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Durable Goods and Sectoral Effects of Monetary Policy

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Abstract
High degree of interest sensitivity of durable goods is now a stylized fact in the literature of monetary policy. This literature, however, does not provide a clear and consensual explanation for the modalities of this stylized fact. In this paper, two independent empirical models are performed to shed more light on the cross-sectoral impacts of monetary policy. The results of first study indicate that there is no straightforward qualitative relationship between the degree of durability and the interest-sensitivity of durables. While, the second study shows that, in response to monetary policy shocks, productive durables behave differently from consumer durables. For both studies, two models have been estimated using the quarterly data of the U.S. over the period 1954:III – 2007:II

Keywords: Durable Goods, Sectoral Effects, Monetary Policy

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1. Introduction

While there is a growing consensus among economists that monetary policy has real effects, at least in short run, on the economy, it seems that the transmission mechanism of monetary policy is still not fully discovered. For example, it is very valuable for monetary authorities to know how the effects of a monetary shock pass through the economy; which sector will respond first to the shock; and which one will respond more pronounced than others. The propagation of monetary policy shock through different sectors is not symmetric. Some sectors may absorb more of a shock compared to the others. Investigation of asymmetric responses of different sectors to monetary policy shocks may help monetary authorities to make more efficient policies. It also helps economists to find better explanation for some economy's features that cannot be simply explained by standard modeling which only considers aggregate variables. The disaggregated analysis of monetary policy can improve our understanding about the transmission mechanism of monetary policy. For example, a mild contractionary monetary policy, which slightly discourages the aggregate demand, might have a drastic impact in one sector and a negligible effect on another sector. On the other hand, a monetary policy which targets a specific sector of an economy might fails as a non-targeted sector absorbs it mostly. Therefore, ordering of sectors which respond to monetary policy by size and swiftness of their responses will provide valuable information for policy makers. This paper targets this issue by performing two independent studies of sectoral impacts of monetary policy shocks in the economy. These two studies, however, are common in two aspects. First, in both studies, sectors are determined based on durability of products. Second, the methodology applied in both studies is structural vector auto-regression, VAR.

Sectoral impacts of monetary policy have recently attracted the interest of economists and policy-makers. Many papers in the literature document the significant sectoral differences of monetary transmission channels[2]. Guiso et al. (2000) show that the use of disaggregated data improves the identification of factors, which are more sensitive to monetary policy shocks and monetary transmission. Bernanke and Gertler (1995), using a VAR model, show the different impacts of monetary policy on spending components of the economy. Following them, several studies investigate the sectoral effects of monetary policy in the economy. Ganley and Salmon (1997) studies industry data for the United Kingdom and shows that some sectors, such as construction, respond more sensitively and rapidly to monetary policy shocks, compared to other sectors. In a similar study, Hayo and Uhlenbrock (1999) focus on the manufacturing industries in Germany. They consider 28 industries in their study and conclude that heavy industries are more sensitive to monetary policy shocks than non-durable industries such as food and clothing. Dedola and Lippi (2000) document the cross-industry heterogeneity of monetary policy effects in five OECD countries. They show that there is no significant cross-country difference in sectoral channels of monetary policy transmission.

Fares and Srour (2001), investigate the sectoral monetary transmission in Canada. They consider two types of disaggregation, one at the level of final expenditures and the other at the level production. They conclude that, at the level of final expenditures, investment responds most substantially and exports respond most quickly among other sectors. While, among the sectors at the level of production, construction is the most quickly responder and manufacturing has the strongest response to monetary policy shocks. Ibrahim (2005) studies sectoral monetary effects on the economy of Malaysia and concludes that manufacturing, construction, finance, insurance, real estate and business services sectors are the driving force behind the aggregate fluctuations. Peersman and Smets (2005) estimate the effects of the monetary sector in eleven industries and seven euro area countries, and find that cross-industry differences of policy effects are related to financial structure and firm size.

