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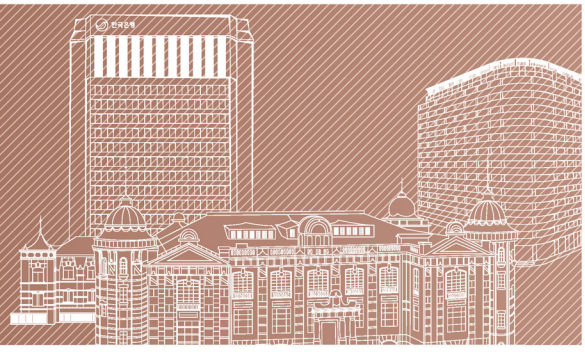
The Effects of Monetary Policy Shocks on Inflation Heterogeneity : The Case of Korea



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The Effects of Monetary Policy Shocks on Inflation Heterogeneity: The Case of Korea

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November, 2023

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Contents

The Effects of Monetary Policy Shocks on Inflation Heterogeneity: The Case of Korea

This paper analyzes the heterogeneous inflation responses by income group to monetary policy shocks. It constructs consumer price indices for different income quintiles using data from the Household Income and Expenditure Survey in South Korea and estimates inflation responses to monetary policy shocks through a local projection method. The estimation results reveal that the price index for high-income groups exhibits a higher sensitivity to monetary policy shocks compared to low-income groups. This is attributed to the high income elasticity of luxury goods, which constitute a significant portion of consumption among high-income households. Luxury goods are typically price rigid, but it has been observed that demand for luxury goods can be significantly responsive to income changes caused by monetary policy shocks, potentially amplifying price volatility. This indicates that monetary policy can generate redistributive effects not only in terms of income or assets but also from a price perspective.

Keywords: Monetary Policy Shocks, Inflation Heterogeneity, Inflation Inequality, Price Stickiness, Income Elasticity, Luxury Goods, Necessities, Sign Restricted VAR, Local Projection

JEL Classifications: C32, E00, E60

Ⅰ. Introduction

The global financial crisis brought attention to the redistribution effects of monetary policy, which were previously overlooked in macroeconomics. Before the crisis, there was a prevalent perception that there was little connection between monetary policy and inequality. Inequality was commonly attributed to skill-biased technological progress, increased international trade, and changes in labor market institutions. However, the excessive compensation of financial industry practitioners came into question during the global financial crisis, leading to the suggestion that central banks had been accommodating the financial sector through low interest rates. This raised significant interest in the relationship between monetary policy and inequality among major advanced economies, particularly the United States. As a result, numerous studies were conducted on this topic.

Initial research on the relationship between monetary policy and inequality primarily focused on income inequality or asset inequality. Coibion et al. (2017) argue that contractionary monetary policy increases inequality in labor income, total income, consumption and overall expenditure. Subsequent studies, such as Furceri et al. (2018), Samarina and Nguyen (2023), and Aye et al. (2019), continued to suggest that contractionary monetary policy shocks exacerbate income inequality. Studies on the relationship between monetary policy and asset inequality have also been reported, but the results vary depending on the countries and time periods analyzed. Hohberger et al. (2020) argue that expansionary monetary policy has a mitigating effect on asset inequality, whereas research by Albert et al. (2020) and Domanski et al. (2016) have reported that it exacerbates asset inequality.

Recently, there has been a growing interest in the distributional effects of monetary policy shocks from the perspective of prices and inflation. Recent empirical studies have revealed that households' consumption baskets are heterogeneously composed based on characteristics such as income or education level. Higher-income or more educated households tend to allocate a larger share of their consumption to non-essential items such as services and luxury goods, which are associated with higher nominal price stickiness. Conversely,

households with lower income and education levels allocate a higher share of their consumption to essential items like groceries and clothing. This implies that households of different income and education levels face varying levels of price and inflation fluctuations. Cavallo (2023) presented the result that low-income households in the United States experienced approximately twice the inflation compared to high-income households during the pandemic period, attributing it to the higher consumption share of essential goods such as food among low-income households. Cravino et al. (2020) found that households with higher income levels have a higher consumption share of non-essential goods such as services and luxury goods, which tend to have lower price adjustment frequencies, indicating a higher exposure of low-income households to inflation volatility. Additionally, Argente and Lee (2021) analyzed the inflation gap by estimating price indices by income levels for US households and found that the bottom income quartile households experienced about 2.4 times higher price increases compared to the top income quartile households during the Great Recession period from 2008 to 2013. Clayton et al. (2018) found that households' consumption baskets and inflation vary heterogeneously even across different education levels. They noted that households with higher education levels tend to consume relatively more goods with higher nominal price rigidity, and this works as a redistributive channel of monetary policy from an expenditure perspective.

Taking into account such household-specific inflation heterogeneity, the effects of monetary policy could also propagate heterogeneously through various channels. In particular, if heterogeneous inflation effects occur across income groups, it can be referred to as inflation inequality effects[1]. However, there is still a limited amount of research conducted on this topic. If monetary policy has heterogeneous effects on the prices of individual consumption items and brings significant differences in price burdens for low-income or high-income groups, it can provide useful insights not only for analyzing the effects of monetary policy but also for welfare analysis of economic agents, stabilization of the economy,

1) In this paper, inflation inequality is defined as uneven burdens on households or groups when inflation pressures arise.

resource allocation, optimal taxation, and other related aspects. This study, based on Korean data, empirically analyzes the impact of monetary policy on inflation inequality, considering these points. First, to measure inflation inequality, households are divided into five income groups, and income quintile-specific price indices are calculated by reflecting the consumption shares of each group. A relative price index is then calculated by dividing the price index of the lowest-income group by the price index of the highest-income group. Using the sign restriction approach proposed by Uhlig (2005), exogenous monetary policy shocks are identified, and the response of the relative price index to contractionary monetary policy shocks is estimated using the local projection method suggested by Jordà (2005).

Cravino et al. (2020) noted that high-income households tend to have a higher share of consumption in price-sticky luxury goods. When monetary policy shocks occur, their inflation rates in the consumption basket were reported to respond about one-third less than those of middle-income households. However, according to the estimations of this study, which uses Korean data, the analysis results reveal that the inflation index of the high-income group is more sensitive to monetary policy shocks. The inflation index of the high-income group decreases significantly more in response to contractionary monetary policy shocks and increases more substantially in response to expansionary shocks. This implies that factors other than price stickiness may also come into play. This possibility has also been corroborated in recent other studies. Argente and Lee (2021) argued that high-income households may have more opportunity to change their shopping behavior when they attempt to reduce their consumption expenditures, potentially explaining why high-income households respond more to monetary policy. Furthermore, Ampudia et al. (2023) provided empirical evidence suggesting that inflation among high-income households could respond more sensitively to monetary policy shocks, citing differences in shopping behavior as a potential cause.

This paper proposes the primary mechanism by which monetary policy triggers inflation heterogeneity as follows: The left-hand side represents the extent of inflation changes in individual items resulting from monetary policy

shocks, and the right-hand side breaks it down into respective pathways:

$$\frac{\Delta P}{\Delta MP} = \frac{\Delta M}{\Delta MP} \times \underbrace{\frac{\Delta Q}{\Delta M}}_{\substack{Income\ Elasticity \\ of\ Demand\ Effects}} \times \underbrace{\frac{\Delta P}{\Delta Q}}_{\substack{Price\ Rigidity \\ Effects}} \tag{1}$$

Here, P represents prices, MP represents monetary policy shocks, M represents income, and Q represents demand for individual items. For example, when a contractionary monetary policy shock occurs, leading to an increase in interest rates and an economic slowdown with reduced investments and employment, household incomes decrease($\Delta M/\Delta MP < 0$). Households tend to reduce their consumption, and the extent of this reduction can vary depending on the nature of the goods. Following the general definitions, luxury goods often experience a significant decrease in demand ($\Delta Q/\Delta M > 1$), while essential goods experience a relatively smaller decrease ($1 > \Delta Q/\Delta M > 0$). The differing income elasticities of goods can be seen as a primary factor in generating inflation heterogeneity. Luxury goods, experiencing a significant drop in demand, exert substantial downward pressure on prices, whereas essential goods exhibit relatively less downward pressure. Furthermore, even for the same reduction in demand, the magnitude of price declines can vary depending on the nature of the goods ($\Delta P/\Delta Q > 0$). Goods with higher price rigidity respond less sensitively to price changes, resulting in smaller price declines. Therefore, based on this pathway, it can be understood that two key factors, namely income elasticity and price rigidity, play a role in generating inflation heterogeneity across goods. Even if luxury goods exhibit price rigidity as suggested by Cravino et al. (2020), significant demand change due to monetary policy shocks can still result in greater price fluctuations in luxury goods compared to essential goods.

To verify these pathways, this paper reviews the monetary policy shock responses and income elasticity estimation results for each of the 66 consumption sub-items and presents the analysis findings. The results showed that items with higher income elasticity exhibited larger price declines in response to contractionary monetary policy shocks. This supports the effective operation of the

income elasticity path in the transmission process. Additionally, this study estimated the price elasticity of demand for each consumption item to estimate price rigidity. The empirical analysis confirmed the previously suggested relationship that items with stronger luxury characteristics exhibit higher price rigidity. Therefore, the extent of inflation inequality due to monetary policy is determined by the relative magnitude of these two effects. Based on the Korean data, it is estimated that the income elasticity effect is relatively higher than the price rigidity effect. Consequently, implementing contractionary monetary policy is expected to result in larger price declines for luxury goods, leading to increased inflation inequality.

The structure of this paper is as follows. First, in Chapter 2, the consumer price index was calculated by income quintiles using the raw data from the Korean Household Income and Expenditure Survey. In Chapter 3, the VAR model incorporating sign restrictions was used to identify monetary policy shocks. Chapter 4 estimated the item-level responses of the consumer price index to monetary policy shocks using local projection methods, and analyzed the response of the consumer price index by income quintiles to examine inflation inequality. The study also examined the paths of income elasticity and price rigidity, which are the channels through which monetary policy shocks affect inflation inequality. Finally, Chapter 5 presents the conclusions.

Ⅱ. Measurement of Consumer Price Index by Income Quintiles

The experienced inflation in daily life by the general population can differ from the movement of actual consumer prices. This difference can be attributed to variations in the consumption structure based on income quintiles. For instance, lower-income households, which allocate a higher proportion of their total expenditure to food, may feel a more significant impact from rising food prices.

Currently, official statistics in South Korea do not provide consumer price indices by income quintiles. Consequently, there have been numerous attempts to estimate income-quintile-specific price indices using microdata. Kim et al. (2015) utilized data from the household Income and Expenditure survey conducted by Statistics Korea to calculate household-equivalent price indices and

compare the rate of increase across income or age groups. The findings indicated that lower-income households experienced a greater disparity with the official inflation rate compared to the middle-income group. Similar results were presented by Jang (2011), who divided the inflation rate by income group and found that the inflation rate for the bottom 10% of households was, on average, 0.2 percentage points higher than that of the top 10% of households. It was also observed that the inflation experienced by low-income groups tended to be more significant during periods of overall price increases, indicating greater price volatility. This study also considered the differences in consumption patterns and calculated income-quintile-specific consumer price indices to examine the impact of monetary policy on inflation heterogeneity.

The overall consumer price index represents the weighted average variation of prices for representative items. The relative importance of each representative item is determined by its weight, which reflects the proportion of expenditure on that item in the overall household consumption. The weights for individual items are derived from the household Income and Expenditure survey conducted by Statistics Korea. Currently, Statistics Korea calculates the consumer price index by averaging the weighted prices of 460 representative items, using the weights based on the consumption patterns of households in 2017, which have been applied since January 2017.

The consumer price index is calculated using the Laspeyres formula, which utilizes fixed weights from a base period. However, as time passes, this approach may not accurately reflect the reality due to the fixed weights for individual items. To address this limitation, Statistics Korea periodically updates the weights, not only through a base period revision every five years but also through revisions in the 2nd and 7th years.

In this analysis, income-quintile-specific consumer price weights for the period from 2003 to 2016[2] were estimated using the data of the Household Income and Expenditure Survey and the weights provided by Statistics Korea for

2) The present study sets its scope from 2003 to 2016, as the Household Income and Expenditure Survey expanded its coverage from urban households with two or more individuals to all households with two or more individuals in 2003, and underwent methodological changes in 2017.

the base years[3]. Since publicly available microdata from the survey only provide information on consumption expenditure for 93 items, the expenditure of the 460 items by income quintile and year was indirectly estimated. Given that there is no official linkage table between the items in the survey and the consumer price index weights from Statistics Korea, a linkage table was established by matching the items based on the COICOP[4] classification.

