde{Z}_t &= A N_{Z,t}^{\alpha\mu} U_{Z,t}^{\alpha(1-\mu)} K_Z^{1-\alpha}, \end{aligned}$$

where

$$U_{X,t} + U_{Z,t} = H_{X,t} + H_{Z,t}.$$

[27] Note that because we assume the symmetric equilibrium where firms i and j set the same price, all of prices and goods are the same across firms in the same sector.

- Factor prices facing goods producers;

$$
\begin{aligned}
W_{s,t} &= (\alpha\mu)\, A N_{s,t}^{\alpha\mu-1} U_{s,t}^{\alpha(1-\mu)} K_s^{1-\alpha}, \text{ for } s = X \text{ and } Z, \\
W_t &= \alpha(1-\mu)\, A N_{X,t}^{\alpha\mu-1} U_{X,t}^{\alpha(1-\mu)-1} K_X^{1-\alpha} = \alpha(1-\mu)\, A N_{Z,t}^{\alpha\mu-1} U_{Z,t}^{\alpha(1-\mu)-1} K_Z^{1-\alpha}, \\
R_{s,t} &= (1-\alpha)\, A N_{s,t}^{\alpha\mu} U_{s,t}^{\alpha(1-\mu)} K_s^{-\alpha}, \text{ for } s = X \text{ and } Z.
\end{aligned}
$$

- Nominal marginal cost of intermediate goods producers;

$$
\begin{aligned}
& MC_{s,t} = \bar{\phi}_{MC} W_{s,t}^{\alpha\mu} W_t^{\alpha(1-\mu)} R_{s,t}^{1-\alpha} A^{-1}, \text{ for } s = X \text{ and } Z, \\
& \text{where } \bar{\phi}_{MC} \equiv (\alpha\mu)^{-\alpha\mu} (\alpha(1-\mu))^{-\alpha(1-\mu)} (1-\alpha)^{\alpha-1}.
\end{aligned}
$$

- Price dynamics of final goods producers;

$$
\begin{aligned}
& (1-\varepsilon)\tfrac{P_{s,t}}{P_t} S_t + \varepsilon\left(\tfrac{MC_{s,t}}{P_t}\right) S_t - \kappa_s\left(\tfrac{P_{s,t}}{P_{s,t-1}}\pi_t - 1\right) S_t \tfrac{P_{s,t}}{P_{s,t-1}} \\
& + \tfrac{\kappa_s}{2}\left(\tfrac{P_{s,t}}{P_{s,t-1}} - 1\right)^2 S_t \varepsilon + \beta\kappa_s\left(\tfrac{P_{s,t+1}}{P_{s,t}} - 1\right) S_{t+1}\tfrac{P_{s,t+1}}{P_{s,t}} = 0, \\
& \text{for } s = X \text{ and } Z, \text{ and } S_t = X_t \text{ and } Z_t.
\end{aligned}
$$

- Aggregation of consumption composite from goods X and Z;

$$
C_t = X_t^{\rho} Z_t^{1-\rho}.
$$

B.3 Other equations

- Resource constraint for goods X_t, Z_t, C_t, and the government bond;

$$
\begin{aligned}
\tilde{X}_t &= \left(1 + \frac{\kappa_X}{2}\left(\frac{P_{X,t}}{P_{X,t-1}} - 1\right)^2\right) \times X_t, \\
\tilde{Z}_t &= \left(1 + \frac{\kappa_Z}{2}\left(\frac{P_{Z,t}}{P_{Z,t-1}} - 1\right)^2\right) \times Z_t, \\
C_t &= C_{X,t} + C_{Z,t} + \kappa_B\left(\frac{B_{X,t}}{P_t}\right)^2 + \kappa_B\left(\frac{B_{Z,t}}{P_t}\right)^2, \\
B_{X,t} &= -B_{Z,t}.
\end{aligned}
$$

- Monetary policy;

$$\log R_{n,t} = \rho_n \log R_{n,t-1} + (1-\rho_n)\, \varphi \log \pi_t + \epsilon_{R,t},$$

where

$$\pi_t \equiv \frac{P_t}{P_{t-1}}.$$

- Definition of aggregate price index;

$$P_t \equiv \rho^{-\rho} \left(1-\rho\right)^{-1+\rho} \left(P_{X,t}\right)^{\rho} \left(P_{Z,t}\right)^{1-\rho}.$$

C Appendix: Shadow rate [NOT FOR PUBLICATION]

This appendix serves for the sensitivity analysis of our empirical results. We conduct four different estimation exercises to as to formulate exercises shown in Figures 4 and 5 in the main text under the following settings: (*i*) estimation using the shadow rate constructed by Krippner (2015), instead of the shadow rate of Ueno (2017), as the policy rate R_t, (*ii*) estimation using the two-year government bond yield, instead of the shadow rate of Ueno (2017), as the policy rate R_t, (*iii*) estimation that sets the number of unobservable factors $K = 3$, instead of $K = 2$, and (*iv*) estimation that sets the ordering of macroeconomic variables M_t in the estimation equation so that the short-term interest rate R_t comes first, instead of the setting where the short-term interest rate R_t is the least exogenous to the system. Note that for all of the four exercises, estimation procedures are unchanged from those of the baseline estimation except for the procedure specified above.

The first two exercises intend to examine the robustness of our results to the use of alternative measures of the monetary policy instrument. Note also that in the second setting, we use the two-year government bond yield for estimates of both sample periods, 1981Q1 to 1998Q4, and 1981Q1 to 2008Q4. The third exercise intends to examine the robustness to a change in the number of factors. The fourth exercises intends to check the robustness when alternative relationship between a monetary policy shock and other macroeconomic factors is considered.

Figures C1 to C4 show the estimation results under the four alternative settings, (*i*), (*ii*), (*iii*), and (*iv*). While there are some differences across settings, to a greater or lesser degree, the key observations are robust to the estimation methodologies.

Table 1: Model Parameters

		Description
δ	.999	Discount factor
b	.5	Degree of habit formation
θ and ϕ	1	Utility weight attached to attached and mobile labor inputs
η and δ	1	Frisch elasticity of labor supply of attached and mobile labor inputs
γ_{K_X} and γ_{K_Z}	.5	Share of a household's ownership of capital stock
γ_{Π_X} and γ_{Π_Z}	.5	Share of a household's ownership of firms
κ_B	10	Adjustment cost associated with bond holdings
A	1	Technology level
α	.65	Labor share in goods production
μ	.6	Share of attached labor inputs
K_X	1	Aggregate capital stock in sector X
K_Z	1	Aggregate capital stock in sector Z
ρ	.51	Share of goods X in the aggregate composite C_t
ε	11	Price elasticity of differentiated goods
κ_X	500	Adjustment cost associated with price setting in sector X
κ_Z	50	Adjustment cost associated with price setting in sector Z
ρ_n	.9	Persistence of the policy rate
φ	1.5	Policy weight attached to inflation rate

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Table 2: List of variables used in extracting latent factors

Descriptions appearing in the table are as follows:

"Trans" - The transformation code.

The transformation codes are: 1 - no transformation; 0 - first difference of logarithm.

"SA" - Seasonal adjustment code (1=seasonally adjusted, 0=not adjusted).

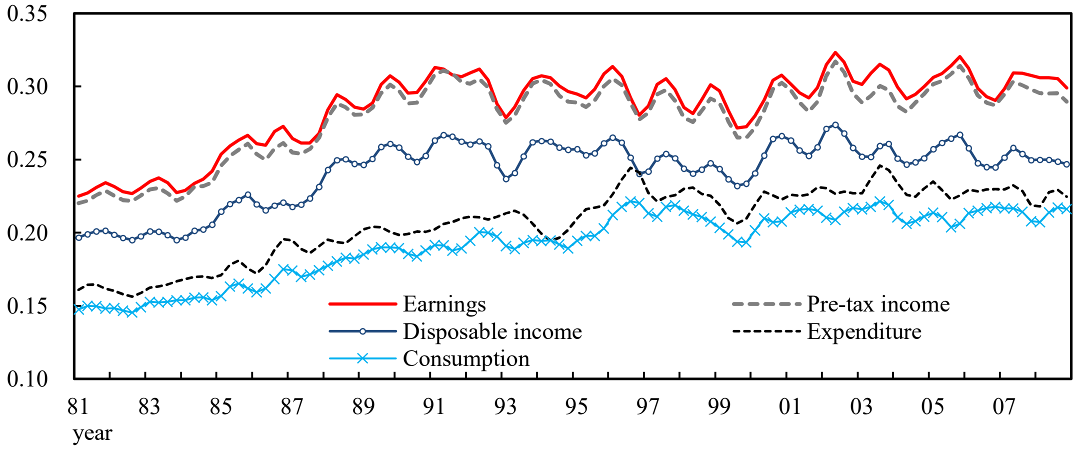
No	Data description	Trans	SA
Real output and income			
1.	GDP: Real Gross domestic expenditure (GDE=GDP)	0	1
2.	GDP: Real Private non-residential investment	0	1
3.	GDP: Real Private final consumption expenditure	0	1
4.	GDP: Real exports	0	1
5.	GDP: Real imports	0	1
6.	GDP gap	1	1
7.	Industrial production: Production (2010=100)	0	1
8.	Industrial production: Shipments (2010=100)	0	1
9.	Industrial production: Index of capacity utilization (manufacturing)	0	1
10.	ROA (operating profits/total assets)	1	0
Employment and hours			
11.	Monthly Labour Survey, Total hours worked (2010=100)	0	1
12.	Labour Force Survey, Unemployment rate	1	1
13.	Labour Force Survey, Labour force population	0	0
14.	Labour Force Survey, Number employed	0	0
15.	Labour Force Survey, Number of employees	0	1
16.	Employment Referrals for General Workers, Active job openings-to-applicants ratio	1	1
17.	Financial Statements Statistics of Corporations by Industry: All industries, number of labor	0	1
18.	Financial Statements Statistics of Corporations by Industry: Manufacturing, number of labor, share of total	1	1
Consumption			
19.	Current Survey of Commerce, sales at retail stores (deflated by the GDP deflator)	0	1
20.	Sales profit ratio	1	0
Housing starts			
21.	Housing starts	0	1
Real inventories			
22.	Industrial production: Inventories (2010=100)	0	1

No	Data description	Trans	SA
Stock prices			
23.	TOPIX (2005=100)	0	0
24.	Real stock price (Nikkei 225 deflated by the GDP deflator)	0	0
Exchange rates			
25.	Real effective exchange rate	0	0
Interest rates			
26.	Interest rate: Long-term Prime Lending Rates adopted and released by Mizuho Bank	1	0
27.	Interest rate: Government bond yield (10-year)	1	0
28.	Financial Statements Statistics of Corporations by industry: All industries, Interest cost/liability with interest	1	0
29.	Financial Statements Statistics of Corporations by industry: Manufacturing, Interest cost/liability with interest	1	0
Money and credit quantity aggregates			
30.	Flow of Funds Accounts: depository corporations, Asset Loans (deflated by the GDP deflator)	0	0
31.	Financial Statements Statistics of Corporations by Industry: Liability, Bank loans (deflated by the GDP deflator)	0	1
32.	Tokyo Shoko Research, LTD, Corporate bankruptcies (number of cases)	0	1
33.	Tokyo Shoko Research, LTD, Corporate bankruptcies (amount of liability)	0	0
34.	Money stock: M1 (average amounts outstanding)	0	1
35.	Money stock: M2 (average amounts outstanding)	0	1
36.	Monetary base (adjusted for reserve requirement change)	0	1
37.	Depository Institute reserve, total (adjusted for reserve requirement change)	0	0
Price Indices			
38.	Urban Land Price Index of Six Large City Areas, Commercial	0	0
39.	Urban Land Price Index; Nationwide, excluding Six Large City Areas, Commercial	0	0
40.	Urban Land Price Index of Six Large City Areas, Residential	0	0
41.	Urban Land Price Index; Nationwide, excluding Six Large City Areas, Residential	0	0
42.	Urban Land Price Index; Nationwide, Commercial	0	0
43.	Urban Land Price Index; Nationwide, Residential	0	0
44.	GDP deflator	0	1
45.	GDP: Private final consumption expenditure deflator	0	1
46.	GDP: Private housing investment deflator	0	1