Jansen *et al.* (2013) studies the effects of monetary policy on net sales of publicly traded firms in different sectors of the U.S. economy and shows that monetary policy has heterogeneous impact on firms in different industries. They conclude that balance sheet characteristics and the size of firms are two important factors which may influence the impact of policy. They find that the strongest effect of monetary policy is shown on firms in Retail and Wholesaling sector and larger firms in different sectors are less sensitive to monetary shocks. Using a Structural VAR method Hammoudeh et al. (2015) study the effects of the monetary policy on sectoral commodity prices in the United States. They show that the effects of a contractionary monetary pol-

[2] Among them are Dale and Haldane (1995), Gertler and Gilchrist (1994), Ganley and Salmon (1997), and Raddatz and Rigobon (2003).

icy is quite heterogeneous amongst various sectors and conclude that recognizing the source of sector inflation is crucial for policymaking. Baumeister *et al.* (2013) shows that the propagation mechanism of monetary policy has asymmetric effects across disaggregate components of personal consumption expenditures. Among many recent studies which have investigated the asymmetric effects of monetary policy through the economy are Cloyne et al. (2015), Nampewo *et al.* (2013), Chakrabarti (2015), Sudo (2012), Selezneva et al. (2015), Doepke et al. (2015) and Muhammad and Muhammad (2016).

Durable goods sector is one of the economy's sectors which has been documented as one of the most sensitive sector in response to monetary policy shocks (Ganley and Salmon (1997), Fares and Srour (2001), Dedola and Lippi (2000), Peersman and Smets (2005)). Recent empirical studies on the monetary transmission mechanism (e.g. Barsky et al. (2003), Erceg and Levin (2002, 2006), Monacelli (2009)) have revealed two special features for durable spending in response to monetary policy shocks. First, durable goods sector is significantly more sensitive to monetary policy shocks compared to other sectors. Second, in response to a monetary policy shock, durable sector spending co-moves closely along with other sectors. In their VAR analysis, Erceg and Levin (2002) disaggregate the total output in five major expenditure components: consumer durables, residential structures, business equipment, business structures, and other goods and services. Aside from the last sector, labeled as non-durable GDP in the paper, other four sectors are durables. This paper documents that the peak impact of a monetary policy shock on durable expenditures is roughly five times as large as that on non-durable expenditures. Barsky et al. (2003), instead, perform a VAR study considering a sector for non-durable goods and three sectors for durable goods, i.e. durables expenditures, residential investment, and automobile sales. This paper shows that after a contractionary monetary policy innovation durable goods sectors contract very sharply while non-durable goods and overall GDP do not. In a separate paper, Erceg and Levin (2006) perform another VAR analysis in which real GDP is disaggregated into two types of expenditures: a chain-weighted index of consumer durables and residential investment, and a chain-weighted composite of all other GDP components. The result of this paper confirms previous documented results in the literature. That is, the decline of consumer durables spending caused by monetary policy shocks is over three times as large as that for the other GDP components. It also verifies the co-movement of both sectors in response to monetary policy shocks. In a slightly different VAR analysis, Monacelli (2009) confirms these two, now, stylized fact about durables sector. Monacelli incorporates total real household debt as one of the role player in the analysis. Two disaggregated sectors in Monacelli are real durable consumption along with real non-durable consumption and services. His paper shows that, in response to monetary policy shocks, household debt also gradually and very closely co-moves with non-durable sector. In two more recent papers, Barsky and Boehm (2015) and Kimball et al. (2016) compare the impact of monetary policy on durable sector with that on non-durable sector and demonstrate that durability has profound implications for the business cycle properties and interest rate interventions.

This paper performs two independent simple VAR analyses regarding the role of durable goods in transmission of monetary policy shocks. Two models are estimated using the quarterly data of the U.S. over the period 1954:III – 2007:II. The first study examines that how the durability of a sector's output can be related to the strength and the rapidity of the sector's response to monetary policy innovation. In this study, eight different industrial sectors of the economy are ranked based on the durability of their output. Then, the responses of each sector are ranked based on the period and the amount of the strongest response. The comparisons of the ranking of durability with the ranking of response strength and the ranking of response swiftness are then documented.