Utilizing the estimated weights for each income quintile, income-quintile-specific consumer price indices were calculated through two methods. Firstly, a method similar to that of Statistics Korea was applied, where separate consumer price index time series for each base year (2000, 2005, 2010, 2012, and 2015) were derived using the corresponding weights. These series were then connected using the annual chaining method, involving the creation of monthly chain indices based on the average prices of the previous year and multiplying them with the index of the previous year to determine the index for each month. For example, the annual chaining method used in calculating the 2015 consumer price index is as follows:

$$CPI^{2015.m} = \frac{\sum P_i^{2014} \omega_i^{2014}}{\sum P_i^{2014} \omega_i^{2015}} \times \sum P_i^{2015.m} \omega_i^{2015} \tag{2}$$

In equation (2), $CPI^{2015.m}$ represents the Consumer Price Index for the specific month m in the year 2015. P_i^y and ω_i^y represent the price index and weight, respectively, for item i in year y. The expression $\frac{\Sigma P_i^{2014} \omega_i^{2014}}{\Sigma P_i^{2014} \omega_i^{2015}}$ in equation (2) calculates the month-to-month index.

Secondly, the specific month-chaining method was employed to calculate the income group-specific Consumer Price Index with the updated weights for each year[5]. The specific month-chaining method calculates the chained index for

3) Weighting adjustments were made in 2005, 2010, 2012, and 2015 within the period of 2003 to 2016.

4) Classification Of Individual Consumption according to Purpose

5) The second method has the advantage of reflecting changes in consumption patterns more promptly since it updates the weights annually. However, for years other than the reference year in which the consumption structure for the 460 items is provided, the process of estimating weights using microdata

each month by multiplying the monthly relative index with the previous year's ending month index. The calculation for the Consumer Price Index in 2015 is as follows:

$$CPI^{2015.m} = \frac{\sum P_i^{2014/12} \omega_i^{2014}}{\sum P_i^{2014/12} \omega_i^{2015}} \times \sum P_i^{2015.m} \omega_i^{2015} \quad (3)$$

In equation (3), $\frac{\Sigma P_i^{2014/12} \omega_i^{2014}}{\Sigma P_i^{2014/12} \omega_i^{2015}}$ represents the monthly chain index for the month "m."

This study utilized the concept of equivalized disposable income as a basis for determining income distribution. Since the Household Income and Expendituer Survey is conducted at the household level, it is necessary to transform household income into individual income, known as equivalized individual income. In Korea, the Organization for Economic Cooperation and Development (OECD) square root scale method is employed for equivalization. The OECD square root scale method calculates equivalized individual income by dividing household income by the square root of the number of household members.

Equivalized disposable income is the income obtained by adding public transfers to equivalized market income and subtracting public transfers and taxes. Equivalized market income consists of the sum of earned income, business income, property income, and private transfers, representing the income directly earned by the household. Public transfers include public pensions such as national pension and civil servant pensions, as well as basic pensions. Public transfers and taxes include social security contributions and taxes. When analyzing income distribution using a single income indicator, either equivalized market income or equivalized disposable income can be used as the basis.

The following figures illustrate the consumer price index (CPI) by income quintiles. Figure 1 represents the yearly increasing rates of the consumer price index for each income group. Figure 2 shows the ratio of the consumer price index perceived by the lowest-income group (denoted as 'CPI1') to the consumer

from the Household Income and Expenditure Survey is required.

price index perceived by the highest-income group (denoted as 'CPI5'). An increasing ratio indicates that the inflation rate perceived by the low-income group is relatively higher. The trend since 2003 indicates a gradual increase in this ratio, particularly from 2010 onwards.

Figure 1. Income Specific Consumer Price Index Increasing Rates(YoY)

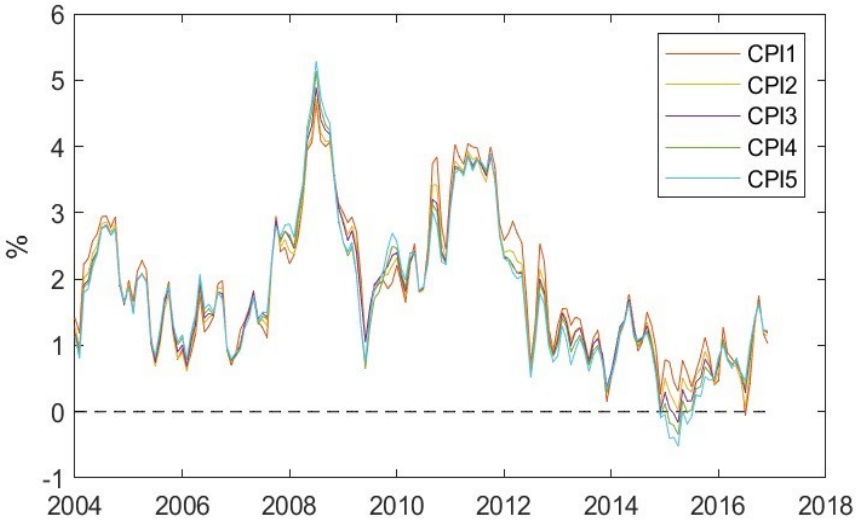
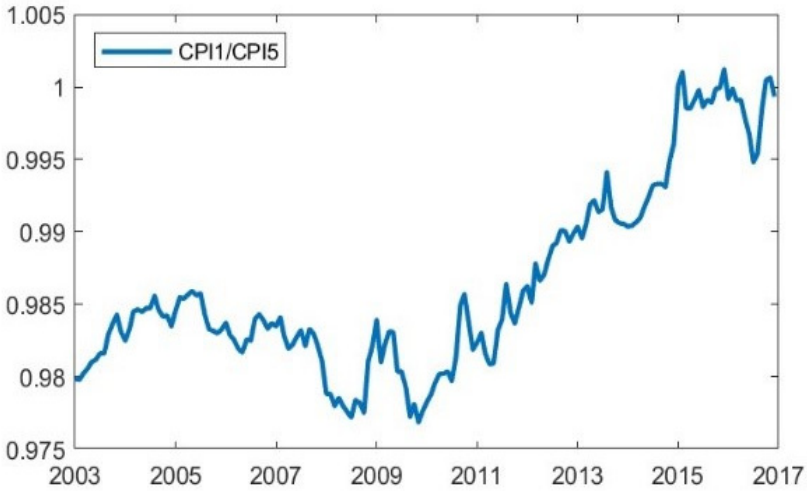


Figure 2. Trend of Consumer Price Index Ratios by Income Quintiles



Ⅲ. Identification of Monetary Policy Shocks

3.1. Identification Models and Estimation Methods

To examine the impact of monetary policy shocks on inflation, it is necessary to first extract exogenous monetary policy shocks. In this study, monetary policy shocks are limited to the shocks resulting from the Bank of Korea's Monetary Policy Committee independently adjusting the policy interest rate, regardless of the expectations of other economic agents, under the condition that all other conditions remain constant. The reason for defining monetary policy shocks in this way is that the policy instruments controlled by monetary authorities, such as interest rates or money supply, generally have endogeneity issues. This means that if the policy instruments of the monetary authorities are determined according to certain rules or in response to other macroeconomic shocks, they cannot be regarded as independent shocks.

VAR (Vector Autoregression) models or DSGE (Dynamic Stochastic General Equilibrium) models are widely used for identifying monetary policy shocks. DSGE models have the advantage of inferring structural relationships based on macroeconomic theory but suffer from the drawback of incorporating arbitrary structural constraints. On the other hand, VAR models have limitations in identifying structural relationships but offer the advantage of relative flexibility in model specification. Therefore, VAR models have been widely used for empirical analysis of responses to macroeconomic shocks. In this study, VAR models were employed to identify monetary policy shocks.

Various methods, such as recursive identification, short-run restrictions, and long-run restrictions, can be used to identify monetary policy shocks using VAR models. However, recently, the sign restrictions approach has been widely used for identifying monetary policy shocks. The sign restrictions approach, proposed by Faust (1998), Uhlig (2005), and others, constrains the signs of shock responses in order to avoid liquidity puzzles or price puzzles. It has the advantage of intuitive constraint specification and robustness to model specification. Taking these factors into account, this paper imposed sign restrictions to identify monetary policy shocks and specifically followed the estimation method proposed by Uhlig (2005).

To explain the estimation method using a structural VAR model with sign restrictions, the following steps were taken. First, we assume the following reduced-form VAR model:

$$Y_t = B(L)\,Y_{t-1} + C(L)X_t + u_t \tag{4}$$

Here, Y_t is an $l \times 1$ vector of endogenous variables, X_t is an $m \times 1$ vector of exogenous variables, and u_t is an $l \times 1$ vector of disturbance terms satisfying $E(u_t) = 0$ and $E(u_t u_t') = \Sigma$. $B(L)$ and $C(L)$ are polynomial matrices of dimension $l \times l$ and $l \times m$, respectively, with respect to the lag operator L.

The reduced-form disturbance vector can be expressed as a linear combination of structural shocks, as follows:

$$u_t = Av_t \tag{5}$$

Assuming A is an $l \times l$ matrix and v_t is an $l \times 1$ vector representing structural shocks with $E(v_t) = 0$ and $E(v_t v_t') = 1$. Here, Uhlig (2005) identifies only one structural shock, which can be seen as identifying a single row of matrix A. Uhlig (2005) refers to such a vector, when $a \in R^m$ is one column of matrix A, as an impulse vector. Furthermore, Uhlig (2005) shows that the impulse vector a can be expressed as follows:

$$a = \tilde{A}\alpha \tag{6}$$

Here, $\tilde{A}\tilde{A}' = \Sigma$, where $\tilde{A}$ is the Cholesky factorization of Σ, and α represents a one-dimensional vector indicating the unit length. Therefore, the impulse response function vector $r_a(k)$ for a can be expressed as:

$$r_a(k) = \sum_{j=1}^{i} \alpha_j r_j(k) \tag{7}$$

Here, $r_j(k) \in R^i$ is the vector of k-period responses for the jth shock in the case of Cholesky decomposition. Next, sign restriction is imposed on each element of the impulse response function vector $r_a(k)$ for various periods k,

Uhlig (2005) applies a pure sign restriction approach. According to this approach, Bayesian priors are assumed for the VAR estimation coefficients (B, Σ), and an independent uniform prior is assumed for α. Probability bands are constructed for candidate solutions satisfying the sign restrictions to estimate the coefficients.

3.2. Analysis Data and Model Specification

To identify monetary policy shocks, five types of models were employed. The identification method for monetary policy used the sign restriction approach described earlier, with two models estimated including only endogenous variables, while the other three models included exogenous variables to control for external shocks. Table 1 summarizes the endogenous and exogenous variables included in each model.

Table 1. Identification Models and Variables with Sign Restrictions

		Model1	Model2	Model3	Model4	Model5
Endogenous Variables	Call Rate	●(+)	●(+)	●(+)	●(+)	●(+)
	Real GDP		●(−)		●(−)	●(−)
	Industrial Production Index	●(−)		●(−)		
	Consumer Price Index	●(−)	●(−)	●(−)	●(−)	●(−)
	Commodity Price Index	●(−)	●(−)	●(−)	●(−)	●(−)
	Base Money	●(−)	●(−)	●(−)	●(−)	●(−)
Exogenous Variables	Oil Price			●	●	●
	US Real GDP			●	●	●
	US Policy Interest Rate			●	●	●
	US Consumer Price Index					●
	Dummy Variable					●

Note: Variables included in the models are indicated by '●', and the parentheses indicate the imposed sign constraints.

Six variables were used as endogenous variables: Call Rate, Real GDP, Industrial Production Index, Consumer Price Index, Commodity Price Index, and Base Money. Instead of using the policy interest rate as the indicator for

interest rates, the Call Rate was employed. This choice was based on the fact that the Call Rate was the policy target rate prior to the shift in the policy objective from the policy interest rate. Furthermore, it closely tracks the policy interest rate even after the change in the policy objective. For production indicators, Real GDP and the Industrial Production Index were employed. However, since Real GDP is reported on a quarterly basis, the monthly Industrial Production Index was used to convert it into monthly data using the Chow-Lin method and seasonally adjusted with X-13ARIMA. To ensure robustness, Models 1 and 3 identified monetary policy shocks using the seasonally adjusted series of the Industrial Production Index instead of Real GDP. The Consumer Price Index was included as a variable, taking into account that the Core Consumer Price Index was adopted as the target price index during the initial period of the inflation targeting regime (from 2000 to 2006), and the Consumer Price Index was adopted as the target price index for other periods. Price indices were seasonally adjusted using X-13ARIMA. Additionally, the Commodity Price Index was included to avoid the price puzzle, and the Base Money variable was added to reflect the credit channel in the transmission of monetary policy.

