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# How Does the Oil Price Shock Affect Consumers?\*

Liping Gao\*\*, Hyeongwoo Kim†, and Richard Saba‡

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## *Abstract*

This paper evaluates the degree of the pass-through effect of the oil price shock using disaggregated CPIs in the US. We find a significantly positive effect of the oil price shock only on energy-intensive CPIs, which imply that the strong pass-through effect on the total CPI is mainly driven by substantial increases in prices of energy-related commodities. Unexpected changes in the oil price may result in decreases in the budget for non-energy commodities, if the demand for energy is inelastic (Edelstein and Kilian, 2009). Decreases in the demand for non-energy commodities will then result in limited pass-through effects on prices of those goods, which is consistent with our empirical findings.

**Key Words:** Oil Price Shocks; Pass-Through Effect; Disaggregated Consumer Price Indices; Vector Autoregression

**JEL Classification:** E21; E31; Q43

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## 1 Introduction

As Barsky and Kilian (2002) argue, oil price shocks are unambiguously inflationary. That is, we often observe very strong positive responses of the consumer price index (CPI) when unexpected changes in the oil price occur. This so-called pass-through effect of the oil price shock may be consistent with the view that oil shocks are primarily supply shocks because higher oil/energy prices may shift the (aggregate) supply curve to the left. See Hooker (2002), Leblanc and Chinn (2004), van den Noord and Andre (2007), and Chen (2009) for discussions on the pass-through effect of the oil price shock.

As Hamilton (2009) notes, oil price shocks may be also considered primarily demand shocks. Facing higher energy prices given real income, consumers may have to reduce their spending on goods and services other than energy, which may result in recessionary effects of oil price shocks. Edelstein and Kilian (2009) quantified the effect of the oil price shock on real consumption via unanticipated changes in discretionary income due to the shock.

This paper seeks disaggregate level evidence of the pass-through effect of oil price shocks using 84 CPI components in 9 CPI sub-categories, which would shed useful insights to the current literature in addition to the aggregate level evidence of the pass-through effect (Kilian and Lewis, 2011). The importance of studying disaggregate level evidence of the effect of oil price shocks has been illustrated in number of related contexts including stock returns (Kilian and Park, 2009), consumer expenditures (Edelstein and Kilian, 2009), and industrial production (Herrera, Lagalo, and Wada, 2011).

In what follows, we report very strong and statistically significant inflationary effects only in the expenditure categories of highly energy-intensive

commodities, while very limited pass-through effects for goods and services are found from less energy-intensive expenditures.

We interpret these findings as follows. When the oil price shock occurs, consumers may experience a decrease in real consumption expenditures for non-energy-related goods and services, if the demand for energy-related goods and services is inelastic (Edelstein and Kilian, 2009). This may shift the demand for less energy-intensive goods and services more than those of highly energy-intensive expenditures, resulting in heterogeneous responses to the oil price shock.

The rest of our manuscript is organized as follows. Section 2 provides a data description and the empirical model to study the pass-through effect. In Section 3, we provide our main findings using highly disaggregated CPI components as well as aggregate level indices. Section 4 concludes.

## **2 Data Descriptions and the Empirical Model**

All data are seasonally adjusted and obtained from the Federal Reserve Economic Data (FRED). The oil price is the spot western Texas intermediate (WTI) and deflated by the US Consumer Price Index (CPI). We study pass-through effects of the oil price shock on 7 categories of CPI sub-indices that include: Food and Beverages (12 components); Housing (11 components); Apparel (7 components), Medical Care (6 components); Recreation (5 components); Education and Communication (8 components); Transportations (11 components). We also implement similar analysis for 24 components in two additional categories: Commodity and Services Groups (9 components); Special Indexes (15

components). Observations are monthly and span from 1974 M1 to 2013 M7 for most indices.<sup>1</sup> See Table 1 for detailed information.

**Table 1 around here**

To measure dynamic effects of the oil price shock on each CPI component, we employ the impulse response function analysis. That is, we use the following bivariate vector autoregressive (VAR) model for the real spot oil price ( $rop_t$ ) and CPI sub-index ( $sp_t^i$ ), expressed in natural logarithms. We transform all variables to percent changes by taking first differences ( $\Delta rop_t, \Delta sp_t^i$ ).

$$\mathbf{x}_t = a + \mathbf{B}(L)\mathbf{x}_{t-1} + \mathbf{C}\mathbf{u}_t, \tag{1}$$

where  $\mathbf{x}_t = [\Delta rop_t, \Delta sp_t^i]'$ ,  $\mathbf{B}(L)$  denotes the lag polynomial matrix,  $\mathbf{u}_t$  is a vector of normalized underlying shocks, and  $\mathbf{C}$  is a matrix that describes the contemporaneous relationships between  $\Delta rop_t$  and  $\Delta sp_t^i$ .<sup>2</sup> We obtain the conventional orthogonalized impulse-response function (OIRF; Sims, 1980; Kilian and Vega, 2011) accompanied by the 95% confidence bands by taking 2.5% and 97.5% percentiles from residual-based wild bootstrap (Goncalves and Kilian, 2004).

### 3 Pass-Through Effects of the Oil Price Shock

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<sup>1</sup> Observations prior to 1974 are not used since we noticed a substantial structural change in the oil price distribution in 1973, which is not our major concern in the present paper. See Alquist, Kilian, and Vigfusson (2013).

<sup>2</sup> To get the response of the level variable, we report the *accumulated* impulse-response function from a bivariate vector autoregressive model with differenced variables. The real oil price inflation is ordered first with an assumption that the US CPI inflation does not contemporaneously affect the oil price inflation within one month.