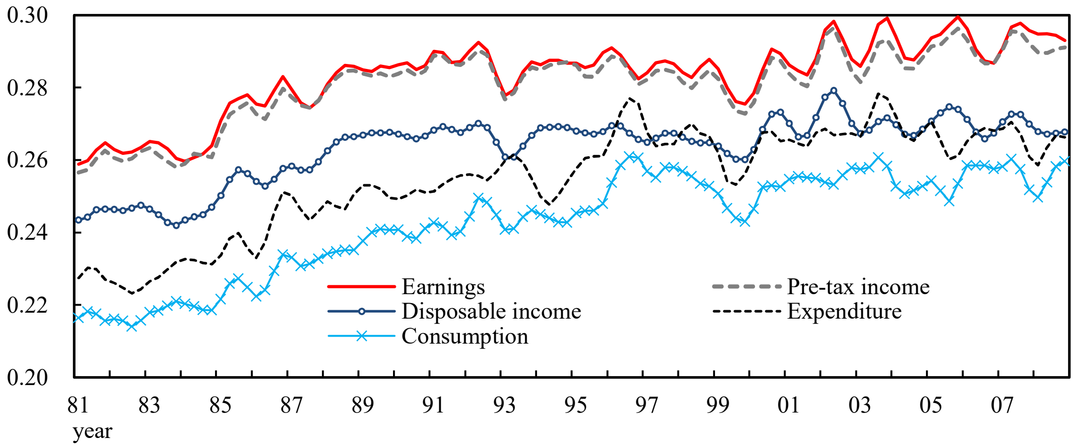
No	Data description	Trans	SA
47.	GDP: Private non-residential investment deflator	0	1
48.	GDP: Real Government final consumption expenditure deflator	0	1
49.	GDP: Public fixed capital formation deflator	0	1
50.	CPI excluding fresh food (adjusted to exclude the effects of changes in the consumption tax)	0	0
51.	CGPI excluding consumption tax	0	0
52.	CGPI export price index (contract currency basis)	0	0
53.	CGPI import price index (contract currency basis)	0	0
Earnings			
54.	Monthly Labour Survey, Total cash earnings (2010=100) (nominal)	0	1
55.	Monthly Labour Survey, Scheduled cash earnings (2010=100) (nominal)	0	1
Others (Commodity prices, US variables)			
56.	Crude Oil prices (WTI)	0	0
57.	U.S. GDP: Real Gross domestic expenditure (GDE=GDP)	0	1
58.	U.S. CPI: all items	0	1

Figure 1: Time path of inequality measures

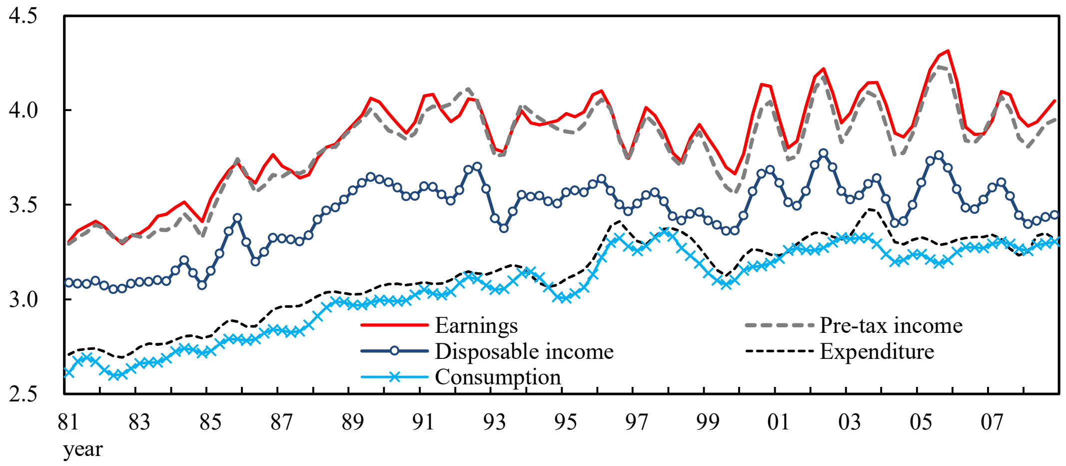
(1) Variance of log



(2) Gini coefficient

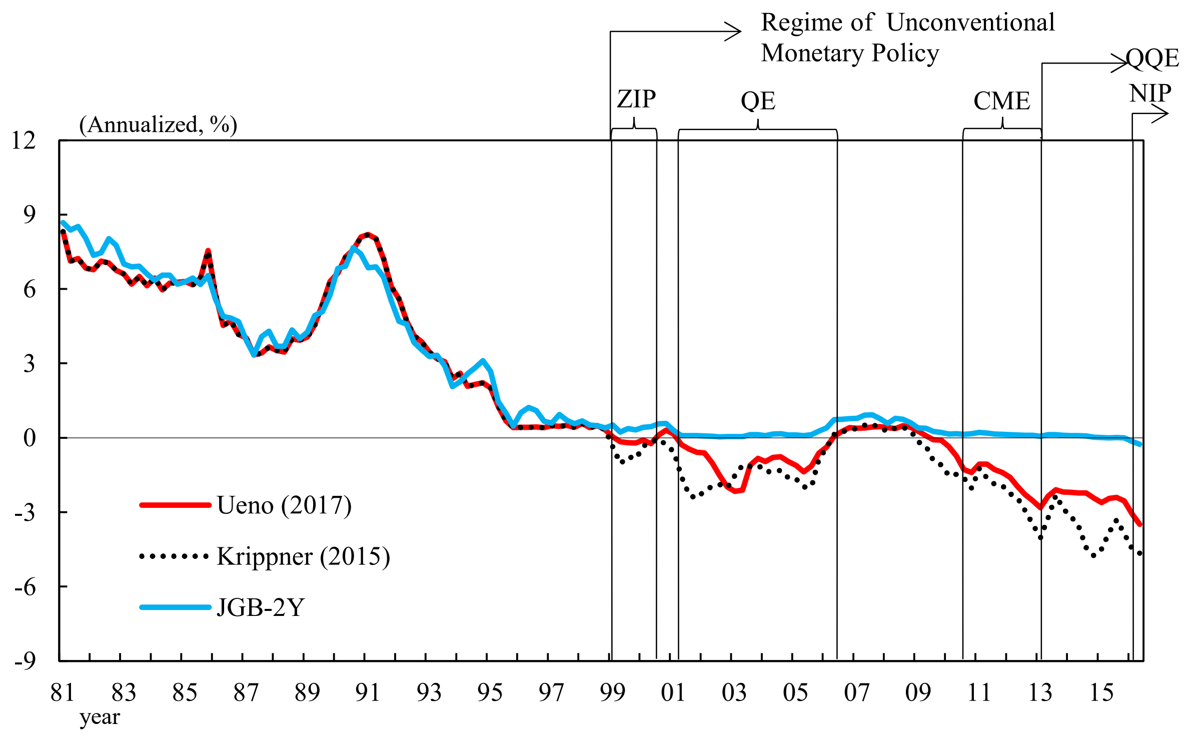


(3) P9010



Source: Ministry of Internal Affairs and Communications, "Family Income and Expenditure Survey."

Figure 2: Time path of monetary policy instruments

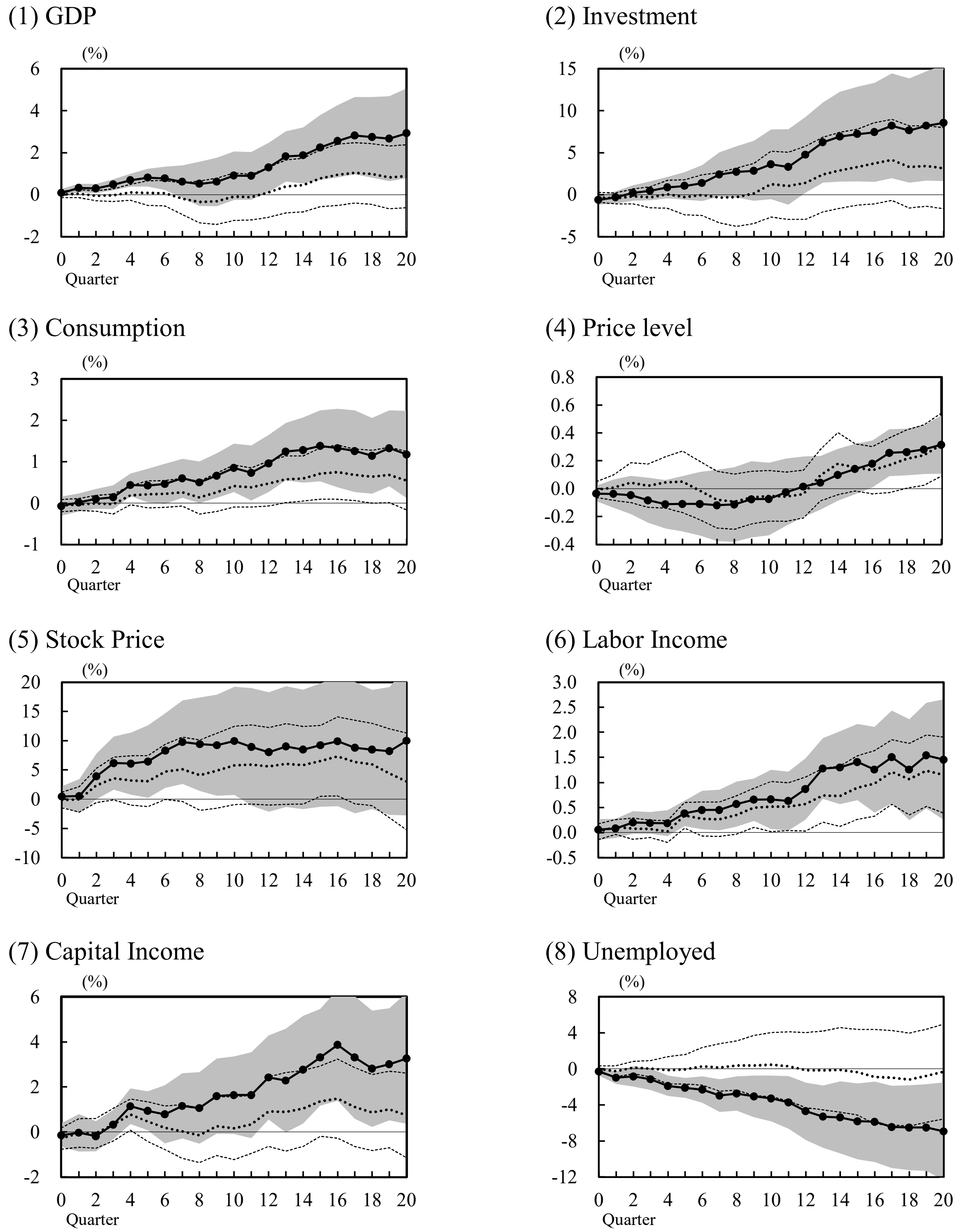


Notes: 1. ZIP: Zero Interest Rate Policy, QE: Quantitative Easing, CME: Comprehensive Monetary Easing, QQE: Quantitative and Qualitative Monetary Easing, NIP: Negative Interest Rate Policy.

2. The solid red line is constructed using the shadow nominal short-term interest rate estimated by Ueno (2017). The dotted line is constructed using the shadow nominal short-term interest rate estimated by Krippner (2015). The solid blue line shows the time path of the two-year Japanese government bond yield.

Sources: Bank of Japan, Ueno (2017), Krippner (2015), and Haver.