The second study addresses a gap in the literature. That is, it compares the responses of durable goods, with different functions, to monetary policy shocks. Some durables are utility-deriving and others are productive. This study addresses the question that how the function of durable goods affect their responses to the monetary policy shocks. As mentioned above, there are numerous empirical studies that investigate sectoral effects of monetary policy shocks in the economy. Some of them document the special role of durable goods in the transmission of monetary policy. The function-effect of durables, however, has not been investigated in the literature. Therefore, this section reports a VAR analysis in which the real GDP is disaggregated based on two characteristics; durability and function. Hence, three disaggregated sectors in this model

are as follows. Non-durable sector consists of products which are purchased by households, so are utility deriving, and are non-durable. Consumer durables sector consists of durable goods purchased by households. Capital sector consists of durable goods purchased by firms. This analysis complements other similar studies, e.g. Erceg and Levin (2002) and Monacelli (2009), by comparing responses of durable goods with different functions, i.e. utility deriving durables and productive durables (capital).

The key findings of this analysis are as follows. Consumer durable expenditures closely comoves with non-durable spending and declines in response to contractionary monetary policy shock; however, consumer durable spending responds more sensitively. Also, in short run, the response of capital investment is the opposite to the response of two other sectors. In the long term, capital investment follows two other sectors and declines. Moreover, the results show that inclusion of the residential investment into consumer durable sector does not change the qualitative behavior of three sectors in response to monetary policy innovations.

The plan of this paper is the following. Section 2 outlines the methodological approach of the study, while the findings of the analysis are discussed in section 3. Finally section 4 concludes.

2. Durability and Cross-sector Monetary Policy Channels

High sensitivity of durable goods in response to monetary policy shocks have been broadly documented in the literature. This section compares the strength and quickness of responses of different industrial sectors to monetary policy and addresses following question: To what extent the degree of durability is related to the strength and quickness of responses?

As the first step, the total output of the economy is disaggregated into eight major sectors. These sectors are shown in Table 1. Next, the sectors are ranked by their durability level; 1 as the most durable and 8 as the least durable sector. The ranking is based on the Table 3 in Baxter (1996), which indicates the percentage of each sector's output that is consumed and the percentage of it that is invested. Boxter defines the industries that produce predominantly consumption goods, such as agriculture and utilities, as "consumption good sector" and other industries as "durable goods sector". Instead of categorizing industries into two sectors, based on the information of Table 3 in Baxter (1996), I rank the industries from 1 to 8 for their degree of durability. The second column of Table 1 indicates the rank assigned for each sector.

Table 1: Ranking of sectoral output based on degree of durability

Industry	Code	Degree of Durability	
Construction	CNS	1	Durable
Mining	MIN	2	↑
Manufacturing	MAN	3	|
Transportation, Communication, and Utilities	TCU	4	|
Wholesale and Retail Trade	WRT	5	|
Finance, Insurance, and Real Estate	FIR	6	|
Services	SRV	7	↓
Agriculture	AGR	8	Non-durable

Source: Author

In order to compare the monetary responses of each sector, I estimate separate VARs for each industrial sector and then compare the effect of a monetary policy shock on each sector's output.

The vector of variables in each VAR analysis comprises four variables respectively: (i) real GDP, (ii) the sector's output, (iii), GDP deflator, and (iv) federal funds rate. The data are sourced from the Bureau of Economic Analysis data tables. All variables apart from federal funds rate are in log terms.

Empirical Results

Table 2 shows the degree of Akaike information criterion (AIC) for each VAR. However, in order to have a consistent comparison results across a series of VARs, I impose a common lag length of six on each of them[3].

The major results of this section are summarized in Table 3. This table shows the size and the quarter of maximum reduction of output in each sector in response to monetary policy shocks. The results do not indicate any clear relationship between degree of durables and size of response to monetary policy shocks. Although two strongest responses to monetary policy refer

[3] This study is replicated for common lag of four and five and the quantitative results did not change.

to construction sector and mining sector, which are two sectors with highest degree of durability, the response of agriculture sector and service sector, two sectors with low degree of durability, are also sizable compared to other sectors responses. As the results of this table show, the strongest response to monetary policy shocks refers to the mining sector, while the weakest response is for the sector of wholesale and retail trade.

