

1 **How Sensitive are Consumer Expenditures to**
2 **Retail Energy Prices?***

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6 **Abstract**

7 There is growing evidence that the primary effect of energy price shocks on the U.S. economy
8 involves a reduction in consumer spending. We quantify the direct effect on real consumption of
9 unanticipated changes in discretionary income, shifts in precautionary savings, and changes in
10 the operating cost of energy-using durables. The possibility of asymmetries in the response of
11 real consumption to energy price shocks is also considered. We demonstrate that linear models
12 are consistent with the symmetric behavior of real consumption in 1979 (when energy prices
13 increased sharply) and in 1986 (when they fell sharply). It is shown that historically energy
14 price shocks have been an important factor in explaining U.S. real consumption growth, but by
15 no means the dominant factor.

16 KEYWORDS: Energy prices; Consumption; Consumer Sentiment; Purchasing Power; Asym-
17 metry.

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1 Introduction

Large fluctuations in energy prices have been a distinguishing characteristic of the U.S. economy since the 1970s. Between January 2002 and July 2006, for example, the PCE price index for energy goods increased by 68% in real terms. A common perception is that higher energy prices tend to reduce the discretionary household income available for the purchases of other goods and services. Despite the attention that such purchasing power losses have received in the media and in policy discussions, little is known about their magnitude, about their effect on real consumption and about the extent to which consumption patterns change in response to energy price fluctuations. Answers to these questions are important for understanding the transmission of energy price shocks to the U.S. economy. As noted in a recent survey by Hamilton (2009a), the key mechanism whereby energy price shocks affect the economy is through a disruption in consumers' (and firms') spending on goods and services other than energy. The view that energy price shocks are primarily demand shocks for the U.S. economy is also shared by policymakers. For example, Bernanke (2006a) stressed that an increase in energy prices slows economic growth primarily through its effects on consumer spending.

This paper studies the effect of unanticipated energy price changes on consumer spending. There are four mechanisms by which consumer expenditures may be directly affected by energy price changes. First, higher energy prices are expected to reduce discretionary income, as consumers have less money to spend after paying their energy bills.¹ All else equal, this *discretionary income effect* will be the larger, the less elastic the demand for energy, but even with perfectly inelastic energy demand the magnitude of the effect of a unit change in energy prices is bounded by the energy share in consumption. Second, changing energy prices may create uncertainty about the future path of the price of energy, causing consumers to postpone irreversible purchases of consumer durables (see Bernanke 1983, Pindyck 1991). Unlike the first effect, this *uncertainty effect* is limited to consumer durables. Third, even when purchase decisions are reversible, consumption may fall in response to energy price shocks, as consumers increase their *precautionary savings*. This response may arise if consumers smooth their consumption because they perceive a greater likelihood of future unemployment and hence future income losses. By construction, this response will also embody general equilibrium effects on employment and real income otherwise not accounted for in partial equilibrium analysis of the demand channel. This precautionary savings motive implies

¹Implicit in this view is the assertion that higher energy prices are primarily driven by higher prices for imported energy goods, and that at least some of the discretionary income lost from higher prices of imported energy goods is transferred abroad and is not recycled in the form of higher U.S. exports. In the case of a purely domestic energy price shock (such as a shock to U.S. refining capacity), it is less obvious that there is an effect on aggregate discretionary income. First, the transfer of income to the refiner may be partially returned to the same consumers in the form of higher wages or higher stock returns on domestic energy companies. Second, even if the transfer is not returned, higher energy prices simply constitute an income transfer from one consumer to another that cancels in the aggregate.

47 a symmetric responses to energy price increases and decreases. Precautionary savings may also
48 reflect greater uncertainty about the prospects of remaining gainfully employed, in which case any
49 unexpected change in energy prices would lower consumption. Finally, consumption of durables
50 that are complementary in use with energy (in that their operation requires energy) will decline
51 even more than other durables, as households delay or forego purchases of energy-using durables.
52 This *operating cost effect* is more limited in scope than the uncertainty effect in that it only affects
53 specific consumer durables. It should be most pronounced for motor vehicles (see Hamilton 1988).²

54 In addition, there may be indirect effects related to the changing patterns of consumption expen-
55 ditures. A large literature has stressed that shifts in expenditure patterns driven by the uncertainty
56 effect and operating cost effect amount to allocative disturbances that are likely to cause sectoral
57 shifts throughout the economy. For example, it has been argued that reduced expenditures on
58 energy-intensive durables such as automobiles may cause the reallocation of capital and labor away
59 from the automobile sector. As the dollar value of such purchases may be large relative to the
60 value of the energy they use, even relatively small changes in energy prices (and hence in purchasing
61 power) can have large effects on output and unemployment (see Hamilton 1988). A similar realloca-
62 tion may occur within the same sector, as consumers switch toward more energy-efficient durables
63 (see Hamilton 1988; Bresnahan and Ramey 1993). In the presence of frictions in capital and labor
64 markets, these intersectoral and intrasectoral reallocations will cause resources to be unemployed,
65 thus causing further cutbacks in consumption and amplifying the effect of purchasing power losses on
66 the real economy. This *reallocation effect* could be much larger than the direct effects listed earlier,
67 and is viewed by many economists as the primary channel through which energy price shocks affect
68 the economy (see Davis and Haltiwanger (2001) and Lee and Ni (2002) and the references therein).
69 Concerns over reallocation effects also help explain the preoccupation of policymakers with the ef-
70 fects of energy price shocks on the automobile sector (see, e.g., Bernanke 2006b). Unlike other
71 effects, the uncertainty effect and the reallocation effect necessarily generate asymmetric responses
72 of macroeconomic aggregates to energy price increases and decreases. They amplify the response to
73 unexpected energy price increases, but dampen the response to unexpected energy price decreases.