Models 1 and 2 identified monetary policy shocks using only endogenous variables. The analysis data spanned from January 2002 to December 2021 on a monthly basis. All variables, except for the interest rate indicator, were logarithmically transformed and multiplied by 100. Sign restrictions for monetary policy identification were imposed uniformly on each endogenous variable for a six-month period. The study defined a contractionary monetary policy shock as an increase in the Call Rate and decreases in production indicators and price indices. Furthermore, the Commodity Price Index and Base Money were set to have a negative relationship with the monetary policy shock.

Models 3, 4, and 5 included exogenous variables for analysis. As South Korea is a small open economy influenced by external factors, the impact of exogenous shocks could be incorporated into the identification of monetary policy shocks. Assuming that the U.S. economy represents the external economy, relevant variables related to the U.S. were added as exogenous variables. In Models 3 and 4, international crude oil prices, U.S. Real GDP, and U.S. policy interest rates were included. U.S. Real GDP not only reflects U.S. economic activities but also

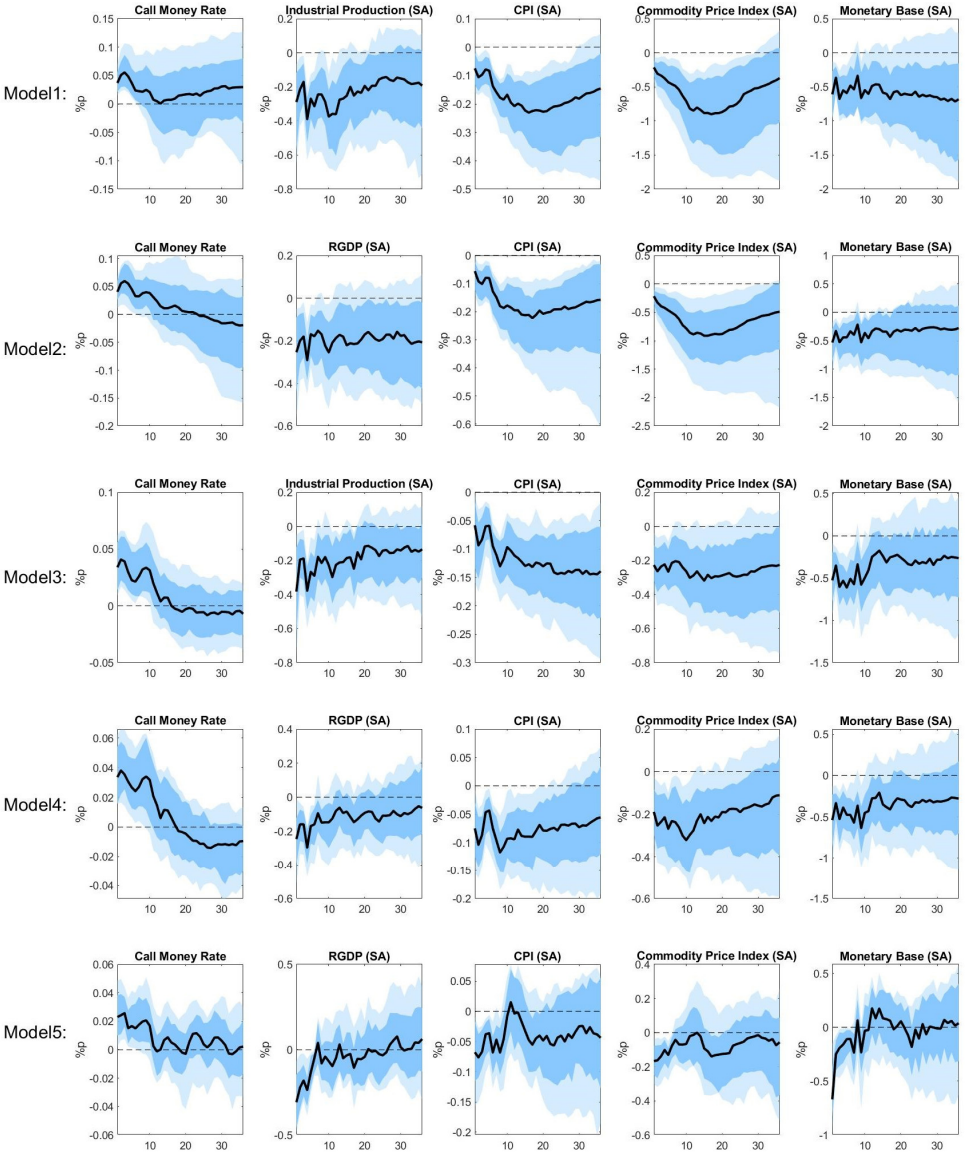
has a significant impact on global trade volume, which could exert an exogenous influence on changes in South Korea's real economy. U.S. policy interest rates are essential variables representing overall U.S. macroeconomic conditions and could potentially affect major macroeconomic variables in South Korea through financial capital flows and major country exchange rates. However, due to the prolonged period of near-zero nominal interest rates in the U.S. during the analysis period and the predominant use of quantitative easing as a policy tool after the global financial crisis, the "shadow policy rate" based on Wu and Xia (2016) was used instead of the Federal Fund rate alone to sufficiently reflect the monetary policy stance. In Model 5, the U.S. Consumer Price Index was included to control for foreign price levels, and dummy variables were added to capture the impact of the global financial crisis in 2008-2009. Like the endogenous variables, all variables except the interest rate indicator were logarithmically transformed and multiplied by 100, and seasonally adjusted series were used[6].

3.3. Identification results of monetary policy shocks

Figure 3 presents the impulse response results of monetary policy shocks estimated using the five models mentioned above. In all five models, a contractionary monetary policy shock led to an increase in interest rates and a decline in production indicators, consumer prices, and commodity prices. The monetary shock of raising the call rate by around 5 basis points resulted in a decrease in real GDP of around 0.2%p and an estimated decline of approximately 0.3%p in the industrial production index. For the consumer price index, it showed a decrease of around 0.2%p in models 1 and 2, but in models with controlled external factors, the magnitude of the decline was generally below 0.1%p, and the duration was shorter. We can observe that indicators such as the commodity price index and the monetary base also decline significantly according to the sign restrictions. Figure 4 illustrates the time series of identified monetary policy shocks for each model. Based on this, the next chapter utilizes local projection methods to estimate the impact on inflation heterogeneity.

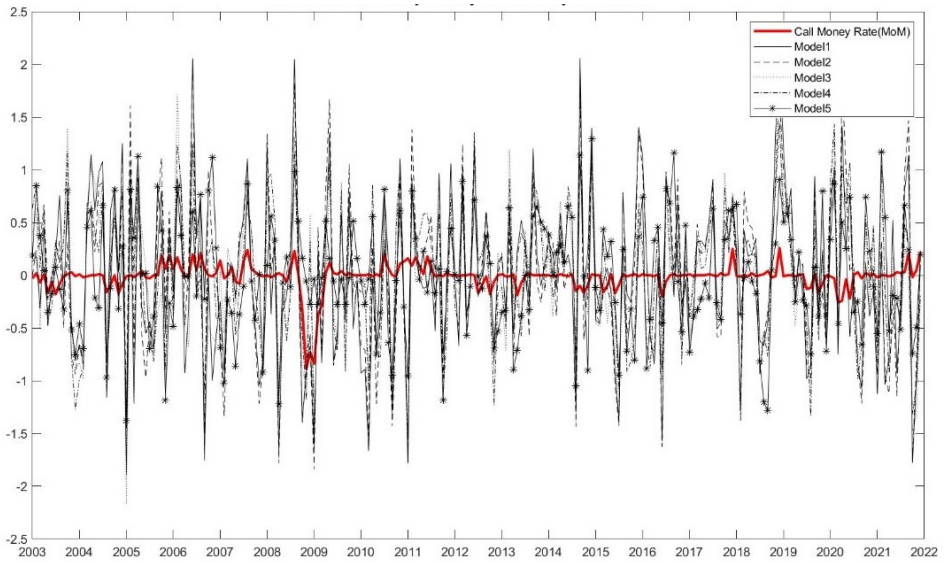
6) International oil prices were seasonally adjusted using X-13ARIMA before being used in the analysis.

Figure 3. Impulse Responses of Variable to Monetary Policy Shock



Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively. The horizontal axis represents the time period in months.

Figure 4. Identified Monetary Policy Shock Time Series by Model



Ⅳ. The Impact of Monetary Policy Shocks on Household Inflation Heterogeneity

4.1. The Impact of Monetary Policy on Inflation by Income Percentile

Using the local projection method proposed by Jordà (2005), the analysis estimated the impact of monetary policy shocks on price levels across income quintiles. The local projection method is superior to the conventional VAR shock response analysis in capturing asymmetry effects in terms of shock direction and magnitude, and it is known to have fewer biases caused by misspecification errors compared to the dynamic models. A brief description of the model is provided below.

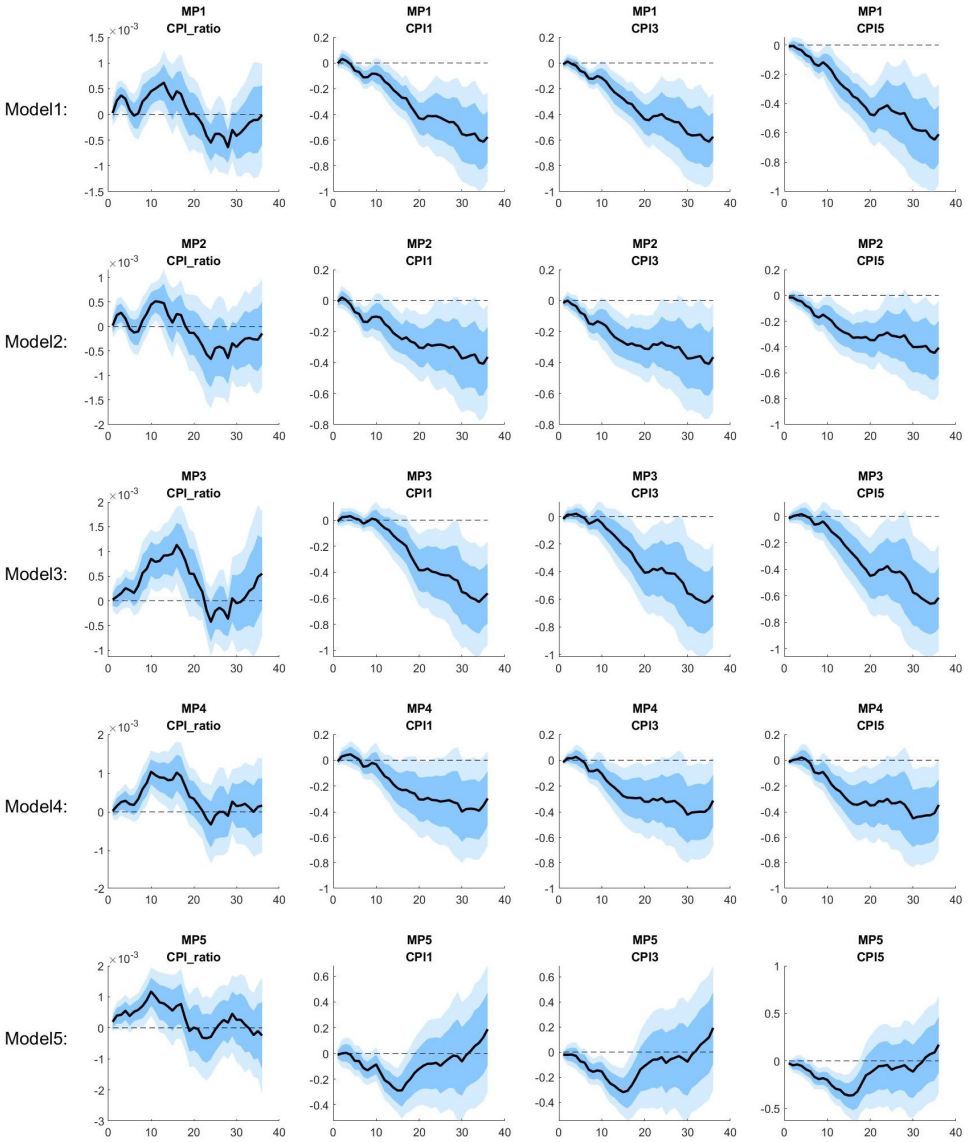
$$X_{t+h} - X_{t+h-1} = C^h + \sum_{j=1}^{J} a_j^h (X_{t-j} - X_{t-j-1}) + \sum_{i=1}^{I} \beta_i^h e_{t-i}^{mp} + \epsilon_{t+h}, \quad h = 0, \ldots, H \tag{8}$$

In this model, X_t represents the price index for each income quintile, and the consumer price index (CPI) for each income quintile derived in Chapter 2 was used. e_t^{mp} represents the respective monetary policy shocks extracted from the five VAR models in Chapter 3. The analysis period is from January 2003 to December 2016, depending on the length of the income quintile-specific price index time series calculated earlier. Using the estimated $\left\{\hat{\beta}_i^h\right\}_{h=0}^{H}$ obtained from the regression equation, accumulated impulse responses were derived. Both J and I were set to 6, and the time horizon H for the impulse response functions was set to 36.