We first report impulse-response function estimates for 9 CPI sub-indices as well as the total (all items) CPI in Figure 1. We find qualitatively different responses across indices to the positive oil price shock. That is, we observe a strong and statistically significant pass-through effect of the oil price shock on the (total) All Items CPI, while very weak evidence of the pass-through effect was found from majority other CPI sub-indices.

It should be noted that the response function estimate for the Energy CPI resembles that of the total CPI, whereas CPI sub-index of All Items Less Energy exhibits negligible and statistically insignificant responses at any conventional significance levels. Similarly, we observed weak and insignificant responses for the Food and Beverage, Apparel, Medical Care, Recreation, and Education CPIs, while strong and significantly positive responses are obtained for the Transportation (5% significance level) and Housing (10% significance level) sub-indices that have greater energy-dependent components (see Table 1) than other indices.

In a nutshell, we found that the pass-through effect of the oil price shock on the overall CPI might have been driven by substantial increases in prices of energy-intensive goods and services. In what follows, we extend our investigation of the pass-through effect using highly disaggregated CPI components to study how the oil price shock may affect the consumers through heterogeneous responses of CPI sub-indices. To save space, we report monthly responses of each sub-index for up to 1 year, because responses tend to get stabilized fairly quickly in around 1 year after the shock occurs.

**Figure 1 around here**

Table 2 reports estimated pass-through effects on the Food and Beverages category CPIs. Overall, we fail to find statistically meaningful pass-through effects for most prices in this category. The Alcohol CPI responds significantly at the 5% level, but shows negative effects. With the exception of the Dairy and the Fruits and Vegetables CPIs, we obtained insignificant responses to the oil price shock in this expenditure category.

**Table 2 around here**

It should be noted that the Housing CPI (Table 3) exhibits statistically significant and positive responses for a little less than a year. However, these responses seem to be attributable to the energy-related components. That is, the Fuel Oil, Fuels and Utilities, Household Energy CPIs exhibit very strong and significantly positive responses, while we find insignificant responses from most other non-energy sub-indices.

**Table 3 around here**

We do not find any meaningful pass-through effects for Apparel (Table 4), Medical Care (Table 5), Recreation (Table 6), or the Education (Table 7) categories. All responses were statistically insignificant at the 5% level and most effects are quantitatively small.

**Tables 4, 5, 6, and 7 around here**

As can be seen in Table 8, Transportation expenditures shows statistically significant pass-through effects in majority components. Interestingly, the Airline Fare CPI shows stronger effects in the intermediate to longer term than in the short-term. This might reflect the fact that airline companies normally purchase fuels in the futures market, dampening the effect of unexpected oil price increases on short term airfares. We also

note that the Public Transportation CPI did not increase much after the shock, whereas we observe a much stronger responses in the Private Transportation CPI. This reflects higher level price stickiness in the former than its unregulated counterpart.

### **Table 8 around here**

In a nutshell, we find strong and meaningful pass-through effects only from 2 out of the 7 major expenditure categories, the Transportation and Housing CPIs. We also note that the significantly positive responses of the Housing index is driven mostly by 3 out of the 10 components, which are highly energy-intensive expenditures. These findings imply that observed strong pass-through effects on the total All Items CPI might be driven by a few energy-related expenditures. Does this mean that the oil price shock may not influence consumer welfare much because it has insignificant pass-through effects in majority expenditure categories?

We do not think so. When the oil price shock occurs, consumers experience a decrease in real income for non-energy expenditures if the demand for energy is inelastic. Statistically significant pass-through effects in energy-related expenditures shown in the present paper are consistent with this view. As decreases in real spending for non-energy expenditures shift the demand curve to the left, prices in those expenditure categories will increase less than those of energy-intensive expenditures, because both the supply and the demand curve shift back in those markets. Our findings are consistent with this interpretation.

We also investigate the pass-through effects in expenditures for Commodities/Nondurables, Services, and Durables. As shown in Table 9, we observed meaningful pass-through effects only from commodity expenditures. We find stronger effects when Food and Beverages and Apparel expenditures are excluded, which is consistent with our findings. Service and durable components show no significant effects.



We obtain very similar and consistent patterns in Special Indices (Table 10). That is, items that exclude energy tend to exhibit insignificant responses, while items that exclude Food and Apparel show significant responses.

**Tables 9 and 10 around here**

Lastly, we implement the variance decomposition analysis to see how much variations of each sub-index are explained by the oil price shock (see Table 11). We observe a substantial effect of the oil price shock only for the Energy and Transportation CPIs, while the contributions from other expenditure categories are limited. For example, the oil price shock explains less than 3% of variations even in the one-year ahead forecast of the Apparel CPI, whereas it explains 18.7% for the Energy CPI in the short-run and 41.9% after about a year. Similarly, we find an important role of the oil price shock in explaining the Transportation CPI.

**Table 11 around here**

## **5 Concluding Remarks**

This paper empirically evaluates the degree of the pass-through effect of the oil price shock using highly disaggregated CPIs as well as 9 aggregate level CPIs in the US. We find very limited pass-through effects of the oil price shock on majority CPIs including the Food and Beverage, the Apparel, the Housing, the Medical Care, the Recreation, and the Education CPIs, while more energy-intensive expenditures such as the Energy and Transportation CPIs show strong evidence of the pass-through effect. Therefore, a strong pass-through effect on the total CPI seems to be mainly driven by substantial increases in energy-related expenditures.