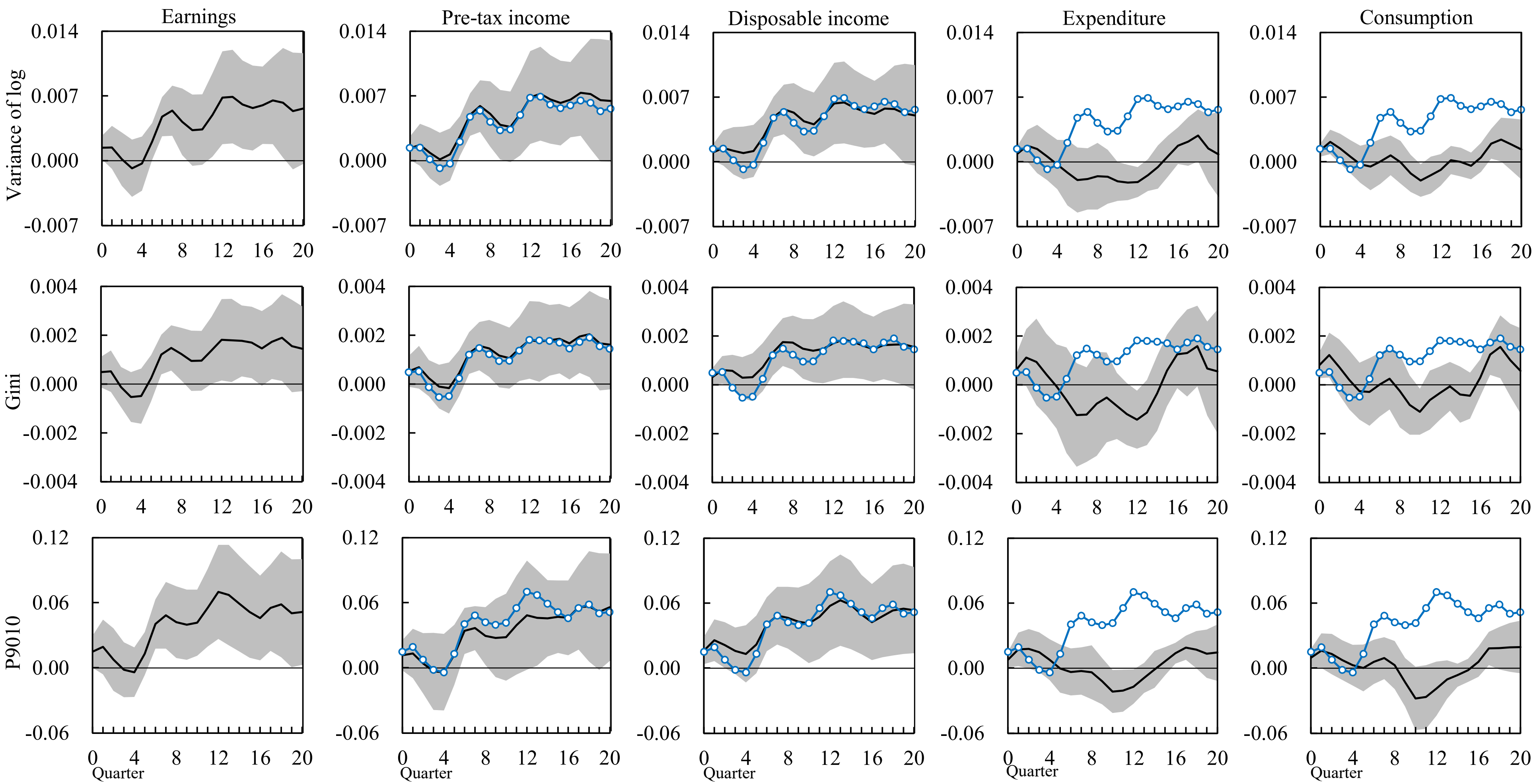
Figure 3: Responses of macroeconomic variables



Note: The figure shows the impulse responses of macroeconomic variables to an expansionary monetary policy shock. The vertical axis denotes the percentage deviation of the variable after a monetary policy shock. The solid line is the point estimate and the dark areas are 90% confidence intervals of the estimate based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 90% confidence interval of the estimate based on the data from 1981Q1 to 2008Q4.

Sources: Cabinet office, "National Accounts"; Ministry of internal affairs and communications, "Consumer Price Index", "Labour Force Survey"; Ministry of Health, Labour and Welfare, "Monthly Labour Survey"; Haver.

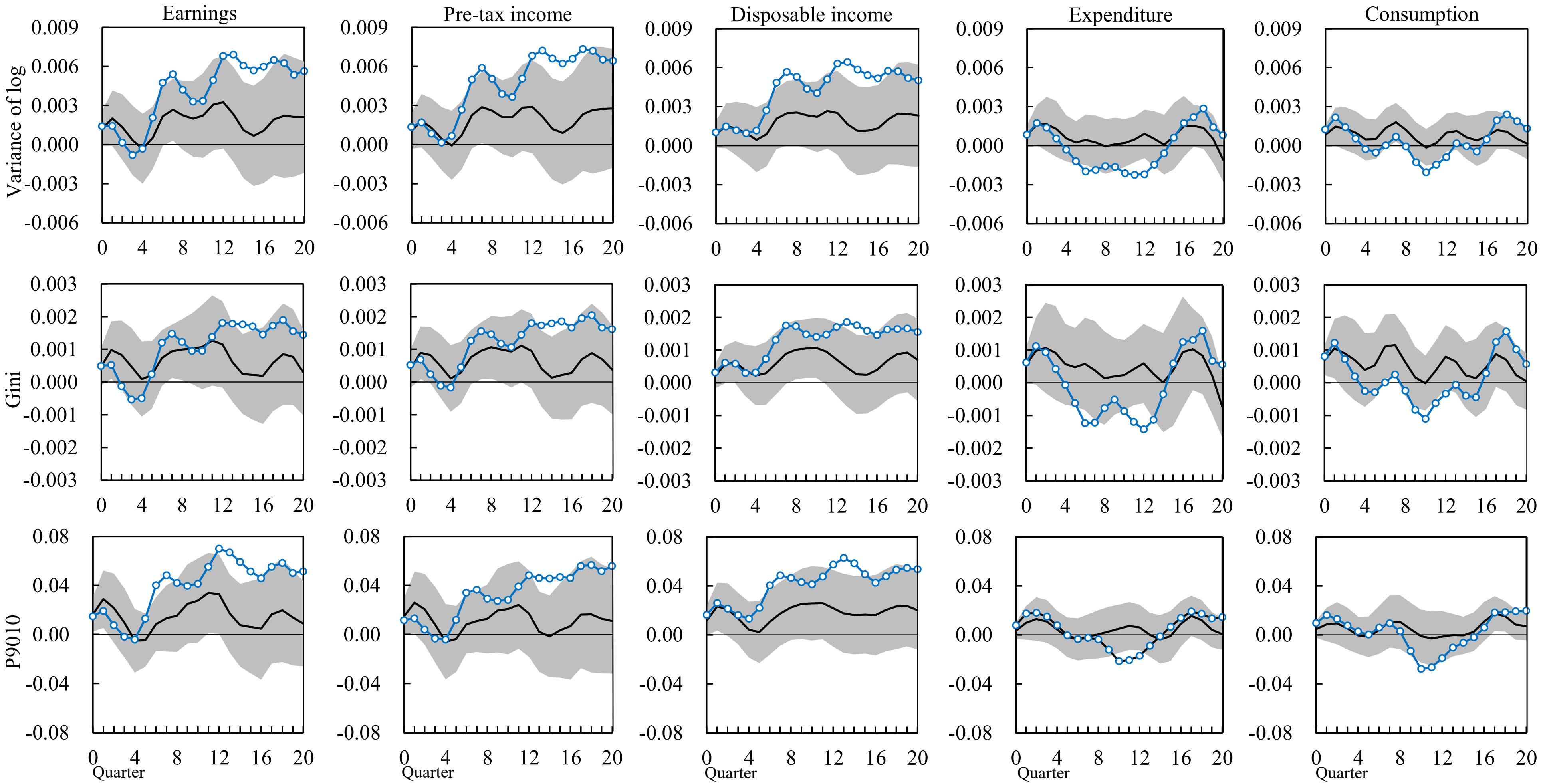
Figure 4: Responses of inequality measures across households: baseline



Notes: 1. The figure plots the impulse responses of inequality measures to an expansionary monetary policy shock based on the data from 1981Q1 to 1998Q4. The solid line shows the point estimate and the dark areas are 95 % confidence intervals of the estimates.

2. The blue line with circles plots the impulse response of earnings inequality of the same inequality measure.

Figure 5: Responses of inequality measures across households: 1981 to 2008

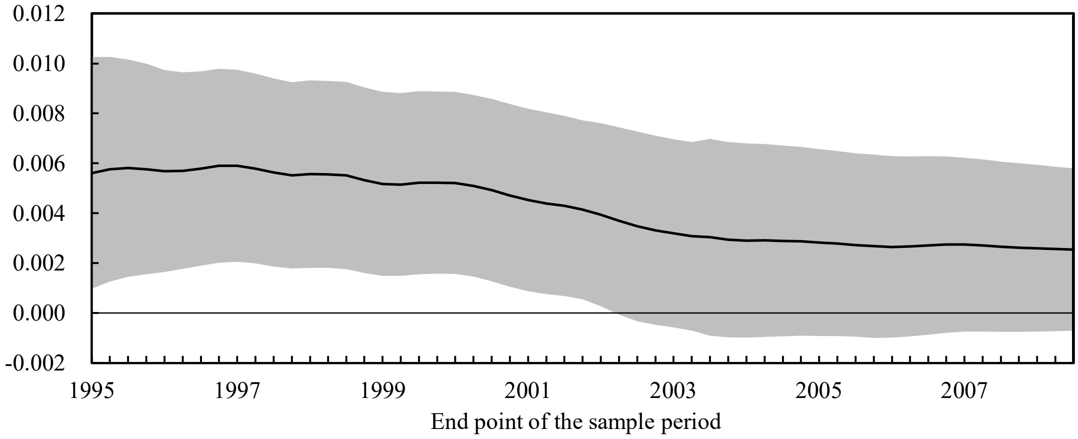


Notes: 1. The figure plots the impulse responses of inequality measures to an expansionary monetary policy shock based on the data from 1981Q1 to 2008Q4. The solid line shows the point estimate and the dark areas are 95 % confidence intervals of the estimates.

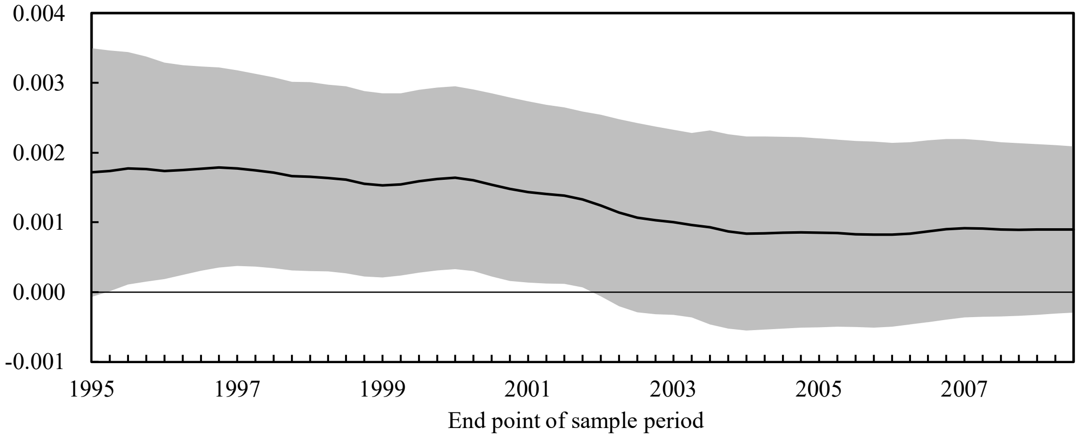
2. The blue line with circles plots the impulse response of the same inequality measure based on the data from 1981Q1 to 1998Q4.