74 In this paper, we provide a comprehensive look at the evidence for these channels of transmission
75 based on a detailed analysis of BEA data on personal consumption expenditures (PCE) and Michigan
76 Survey of Consumers data on consumer expectations. The remainder of the paper is organized as

²The effect of changes in operating costs on the consumption of energy-using durables is likely to be symmetric. This point deserves some elaboration. Hamilton (2009a) makes the case that consumers may postpone car purchases, when the price of energy rises, but will not buy a second car, when energy prices go down. However, there are likely to be consumers who used to think that purchasing their first (or second) car was beyond their means, and who may elect to buy a car after all, following a decline in energy prices. In addition, consumers will tend to replace their existing car with a new and less energy-efficient car.

77 follows. In section 2, we document how retail energy price fluctuations have affected consumers’
78 purchasing power since 1970. We construct time series of real energy prices and of the corresponding
79 expenditure shares. Using these data, we construct a monthly time series of the losses and gains in
80 purchasing power associated with changes in retail energy prices. That series indicates the required
81 change in discretionary spending if households wish to purchase last month’s quantity of energy
82 goods at the current month’s prices.

83 In section 3, we discuss our econometric methodology. Since preliminary statistical tests did
84 not provide evidence of statistically significant departures from the null hypothesis of symmetric
85 impulse response functions, our analysis abstracts from all effects of energy price shocks that involve
86 asymmetries such as the uncertainty and reallocation effect. Instead, in section 4, we rely on standard
87 linear models that impose symmetry in the responses to unexpected increases and decreases in
88 purchasing power. We quantify the three remaining symmetric effects based on the differential
89 response of major components of real consumption to unpredictable changes in purchasing power
90 driven by energy price fluctuations. We bound the magnitude of the discretionary income effect with
91 the help of estimates of the short-run price elasticity of energy demand, and infer the precautionary
92 savings effect from the excess response of nondurables and services consumption relative to this
93 benchmark. We measure the effect of changes in operating costs on the consumption of energy-
94 using durables by comparing the response of vehicles consumption to the consumption response
95 for other durables. We relate these findings to the effects of purchasing power shocks on measures
96 of consumer confidence. Finally, we study the role of fuel economy using disaggregate data on
97 automobile purchases.

98 In section 5.1, we focus on the ability of our model to explain the 1979 episode (when energy
99 prices increased sharply) and the 1986 episode (when they fell sharply). We demonstrate that the
100 linear model is capable of explaining these key episodes in the data without introducing asymmetries,
101 consistent with the lack of statistical evidence for the reallocation and uncertainty effects. In section
102 5.2, we study the declining importance of energy price shocks for consumption compared to the
103 1970s and early 1980s. The conclusions are discussed in Section 6.

104 **2 Measuring Purchasing Power Gains and Losses**

105 The quantitative importance of changes in energy prices for discretionary income is by no means
106 self-evident. For one thing, the degree to which rising energy prices affect household purchasing
107 power depends not only on how much energy prices increase, but also on the fraction of consumer
108 expenditures devoted to energy. In this section, we construct a measure of the gains and losses

109 in purchasing power attributable to fluctuating energy prices. The thought experiment underlying
 110 this measure is that a household, when faced with rising energy prices, is unable to reduce its
 111 energy consumption in the short run, resulting in higher energy expenditures. The resulting loss
 112 in “purchasing power” causes households to curtail their discretionary expenditures on non-energy
 113 goods and services.

114 Let E be the quantity of energy goods consumed, N the quantity of non-energy goods consumed,
 115 P^E the price of energy goods, P^N the price of non-energy goods, and P^{PCE} the price index for
 116 personal consumption expenditures. Real energy consumption in consumption units at date t is
 117 given by $e_t \equiv E_t \cdot P_t^E / P_t^{PCE}$. Real total consumption at date t is the sum of real energy consumption
 118 and real non-energy consumption $c_t \equiv E_t \cdot P_t^E / P_t^{PCE} + N_t \cdot P_t^N / P_t^{PCE}$. This leaves the household
 119 with $c_t - e_t$ to spend on non-energy goods at date t . Suppose that at date $t + 1$, the consumer
 120 requires the same quantity of energy as at date t , but now pays P_{t+1}^E . Then the consumer’s real
 121 energy consumption would be $e_{t+1} \equiv E_t \cdot P_{t+1}^E / P_{t+1}^{PCE}$, and he would have $c_t - e_{t+1}$ left to spend
 122 after paying his energy bill. The implied percent change in purchasing power between dates t and
 123 $t + 1$ is:

$$\frac{(c_t - e_{t+1}) - (c_t - e_t)}{c_t - e_t} = \frac{e_t - e_{t+1}}{c_t - e_t} = \frac{E_t \cdot P_t^E / P_t^{PCE} - E_t \cdot P_{t+1}^E / P_{t+1}^{PCE}}{N_t \cdot P_t^N / P_t^{PCE}} \quad (1)$$

124 Multiplying this expression by P_t^E / P_t^E and rearranging terms yields:

$$- \left(\frac{E_t \cdot P_t^E}{N_t \cdot P_t^N} \right) \cdot \left(\frac{P_{t+1}^E / P_{t+1}^{PCE} - P_t^E / P_t^{PCE}}{P_t^E / P_t^{PCE}} \right) \quad (2)$$