Table 2: Akaike Information Criterion (AIC) for each VAR model

	AGR	MIN	CNS	MAN	TCU	WRT	FIR	SRV
0	-2.409	-0.951	-3.999	-3.839	-4.227	-4.311	-4.548	-4.876
1	-19.865	-20.930	-23.046	-22.937	-22.582	-23.072	-23.354	-23.226
2	-20.429	-21.427	-23.749	-23.441	-23.061	-23.529	-23.675	-23.680
3	-20.555	-21.545*	-23.816	-23.517	-23.179*	-23.630*	-23.712	-23.737*
4	-20.535	-21.480	-23.792	-23.475	-23.124	-23.502	-23.622	-23.631
5	-20.607	-21.415	-23.756	-23.425	-23.112	-23.457	-23.637	-23.612
6	-20.754*	-21.507	-23.831*	-23.546*	-23.163	-23.526	-23.739*	-23.622
7	-20.624	-21.479	-23.812	-23.480	-23.078	-23.494	-23.622	-23.510
8	-20.531	-21.417	-23.739	-23.361	-22.933	-23.353	-23.522	-23.377
9	-20.550	-21.457	-23.769	-23.396	-22.899	-23.382	-23.468	-23.411
10	-20.543	-21.439	-23.701	-23.325	-22.901	-23.297	-23.367	-23.349
11	-20.579	-21.489	-23.803	-23.391	-22.980	-23.424	-23.473	-23.406
12	-20.522	-21.411	-23.739	-23.311	-22.882	-23.361	-23.413	-23.298

Source: Author

The comparison of the degree of durability to the quickness of responses of sectors does not show an obvious relationship either. The sector of manufacturing has the fastest response to monetary policy, while the slowest response refers to the sector of Finance, Insurance, and Real Estate. In ranking of quickness responses, construction sector, with the highest degree of durability, and agriculture sector, with the lowest degree of durability, are neighbors. This means that necessarily there is no significant relationship between the degree of durability of sectors and their rapidity of response to monetary policy shocks. The results shown in Table 3 also reveals this fact that the size and the timing rankings of maximum output reduction of sectors does not an obvious relationship.

Table 3: Ranking of sectors based on size and quickness of responses

Industry	Durability rank	Maximum output reduction			
		Size	Size rank	Quarter	Quickness rank
CNS	1	-0.0077	2	10	3
MIN	2	-0.011	1	20	6
MAN	3	-0.0043	4	8	1
TCU	4	-0.0033	6	26	7
WRT	5	-0.0022	8	9	2
FIR	6	-0.0029	7	62	8
SRV	7	-0.0035	5	18	5
AGR	8	-0.0057	3	13	4

Source: Author

Note that the results of this study do not contradict to the well-known stylized fact indicating that durables sector is significantly more interest-sensitive than the sector of non-durables. Rather, this study shows that this feature of durables sector cannot be exclusively explained by the durability characteristics of products. In order to show that the results of this study are consistent with the literature, I performed two other VARs with two parent sectors, i.e. durables sector and non-durables sector. Following Baxter, the non-durables sector is defined as the aggregation of agriculture sector, sector of transport, communication, and utilities, sector of wholesale and retail trade, sector of finance, insurance, and real estate, sector of service, and the non-durable part of manufacturing sector. The durable sector consists of construction sector, mining sector, and the durable part of manufacturing sector. Table 4 summarizes the results of these two VARs. As it is indicated in this table, the response of durables sector is more than three times stronger than the response of non-durables sector to monetary policy innovations. Durables sector also responds faster than non-durables sector. Figure 1 illustrates the impulse response functions of durables and non-durables sector.