Figure 6: Changes in responses of earnings inequality over time

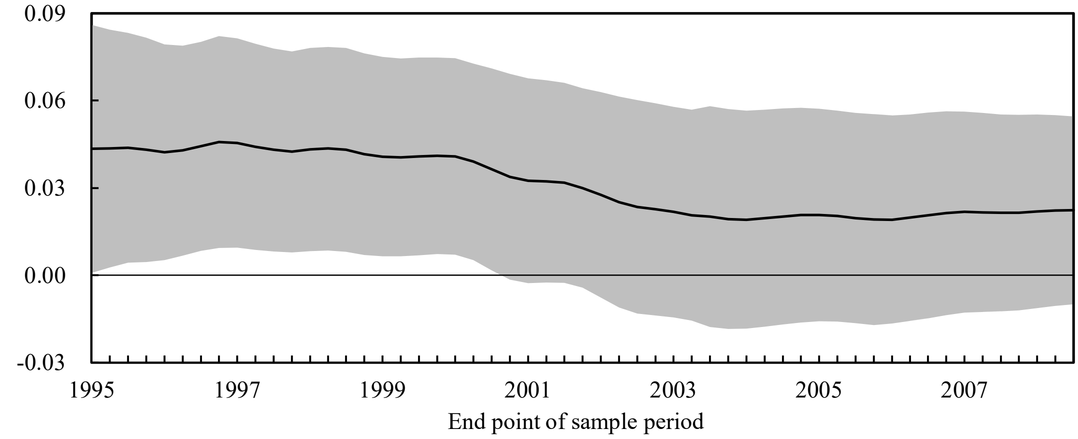
(1) Variance of log



(2) Gini



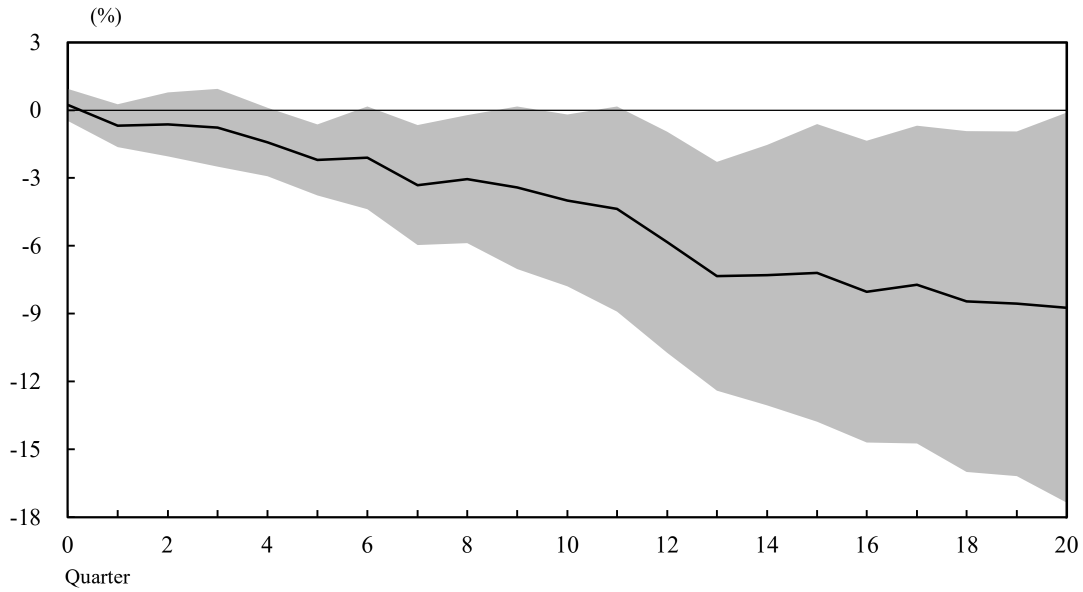
(3) P9010



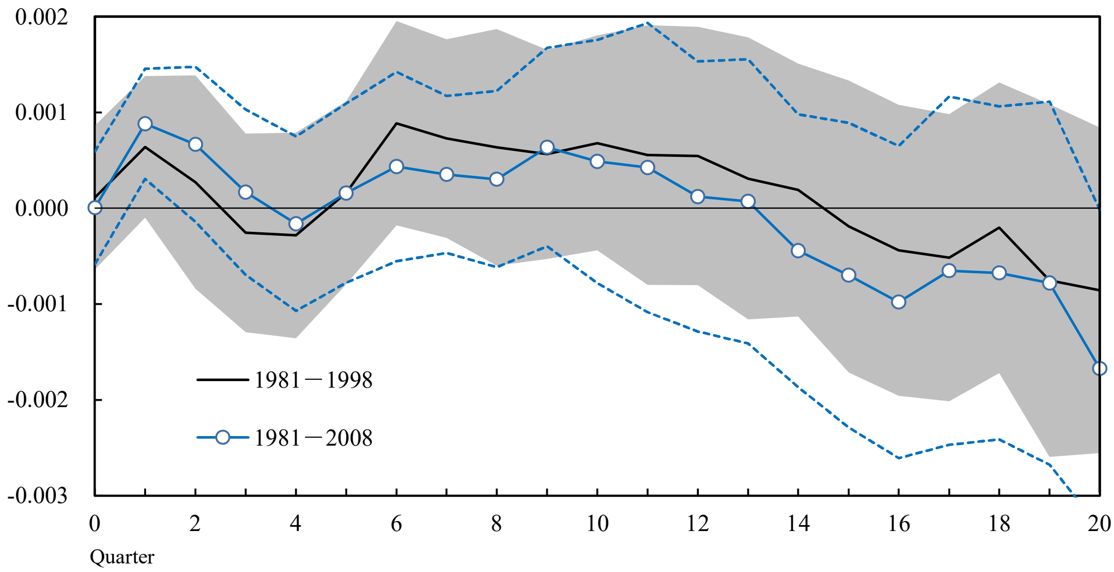
Notes: 1. The dark areas are 95% confidence intervals.
2. The y-axis denotes the size of the response to an expansionary monetary policy shock of the three earnings inequality measures that is estimated using the different sample period. The sample periods all run from 1981Q1 to an end point that is specified by the x-axis.
3. The size of the response is measured by the average of the impulse response functions over 20 quarters after a shock's impact period.

Figure 7: Responses of adjusted Gini coefficients

(1) The number of unemployed household heads



(2) Adjusted Gini coefficients of earnings



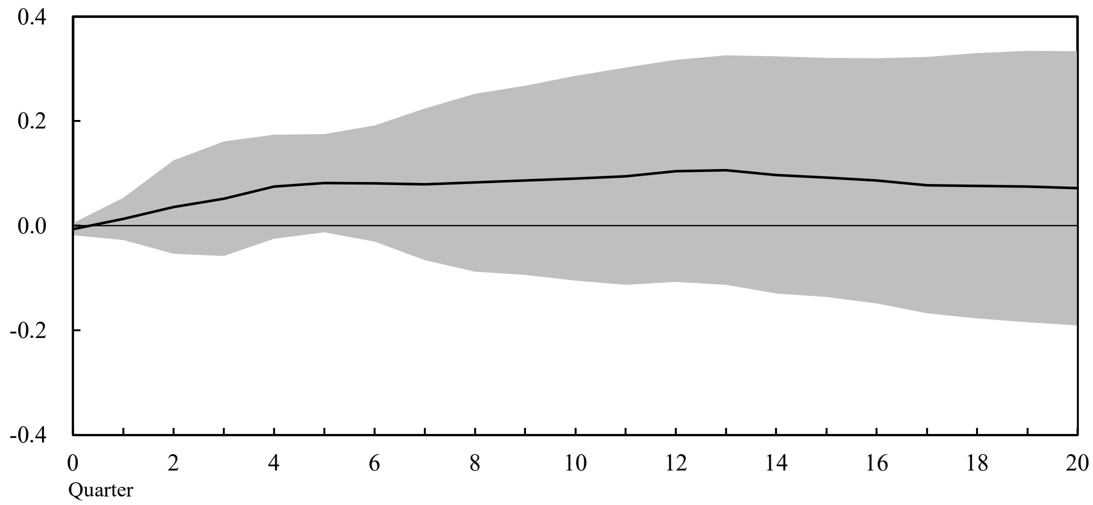
Notes: 1. The figure shows the impulse responses to an expansionary monetary policy shock. The solid line shows the point estimate and the dark areas are 95% confidence intervals of the estimates based on the data from 1981Q1 to 1998Q4. The blue line with circles shows the point estimate and the dotted blue lines are 95% confidence intervals of the estimates based on the data from 1981Q1 to 2008Q4.

2. In estimating the responses in the panel (1), we use the number of unemployed household heads as the dependent variables.

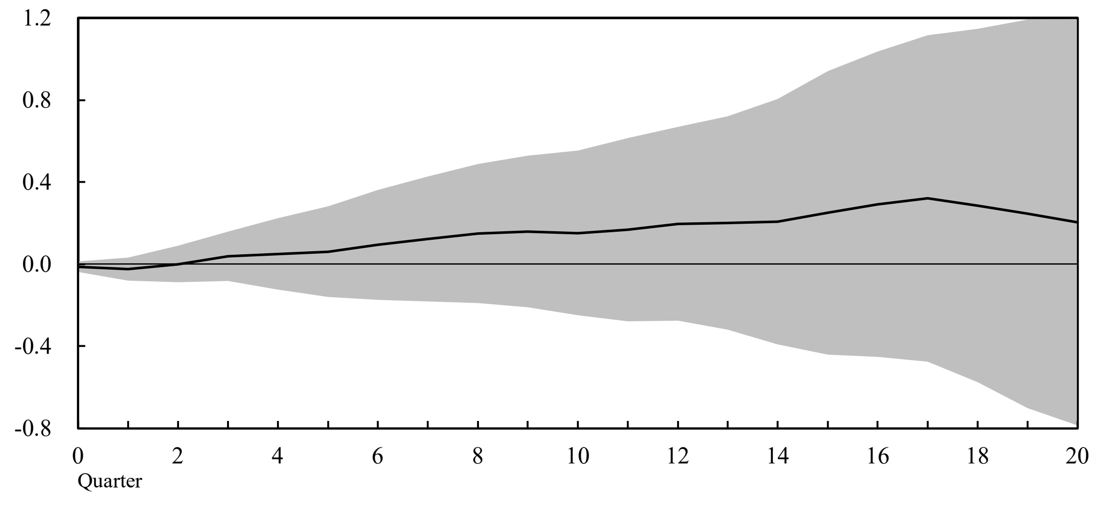
Source: Ministry of Internal Affairs and Communications, “Labour Force Survey.”

Figure 8: Responses of income inequality measures: 2008 and onwards

(1) Income ratio (top-bottom 20%)



(2) Income ratio (top-bottom 20%)

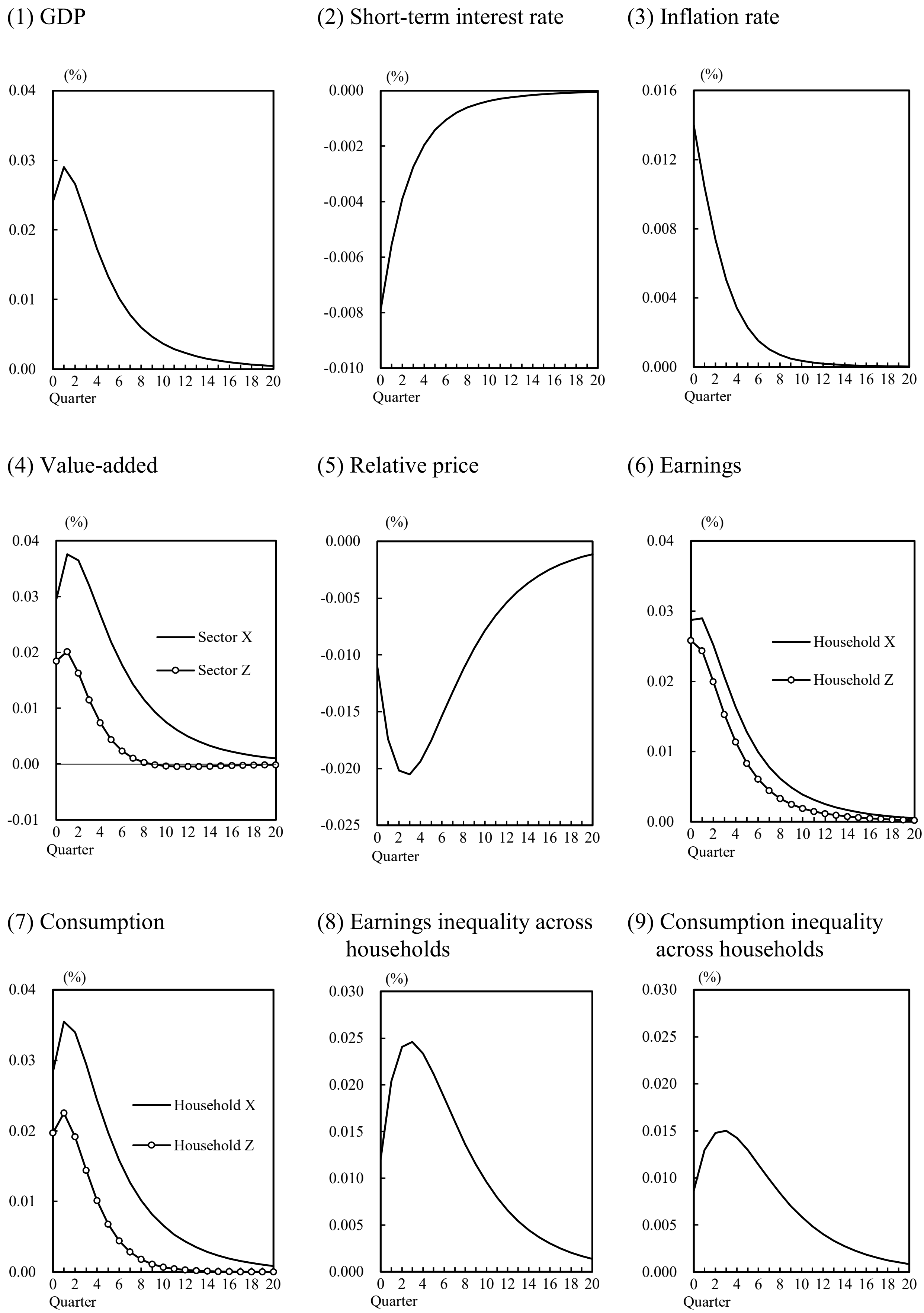


Notes: 1. The sample period covers 2008Q4 to 2016Q2 for the estimates shown in the panel (1). Following Saiki and Frost (2014), we estimate the impulse response of the pre-tax income inequality measure using the VAR framework. We use the central bank's assets to the nominal GDP ratio as the measure of monetary policy instrument.