125 The first term in this expression is the ratio of nominal energy expenditures to nominal non-energy
 126 expenditures. Since the fraction of energy expenditures in total expenditures is small, we can
 127 approximate this ratio with the nominal energy expenditure share. The second term is the monthly
 128 percent change in the real price of energy goods. Thus, the percent change in purchasing power
 129 approximately equals the product of the nominal expenditure share and the percent rate of change
 130 in real energy prices: $-\eta_t^E \cdot \% \Delta (P_{t+1}^E / P_{t+1}^{PCE})$, where $\eta_t^E \equiv E_t \cdot P_t^E / (C_t \cdot P_t^{PCE})$.³

131 The BEA’s PCE price index for energy goods is comprised of four main components: gasoline
 132 (and other motor fuels), natural gas, electricity and all other energy goods (including heating oil,
 133 coal and oil lubricants). Figure 1a shows the monthly real energy price index for January 1970-July

³To illustrate our approach, consider the following numerical example: Suppose that at time t , 3% of the average household’s expenditures are devoted to energy consumption. In other words, the average household’s nominal expenditure share, η_t^E , is equal to 3% and its expenditure share for non-energy goods is 97%. Suppose that at time $t + 1$ the real price of energy increases by 10%. If the household wishes to consume the same quantity of energy as in time t , the energy expenditure share will rise to 3.3%, and the non-energy expenditure share will fall to 96.7%. In other words, the household’s discretionary income falls by 0.3 percentage points.

134 2006. Figure 1b illustrates that, despite the importance attached to energy prices in the press, the
135 energy share in consumption has never been large compared to the expenditure share of food or
136 housing, for example. The overall energy share was stable at about 6.5% in the early 1970s. It rose
137 to a peak of 9.6% in 1980, but fell steadily throughout the 1980s and 1990, reaching a low of 4.1%
138 in 1999, only to rise back to its initial level of about 6.5% by 2006. Figure 1c plots the changes
139 in purchasing power associated with the energy price fluctuations in Figure 1a. A negative value
140 in Figure 1c denotes an increase in prices and thus a decline in purchasing power.⁴ Increases in
141 energy prices left households with less money to spend on other goods in about 46% of the months
142 in the sample. In the mid-1990s, most changes in purchasing power were in the range between
143 plus and minus 0.1 percentage points. Since the late 1990s, when rising global demand for oil
144 and constraints in refining capacity began pushing up gasoline prices, however, the volatility and
145 amplitude of purchasing power losses has greatly increased. The largest monthly loss in purchasing
146 power (-0.66 percentage points) is associated with Hurricanes Rita and Katrina in late 2005, and the
147 largest monthly gains in purchasing power were 0.46 percentage points in March of 1986 (associated
148 with the collapse of OPEC in late 1985) and 0.54 percentage points in November 2005 in the wake of
149 Hurricanes Rita and Katrina. Our measure of purchasing power losses abstracts from all margins of
150 adjustment that might reduce the impact effect of energy price changes. In reality, the quantity of
151 energy demanded is unlikely to be completely inelastic. Our empirical methodology in the sections
152 below is designed to incorporate such endogenous responses.

153 **3 Methodology**

154 The fact that the purchasing power losses and gains induced by energy price fluctuations are small,
155 even under the extreme assumption of perfectly inelastic demand for energy, does not necessarily
156 mean that they cannot have large effects on real consumption. Our empirical strategy is to identify
157 these effects by estimating the differential responses of major components of real consumption to
158 unpredictable changes in purchasing power driven by energy price fluctuations. Our main focus
159 is on aggregate real consumption and its major components (durables, nondurables, and services).
160 Durables are further disaggregated into vehicles (defined to include automobiles, motorcycles, recre-
161 ational vehicles, aircraft and boats) and other durables. This distinction is important for assessing
162 the operating cost effect. While the use of many durables requires some energy input, our rationale

⁴It can be shown that changes in gasoline prices tend to have a disproportionate impact on this measure of household purchasing power. This result is driven by the relatively high amplitude of changes in gasoline prices and the relatively high expenditure share for gasoline. Because natural gas and electricity each comprise a smaller fraction of total expenditures, and because their prices are more stable, their impact on purchasing power is much smaller.

163 is that vehicles are much more energy intensive than, say, appliances, and that effectively operating
164 costs will not matter much for durables other than vehicles. More disaggregated results on motor
165 vehicles will be discussed in section 5 (also see Edelstein and Kilian 2007a).

166 **3.1 The Baseline Linear Model**

167 For each consumption aggregate, we construct the response of consumption to purchasing power
168 shocks from bivariate vector autoregressive (VAR) models. We focus on monthly measures of pur-
169 chasing power changes, as opposed to unweighted changes in energy prices, because the purchasing
170 power changes incorporate the effects of changes in the expenditure share for energy. This allows
171 us to avoid a potential source of structural instability in the relationship between energy prices and
172 the economy. Each VAR model includes the purchasing power loss series described in the previous
173 section (or a suitable transformation of that series) and the percent growth rate of the measure
174 of real consumption of interest. The sample period is 1970.2-2006.7, unless noted otherwise. The
175 monthly real consumption data are from the BEA's National Income and Product Accounts.⁵