These heterogeneous responses may not be explained if one views the oil price shock as primarily the supply shock, because a negative shift of the supply curve will result in an increase in the equilibrium price. We attempt to solve this puzzle using the spending adjustment effect based on the work of Edelstein and Kilian (2009), who propose the possibility of a negative income effect caused by unexpected changes in the oil price. When the oil price increases unexpectedly, consumers will face substantial decreases in their expenditures of non-energy related commodities if the demand for energy is inelastic. Put it differently, they must reduce consumption for non-energy commodities since they are not able to adjust the budget for energy products.

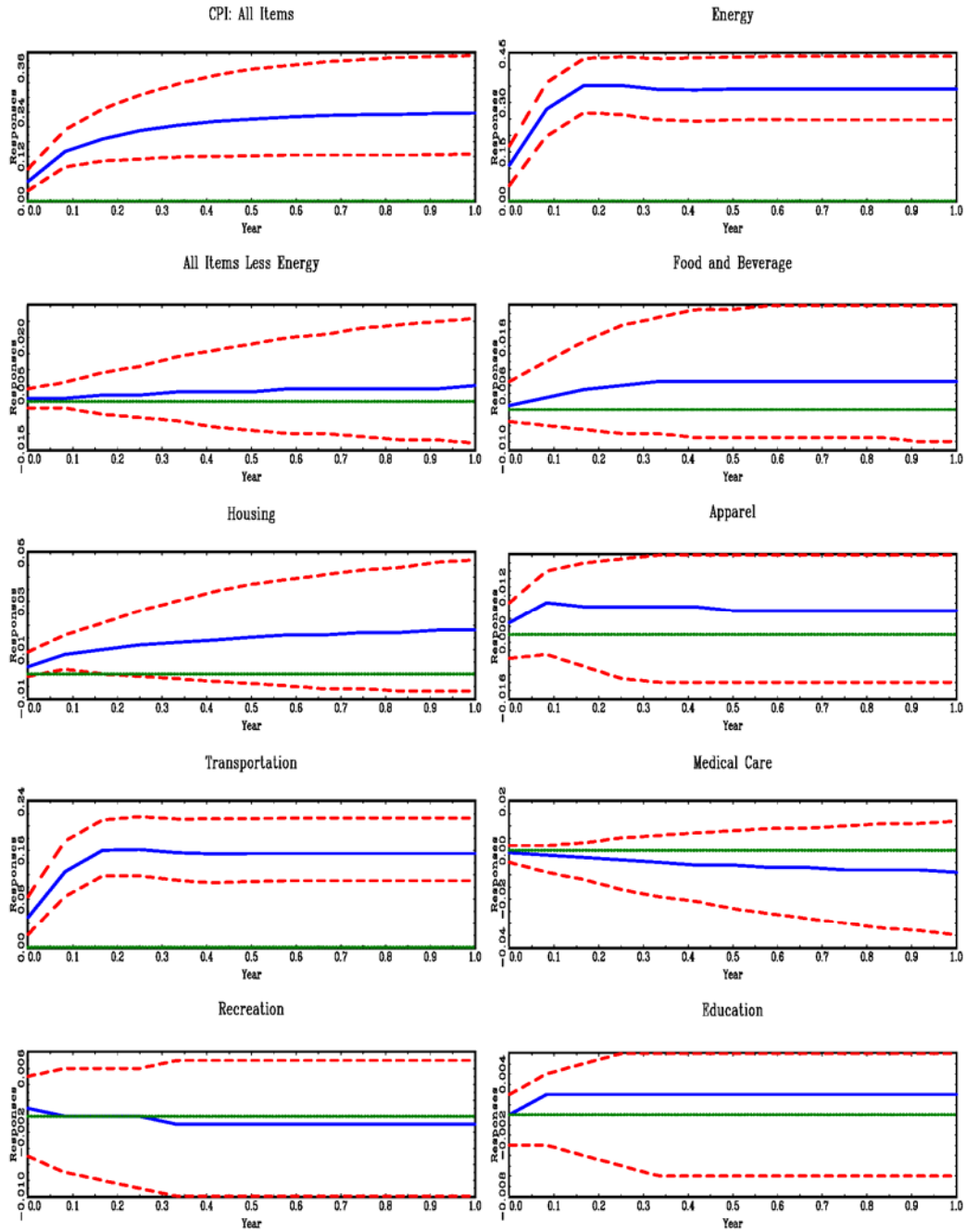
Decreases in the demand for those non-energy commodities then increase the price a lot less compared with more energy-intensive goods and services, because not only the supply but also the demand curve shift to the left, resulting in weak and limited pass-through effects of the oil price shock in those CPI sub-indices. That is, even though the oil price shock has limited pass-through effects on majority expenditures, its influence on consumers may not be negligible because overall consumption is likely to fall, which may provide useful information from the perspective of policymakers.

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**Fig.1. Consumer Price Index Response to an Oil Price Shock.**



Note: Accumulative response functions are obtained from a bivariate vector autoregressive model with the real oil price inflation ordered first. The 95% confidence bands (dashed lines) are obtained from 2,000 nonparametric wild bootstrap (Goncalves and Kilian, 2004).