Figure 5 illustrates the response of the consumer price index for each income quintile to contractionary monetary policy shocks identified by the five different models. Each row represents the estimation results for each model, and each column represents the response of the relative consumer price index, CPI for income quintile 1 (low-income group), CPI for income quintile 3, and CPI for income quintile 5 (high-income group), respectively. The relative consumer price index is calculated by dividing the price index for the 1st income quintile by the price index for the 5th income quintile, and an increase in the index signifies that the price index for the low-income strata has declined relatively less. The shaded areas represent the 68% and 90% confidence intervals[7]. The horizontal axis represents the duration of the impulse response in months.

7) The confidence intervals were calculated using the delta method, which utilizes the central limit theorem.

Figure 5. Response of Income-specific Price Index to Monetary Policy Shock



Note: The solid line represents the median response of the shock, while the shaded areas represent the 68% and 90% percentile confidence intervals. The horizontal axis represents the time period in months. Due to space limitations, the CPI responses for income quintiles 2 and 4 have been excluded.

Based on the estimation results, monetary policy shocks from all five models significantly lowered the CPI for each income quintile. Furthermore, irrespective of the model used, the monetary policy shocks consistently led to a significant increase in the CPI ratios for a specific period. However, the duration of the noticeable increase varied slightly across models. The relative price index, in the case of models 1, 2, and 5, shows a significant increase around 10 months before and after the shock, while according to the estimated results of models 3 and 4, the index is estimated to increase significantly for a period of 10-20 months. These findings indicate that when contractionary monetary policy shocks occur, the price index of the high-income group tends to decline more than the price index of the low-income group. The weights of income quintile-specific price indices remain fixed for a certain period regardless of monetary policy shocks. Therefore, this decline in prices indicates a more sensitive response of goods and services with a higher consumption share by the high-income group to monetary policy shocks. In this paper, focusing on the perspective of inflation burden on households or groups, if the perceived price level by the lower-income group is relatively higher than that of the higher-income group, it can be evaluated as an exacerbation of inflation inequality.

4.2. Transmission Channels: The Impact of Monetary Policy on Prices by Consumer Goods Types

Monetary policy shocks can have a significant impact on households' real income through channels such as asset price dynamics, interest rate changes, and credit conditions. When contractionary monetary policy leads to an increase in interest rates, household wealth can decrease due to declining asset prices, and if there is a high proportion of borrowing households in the economy, the increase in interest burden can reduce disposable income. Moreover, a contractionary stance in monetary policy can affect banks' lending behavior, leading to a contraction in business investment and employment, which in turn can result in a decrease in income.

The decrease in household income leads to a reduction in consumption, and the magnitude of demand reduction can vary depending on the nature of goods.

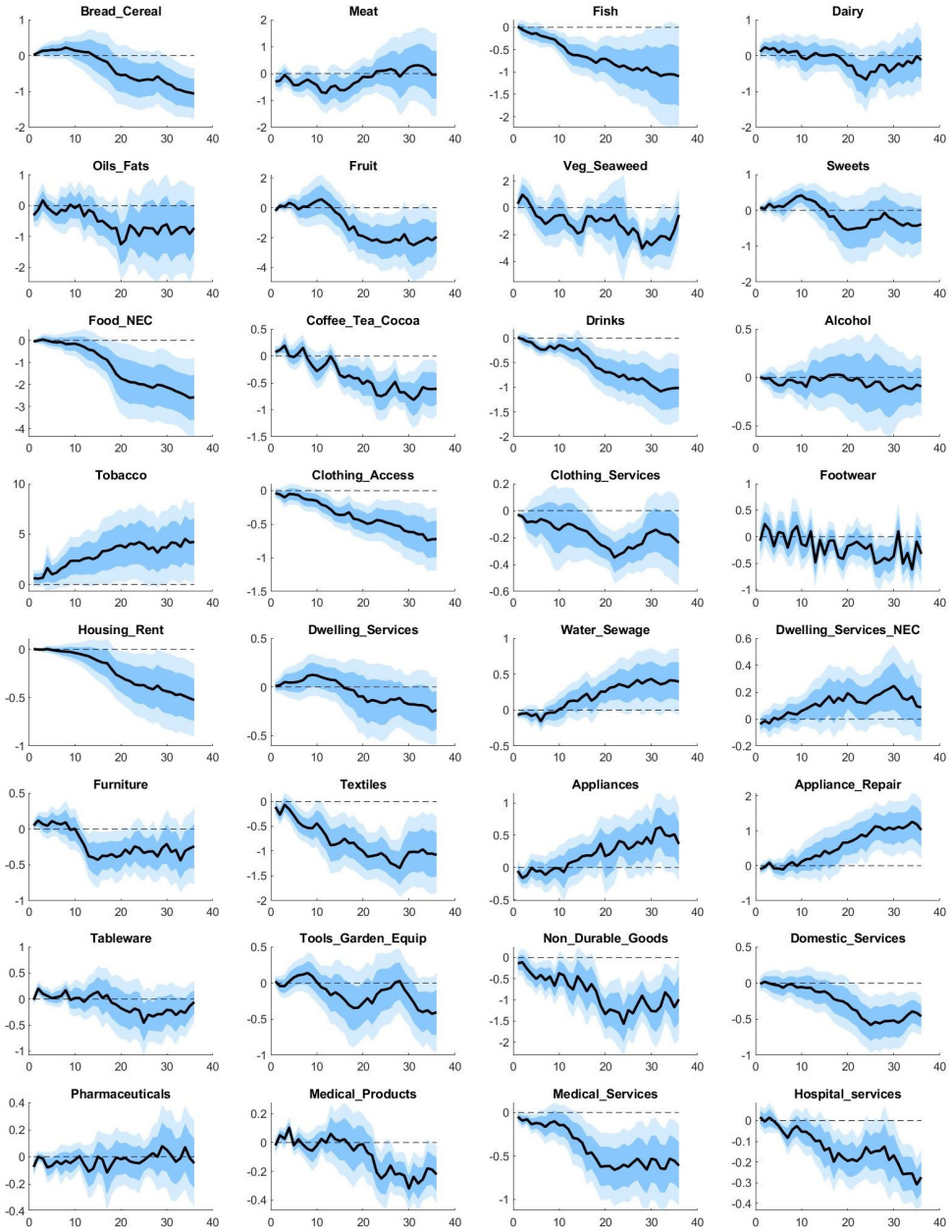
Generally, goods are categorized as normal or inferior based on the direction of changes in demand in response to income changes. Among normal goods, if the income elasticity of demand is greater than 1, they are defined as luxury goods, and if the income elasticity is less than 1, they are defined as necessity goods. Accordingly, when real household income decreases due to contractionary monetary policy shocks, the demand for luxury goods may decrease relatively more, while the demand for necessity goods may decrease relatively less. Due to these differences in demand reduction, luxury goods can experience significant downward price pressures, while necessity goods may experience relatively lower price pressures. To examine this relationship, the consumer price index responses to monetary policy shocks were estimated separately for each subcategory, and the income elasticities of demand for each subcategory were calculated to examine the relationship.

Figure 6 shows the responses of 66 subcategories of the consumer price index to contractionary monetary policy shocks. The price responses for each subcategory were estimated using the same local projection method as before. The time series of monetary policy shocks were based on the estimated results of model 1[8], and the analysis data covered monthly data from January 2003 to December 2016[9]. The consumer price index was seasonally adjusted using the X-13ARIMA procedure.

8) To assess robustness, additional analyses were conducted using models 2 to 5, and the results are presented in the appendix.

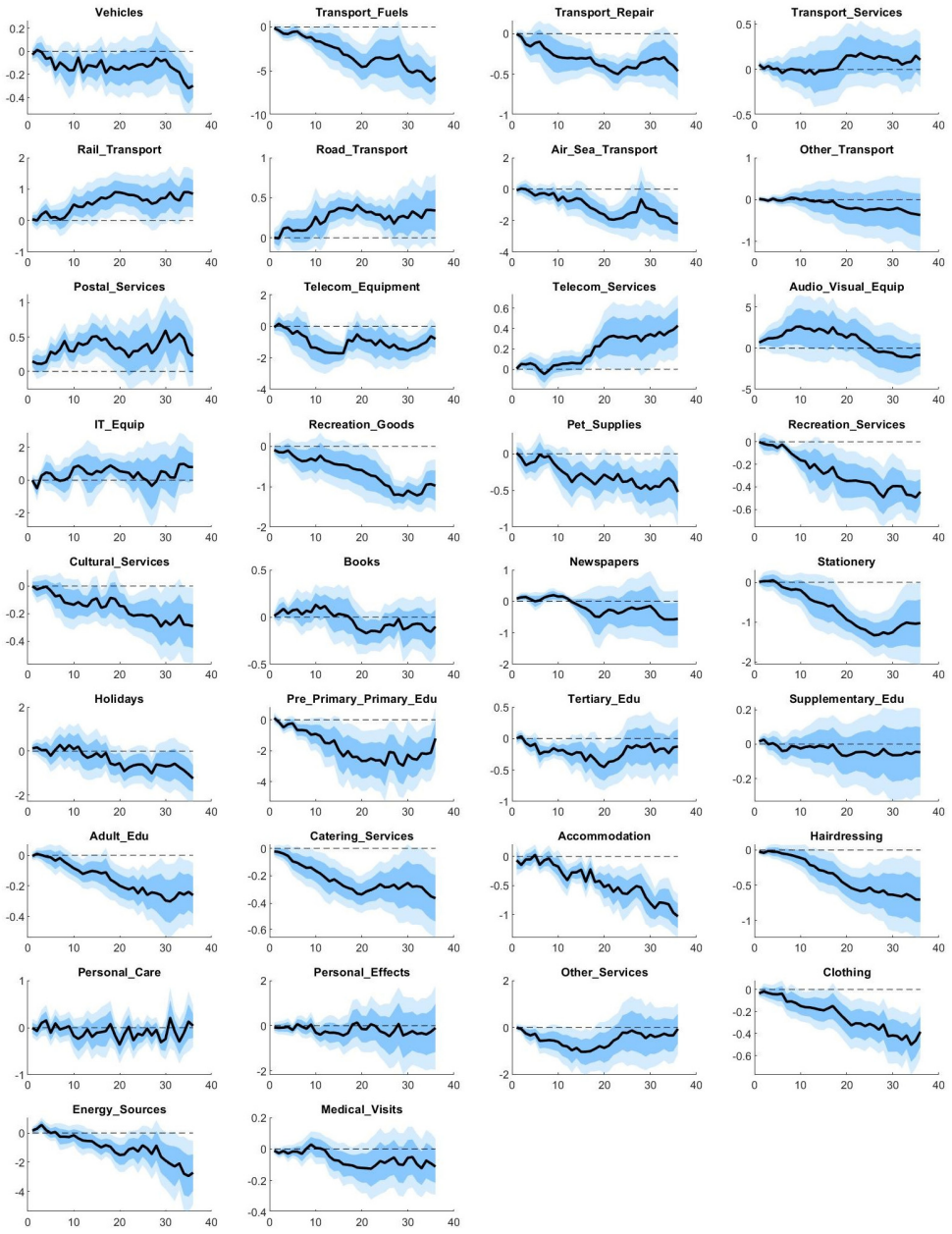
9) The monetary policy shock time series identified for each model and the subcategory-specific price indices were available from 2003 to 2021, as mentioned earlier. However, to compare income elasticities, the Household Income and Expenditure Survey data were used, and the period was aligned with the data up to 2016.