176 The VAR models are identified recursively with the change in purchasing power series ordered
177 first, implying that its innovations are not affected contemporaneously by innovations to real con-
178 sumption growth. The advantage of using a VAR model is that it isolates the linearly unpredictable
179 component of losses in purchasing power and allows for reverse causality. The identifying assumption
180 that energy prices are predetermined with respect to the U.S. macroeconomy at monthly frequency
181 has a long tradition in both empirical and theoretical work (see, e.g., Rotemberg and Woodford
182 1996; Leduc and Sill 2004; Blanchard and Galí 2008). Recent empirical work by Kilian and Vega
183 (2009) lends support to this identifying assumption. The assumption of predeterminedness permits
184 the consistent estimation of the expected response of real U.S. macroeconomic aggregates to an
185 innovation in energy prices. In conjunction with the assumption that there are no other exogenous
186 events that are correlated with the exogenous energy price innovation, these impulse responses can
187 be interpreted as the causal effect of the energy price innovation. More generally, we can interpret
188 these responses as the expected change in consumption associated with energy price shocks.⁶

189 There is no loss of generality from restricting ourselves to a bivariate model under the maintained

⁵Throughout the paper, we impose a VAR lag order of 6. This lag order tends to be larger than the estimates suggested by the Akaike Information Criterion conditional on an upper bound of 12 lags, which in some cases produces implausibly low lag order estimates. While our qualitative results are not sensitive to the lag order choice, given the well-known dangers of underfitting a VAR model, we adopt a conservative approach (see Kilian 2001; Hamilton and Herrera 2004).

⁶Our approach does not allow us to differentiate between energy price changes driven by demand and by supply shocks in energy markets. The distinction between demand and supply shocks can be important, as these shocks tend to have very different effects on macroeconomic aggregates (see Kilian 2009). The impulse responses shown below hence are best viewed as an average reflecting the composition of demand and supply shocks over the sample period.

190 assumption of predetermined energy price innovations, if we are only interested in consistently
191 estimating the causal effects of energy price innovations on macroeconomic aggregates. This result
192 differs sharply from standard VAR models of monetary policy. In such models the monetary policy
193 reaction function is typically ordered last, making the monetary policy shock sensitive to the omission
194 of contemporaneous variables that the policymaker responds to. In contrast, changes in energy
195 prices in our bivariate model are ordered first, which ensures that the resulting responses to energy
196 price shocks are asymptotically invariant to the inclusion of additional variables ordered between
197 energy price changes and consumption growth, if the lag order is chosen appropriately. Given the
198 short sample, however, we rely on the most parsimonious representation of the data in the form of
199 the bivariate model. In the figures below, we show responses of the level of real consumption to
200 a one-time, one standard-deviation purchasing-power shock. The maximum horizon of the impulse
201 response functions is 18 months. All figures show point estimates as well as 90% bootstrap confidence
202 intervals based on the bias-corrected method of Kilian (1998).

203 **3.2 Possible Asymmetries in the Consumption Responses**

204 The standard linear regression framework that treats energy price increases and energy price de-
205 creases symmetrically will only be appropriate, if we can rule out the presence of an allocative
206 channel of transmission and of the asymmetric effects arising from shifts in uncertainty and from
207 precautionary motives. Hence, it is essential that we investigate the evidence for potential asym-
208 metries in the response of real consumption to energy price shocks, before choosing the appropriate
209 regression model. Preliminary statistical tests reported in Edelstein and Kilian (2007a) did not pro-
210 vide evidence of statistically significant departures from the null hypothesis of symmetric impulse
211 response functions for any of the real consumption aggregates, suggesting that any uncertainty ef-
212 fects and reallocation effects are too weak to be detected by formal statistical tests. Nor is there
213 any evidence for the asymmetric version of the precautionary savings effect.⁷ In addition, we will
214 demonstrate in section 5 that the linear symmetric model is capable of explaining key episodes in
215 the data without introducing asymmetries, consistent with the lack of statistical evidence in favor
216 of the reallocation and uncertainty effects. This fact allows us to focus on quantifying the effect of
217 changes in discretionary income, changes in precautionary savings and changes in operating costs
218 based on the standard linear VAR model described in section 3.1.

⁷This empirical finding is also consistent with more sophisticated econometric tests of the hypothesis of symmetric responses recently developed by Kilian and Vigfusson (2009) who, for a variety of energy price measures and macroeconomic aggregates, found no statistically significant departures from the null hypothesis of symmetric response functions.

4 Interpreting the Consumption Responses

Consider the response of selected U.S. real consumption aggregates to unanticipated purchasing power losses. A convenient way of summarizing and comparing the response estimates from the pairwise bivariate regression models is to express them in the form of one-year elasticities with respect to the overall price of energy, evaluated at the average energy share.⁸ The upper panel of Table 1 shows that the elasticity of energy consumption is -0.45 (with confidence bands of -0.27 and -0.66). The lower panel summarizes the corresponding elasticities of major non-energy real consumption aggregates. All estimates have the expected negative sign and most are statistically significant at the 5% level. By far the largest elasticity estimates are obtained for durables. This result suggests that durables play an important role in the transmission of such shocks.⁹ Table 1 demonstrates that the overall elasticity of -0.15 is driven mainly by a reduction in vehicles purchases. The elasticity of demand for vehicles is -0.84. There is much weaker evidence of reduced demand for other durables.

The following thought experiment provides a better understanding of the magnitude of the response of total real consumption. Consider the likely consequences of an energy price increase based on the discretionary income effect alone. Given that households may choose to borrow or to dissave as a short-run response to higher energy prices, it is quite possible for the impact effect of such a shock on consumption to be smaller than consumers' loss in purchasing power, even when energy demand is inelastic. Such consumption smoothing is likely to be short-lived, however, and in the long run the response should be bounded by the magnitude of the purchasing power loss. Hence, a reasonable upper bound on the discretionary income effect is the initial reduction in purchasing power. In practice, the long-run response could be much smaller than this bound to the extent that demand for energy declines over time, as households increasingly utilize extensive and intensive margins of adjustment in response to purchasing power losses driven by higher energy prices. It stands to reason that such efforts at energy conservation will increase over time. Thus, a tighter bound may be obtained by taking account of the elasticity of energy demand obtained in the upper panel of Table 1. Taking account of the estimated price elasticity of energy demand, the reduction in discretionary income associated with a 1% increase in energy prices is bounded by -0.04%. The response of total consumption in Table 1 is about four times as large and hence too large to be accounted for by the discretionary income effect alone.