2. The sample period covers 2008Q4 to 2016Q2 for the estimates shown in the panel (2). We estimate the impulse response of the pre-tax income inequality measure using the LLP specified in the equation (4) in the main text. We use the shadow nominal interest rate estimated by Ueno (2017) as the measure of monetary policy.

3. The solid line is the point estimate and the dark areas are 95% confidence intervals.

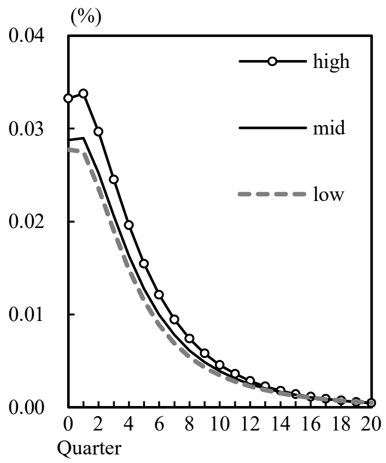
Figure 9: Responses of macroeconomic variables: model simulation



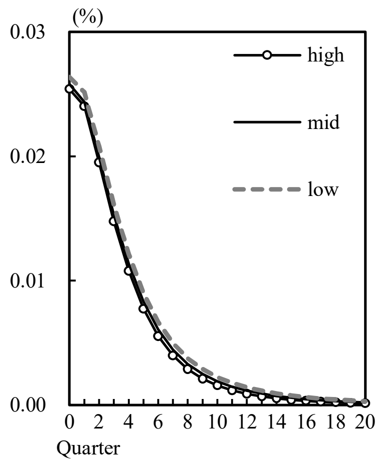
Note: In panel (5), the relative price is defined as $P_{X,t}/P_{Z,t}$. Response of a variable is shown in terms of the log-deviation from its non-stochastic steady state.

Figure 10: Responses of earnings and consumption inequality with different values of μ

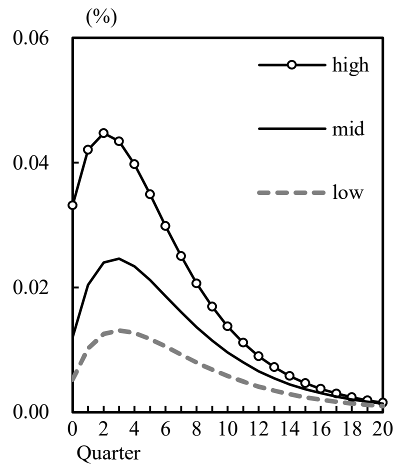
(1) Earnings of household X



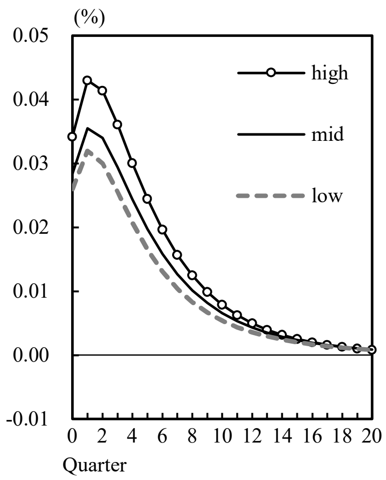
(2) Earnings of household Z



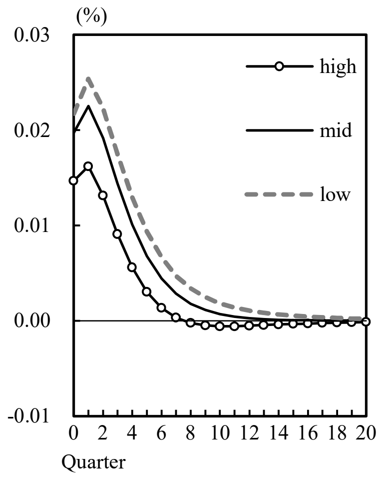
(3) Earnings inequality across households



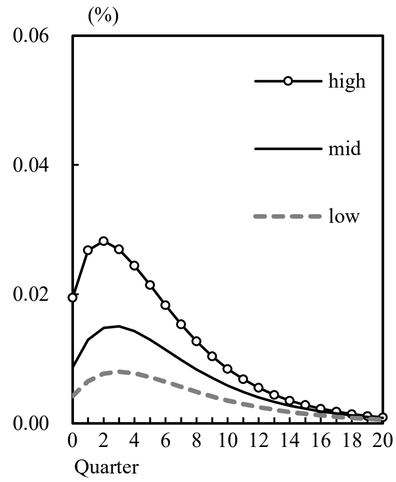
(4) Consumption of household X



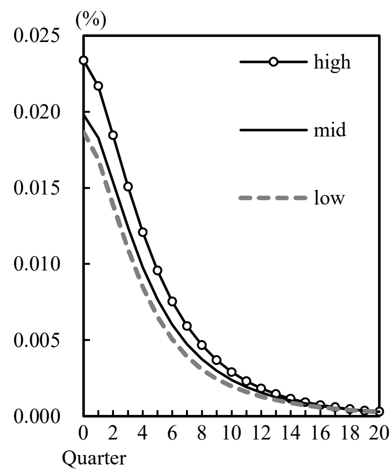
(5) Consumption of household Z



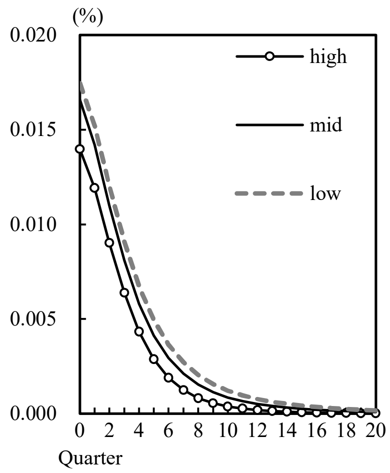
(6) Consumption inequality across households



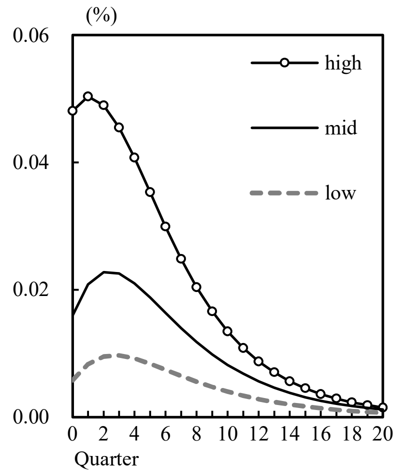
(7) Earnings per labor input in sector X



(8) Earnings per labor input in sector Z

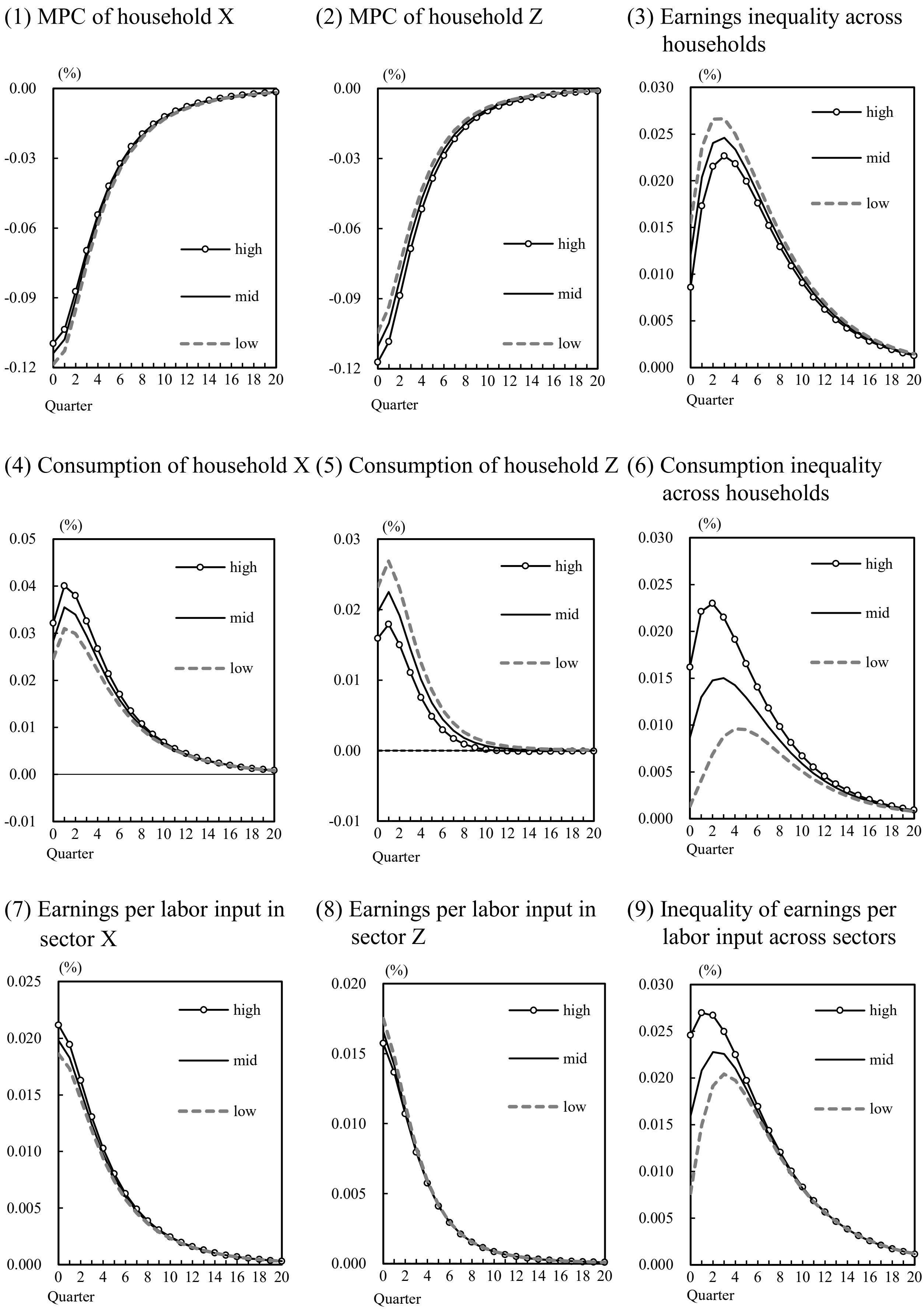


(9) Inequality of earnings per labor input across sectors



Note: Response of a variable is shown in terms of the log-deviation from its non-stochastic steady state.

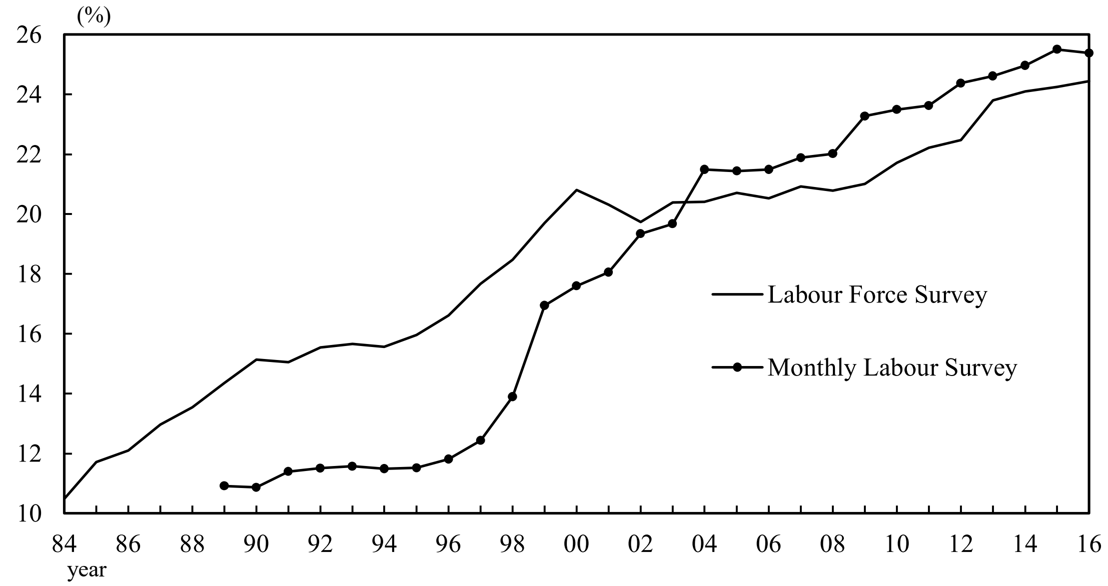
Figure 11: Responses of earnings and consumption inequality with different values of $\gamma_{K,X}$