**Table 1. Consumer Price Index Data**

Category	FRED Code	Sample period	
Food and Beverages	Food and Beverages	1974M1-2013M7	
	Food	1974M1-2013M7	
	Food away from home	1974M1-2013M7	
	Alcoholic beverages	1974M1-2013M7	
	Dairy and related products	1989M1-2013M7	
	Meats, poultry, fish, and eggs	1974M1-2013M7	
	Food at home	1974M1-2013M7	
	Fruits and vegetables	1974M1-2013M7	
	Coffee	2003M1-2013M7	
	Cereals and bakery products	1989M1-2013M7	
	Sugar and sweets	1989M1-2013M7	
	Alcoholic beverages away from home	1978M1-2013M7	
	Housing	Housing	1974M1-2013M7
Rent of primary residence		1981M1-2013M7	
Owners' equivalent rent of residences		1983M1-2013M7	
Fuel oil and other fuels		1974M1-2013M7	
Water and sewer and trash collection services		1997M12-2013M7	
Fuels and utilities		1974M1-2013M7	
Owners' equivalent rent of primary residence		1983M1-2013M7	
Shelter		1974M1-2013M7	
Lodging away from home		1997M12-2013M7	
Household furnishings and operations		1974M1-2013M7	
Household energy		1974M1-2013M7	
Apparel		Apparel	1974M1-2013M7
		Footwear	1974M1-2013M7
	Laundry and dry cleaning services	2004M1-2013M7	
	Men's and boys' apparel	1974M1-2013M7	
	Women's and girls' apparel	1974M1-2013M7	
	Apparel less footwear	1974M1-2013M7	
	Infants' and toddlers' apparel	1989M1-2013M7	
Transportation	Transportation	1974M1-2013M7	
	New vehicles	1974M1-2013M7	
	Gasoline (all types)	1974M1-2013M7	
	Used cars and trucks	1974M1-2013M7	
	Airline fare	1989M1-2013M7	
	Motor fuel	1974M1-2013M7	

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	Motor vehicle maintenance and repair	1974M1-2013M7
	New and used motor vehicles	1993M1-2013M7
	Motor vehicle parts and equipment	1991M1-2013M7
	Public transportation	1989M1-2013M7
	Private transportation	1974M1-2013M7
Medical Care	Medical Care	1974M1-2013M7
	Medical care services	1974M1-2013M7
	Medical care commodities	1974M1-2013M7
	Hospital and related services	1978M1-2013M7
	Professional services	1980M1-2013M7
	Services by other medical professionals	1989M1-2013M7
Recreation	Recreation	1993M1-2013M7
	Admission to movies, theaters, and concerts	1999M1-2013M7
	Video and audio products	2010M1-2013M7
	Video and audio	1994M1-2013M7
	Club dues and fees for participant sports and group exercises	1998M1-2013M7
Education and Communication	Education	1993M1-2013M7
	Personal computers and peripheral equipment	2005M1-2013M7
	Tuition, other school fees, and childcare	1978M1-2013M7
	Information technology, hardware and services	2006M1-2013M7
	Educational books and supplies	1974M1-2013M7
	Communication	1998M1-2013M7
	Information and information processing	2006M1-2013M7
	Fees for lessons or instructions	1989M1-2013M7
Commodity and services groups	Commodities	1974M1-2013M7
	Services	1974M1-2013M7
	Durables	1974M1-2013M7
	Nondurables less food and beverages	1989M1-2013M7
	Transportation services	1974M1-2013M7
	Commodities less food and beverages	1974M1-2013M7
	Other services	1974M1-2013M7
	Rent of shelter	1990M1-2013M7
	Nondurables less food, beverages, and apparel	1991M1-2013M7
Special indexes	All Items Less Food & Energy	1974M1-2013M7
	Energy	1974M1-2013M7

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Commodities less food and energy commodities	1974M1-2013M7
All Items Less Energy	1974M1-2013M7
All items less shelter	1974M1-2013M7
All Items Less Food	1974M1-2013M7
Nondurables	1974M1-2013M7
All items less medical care	1974M1-2013M7
Services less energy services	1974M1-2013M7
Energy commodities	1974M1-2013M7
Nondurables less food and apparel	1991M1-2013M7
Services less rent of shelter	1985M1-2013M7
Commodities less food	1974M1-2013M7
Nondurables less food	1989M1-2013M7
Services less medical care services	1983M1-2013M7

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Note: All data are obtained from the FRED website.



**Table 2: Food and Beverages CPIs**

Category \ $j$	0	1	2	6	12
Food and Beverages	0.001 (-0.004, 0.006)	0.003 (-0.005, 0.011)	0.005 (-0.006, 0.015)	0.007 (-0.008, 0.023)	0.007 (-0.008, 0.024)
Food	0.001 (-0.003, 0.007)	0.003 (-0.004, 0.012)	0.005 (-0.004, 0.017)	0.008 (-0.006, 0.025)	0.008 (-0.006, 0.026)
Food away from home	0.001 (-0.001, 0.003)	0.001 (-0.003, 0.005)	0.001 (-0.004, 0.007)	0.003 (-0.009, 0.016)	0.004 (-0.014, 0.024)
Alcoholic beverages	<b>-0.004</b> (-0.019, -0.003)	<b>-0.005</b> (-0.028, -0.003)	<b>-0.007</b> (-0.034, -0.003)	<b>-0.009</b> (-0.041, -0.001)	<b>-0.009</b> (-0.041, -0.001)
Dairy and related products	<b>0.002</b> (0.004, 0.048)	-0.002 (-0.002, 0.065)	<b>0.009</b> (0.007, 0.087)	<b>0.025</b> (0.014, 0.118)	<b>0.025</b> (0.014, 0.123)
Meats, poultry, fish, and eggs	-0.002 (-0.026, 0.011)	-0.003 (-0.041, 0.017)	0.000 (-0.048, 0.026)	0.005 (-0.059, 0.042)	0.005 (-0.059, 0.044)
Food at home	0.001 (-0.005, 0.010)	0.004 (-0.006, 0.018)	0.008 (-0.005, 0.024)	0.011 (-0.006, 0.031)	0.011 (-0.006, 0.031)
Fruits and vegetables	0.002 (-0.010, 0.042)	<b>0.023</b> (0.005, 0.070)	<b>0.031</b> (0.009, 0.076)	<b>0.029</b> (0.007, 0.074)	<b>0.029</b> (0.007, 0.074)
Coffee	0.002 (-0.017, 0.053)	0.019 (-0.003, 0.093)	0.002 (-0.006, 0.116)	0.003 (-0.011, 0.179)	0.031 (-0.013, 0.204)
Cereals and bakery products	0.000 (-0.003, 0.015)	0.001 (-0.004, 0.018)	0.005 (-0.001, 0.030)	0.010 (0.000, 0.044)	<b>0.011</b> (0.001, 0.048)
Sugar and sweets	-0.002 (-0.006, 0.022)	-0.007 (-0.012, 0.013)	-0.013 (-0.019, 0.006)	-0.013 (-0.020, 0.007)	-0.013 (-0.020, 0.007)
Alcoholic beverages away from home	-0.003 (-0.009, 0.004)	-0.003 (-0.012, 0.007)	-0.002 (-0.013, 0.009)	-0.002 (-0.014, 0.012)	-0.002 (-0.014, 0.012)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 3: Housing CPIs**