⁸For a more detailed analysis of the individual components of energy consumption and a comparison with alternative estimates in the literature see Kilian (2008).

⁹We would also expect households to reduce their expenditures on home improvements and other forms of household residential fixed investment, given the durables goods nature of this form of investment. The latter series is only available at quarterly frequency. Additional results (not shown) confirm that the response of real residential fixed investment after six quarters is large and highly significant, not unlike that of consumer durables.

249 Where does the excess decline come from? One reason is that consumers reduce expenditures on
250 durables that are complementary in use with energy. The most prominent example of such durables
251 are motor vehicles. The excessively high response of vehicles compared to other durables is an
252 indication of the presence of such an operating cost effect. The difference amounts to about -0.65
253 percentage points in Table 1 and is statistically significant. Expenditures on vehicles decline about
254 four times as much as expenditures on other consumer durables. They decline more than seven
255 times as much as expenditures on nondurables and services.

256 The other possible reason for the disproportionate response of real consumption is the presence
257 of a precautionary savings effect. In this view, households respond not only to the immediate loss of
258 discretionary income, but they also respond in anticipation of the delayed effects on unemployment
259 and real household income triggered by such a shock. As the likelihood of becoming unemployed
260 increases, households increase their precautionary savings at the expense of consumption. The cut-
261 backs in consumption need not be spread evenly across all forms of consumption, but will depend
262 on how essential a given expenditure item is. Table 1 allows us to quantify the precautionary sav-
263 ings effect. For example, a decline in nondurables and services consumption by more than -0.04%
264 can be interpreted as an indication that consumers reduce expenditures because they increase their
265 precautionary savings. The data imply a marginally statistically insignificant precautionary savings
266 effect of -0.08 percentage points for nondurables and a statistically significant effect of -0.07 percent-
267 age points for services. The corresponding precautionary savings effect of -0.16 percentage points
268 implied for durables other than vehicles is not statistically significant. Taken together, the effects
269 of changes in discretionary income, precautionary savings and operating costs imply a much larger
270 reduction in real consumer expenditures in response to an unanticipated energy price increase than
271 would be expected based on the small share of energy in consumption.

272 4.1 The Effects on Consumer Sentiment

273 The evidence in Table 1 suggests that consumer expectations play an important role in the propa-
274 gation of purchasing power shocks. Indeed, rising energy prices are often associated with pessimism
275 and uncertainty about one's financial situation and the broader economy.¹⁰ If households are fearful
276 of the economic outlook, they may curtail their consumption on a variety of goods and services
277 driven by a precautionary savings motive. The importance of this channel has also been recognized

¹⁰For example, in a report on the February 2006 Survey of Consumers at the University of Michigan, Richard Curtin noted that "the February loss in confidence was due to higher energy costs, higher interest rates, and a heightened concern about potential future increases in the unemployment rate". The same report stated that one-in-five families cited higher prices, mainly for energy, as the cause of their decreased living standards. Such attitudes could lead to a decline in non-energy consumption, even if the discretionary income effect of the purchasing power loss is miniscule.

278 by policymakers. For example, Bernanke (2006b) in a recent speech on the U.S. economic outlook
279 stressed that “recent declines in energy prices ... have boosted household purchasing power and *con-*
280 *sumer confidence* [emphasis added]”. Below we investigate the empirical support for this explanation
281 using data from the Michigan Survey of Consumers. These results complement the evidence in Table
282 1 on the precautionary savings and operating cost effects. We estimate the responses of measures
283 of consumer confidence and consumer expectations to a negative one-time, one standard-deviation
284 purchasing-power shock. Our data set includes the overall index of consumer sentiment as well as
285 individual series. One set of expectations data relates to households’ perceptions about the future
286 evolution of the economy and includes expected changes in business conditions and expected changes
287 in unemployment. Another set of measures relates to households’ precautionary savings motives and
288 includes expected changes in households’ personal financial situation and expected changes in real
289 family income. A third set of expectations measures relates directly to households’ decisions about
290 major durables purchases and includes current buying conditions for large household goods and
291 current buying condition for vehicles.¹¹

292 The sample period is 1978.1-2006.5. No monthly expectations data are available prior to 1978.
293 The impulse response functions are estimated in the same fashion as in the previous sections. Our
294 identifying assumption is that purchasing power innovations are predetermined with respect to inno-
295 vations in consumer sentiment within the month. While the scale of the responses is not comparable,
296 given the way survey responses are represented, the qualitative patterns of the responses are. Fig-
297 ure 2 shows the response of each sentiment series to an unexpected one standard deviation loss in
298 purchasing.¹² This shock decreases the overall index of consumer sentiment by 1.6 points. The fall
299 in the index is immediate. While the index begins to rise again a few months after the shock, it
300 remains below its initial level even 18 months after the shock. The observed decline in consumer
301 sentiment compares to a standard deviation of 12.3 for this series, suggesting that an unusually large
302 shock such as Hurricane Katrina, all else equal, could move consumer sentiment nearly one standard
303 deviation away from its mean.