Figure 6-1. Responses of Consumer Price Index Subcategories to Tight Monetary Policy Shocks



Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure 6-2. Responses of Consumer Price Index Subcategories to Tight Monetary Policy Shocks



Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Regarding the response of individual categories to tight monetary policy shocks, they generally exhibit significant price declines but display heterogeneity in terms of the magnitude, patterns, starting points, and duration of the price declines. To investigate whether items with high income elasticity of demand, which can be considered as luxury goods, are more sensitive to monetary policy shocks, income elasticities were estimated for the aforementioned 66 items. To do this, individual consumption time series data for each item were required, so the consumption data of sampled households from the Household Income and Expenditure Survey were matched with the 66 subcategories of the Consumer Price Index. However, it should be noted that due to a change in the survey methodology in 2017, where expenditure data was collected annually instead of quarterly, the time series became discontinuous, and quarterly data was used only until 2016. The income elasticity of demand for each category was measured according to the following equation.

$$ln C_{it} = \gamma_i^0 + \gamma_i^1 ln Y_t + \epsilon_t \quad (9)$$

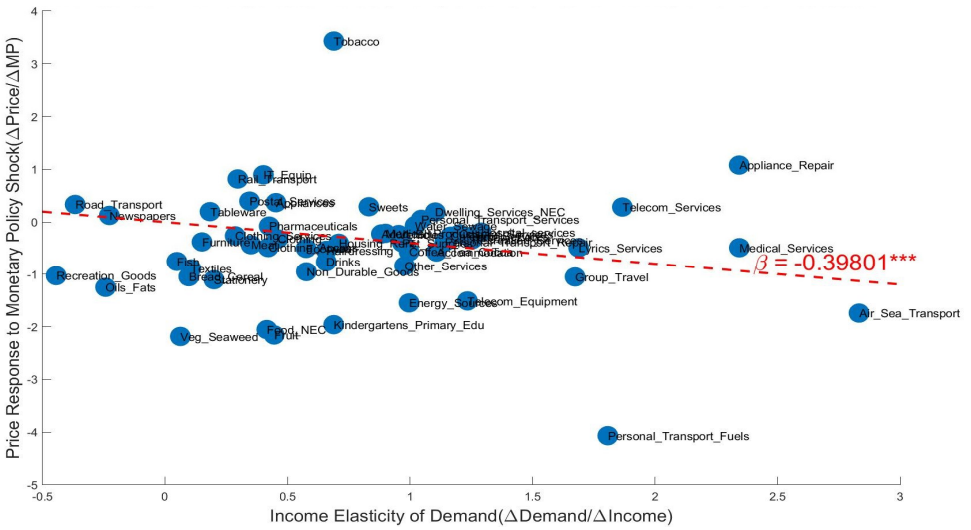
Here, $ln C_{it}$ represents the log-transformed household consumption of item i at time t, and $ln Y_t$ represents the log-transformed household income. Consumption quantities were derived from the Household Income and Expenditure Survey, adjusted for seasonality, and used as the real consumption for each item. Real GDP, seasonally adjusted, was used as the income indicator[10]. In the regression equation, γ_i^1 represents the rate of change in consumption for individual items when income increases by a certain percentage. In this study, this parameter was used as the income elasticity of demand for each item.

Figure 7 illustrates the relationship between price response to monetary shocks and income elasticity of demand for each category. Each point represents one of the 66 subcategories. The average value of the significant response within the 90% confidence interval of the price response to monetary shocks, estimated earlier, is plotted on the y-axis, while the income elasticity of demand is plotted on the x-axis. The regression line of the points reveals a statistically significant slope

10) Income elasticities were estimated using measures such as real GDI (Gross Domestic Income) and real GNI (Gross National Income) in addition to real GDP. The relationship between income elasticities and monetary shocks was analyzed in the same manner. However, the results showed no significant differences.

of -0.39, indicating that as the income elasticity of demand increases, i.e., for luxury goods, the magnitude of price decline in response to tight monetary policy shocks tends to be larger[11]. This finding helps explain the earlier analysis showing a relatively higher increase in the relative price index for the lower income strata due to tight monetary policy. When household income decreases due to tight monetary policy, there is a significant decrease in demand for luxury goods with high income elasticity, leading to substantial downward pressure on prices. Consequently, it implies that the perception of inflation levels faced by high-income households, who have a higher share of luxury goods consumption, may be lower.

Figure 7. The Relationship between Price Response to Monetary Shocks and Income Elasticity of Demand



Meanwhile, the price elasticity of demand for each item were also estimated separately. According to Cravino et al. (2020), luxury goods exhibit lower price adjustment frequency compared to necessity goods, indicating their price stickiness characteristics. Price elasticity of demand serves as an indicator of price stickiness, where a higher elasticity implies greater price rigidity. The price elasticity of demand was estimated using the following formula.

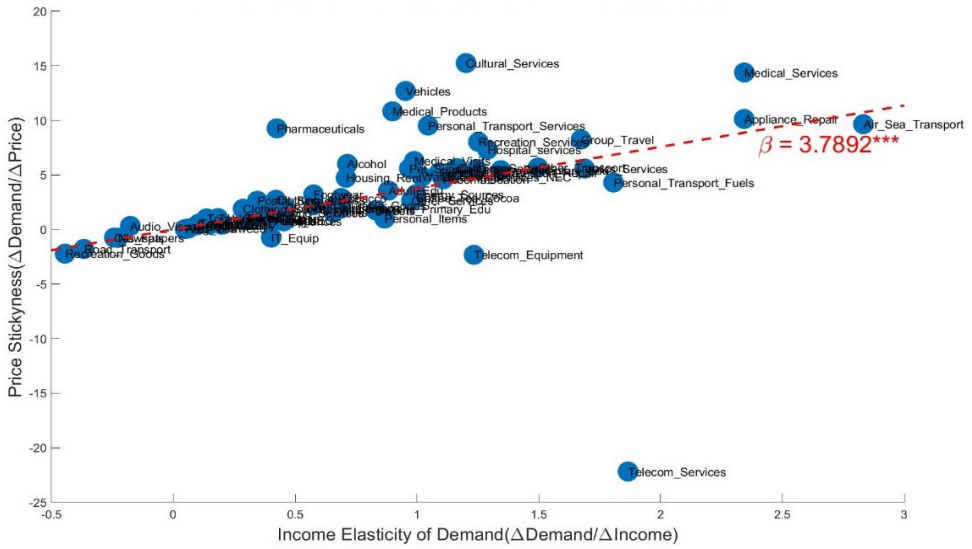
11) To check for robustness, the same analysis using monetary policy shocks extracted from models 2 to 5 was conducted, and the consistent estimation results showed that as the luxury nature deepened, the response to monetary policy shocks was more sensitive. The results are presented in the appendix.

$$lnC_{it} = \phi_i^0 + \phi_i^1 lnP_{it} + \epsilon_t \tag{10}$$

Here, lnC_{it} represents the log-transformed household consumption of item i at time t, and lnP_{it} represents the log-transformed price of item i at time t. The consumption variable is the same as before, and the price variable uses the consumer price index of the 66 items mentioned earlier, but with directly seasonally adjusted quarterly indicators. In the regression equation, ϕ_i^1 represents the rate of increase in consumption of item i when the price increases by a certain proportion. Thus, it is used as the price elasticity of demand for individual items.

Figure 8 presents the estimated price elasticity of demand index and the income elasticity of demand index representing the luxury and necessity characteristics of demand by item. Each point represents one of the 66 sub-items, with the Y-axis representing the price elasticity of demand and the X-axis representing the income elasticity of demand. The estimated regression coefficient for each point is approximately 3.79, and it is statistically significant at the 1% level. This confirms the previous research findings that luxury goods tend to exhibit price rigidity.

Figure 8. The Relationship between Price stickiness and Income Elasticity of Demand



The analysis so far implies that when understanding the impact of monetary policy on inflation inequality, it is necessary to consider both the income elasticity path and the price rigidity path comprehensively. Luxury goods can experience significant price declines compared to essential goods when income decreases due to monetary policy shocks, even though they have lower price adjustment frequencies and exhibit price rigidity. In the case of South Korea, inflation inequality, where lower-income households experience relatively higher perceived inflation, has arisen due to the contractionary monetary policy. This can be interpreted as a consequence of price rigidity in luxury goods and other factors, but, on the other hand, a more significant decrease in demand due to income reduction played a more substantial role. These factors can lead to increased price volatility for luxury goods, and during a contractionary monetary policy shock, the price decline for luxury goods may be significantly larger than that for essential goods. Therefore, it appears that the income 5th quintile consumer price index with a higher consumption share of luxury goods experiences a more substantial decrease compared to the 1st quintile index, leading to the significant increase in the CPI ratio observed in Figure 5.

Ⅴ. Conclusion

This review aims to analyze inflation heterogeneity that can occur when monetary policy shocks take place. Previous research findings suggest that household consumption baskets exhibit heterogeneity based on income and educational levels. Given this, it can be inferred that the impact of monetary policy shocks may vary among households. The analysis reveals that high-income households tend to experience more significant price changes as a result of monetary policy shocks. This can be attributed to the greater sensitivity of prices for luxury goods, which are more commonly consumed by high-income households, to monetary policy shocks. By individually assessing the effects of monetary policy shocks on 66 sub-items of goods and calculating the income elasticity of demand for each item, empirical evidence supporting this relationship was found.

This implies that monetary policy shocks can influence household income, leading to diverse changes in the demand for each item and ultimately resulting in inflation heterogeneity. This research holds significance because it introduces the concept of income elasticity of demand for goods as a contributing factor to inflation heterogeneity, in contrast to previous studies that primarily focused on factors like price rigidity or variations in consumption patterns.

Furthermore, this research reaffirms characteristics like price rigidity, as mentioned in prior studies, and suggests that inflation heterogeneity can vary depending on the relative magnitudes of price rigidity and income elasticity effects. In the analyzed data of this study, the latter effect appeared to be relatively more significant than the former, resulting in a greater estimated decline in prices faced by high-income households due to contractionary monetary policy. This is expected to benefit high-income households in terms of price dynamics. Conversely, expansionary monetary policy shocks appeared to have a relatively less pronounced upward effect on prices for low-income households, which benefits these households. However, it's important to note that the distributional effects of such monetary policies may not consistently follow this pattern. In economies where price rigidity effects are more pronounced, distributional effects may manifest differently.