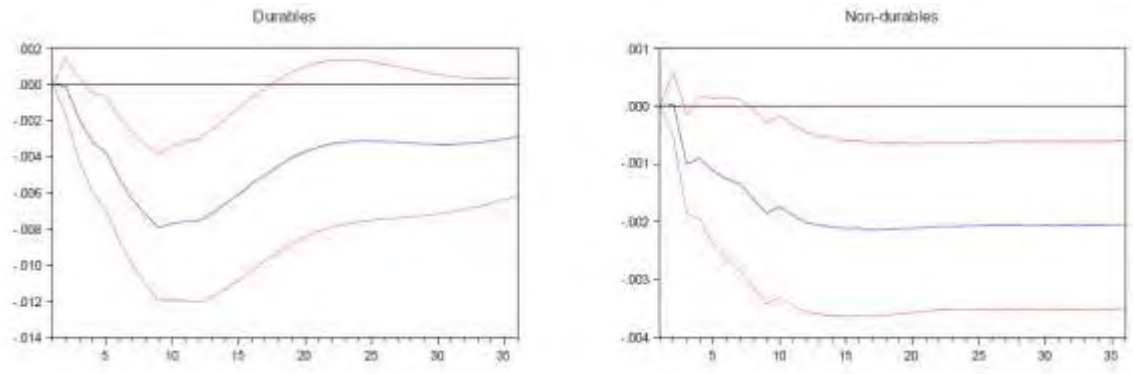

Figure 1: Impulse responses of durables and non-durables to monetary policy shocks
Source: Author

Table 4: Size and quickness of responses of durables and non-durables to monetary policy shocks

Sector	Maximum output reduction	
	Size	Quarter
Durables	-0.0079	9
Non-durables	-0.0021	13

Source: Author

3. Consumption durables vs. productive durables: another VAR analysis

This section accomplishes an independent VAR analysis regarding the role of durables in transmission of monetary policy through the economy. The focus of this study is on the functions of durables. Not all durable goods have similar functions. Some, purchased by households, are mostly utility deriving and others, purchased by firms, are mostly productive. In national accounting, the former is called consumer durables, while the latter is capital. In this study, total output is disaggregated based on two characteristics of products: durability and function. Therefore, three major sectors are considered in the economy: consumer durables sector, consumer non-durables sector, and capital sector.

There is no consensus in the literature of macroeconomics about how to identify residential constructions in the models. Many studies, following national accounting, consider residential investment as a part of total investment; there are a number of papers which identify this category of products as consumer durables. As this study tries to differentiate between productive and utility-deriving durables, the classification of residential investment is crucial. Therefore, this study considers and addresses both possibilities. That is this section introduces and investigates two alternative models, which their only difference is the way that they classify residential investment. So, the major variable vectors of these two alternative models are introduced as follows.

In model I, the variable vector of Y_t is respectively composed of six variables: (1) real GDP, (2) personal consumption expenditures on durable goods, (3) gross private domestic investment, (4) personal consumption expenditures on non-durable goods and services, (5) the GDP deflator, and (6) the federal funds rate. While in model II, Y_t is respectively consists of the following six variables: (1) GDP, (2) personal consumption expenditures on durable goods plus residential fixed investment, (3) gross private domestic investment minus residential fixed investment, (4) personal consumption expenditures on non-durable goods and services, (5) the GDP deflator, and (6) the federal funds rate. All above variables, except for federal funds rate, are in real term and in logarithm. As mentioned above, the order of variables indicates the recursive identification scheme. In ordering variables, we followed Christiano et al. (1999), Erceg and Levin (2002), and Monacelli (2009).

This study follows the approach of Christiano et al. (1999) to investigate the behavior of three major sectors in response to monetary policy innovations. Both above models are estimated using the quarterly data over the period 1954:III – 2007:II with the total number of 212 observations.

6. Empirical Results

Table 5 presents the values of Akaike's Information Criterion (AIC) for both models. Base the information provided in this table, lag lengths of four and three are respectively selected for model I and model II. Figure 2 and Figure 3 show the impulse response functions of GDP, durables, non-durables and investment in Model I and Model II respectively. According to these two figures, both models show that the response of consumer durables is significantly stronger than the response of non-durables, or even the response of total GDP, to monetary policy shocks. Furthermore, in both models, capital investment sector first have a short rise and then falls to-

gether with other sectors, while consumer durables sector co-moves with non-durables sector and GDP. Capital investment is also significantly more interest-sensitive than the total output and non-durables. The consumer durables sector in Model II is slightly more sensitive to the consumer durables sector in model I. The initial rise of capital investment is stronger in Model II, in which residential investment is excluded from investment, than model I, which consider residential investment as a part of investment. While, the trough of investment in model I is more serious than in model II. This may mean that although consumer durables co-move with non-durables in response to monetary policy shocks, investment does not co-move with them at least in short run. In conclusion, even though capital investment sector and consumer durables sector both consist of durable products, at least in short-run, they co-move negatively in response to monetary policy shocks. However, after a few quarters both sectors positively co-move along with other sectors and with the total output.