¹¹All series are constructed such that a fall in the index indicates a worsening of conditions from the consumer’s point of view. The indices for consumer sentiment, expected change in one’s personal financial situation, and expected changes in business conditions measure the difference between the number of respondents who expect a better situation and the number who expect a worse situation. A decline in the index suggests that more respondents expect a worsening situation, fewer expect a better situation, or both. Similarly, a decline in the index for buying conditions for large household goods and vehicles suggests that an increasing proportion of respondents think it is currently a bad time to make these purchases. A decline in the indices for unemployment, interest rate, and real family income expectations suggests that a greater proportion of survey respondents expect more unemployment, higher interest rates, and a decline in real family income, respectively.

¹²This shock corresponds approximately to a 1.5% increase in energy prices. Historically, the average change in prices has been 1.2% in absolute terms. The largest monthly energy price increase in our sample is 11% and occurred following Hurricane Katrina in September of 2005. This corresponds to a purchasing power loss of -0.66% evaluated at the 2005 energy share.

304 The indices for expected changes in one's personal financial situation and for general business
305 conditions fall by 1.4 and 2.3 points, respectively, suggesting that an increasing number of people
306 expect general business conditions and their personal financial situation to deteriorate over the
307 coming year in response to an unanticipated loss in purchasing power. Whereas the response of the
308 expected change in one's personal financial situation is quite persistent and statistically significant
309 even after 18 months, the response of the expected change in general business conditions, while
310 larger in magnitude, reverts back to zero more quickly and is statistically insignificant after only four
311 months. Given this evidence, one would expect households to cut back on nonessential consumption
312 and to increase precautionary savings.

313 Of particular interest in judging the empirical plausibility of an operating cost effect is the re-
314 sponse of expectations about current buying conditions for durables. Figure 2 shows that the index
315 for buying conditions for large household goods falls by 1.9 points. An even larger decrease is
316 observed for vehicles. The latter index falls by 2.8 points. This implies that a shock of the size asso-
317 ciated with Hurricane Katrina would move the vehicle index by nearly one standard deviation. The
318 relatively strong reaction of the index for buying conditions for vehicles in particular is qualitatively
319 consistent with theories stressing energy complementarities in use.

320 The remaining results in Figure 2 provide additional insight into why rising energy prices cause
321 households to curb their consumption. Increased pessimism about buying conditions in response
322 to purchasing power losses is associated with expectations of higher unemployment, higher interest
323 rates, and lower real family income. First, the index for expected changes in unemployment falls
324 by 2.1 points, indicating that an increasing number of people expect higher unemployment. This
325 response is consistent with households perceiving an increased risk of unemployment, as required
326 for the existence of a precautionary savings effect. Second, the index for expected interest rates
327 falls by 1.1 points, indicating that an increasing number of people expect higher interest rates in
328 the future. This suggests another channel of transmission. To the extent that consumers (rightly or
329 wrongly) expect interest rates to rise in response to higher energy prices, their expected liabilities
330 would increase as credit card rates and mortgage rates increase, making it necessary to cut back on
331 consumption. This second channel, however, is short-lived and the responses are largely insignificant,
332 suggesting that it is of minor importance. Third, the index for changes in expected real family income
333 falls by 1.2 points, indicating that a greater number of survey respondents expects real family income
334 to fall in the future. These results are fully consistent with the view that the effect of purchasing
335 power shocks on real consumption operates in part through changes in precautionary savings and
336 through changes in the operating cost of vehicles.

4.2 Automobile Consumption: How Much Does Fuel Economy Matter?

We have already shown that declines in real motor vehicles consumption are one of the main causes for the disproportionate fall in real total consumption in response to purchasing power losses. This result is consistent with the automobile sector playing a crucial role in the transmission of energy price shocks. In fact, the bulk of the vehicles response is driven by automobile consumption. If we are interested in whether there is an effect from reduced demand for automobiles on the automobile industry, the relevant metric is the effect of unanticipated purchasing power losses on the demand for new automobiles. The estimated short-run elasticity of demand for new automobiles is about -0.71, which is close to the fuel cost elasticity of -0.5 reported in Goldberg (1998) based on a structural model and micro data, but the response is barely statistically significant.

One possible explanation is that the consumer response reflects not so much an overall reduction in the demand for cars, but an increase in the demand for energy-efficient small cars at the expense of energy-inefficient large cars. While we do not have data on the consumption of automobiles broken down by energy efficiency, we can contrast the consumption of *new domestic automobiles* with that of *new foreign automobiles*.¹³ To the extent that U.S. automobile manufacturers tend to produce less energy-efficient cars, as was certainly the case in the 1970s, considering the larger share of pickup trucks and SUVs in U.S. automobile production, a disproportionate decline in the consumption of domestically produced new cars would be evidence in favor of a shift in demand. VAR models indicate a strong and highly significant decline in new domestic automobile consumption. In contrast, consumption of new foreign automobiles initially increases, albeit insignificantly. After four months, consumption of new foreign cars slumps as well, although the effect is not as persistent, insignificant, and smaller in the long run than for domestic autos. The excess response of the consumption of domestically produced automobiles over its foreign-produced counterpart is statistically significant for months 2, 3 and 4. The excess decline reaches its maximum of -1.34% after two months. The model implies that a permanent energy price increase of the magnitude associated with Hurricane Katrina would wipe out 10.3% of the domestic demand for U.S. automobiles.¹⁴

¹³Domestic cars are defined by the BEA to include cars assembled in the United States, Canada, or Mexico.