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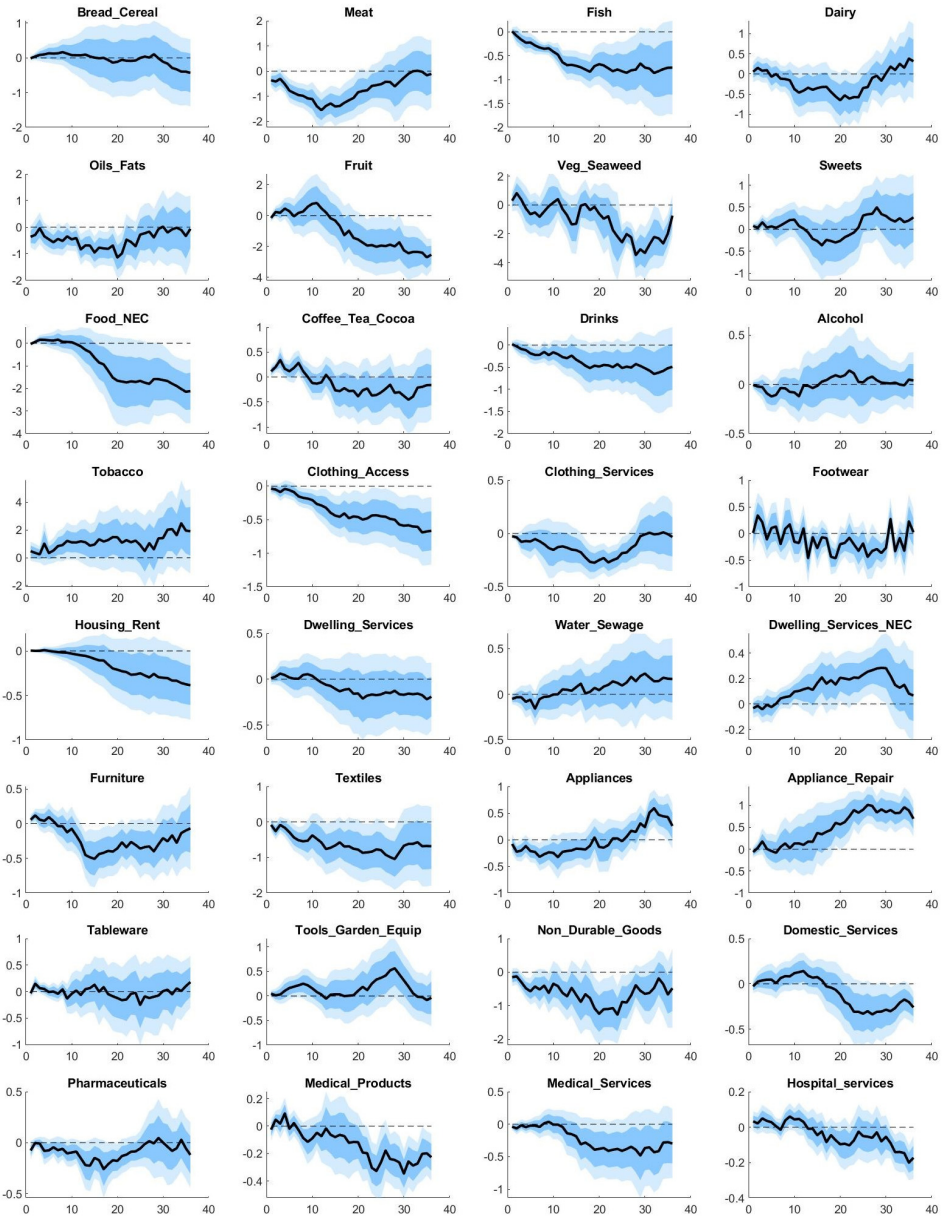
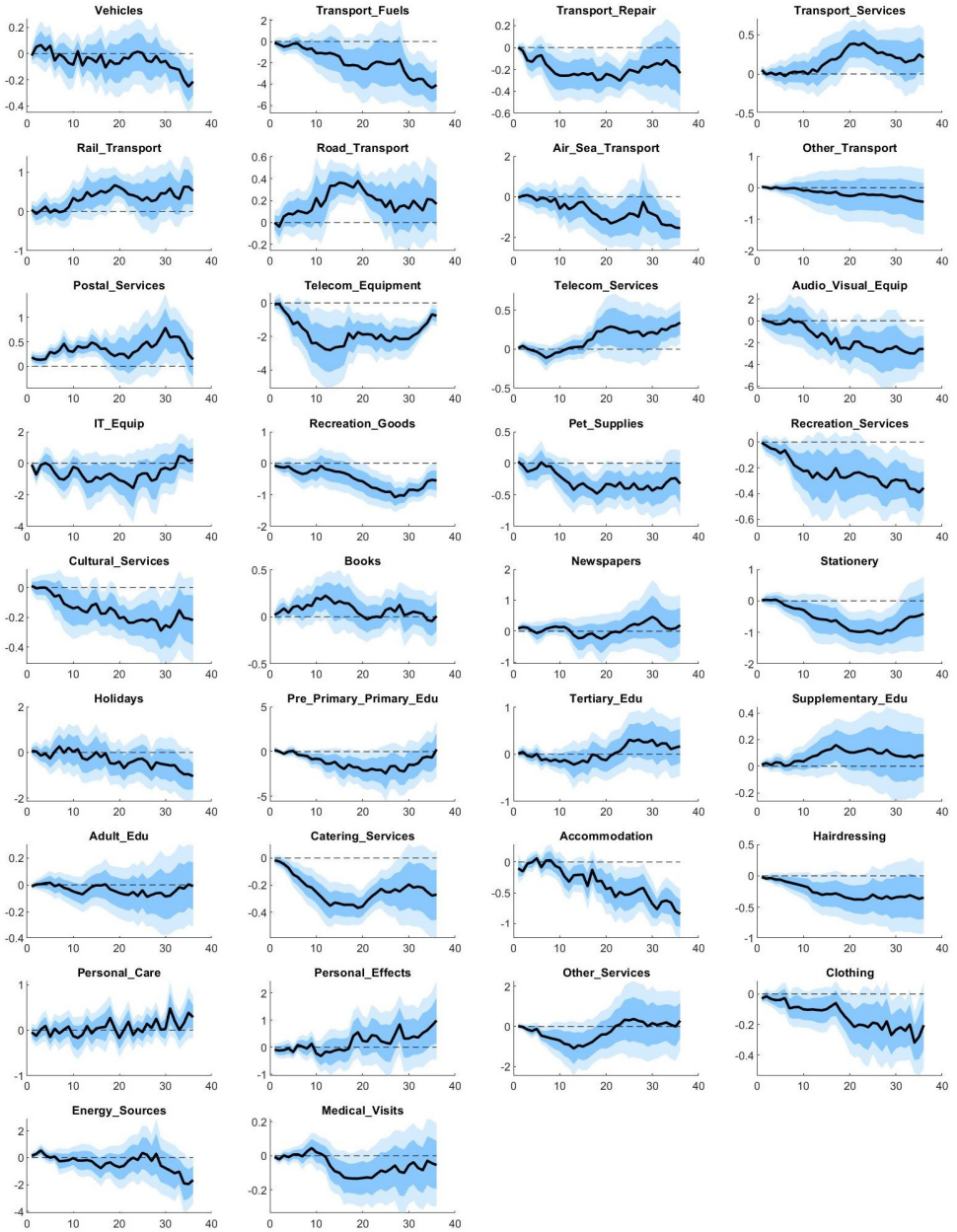
Appendix A: Response of Price Indices to MP Shock by Model

Figure A1-1. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 2



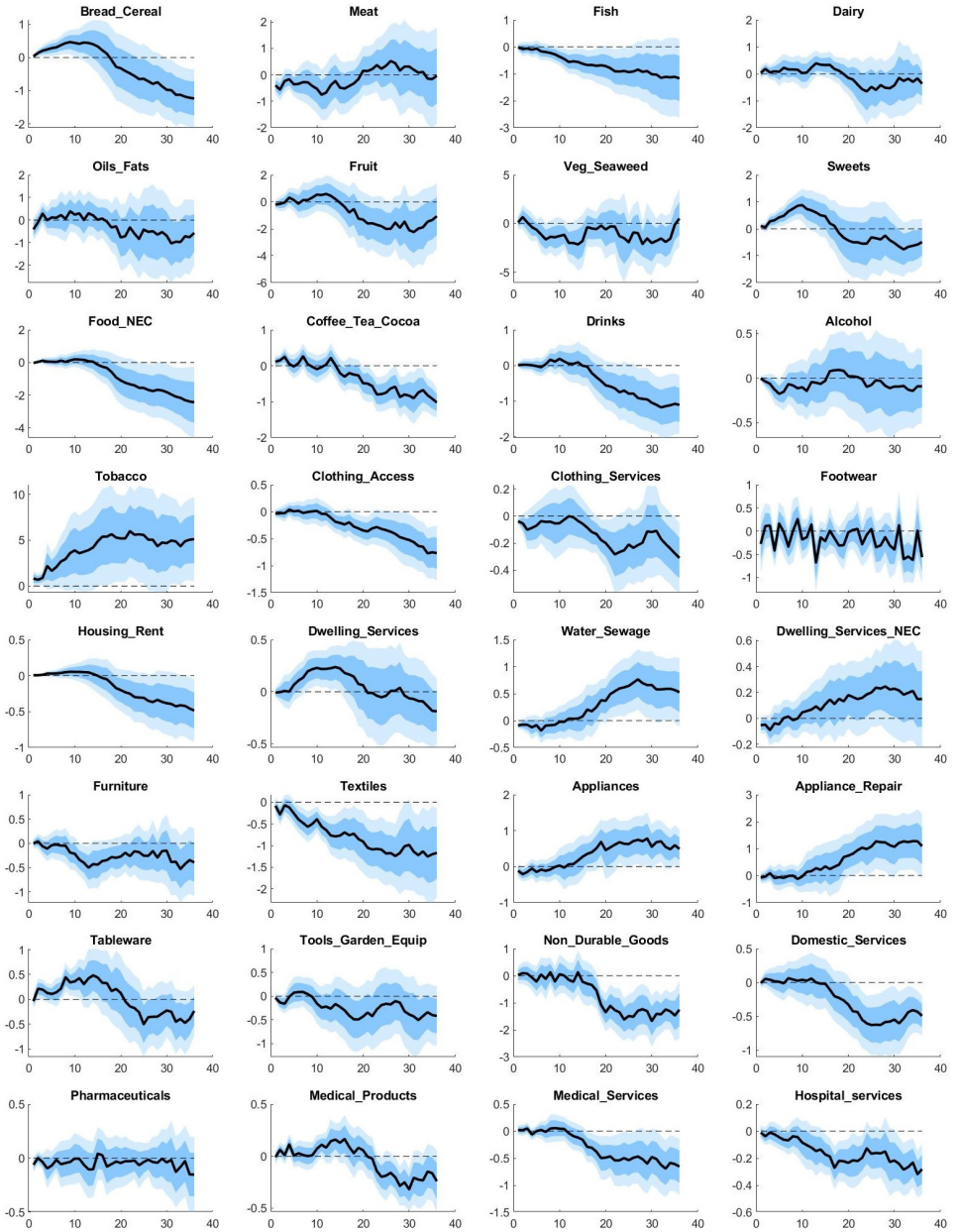
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A1-2. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 2



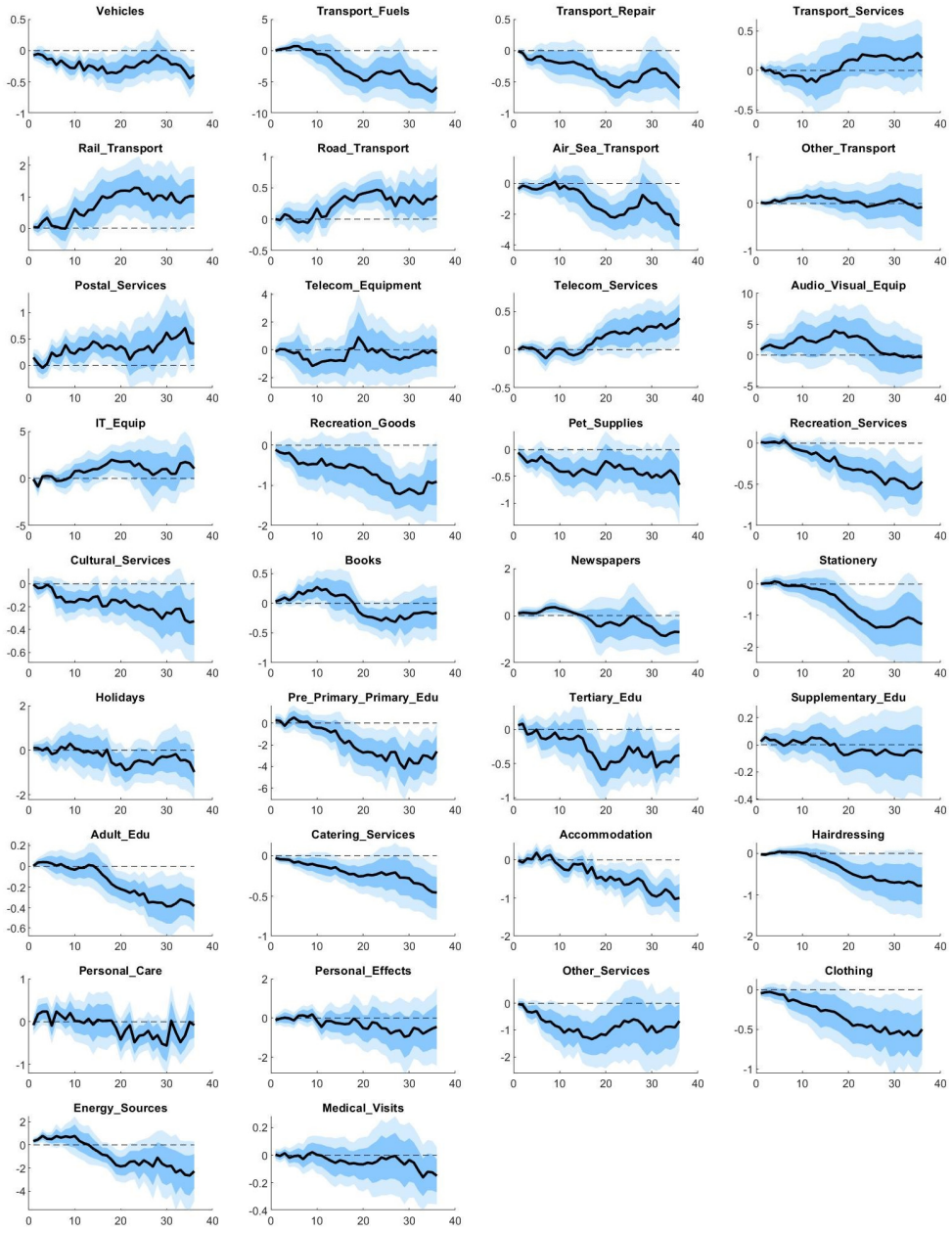
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A2-1. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 3