Category \ <i>j</i>	0	1	2	6	12
Housing	<b>0.003</b> (0.001, 0.008)	<b>0.008</b> (0.003, 0.016)	<b>0.010</b> (0.003, 0.022)	<b>0.015</b> (0.001, 0.037)	0.018 (-0.002, 0.048)
Rent of primary residence	-0.002 (-0.005, 0.001)	-0.003 (-0.008, 0.000)	-0.004 (-0.011, 0.000)	-0.007 (-0.018, 0.000)	-0.008 (-0.022, 0.000)
Owners' equivalent rent of residences	-0.001 (-0.004, 0.001)	-0.003 (-0.007, 0.000)	<b>-0.006</b> (-0.012, -0.002)	<b>-0.010</b> (-0.019, -0.005)	<b>-0.011</b> (-0.021, -0.005)
Fuel oil and other fuels	<b>0.170</b> (0.163, 0.290)	<b>0.380</b> (0.362, 0.518)	<b>0.498</b> (0.463, 0.659)	<b>0.545</b> (0.485, 0.741)	<b>0.543</b> (0.484, 0.739)
Water and sewer and trash collection services	0.000 (-0.002, 0.005)	0.001 (-0.003, 0.008)	0.003 (-0.003, 0.012)	0.005 (-0.005, 0.020)	0.005 (-0.006, 0.022)
Fuels and utilities	<b>0.014</b> (0.007, 0.043)	<b>0.045</b> (0.034, 0.084)	<b>0.061</b> (0.047, 0.109)	<b>0.080</b> (0.058, 0.144)	<b>0.082</b> (0.058, 0.148)
Owners' equivalent rent of primary residence	-0.001 (-0.004, 0.001)	-0.003 (-0.007, 0.000)	<b>-0.006</b> (-0.012, -0.002)	<b>-0.010</b> (-0.019, -0.005)	<b>-0.011</b> (-0.021, -0.005)
Shelter	0.002 (-0.004, 0.006)	0.001 (-0.008, 0.009)	0.000 (-0.013, 0.011)	-0.002 (-0.024, 0.018)	-0.003 (-0.031, 0.022)
Lodging away from home	0.018 (-0.021, 0.047)	0.006 (-0.038, 0.038)	0.015 (-0.028, 0.049)	0.017 (-0.030, 0.052)	0.017 (-0.030, 0.052)
Household furnishings and operations	0.001 (-0.004, 0.009)	0.003 (-0.004, 0.015)	0.003 (-0.007, 0.019)	0.003 (-0.016, 0.033)	0.003 (-0.023, 0.042)
Household energy	<b>0.019</b> (0.009, 0.053)	<b>0.061</b> (0.046, 0.108)	<b>0.085</b> (0.065, 0.143)	<b>0.114</b> (0.082, 0.190)	<b>0.117</b> (0.084, 0.197)

Note: We report the response of each level variable in *j* month. Statistically significant responses at the 5% level are in bold.

**Table 4: Apparel CPIs**

Category \ $j$	0	1	2	6	12
Apparel	0.003 (-0.018, 0.005)	0.008 (-0.018, 0.013)	0.007 (-0.021, 0.014)	0.006 (-0.024, 0.015)	0.006 (-0.024, 0.015)
Footwear	0.005 (-0.006, 0.023)	0.007 (-0.007, 0.028)	0.007 (-0.008, 0.028)	0.007 (-0.008, 0.029)	0.007 (-0.008, 0.029)
Laundry and dry cleaning services	0.004 (-0.006, 0.009)	0.004 (-0.007, 0.010)	0.010 (-0.004, 0.017)	0.014 (-0.003, 0.025)	0.014 (-0.003, 0.027)
Men's and boys' apparel	0.003 (-0.016, 0.006)	-0.001 (-0.024, 0.004)	-0.006 (-0.031, 0.001)	-0.008 (-0.035, 0.000)	-0.008 (-0.035, 0.000)
Women's and girls' apparel	0.002 (-0.039, 0.006)	0.013 (-0.033, 0.020)	0.014 (-0.029, 0.024)	0.013 (-0.031, 0.023)	0.013 (-0.031, 0.023)
Apparel less footwear	0.003 (-0.023, 0.004)	0.009 (-0.021, 0.012)	0.008 (-0.024, 0.014)	0.007 (-0.026, 0.014)	0.007 (-0.027, 0.014)
Infants' and toddlers' apparel	0.002 (-0.035, 0.012)	0.003 (-0.043, 0.020)	-0.003 (-0.049, 0.018)	-0.005 (-0.054, 0.018)	-0.005 (-0.054, 0.018)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 5: Medical Care CPIs**