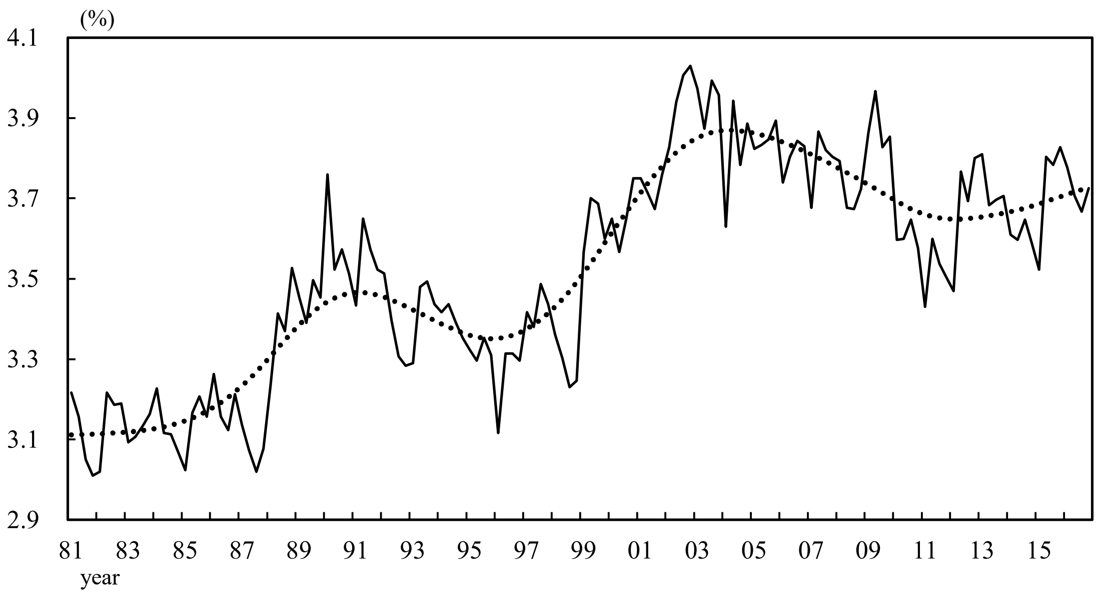
Note: Response of a variable is shown in terms of the log-deviation from its non-stochastic steady state.

Figure 12: Increases in labor market flexibility in Japan

(1) Proportion of the number of employees who work as temporary workers



(2) Labor turnover ratio



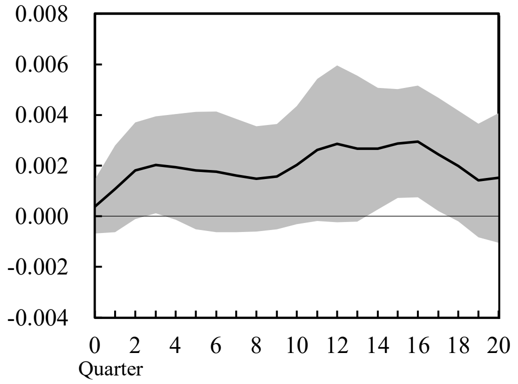
Notes: 1. The solid black line indicates the ratio of temporary workers to employees, which is constructed using data from the Labour Force Survery. The black line with black circles shows the ratio of part-time employees to regular employees, which is constructed using data from the Monthly Labour Survey.

2. The labor turnover ratio is the sum of the job separation ratio and the hiring ratio. The dotted line shows the HP trend component with a smoothing parameter of 1600.

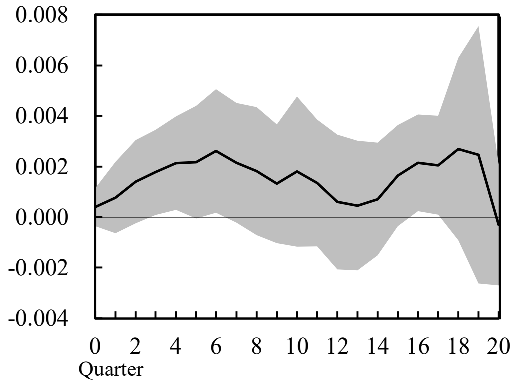
Sources: Ministry of Internal Affairs and Communications, "Labour Force Survey"; Ministry of Health, Labour and Welfare, "Monthly Labour Survey."

Figure 13: Responses of inequality measures across industries

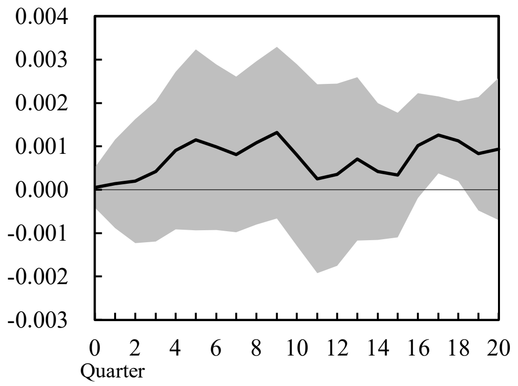
(1) Value-added: 1981－1998



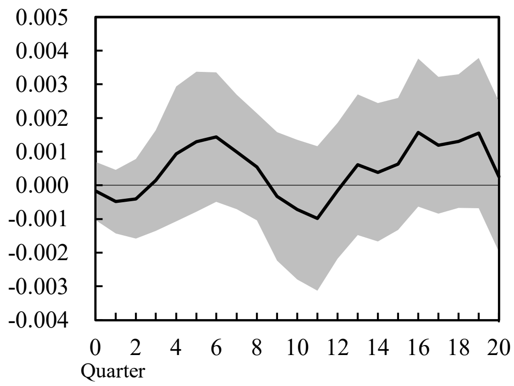
(2) Value-added: 1981－2008



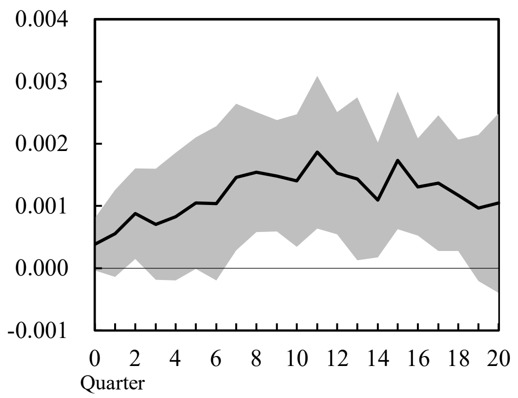
(3) Earnings per employee: 1981－1998



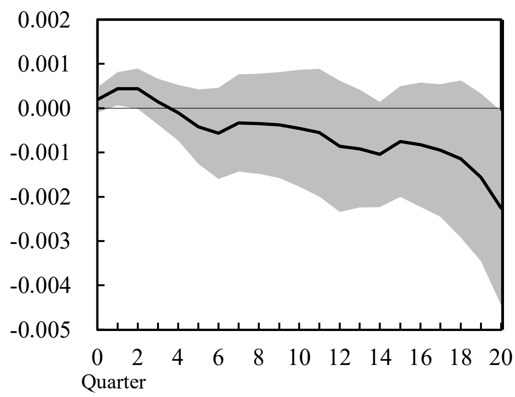
(4) Earnings per employee: 1981－2008



(5) Earnings per working hour:
1981－1998



(6) Earnings per working hour:
1981－2008



Notes: 1. Inequalities are measured by the variance of log across industry groups constructed using the data of the middle division of industrial classification.

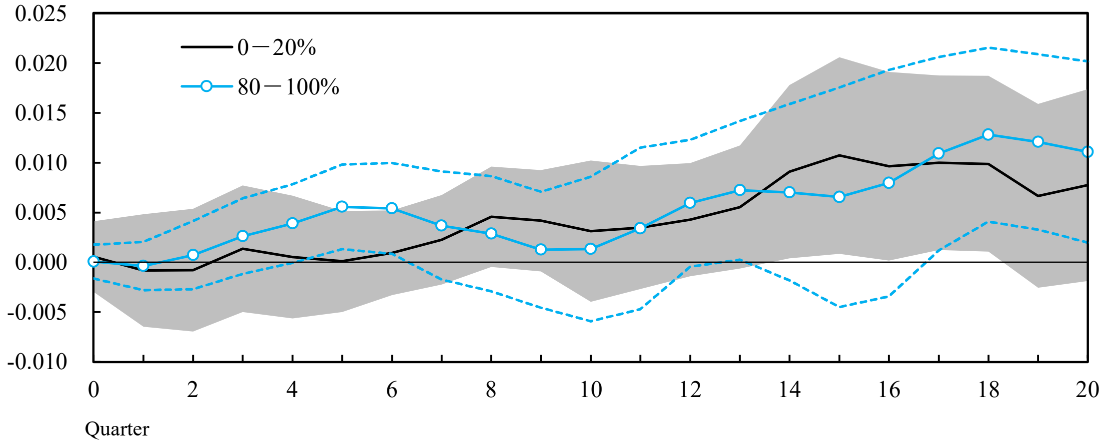
2. In estimating the responses in the panels (1), (3), and (5), we use the data from 1981Q1 to 1998Q4. In estimating the responses in the panels (2), (4), and (6), we use the data from 1981Q1 to 2008Q4. The solid line shows the point estimate and the dark areas are the 95% confidence intervals of the estimates.

3. The earnings per employee is calculated by dividing “Salaries and wages” of an industry group by “Number of employees” of the same group reported in FSSC. The earnings per working hour is calculated by dividing “Total cash earnings” per employee by “Total hours worked” per employee reported in MLS.

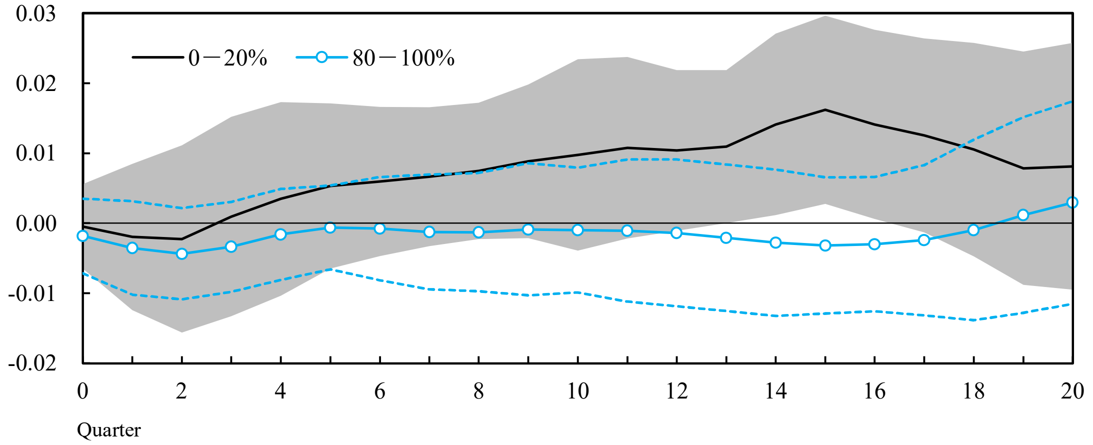
Sources: Ministry of Finance, “Financial Statements Statistics of Corporations”; Ministry of Health, Labour and Welfare, “Monthly Labour Survey.”