Table 5: Values of Akaike Information Criterion (AIC) for different lag lengths for both models

Lags	Model I	Model II
0	-14.65899	-14.12795
1	-39.17172	-38.34259
2	-40.12433	-39.26116
3	-40.20345	-39.35888
4	-40.21515	-39.33770
5	-40.15696	-39.26086
6	-40.14080	-39.27453
7	-39.98957	-39.18539
8	-39.89323	-39.02521

Source: Author

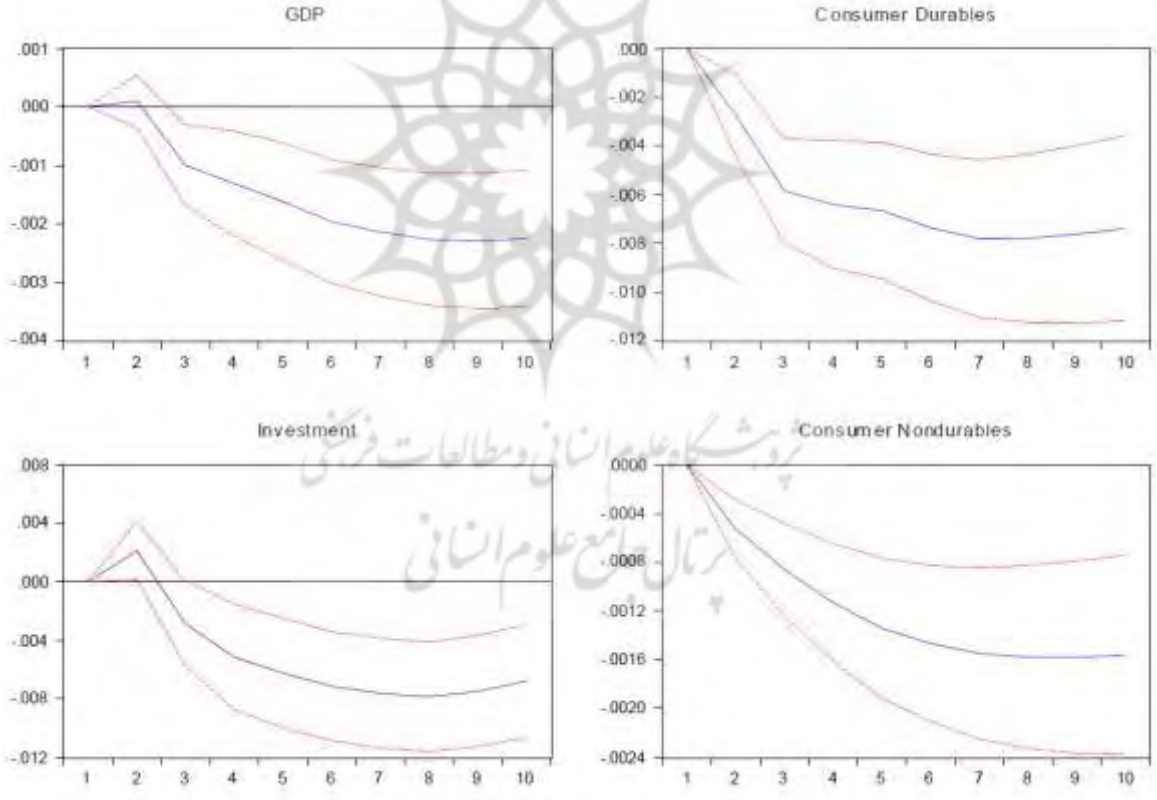

Figure 2: Model I Impulse Responses

Source: Author

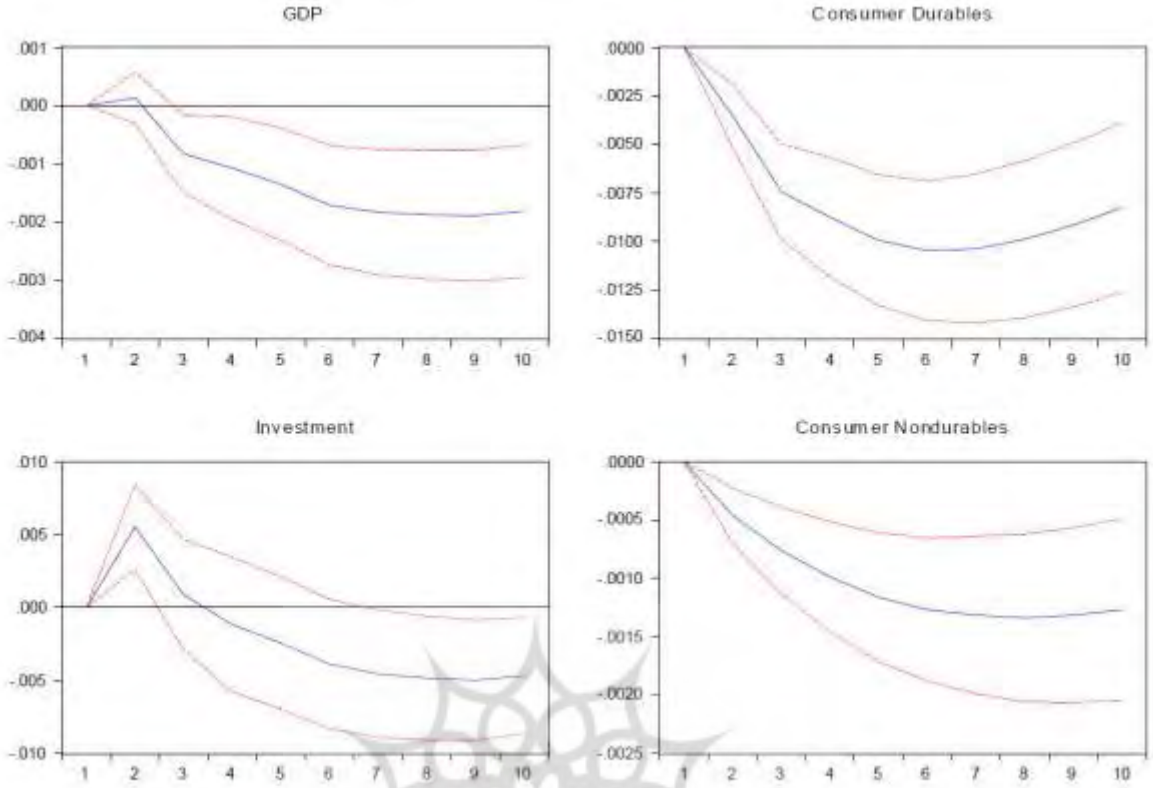

Figure 3: Model II impulse responses

Source: Author

5. Conclusion

This paper, using a simple VAR methodology, performs two independent models for the US economy, both of which try to shed light on the behavior of durable goods in response to monetary policy shocks. Each study investigates one of the following research questions: (i) To what extent the interest-sensitivity of a sector in the economy is related to the degree of durability in the sector? (ii) Is the application, i.e. being whether productive or utility-deriving, of a durable good critical in determining the behavior of it in response to monetary policy? To address the first question, I disaggregate the total output in eight separate industrial sectors, ranked based on their degree of durability, and compare the responses of sectors to monetary policy shocks, using a simple vector auto-regression (VAR) analysis.

The results of this study show that there is no straightforward relationship between the degree of durability and the strength or the quickness of responses to monetary policy innovations. The second question is addressed in another cross-sectoral VAR analysis, in which the total output is disaggregated in three major sectors; consumer non-durable goods, consumer durable goods, and productive durable goods (capital). This study shows that despite the large interest-sensitivity of all types of durables compared to non-durables, productive durables are slightly less sensitive to monetary policy shocks. It also indicates that the immediate response of productive durables to monetary shocks is inverse to the response of other sectors and with total GDP in response to monetary policy shocks. However, after a couple of quarters it co-moves with other sectors.

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