Category \ <i>j</i>	0	1	2	6	12
Medical Care	0.002 <b>(-0.035, 0.012)</b>	0.003 <b>(-0.043, 0.020)</b>	-0.003 <b>(-0.049, 0.018)</b>	-0.005 <b>(-0.054, 0.018)</b>	-0.005 <b>(-0.054, 0.018)</b>
Medical care services	-0.001 <b>(-0.003, 0.002)</b>	-0.002 <b>(-0.006, 0.003)</b>	-0.003 <b>(-0.008, 0.004)</b>	-0.006 <b>(-0.017, 0.009)</b>	-0.008 <b>(-0.023, 0.013)</b>
Medical care commodities	-0.002 <b>(-0.004, 0.004)</b>	-0.003 <b>(-0.006, 0.006)</b>	-0.004 <b>(-0.009, 0.010)</b>	-0.005 <b>(-0.015, 0.018)</b>	-0.005 <b>(-0.018, 0.022)</b>
Hospital and related services	-0.001 <b>(-0.008, 0.003)</b>	-0.002 <b>(-0.012, 0.005)</b>	-0.002 <b>(-0.017, 0.008)</b>	-0.003 <b>(-0.028, 0.015)</b>	-0.004 <b>(-0.033, 0.019)</b>
Professional services	-0.001 <b>(-0.008, 0.003)</b>	-0.002 <b>(-0.012, 0.005)</b>	-0.002 <b>(-0.017, 0.008)</b>	-0.003 <b>(-0.028, 0.015)</b>	-0.004 <b>(-0.033, 0.019)</b>
Services by other medical professionals	0.000 <b>(-0.014, 0.000)</b>	0.001 <b>(-0.016, 0.002)</b>	0.000 <b>(-0.018, 0.002)</b>	-0.001 <b>(-0.021, 0.002)</b>	-0.001 <b>(-0.021, 0.002)</b>

Note: We report the response of each level variable in *j* month. Statistically significant responses at the 5% level are in bold.

**Table 6: Recreation CPIs**

Category \ $j$	0	1	2	6	12
Recreation	-0.003 (-0.009, 0.004)	-0.003 (-0.012, 0.007)	-0.002 (-0.013, 0.009)	-0.002 (-0.014, 0.012)	-0.002 (-0.014, 0.012)
Admission to movies, theaters, and concerts	-0.002 (-0.018, 0.022)	-0.007 (-0.029, 0.021)	0.002 (-0.019, 0.030)	0.005 (-0.017, 0.036)	0.006 (-0.017, 0.036)
Video and audio products	0.029 (-0.033, 0.072)	0.027 (-0.035, 0.076)	0.018 (-0.040, 0.069)	0.020 (-0.036, 0.070)	0.020 (-0.035, 0.070)
Video and audio	0.004 (-0.007, 0.007)	0.000 (-0.013, 0.005)	0.000 (-0.013, 0.006)	0.001 (-0.013, 0.007)	0.001 (-0.013, 0.007)
Club dues and fees	-0.001 (-0.018, 0.006)	0.006 (-0.013, 0.015)	0.007 (-0.012, 0.018)	0.007 (-0.013, 0.019)	0.007 (-0.013, 0.019)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 7: Education CPIs**

Category \ $j$	0	1	2	6	12
Education	-0.001 (-0.018, 0.006)	0.006 (-0.013, 0.015)	0.007 (-0.012, 0.018)	0.007 (-0.013, 0.019)	0.007 (-0.013, 0.019)
Personal computers and peripheral equipment	0.001 (-0.041, 0.046)	0.001 (-0.056, 0.057)	-0.011 (-0.070, 0.042)	-0.020 (-0.088, 0.037)	-0.020 (-0.094, 0.039)
Tuition, other school fees, and childcare	-0.001 (-0.007, 0.000)	0.000 (-0.009, 0.003)	-0.004 (-0.014, 0.001)	-0.007 (-0.022, 0.001)	-0.007 (-0.024, 0.001)
Information technology, hardware and services	-0.001 (-0.025, 0.005)	0.000 (-0.045, 0.012)	0.000 (-0.060, 0.020)	0.000 (-0.102, 0.043)	-0.001 (-0.118, 0.054)
Educational books and supplies	-0.002 (-0.030, 0.010)	0.002 (-0.026, 0.015)	0.004 (-0.022, 0.018)	0.004 (-0.023, 0.017)	0.004 (-0.023, 0.017)
Educational books and supplies	-0.006 (-0.019, 0.012)	-0.006 (-0.020, 0.012)	-0.002 (-0.020, 0.021)	0.000 (-0.020, 0.027)	0.000 (-0.020, 0.028)
Information and information processing	-0.003 (-0.008, 0.003)	-0.002 (-0.011, 0.007)	0.000 (-0.011, 0.011)	0.003 (-0.013, 0.020)	0.004 (-0.014, 0.023)
Fees for lessons or instructions	-0.002 (-0.014, 0.004)	0.000 (-0.014, 0.009)	-0.004 (-0.018, 0.006)	-0.005 (-0.021, 0.006)	-0.005 (-0.022, 0.006)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 8: Transportation CPIs**