Figure 14: Responses of consumption and the MPC

(1) Consumption responses by household income quantiles



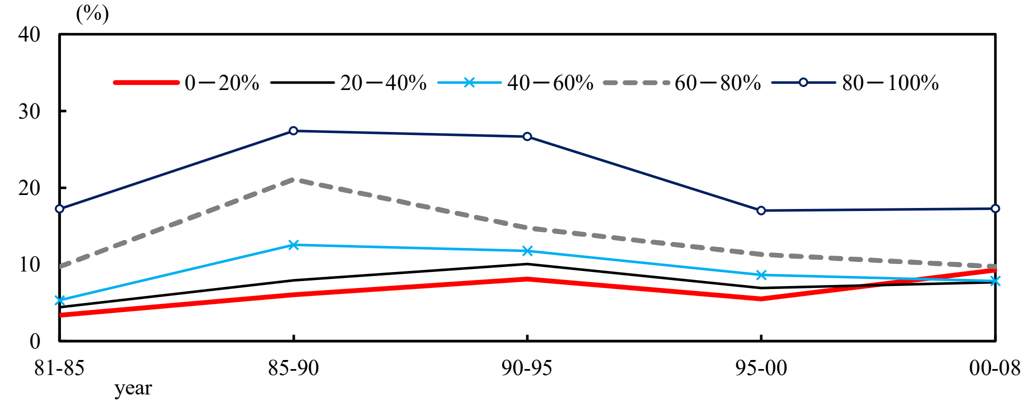
(2) MPC responses by household income quantiles



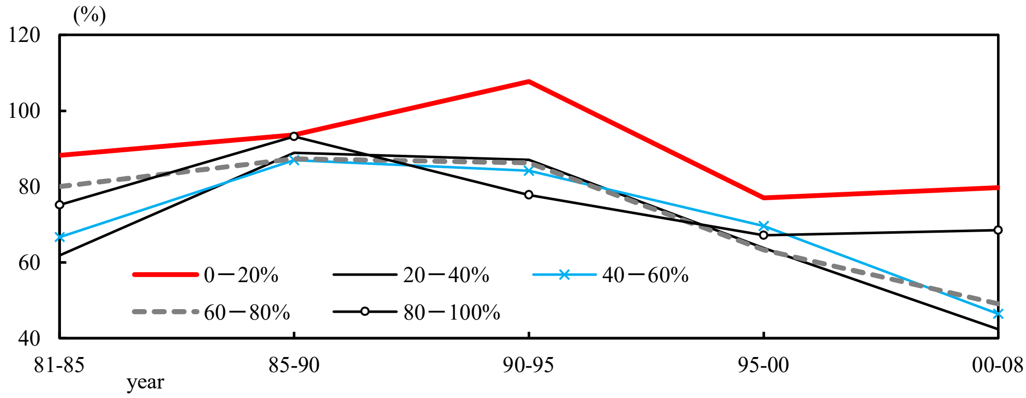
Note: The figure shows the impulse responses of consumption and the MPC to an expansionary monetary policy shock. The sample period covers from 1981Q1 to 1998Q4. The solid line is the point estimate and the dark areas indicate 95% confidence intervals using data for households of income quantile of 0−20%. The blue line with circles is the point estimate and the blue dotted lines show 95% confidence intervals for households of income quantile of 80−100%.

Figure 15: Financial asset holdings of Japanese households

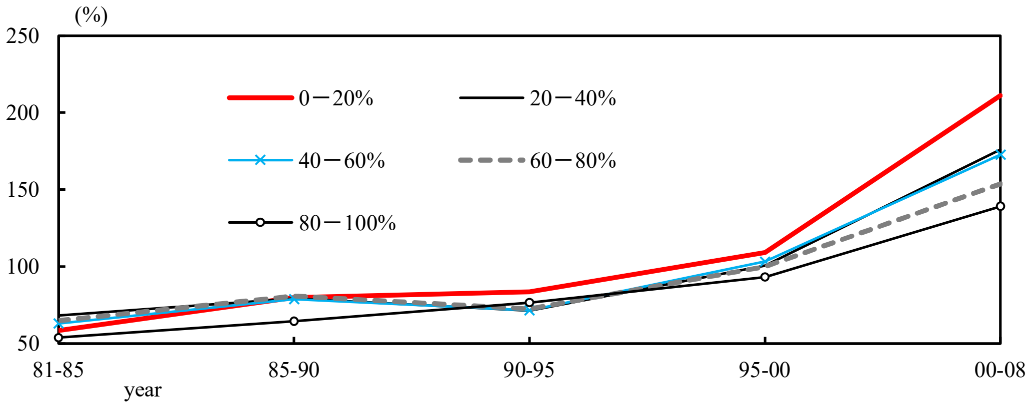
(1) Stock holdings by income quantile



(2) Cash holdings by income quantile



(2) Financial liabilities by income quantile



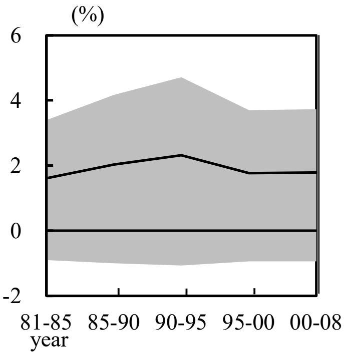
Notes: 1. Series shown in the figure are the ratios of stock holdings, cash, and financial liabilities to income by households' income quantile level.
2. Here, cash is defined as net financial asset less stock holdings.

Source: The Central Council for Financial Services Information, "Survey of Household Finances".

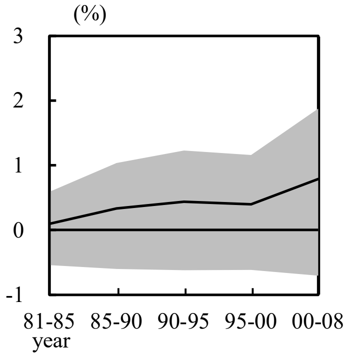
Figure 16: Distributional effects via financial assets and liabilities

(1) Response of real value of financial assets: case 1

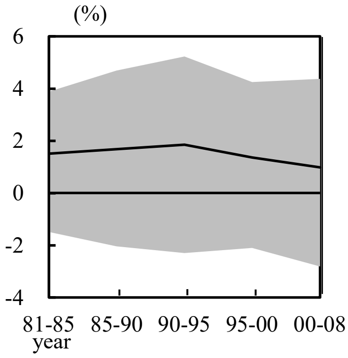
(a) 80－100%



(b) 0－20%

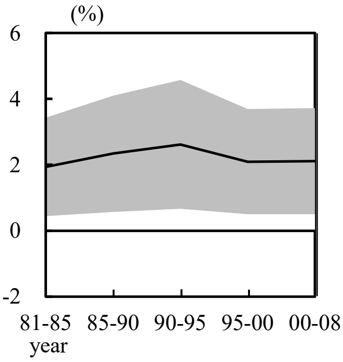


(c) Difference between (a) and (b)

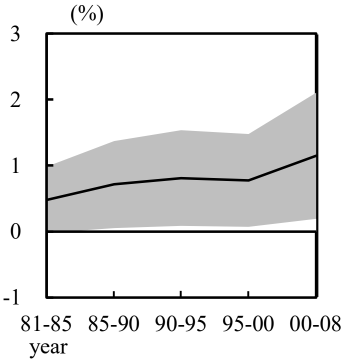


(2) Response of real value of financial assets: case 2

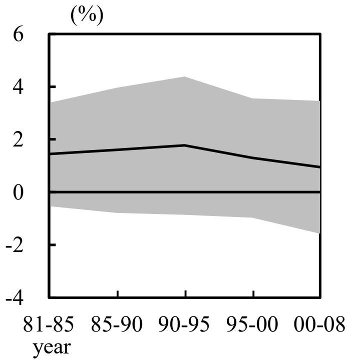
(a) 80－100%



(b) 0－20%

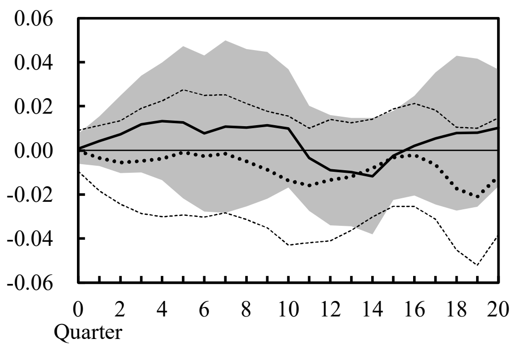


(c) Difference between (a) and (b)

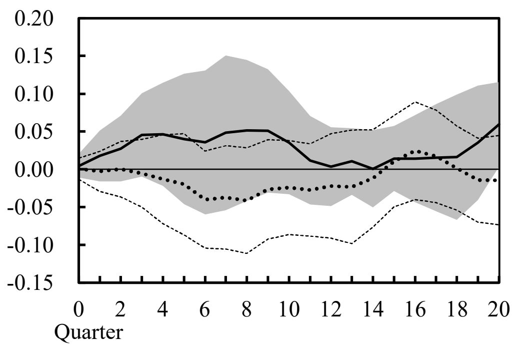


(3) Responses of inequality of financial assets across households

(a) Variance of log



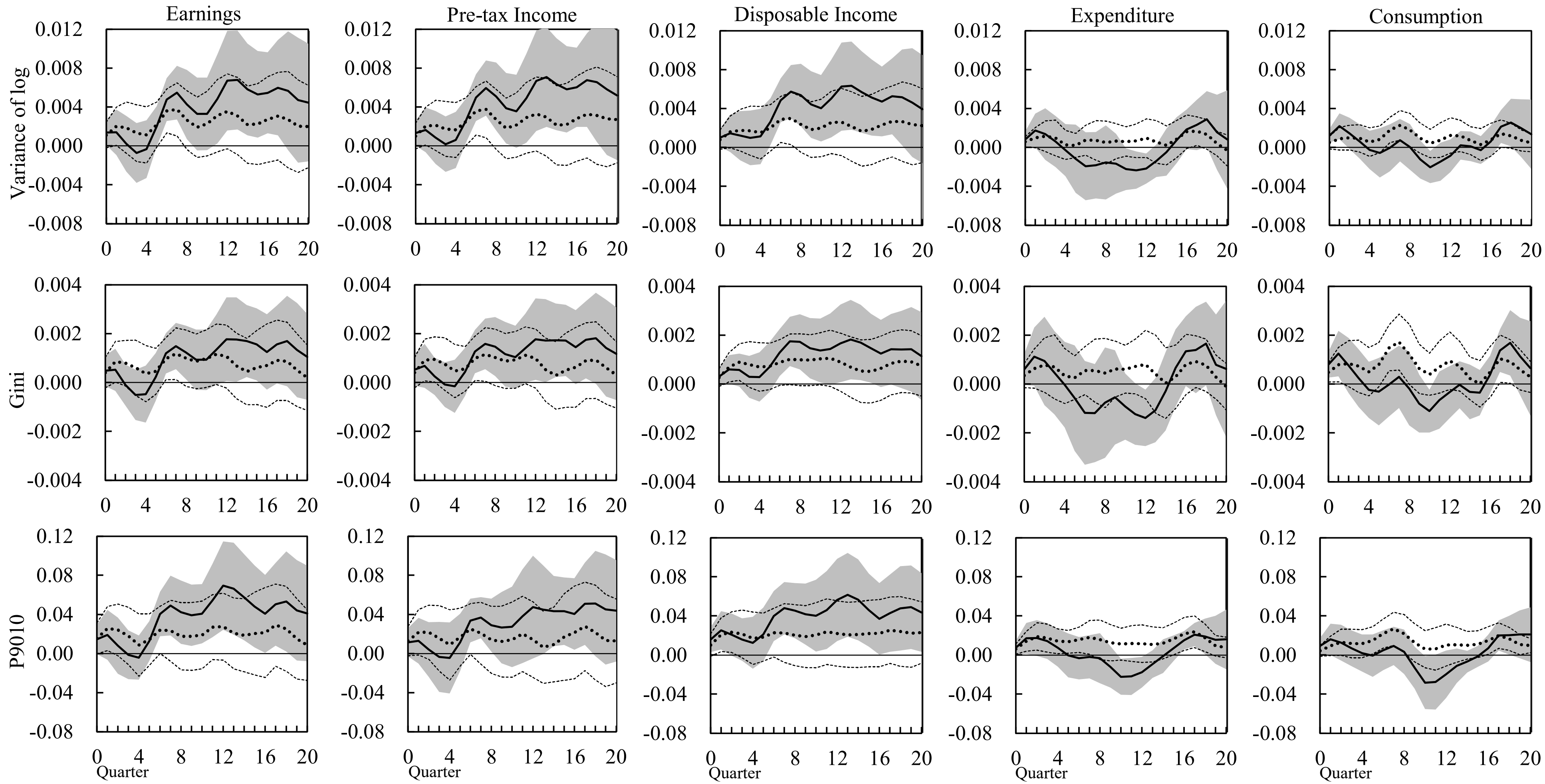
(b) P9010



Notes: 1. Figures in the panel (1) and (2) are computed using the response of stock prices and prices to an expansionary monetary shock as well as balance sheet information of households in each year. Case 1 and 2 differ in terms of estimated responses of the two variables. Case 1 uses the responses at 20th quarters after the impact period. Case 2 uses the responses at 8th quarters after the impact period. The solid line is the point estimate and the dark areas indicate 95% confidence intervals.