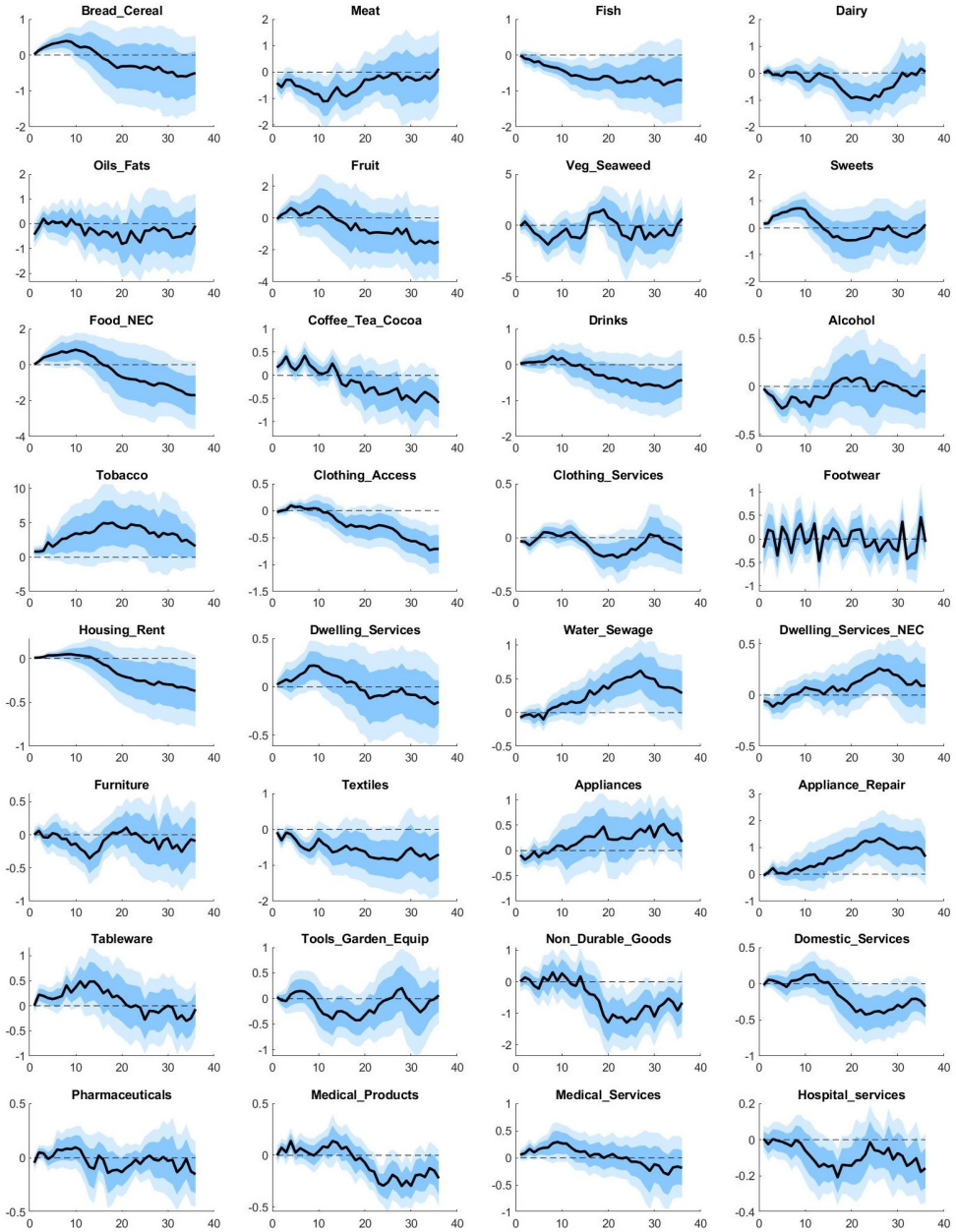
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A2-2. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 3



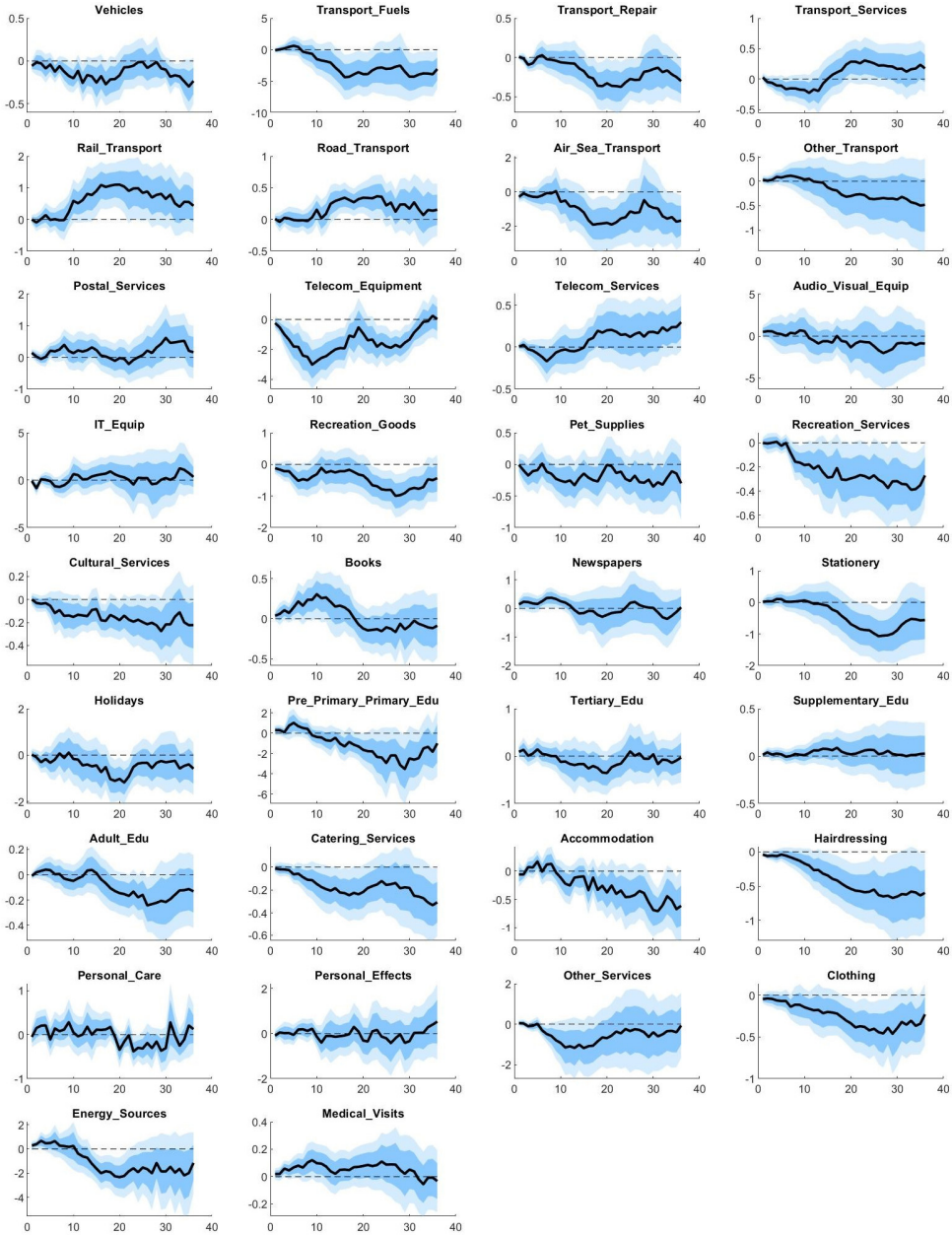
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A3-1. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 4



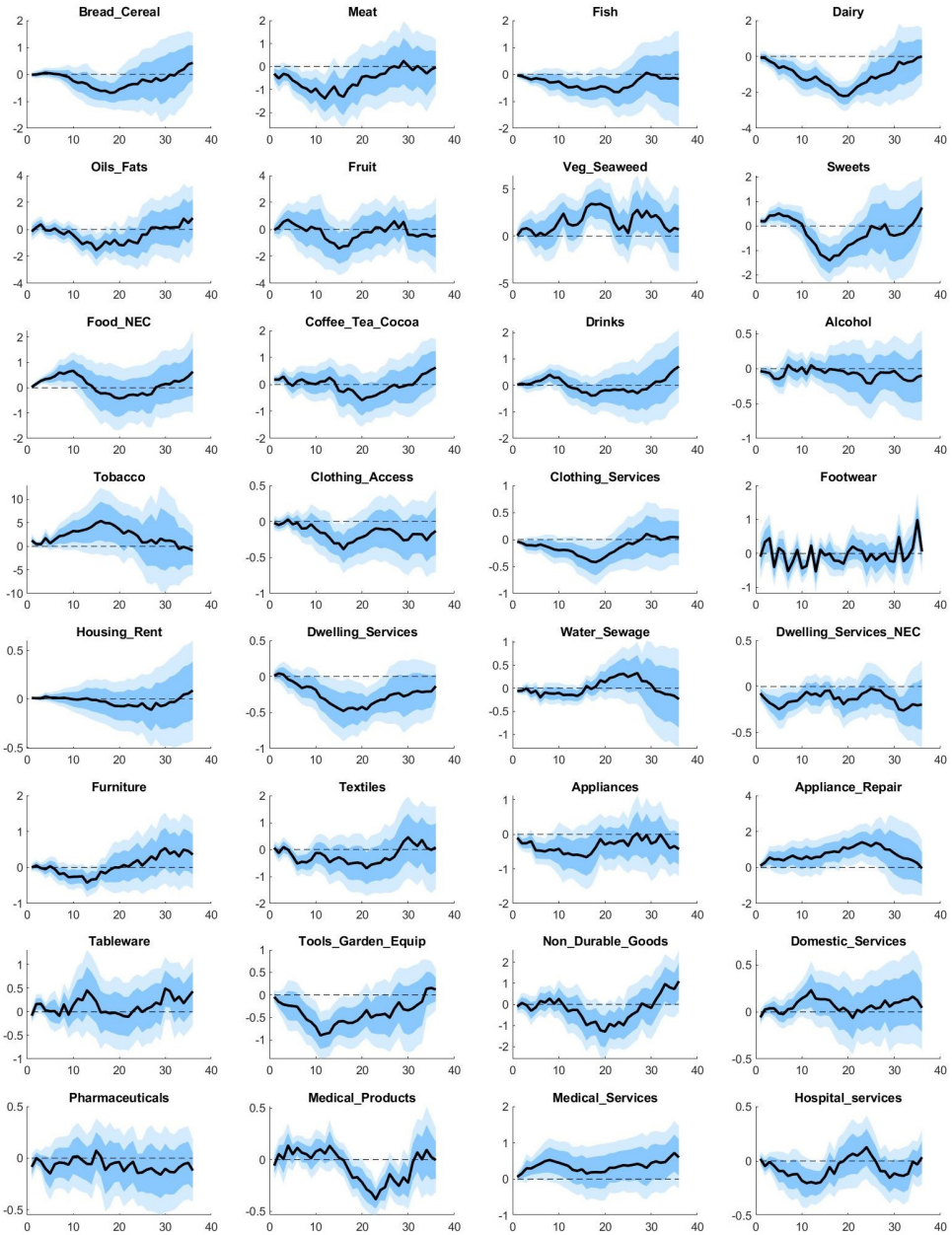
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A3-2. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 4