Category \ j	0	1	2	6	12
Transportation	<b>0.050</b> (0.030, 0.115)	<b>0.125</b> (0.095, 0.213)	<b>0.160</b> (0.128, 0.247)	<b>0.155</b> (0.120, 0.242)	<b>0.155</b> (0.121, 0.243)
New vehicles	0.001 (-0.011, 0.004)	0.002 (-0.016, 0.006)	0.003 (-0.018, 0.010)	0.005 (-0.022, 0.016)	0.005 (-0.022, 0.016)
Gasoline (all types)	<b>0.053</b> (0.033, 0.122)	<b>0.133</b> (0.103, 0.226)	<b>0.168</b> (0.137, 0.259)	<b>0.161</b> (0.127, 0.252)	<b>0.162</b> (0.128, 0.254)
Used cars and trucks	<b>0.204</b> (0.136, 0.441)	<b>0.509</b> (0.416, 0.813)	<b>0.634</b> (0.545, 0.901)	<b>0.593</b> (0.489, 0.868)	<b>0.593</b> (0.491, 0.867)
Airline fare	<b>0.009</b> (0.011, 0.070)	<b>0.030</b> (0.022, 0.111)	<b>0.071</b> (0.050, 0.155)	<b>0.081</b> (0.057, 0.177)	<b>0.082</b> (0.058, 0.180)
Motor fuel	0.007 (-0.006, 0.017)	0.015 (-0.012, 0.034)	0.029 (-0.008, 0.058)	0.064 (-0.001, 0.115)	<b>0.072</b> (0.001, 0.131)
Motor vehicle maintenance and repair	<b>0.201</b> (0.135, 0.433)	<b>0.507</b> (0.419, 0.800)	<b>0.632</b> (0.544, 0.889)	<b>0.595</b> (0.494, 0.865)	<b>0.595</b> (0.493, 0.867)
New and used motor vehicles	-0.001 (-0.007, 0.001)	-0.001 (-0.010, 0.003)	-0.001 (-0.013, 0.005)	0.001 (-0.022, 0.013)	0.002 (-0.027, 0.018)
Motor vehicle parts and equipment	0.000 (-0.010, 0.004)	0.004 (-0.014, 0.011)	0.009 (-0.014, 0.019)	0.020 (-0.012, 0.036)	0.022 (-0.012, 0.039)
Public transportation	0.000 (-0.009, 0.002)	0.002 (-0.010, 0.007)	0.003 (-0.011, 0.010)	0.006 (-0.014, 0.017)	0.007 (-0.015, 0.018)
Private transportation	<b>0.004</b> (0.000, 0.044)	<b>0.018</b> (0.008, 0.070)	<b>0.054</b> (0.037, 0.108)	<b>0.065</b> (0.043, 0.126)	<b>0.066</b> (0.045, 0.128)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 9: Commodity and Services Groups CPIs**

Category \ j	0	1	2	6	12
Commodities	<b>0.023</b> (0.014, 0.050)	<b>0.058</b> (0.044, 0.096)	<b>0.072</b> (0.056, 0.114)	<b>0.076</b> (0.057, 0.122)	<b>0.076</b> (0.058, 0.123)
Services	0.001 (-0.001, 0.006)	0.002 (-0.002, 0.009)	0.003 (-0.003, 0.013)	0.005 (-0.007, 0.025)	0.007 (-0.010, 0.035)
Durables	0.003 (-0.005, 0.005)	0.007 (-0.007, 0.010)	0.009 (-0.010, 0.015)	0.014 (-0.022, 0.027)	0.017 (-0.029, 0.036)
Nondurables less food and beverages	<b>0.073</b> (0.050, 0.120)	<b>0.166</b> (0.133, 0.231)	<b>0.198</b> (0.161, 0.264)	<b>0.186</b> (0.143, 0.262)	<b>0.187</b> (0.143, 0.263)
Transportation services	0.000 (-0.007, 0.006)	0.000 (-0.010, 0.009)	0.007 (-0.006, 0.020)	0.018 (-0.002, 0.038)	0.020 (-0.002, 0.044)
Commodities less food and beverages	<b>0.038</b> (0.022, 0.080)	<b>0.092</b> (0.070, 0.152)	<b>0.115</b> (0.091, 0.176)	<b>0.113</b> (0.088, 0.176)	<b>0.114</b> (0.088, 0.176)
Other services	0.000 (-0.004, 0.003)	0.000 (-0.005, 0.006)	0.000 (-0.007, 0.008)	0.001 (-0.013, 0.015)	0.001 (-0.017, 0.019)
Rent of shelter	0.002 (-0.002, 0.004)	0.000 (-0.006, 0.003)	-0.002 (-0.008, 0.003)	-0.005 (-0.015, 0.003)	-0.005 (-0.017, 0.003)
Nondurables less food, beverages, and apparel	<b>0.118</b> (0.050, 0.145)	<b>0.256</b> (0.169, 0.299)	<b>0.298</b> (0.207, 0.348)	<b>0.282</b> (0.186, 0.351)	<b>0.281</b> (0.184, 0.353)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.