¹⁴The consumption data on new automobiles do not include light trucks or trucks. A different approach to determining the importance of shifts among different types of automobiles is to focus on unit sales reported by the BEA. While these data ignore the price of a given car (and hence differences in quality), they do allow us to assess whether consumption of light trucks (including minivans, SUVs or pickup trucks) responds differently to unanticipated losses in purchasing power than regular automobiles. There has been much discussion of the softening market for SUVs in recent years. We find no significant decline in *unit auto sales* (consistent with the evidence on new auto consumption), but a significant decline in both *unit light truck sales* and *unit heavy truck sales*, with long-run responses of -1.6% and -1.3%, respectively. This evidence strengthens the case for the operating cost channel. Assuming that all producers of light trucks are equally affected by such a shock, a shock associated with an event such as Hurricane Katrina (if sustained forever) would reduce the number of light trucks sold by about 11.2%, making this channel economically significant for U.S. companies such as Ford, GM and Chrysler, which devote between 35% and 80% of their production to trucks.

5 Understanding the 1986 Episode: Where is the Boom?

Our results in section 4.2 confirm Hamilton's (1988) conjecture that automobile purchases are very sensitive to energy price fluctuations. However, there is no evidence in the real consumption data that changes in the demand for vehicles cause a sectoral reallocation effect that amplifies the effect of energy price increases and counteracts the effect of energy price decreases, as postulated in Hamilton's model. This conclusion may seem surprising, but is consistent with the fact that the U.S. automobile industry only accounts for about 1% of aggregate U.S. employment and 1% of real U.S. GDP. Thus, even if there is a drastic decline in the demand for U.S. automobiles, the effect on other parts of the economy is likely to be small in scale, which may account for our inability to detect a statistically significant reallocation effect in the data.

There are other reasons, however, for the popularity of models that embody a reallocation effect. One reason is that there was no noticeable economic expansion in U.S. real GDP after the sharp fall in the price of crude oil in 1986. This evidence seems hard to reconcile with the perception that rising crude oil prices in 1979 contributed to a sharp economic downturn, unless one appeals to a model with asymmetric responses to energy price changes (see, e.g., Gramlich 2004). The theoretical model of Hamilton (1988) seemed to provide an explanation for this puzzling asymmetry. A common view is that this asymmetry in the data simply necessitates the existence of a large reallocation effect. Although this view is appealing upon casual inspection of the data, it misses important pieces of the puzzle.

It is useful to be explicit about the counterfactual. The implicit premise in this literature is that it suffices to compare the U.S. economic performance before and after the collapse of OPEC. Clearly, however, we need to compare what actually happened in 1986 to what would have happened without the sharp fall in energy prices (rather than to the status-quo-ante). This question may be answered based on historical decompositions of the real consumption data. Historical decompositions measure the cumulative effect of the historically observed sequence of purchasing power shocks on the level of real consumption at each point in time. Quantifying this effect is important because it conveys information that cannot be gleaned from impulse response estimates. Sometimes energy price increases come in clusters, and at other times energy price increases may alternate with decreases. The cumulative effect on real consumption is a weighted average of the entire history of shocks up to a given point in time. We compute this effect based on the bivariate VAR model estimates of section 4. Figure 3 shows the actual (demeaned) U.S. real consumption growth rates and the consumption growth rates predicted based on the cumulative effect of the purchasing power shocks alone. The difference between the two series measures the extent to which consumption growth is not explained

396 by purchasing power shocks. To improve the readability of the plot, we have converted all growth
397 rates to annual averages.

398 It is instructive to compare the annual results for 1979 and 1986. In 1979, purchasing power
399 declined by 1.69% due to energy price increases, whereas in 1986 purchasing power increased by
400 1.43% due to energy price decreases. Thus one would expect the effect on real consumption to be
401 roughly symmetric. As shown in Figure 3, the VAR model implies that unexpectedly rising energy
402 prices (all else equal) lowered real consumption growth by -1.92% in 1979, and unexpectedly falling
403 energy prices raised it by +2.02% in 1986, making these effects nearly symmetric. Moreover, actual
404 real consumption growth in 1979 was -2.20% relative to its mean, whereas in 1986 it was +1.44%.
405 Thus, energy prices alone are capable of explaining a substantial part of observed real consumption
406 growth in 1979 and 1986.

407 Figure 3 also provides two additional insights. First, energy price shocks were responsible for
408 substantial declines (defined as an effect on the real consumption growth rate in excess of -0.65%)
409 in consumption growth in 1974, 1979/80, 1990 and 2004/05, but they also caused large increases
410 in real consumption growth (defined as an effect on the growth rate in excess of +0.65%) in 1986,
411 1991, 1998 and 2001. Second, a substantial part of real consumption growth is not associated with
412 energy prices. Notably, the pattern of excess consumption growth in the 1970s is consistent with
413 go-and-stop monetary policies of the type described in Barsky and Kilian (2002) and the unusually
414 low growth in 1980-82 and 1990-91 is at best partially explained by energy prices and suggests an
415 important role for monetary policy under Paul Volcker. Likewise, the unusually high growth of
416 1984-85, 1996-1999, and 2004 cannot be attributed mainly to energy prices.

417 **5.1 An Alternative Explanation of the 1986 Episode**

418 The observed behavior of real consumption growth in 1979 and 1986 contrasts sharply with that of
419 real GDP growth. Real GDP growth was -1.81% relative to its mean in 1979 *and* -0.31% relative to
420 its mean in 1986. Thus, the apparent asymmetry alluded to earlier does exist in real GDP growth,
421 but is not reflected in real consumption growth. A systematic comparison of the 1979 and 1986
422 growth rates of real GDP and its components reveals that the source of the asymmetry in real GDP
423 growth lies in private investment. More specifically, real nonresidential investment in equipment and
424 structures are the two key components that caused real GDP growth in 1986 to be so low. In 1979,
425 they grew by -2.80% and +7.54% relative to their means, respectively, whereas in 1986 they grew
426 by -4.65% and -16.35%. The behavior of firms' investment expenditures in 1986 contrasts sharply
427 with that of private residential fixed investment and consumption.