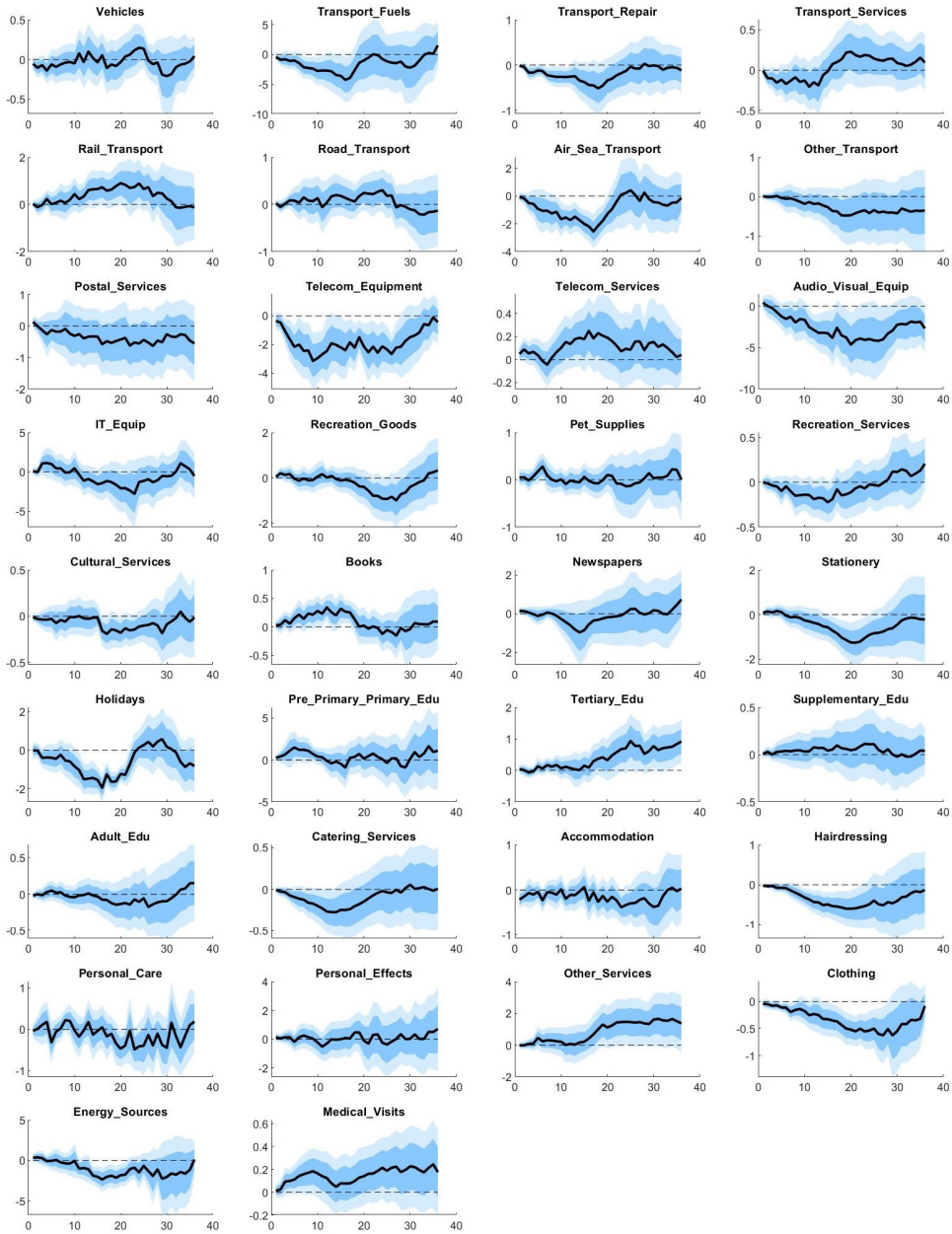
Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A4-1. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 5



Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Figure A4-2. Responses of Subcategory CPIs to Contractionary MP Shock extracted from Model 5



Note: The solid line represents the median response of shocks, while the shaded areas represent the 68% and 90% percentile confidence intervals, respectively.

Appendix B: Relationship between Price Response to MP Shock and Income Elasticity of Demand by Model

Figure B-1. Using MP Shock from Model2

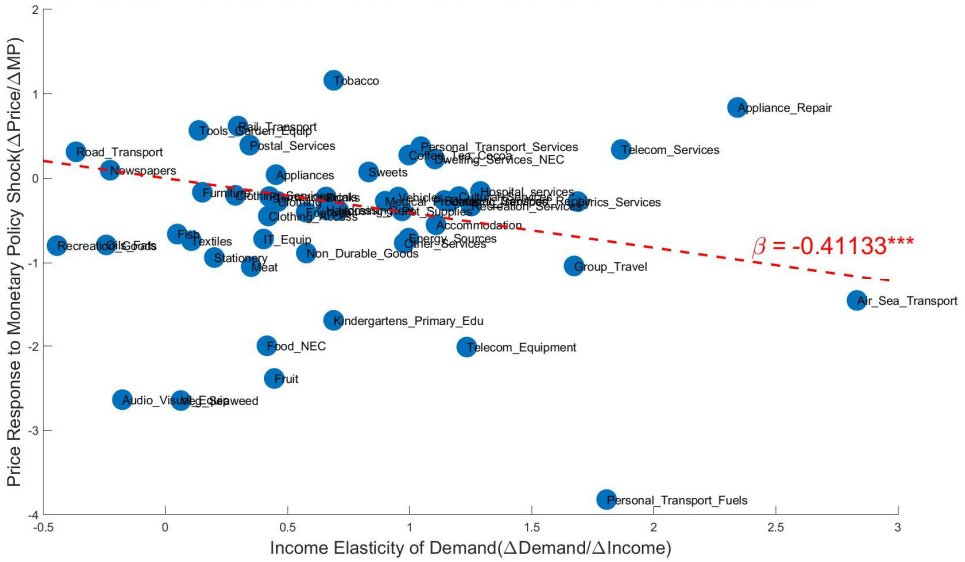


Figure B-2. Using MP Shock from Model3

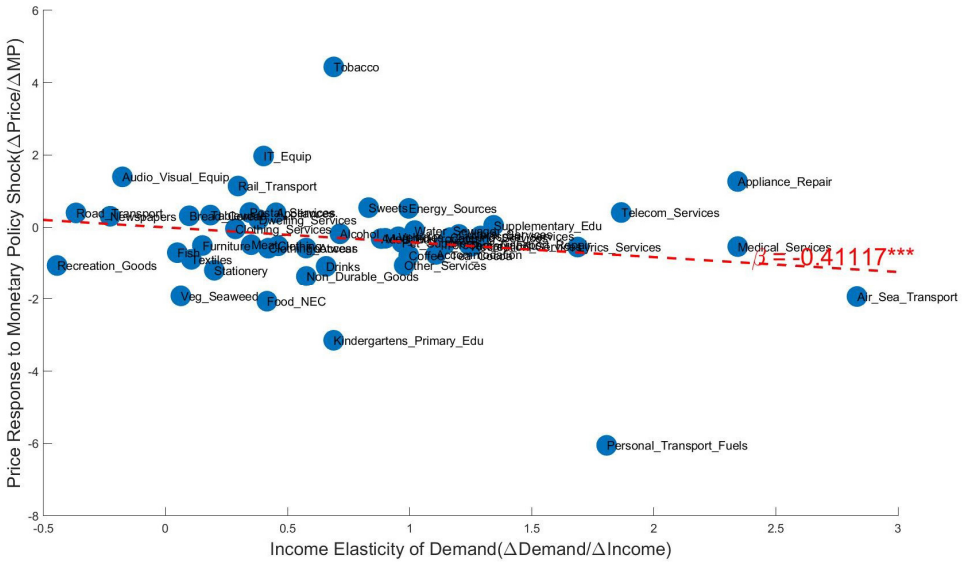


Figure B-3. Using MP Shock from Model4

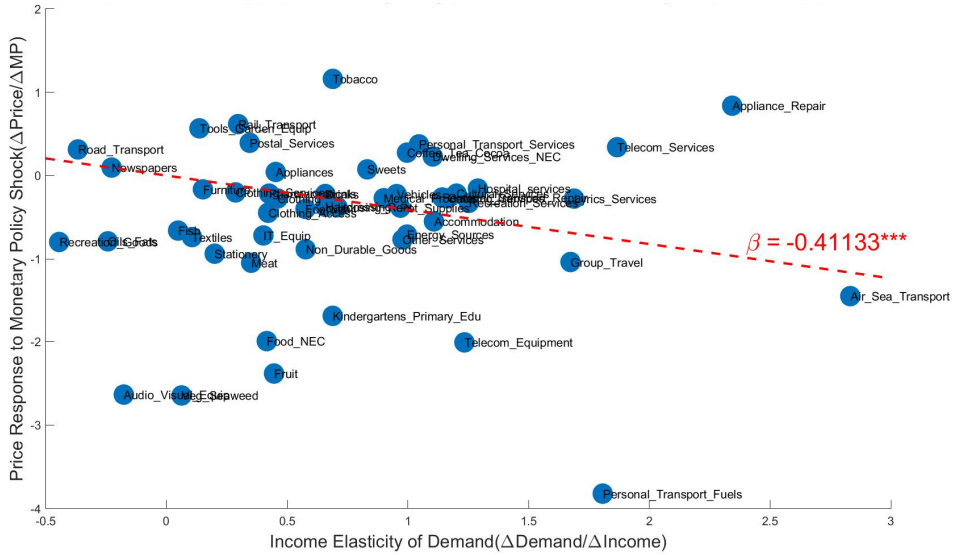
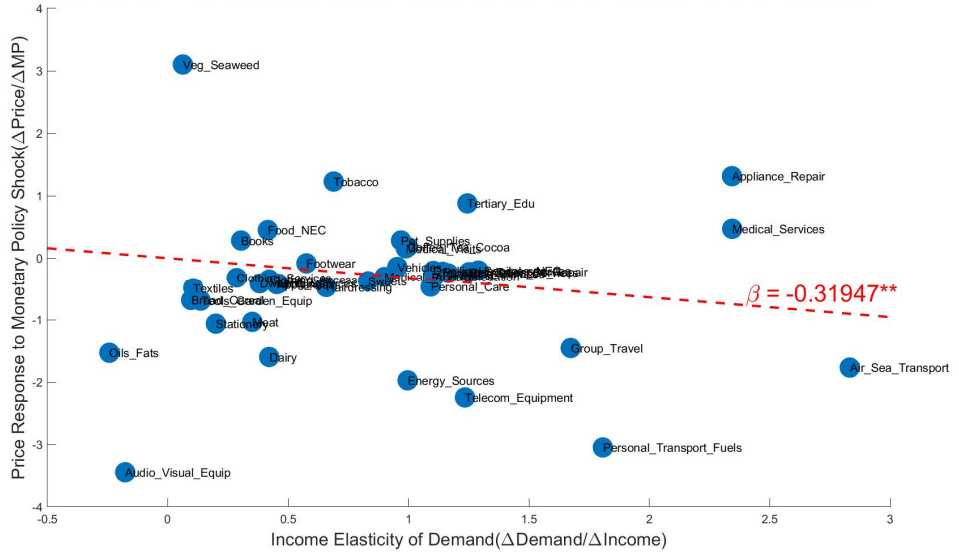


Figure B-4. Using MP Shock from Model5



<Abstract in Korean>

통화정책충격이 인플레이션 이질성에 미치는 영향: 한국사례를 중심으로

황설웅*

본 논고는 통화정책 충격에 대한 소득 그룹별 인플레이션의 이질적인 반응을 분석하였다. 이를 위해 우리나라 가계동향조사 자료를 이용하여 소득분위별 물가지수를 구축하고 통화정책 충격에 따른 인플레이션 반응을 국소투영법을 통해 추정하였다. 추정 결과에 따르면, 고소득 그룹의 물가지수가 통화정책 충격에 민감하게 반응하는 것으로 나타났다. 이는 고소득 가구 중에서 소비의 상당한 부분을 차지하는 사치재의 경우 수요의 소득탄력성이 높은데 기인하는 것으로 분석되었다. 사치재의 경우 일반적으로 가격 경직적이지만 통화정책 충격으로 인한 소득변화로 수요가 민감하게 반응하여 가격 변동성이 확대될 수 있는 것으로 나타났다. 이는 통화정책이 기존에 연구되어왔던 소득이나 자산 측면 이외에도 가격 측면에서 재분배 효과를 발생시킬 수 있음을 시사한다.

핵심 주제어: 통화정책충격, 인플레이션이질성, 인플레이션불평등, 가격경직성, 소득탄력성, 사치재, 필수재, 부호제약VAR, 국소투영법

JEL Classification: C32, E00, E60

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BOK 경제연구 발간목록

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	3	Taking a Bigger Slice of the Global Value Chain Pie: An Industry–level Analysis	Chong–Sup Kim · Seungho Lee · Jihyun Eum
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