**Table 10: Special Indexes**

Category \ j	0	1	2	6	12
All Items Less Food & Energy	0.001 (-0.003, 0.003)	0.001 (-0.005, 0.005)	0.001 (-0.007, 0.007)	0.002 (-0.015, 0.014)	0.003 (-0.022, 0.021)
Energy	<b>0.110</b> (0.080, 0.240)	<b>0.280</b> (0.237, 0.447)	<b>0.353</b> (0.303, 0.512)	<b>0.341</b> (0.285, 0.505)	<b>0.342</b> (0.286, 0.506)
Commodities less food and energy commodities	0.001 (-0.008, 0.002)	0.004 (-0.010, 0.006)	0.005 (-0.013, 0.009)	0.009 (-0.023, 0.019)	0.012 (-0.030, 0.025)
All Items Less Energy	0.001 (-0.002, 0.003)	0.001 (-0.003, 0.005)	0.002 (-0.004, 0.007)	0.003 (-0.010, 0.015)	0.005 (-0.015, 0.021)
All items less shelter	<b>0.014</b> (0.009, 0.032)	<b>0.037</b> (0.028, 0.062)	<b>0.047</b> (0.037, 0.077)	<b>0.054</b> (0.040, 0.093)	<b>0.055</b> (0.040, 0.095)
All Items Less Food	<b>0.013</b> (0.007, 0.024)	<b>0.032</b> (0.023, 0.050)	<b>0.039</b> (0.027, 0.062)	<b>0.051</b> (0.032, 0.089)	<b>0.054</b> (0.033, 0.098)
Nondurables	<b>0.031</b> (0.018, 0.061)	<b>0.075</b> (0.056, 0.116)	<b>0.092</b> (0.072, 0.136)	<b>0.092</b> (0.069, 0.140)	<b>0.092</b> (0.069, 0.140)
All items less medical care	<b>0.012</b> (0.008, 0.024)	<b>0.030</b> (0.023, 0.048)	<b>0.037</b> (0.029, 0.061)	<b>0.048</b> (0.035, 0.085)	<b>0.051</b> (0.036, 0.095)
Services less energy services	0.001 (-0.002, 0.005)	0.000 (-0.005, 0.007)	0.000 (-0.007, 0.010)	0.000 (-0.014, 0.019)	0.000 (-0.019, 0.026)
Energy commodities	<b>0.202</b> (0.143, 0.423)	<b>0.501</b> (0.420, 0.775)	<b>0.625</b> (0.540, 0.874)	<b>0.591</b> (0.497, 0.852)	<b>0.592</b> (0.496, 0.852)
Nondurables less food and apparel	<b>0.108</b> (0.046, 0.131)	<b>0.234</b> (0.152, 0.270)	<b>0.271</b> (0.189, 0.316)	<b>0.256</b> (0.168, 0.317)	<b>0.255</b> (0.168, 0.319)
Services less rent of shelter	-0.001 (-0.003, 0.006)	0.002 (-0.001, 0.011)	<b>0.005</b> (0.001, 0.015)	<b>0.008</b> (0.002, 0.022)	<b>0.008</b> (0.002, 0.023)
Commodities less food	<b>0.035</b> (0.020, 0.076)	<b>0.088</b> (0.067, 0.146)	<b>0.110</b> (0.086, 0.169)	<b>0.109</b> (0.084, 0.172)	<b>0.109</b> (0.084, 0.172)
Nondurables less food	<b>0.068</b> (0.048, 0.113)	<b>0.155</b> (0.125, 0.216)	<b>0.184</b> (0.151, 0.247)	<b>0.174</b> (0.135, 0.244)	<b>0.174</b> (0.135, 0.246)
Services less medical care services	0.000 (-0.003, 0.001)	0.000 (-0.004, 0.002)	0.001 (-0.005, 0.004)	0.001 (-0.006, 0.006)	0.002 (-0.007, 0.007)

Note: We report the response of each level variable in  $j$  month. Statistically significant responses at the 5% level are in bold.

**Table 11. Variance Decomposition Analysis**

<i>k</i>	Oil	Food and Beverage	se	<i>k</i>	Oil	Housing	se
1	0.001	0.999	0.003	1	0.019	0.981	0.009
2	0.002	0.998	0.006	2	0.031	0.969	0.016
3	0.004	0.996	0.008	3	0.025	0.975	0.016
6	0.005	0.995	0.010	6	0.021	0.979	0.018
12	0.005	0.995	0.011	12	0.019	0.981	0.018
<i>k</i>	Oil	Apparel	se	<i>k</i>	Oil	Transportation	se
1	0.005	0.995	0.005	1	0.166	0.834	0.038
2	0.015	0.985	0.010	2	0.344	0.656	0.043
3	0.025	0.975	0.010	3	0.367	0.633	0.045
6	0.028	0.972	0.010	6	0.367	0.633	0.045
12	0.028	0.972	0.010	12	0.367	0.633	0.045
<i>k</i>	Oil	Medical Care	se	<i>k</i>	Oil	Recreation	se
1	0.000	1.000	0.004	1	0.000	1.000	0.007
2	0.000	1.000	0.007	2	0.008	0.992	0.009
3	0.003	0.997	0.008	3	0.011	0.989	0.011
6	0.005	0.995	0.01	6	0.011	0.989	0.011
12	0.006	0.994	0.012	12	0.011	0.989	0.011
<i>k</i>	Oil	Education	se	<i>k</i>	Oil	Energy	se
1	0.000	1.000	0.004	1	0.187	0.813	0.039
2	0.022	0.978	0.014	2	0.401	0.599	0.044
3	0.026	0.974	0.015	3	0.419	0.581	0.045
6	0.027	0.973	0.016	6	0.419	0.581	0.045
12	0.027	0.973	0.016	12	0.419	0.581	0.045

Note: Variance decomposition analysis is implemented from a bivariate vector autoregressive model with the real oil price inflation ordered first. We report the variance decomposition for the  $k$ -period (month) ahead forecast of the variable  $x$  (each sub-index) at time  $t$ . Standard errors (se) are obtained from 2,000 nonparametric bootstrap simulations.