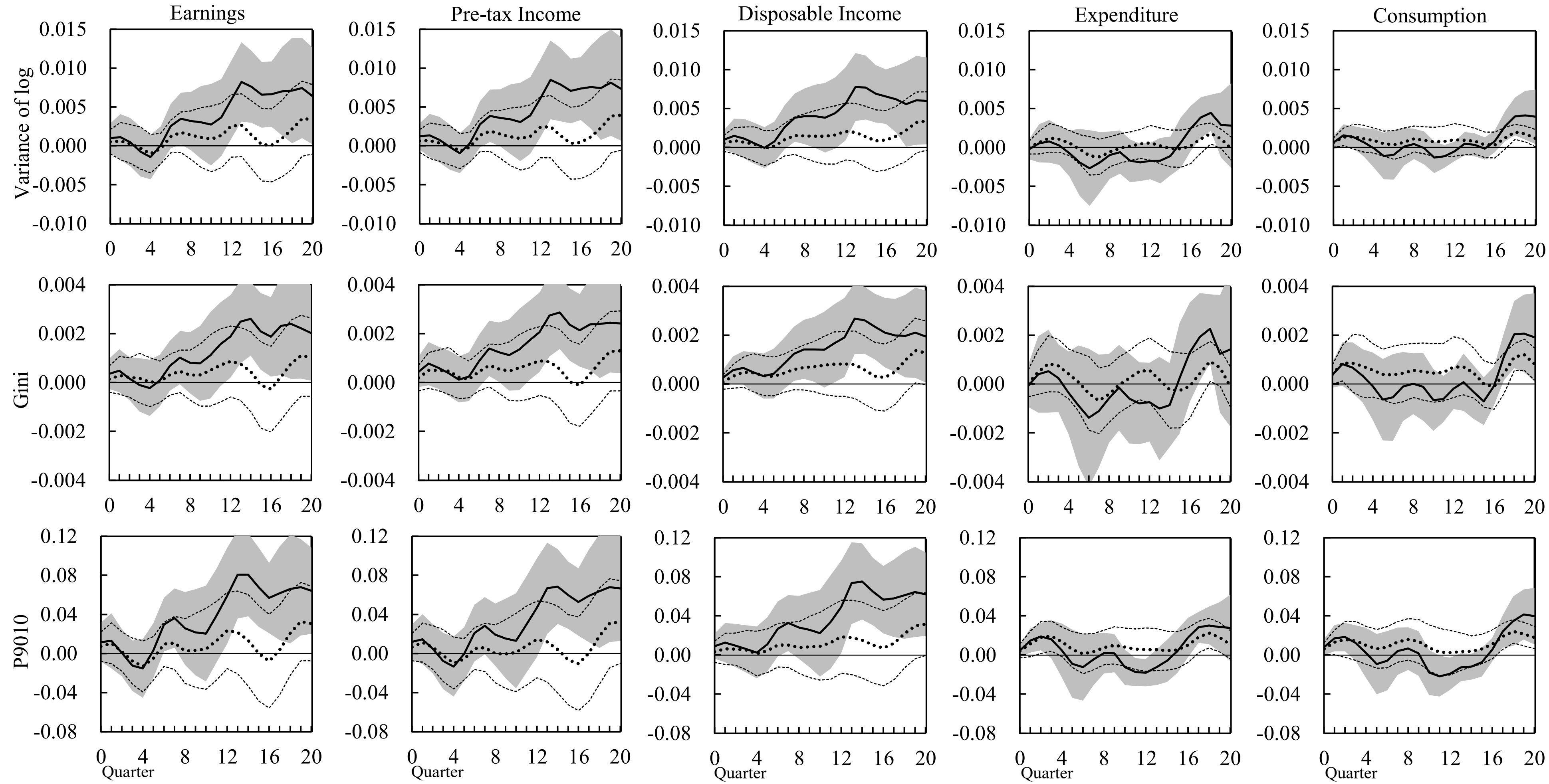
2. The panels (3) show the responses of inequality measures of financial assets to an expansionary monetary policy shock. The solid line is the point estimate and the dark areas are 95% confidence intervals based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 95% confidence intervals based on the data from 1981Q1 to 2008Q4.

Appendix C1: Effects of an expansionary monetary policy shock on inequality measures, Krippner (2015)



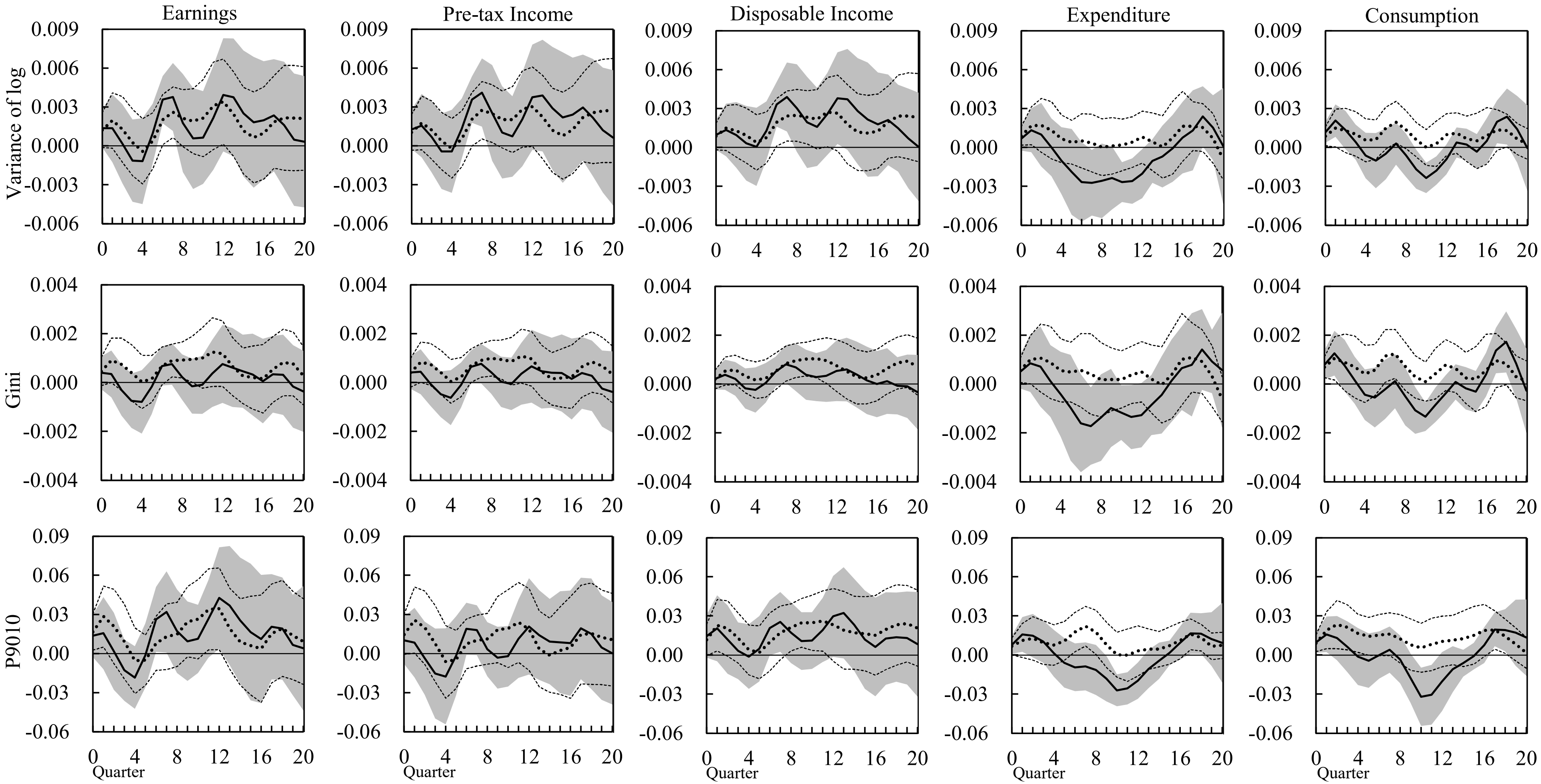
Note: The solid line is the point estimate and the dark areas are 95% confidence intervals of the estimate based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 95% confidence interval of the estimate based on the data from 1981Q1 to 2008Q4.

Appendix C2: Effects of an expansionary monetary policy shock on inequality measures, JGB-2Y



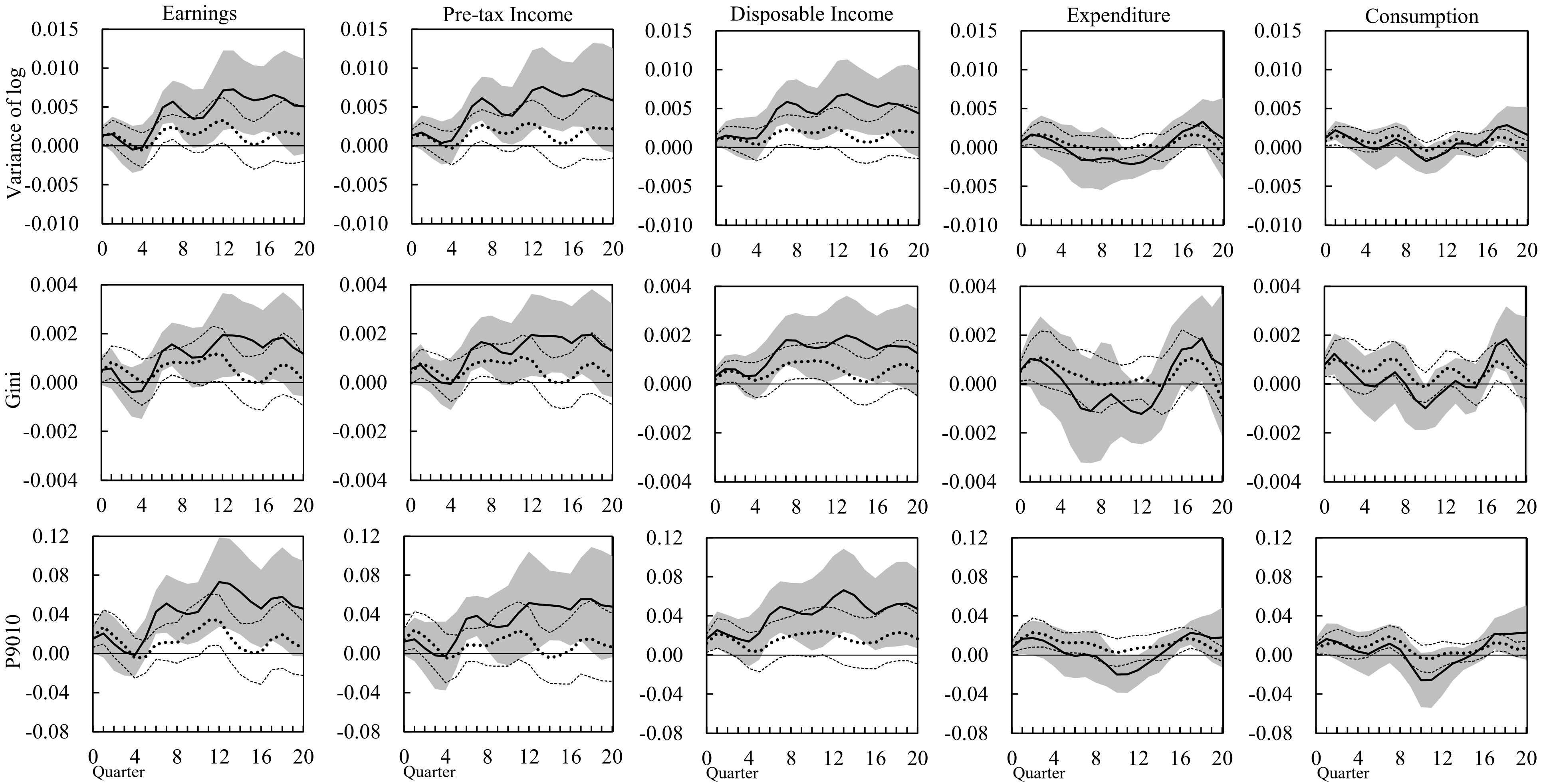
Note: The solid line is the point estimate and the dark areas are 95% confidence intervals of the estimate based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 95% confidence interval of the estimate based on the data from 1981Q1 to 2008Q4.

Appendix C3: Effects of an expansionary monetary policy shock on inequality measures, 3 factors



Note: The solid line is the point estimate and the dark areas are 95% confidence intervals of the estimate based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 95% confidence interval of the estimate based on the data from 1981Q1 to 2008Q4.

Appendix C4: Effects of an expansionary monetary policy shock on inequality measures, Alternative ordering of Cholesky decomposition



Note: The solid line is the point estimate and the dark areas are 95% confidence intervals of the estimate based on the data from 1981Q1 to 1998Q4. The dotted line is the point estimate and the light dashed lines show 95% confidence interval of the estimate based on the data from 1981Q1 to 2008Q4.