428 There are two potential explanations for this pattern. One explanation is that energy price shocks
429 have asymmetric effects on firms' fixed investment expenditures. Such an explanation seems implau-
430 sible for several reasons. First, while there is some evidence of asymmetries in the point estimates
431 of the nonresidential fixed investment responses (not shown), as discussed in Edelstein and Kilian
432 (2007b), the type of asymmetry found in these responses (and of business investment in structures
433 in particular) does not conform to what we would expect to see if these responses were driven by
434 the uncertainty effect of Bernanke (1983). Specifically, the response to purchasing power losses is
435 near zero, whereas the response to gains is strongly negative. Second, Edelstein and Kilian (2007b)
436 found no statistically significant evidence against symmetry in the nonresidential fixed investment
437 responses. Third, the mechanisms commonly discussed in support of an asymmetric response of
438 nonresidential fixed investment (such as the Bernanke (1983) uncertainty effect on durables) should
439 apply equally to consumer durables and to firms' purchases of durables. If firms' fixed investment
440 responds much more asymmetrically to energy price changes than durables consumption and real
441 residential fixed investment, then it must do so for unrelated reasons. It is unclear what economic
442 mechanism would explain such an asymmetry in the responses of firms' fixed investment expen-
443 ditures. Finally, one would expect an asymmetric effect on nonresidential fixed investment to be
444 reflected in similarly asymmetric responses of aggregate unemployment and therefore consumer ex-
445 pectations, consumer expenditures and residential fixed investment. We have already observed that
446 formal statistical tests do not support this conjecture.

447 An alternative and more plausible explanation is that a drop in firms' investment expenditures
448 not related to the preceding fall in energy prices caused the 1986 expansion to fizzle. That expla-
449 nation is consistent with the fact that the growth rate of firms' real investment expenditures fell
450 much more in 1986 than in 1979. Such a pattern is inconsistent with conventional explanations of
451 asymmetric investment responses.¹⁵ In related work, Edelstein and Kilian (2007b) have shown that
452 the unprecedented drop in U.S. investment expenditures in 1986 was limited to specific components
453 of business investment expenditures. They make the case that these specific declines represented in
454 large part an exogenous shift in nonresidential investment expenditures associated with the removal
455 of the investment tax credit and the elimination of real estate tax shelters in the course of the 1986
456 Tax Reform Act. Edelstein and Kilian (2007b) also provide evidence that the energy sector reduced
457 its investment in structures more strongly than it would have based on the fall of energy prices
458 alone. Together these factors explain the seeming asymmetry in nonresidential investment growth

¹⁵Standard theoretical models of asymmetries imply that the response to purchasing power gains cannot be larger in absolute terms than the response to purchasing power losses and typically will be smaller. In contrast, the data show that firms' real investment in structures actually increased by 7.54% relative to trend in 1979 (which is completely at odds with the uncertainty effect), but fell by -16.35% relative to trend in 1986. Investment expenditures on equipment declined in both years, but they declined much more in 1986 than in 1979.

459 (and hence real GDP growth) between 1979 and 1986. They also help explain why real consumption
460 did not grow quite as much in 1986 as predicted by the econometric model on the basis of falling
461 energy prices alone and why unemployment remained higher than it would have been otherwise.

462 **5.2 Has Real Consumption Become Less Responsive to Purchasing Power** 463 **Shocks?**

464 Recently, it has been suggested that perhaps the importance of energy price shocks for the U.S.
465 economy has declined (see, e.g., Hooker 1996, p. 222; Davis and Haltiwanger 2001, p. 482; Bernanke
466 2004). Figure 4 quantifies this phenomenon by comparing responses of consumption aggregates
467 estimated on the first half (1970.2-1987.12) and the second half of our sample (1988.1-2006.7).
468 Otherwise, the models are identical to those used in section 4. The scale of the impulses has been
469 normalized to be the same across the two samples as for the full sample. Compared to the first half
470 of the sample, in the second half the long-run response of total real consumption drops from -0.46%
471 to -0.12%. The corresponding decline for durables is from -1.27% to -0.37%. The response of vehicles
472 consumption declines from -1.99% in the first half to -0.74% in the second half of the sample. The
473 decline in durables consumption excluding vehicles shrinks from -0.67% in the first half of the sample
474 to -0.02% in the second half. The response of nondurables shrinks from -0.44% to -0.03% and that
475 of services from -0.28% to -0.10%. A similar reduction occurs in the response of real residential fixed
476 investment (not shown). The long-run response drops from -7.1% to -2.0%. Similarly, it can be
477 shown that the rise in unemployment associated with an unanticipated purchasing power loss drops
478 from 2.32% to 0.55%.

479 There are several possible explanations for the declining importance of energy price shocks. One
480 conjecture is that this result is related to fluctuations in the share of energy in consumption. Because
481 our results are based on innovations in purchasing power changes rather than innovations in energy
482 price changes, unlike previous estimates in the literature, they already control for changes in the
483 expenditure share of energy, so this explanation can be ruled out. A second conjecture is that the
484 variability of purchasing power shocks may have declined in the second half of the sample. Our
485 analysis shows that actually the variability of both total changes and linearly unpredictable changes
486 in purchasing power has *increased* in the second half of the sample. The innovation standard
487 deviation increased from 0.08 to 0.11. The average size of positive innovations increased from 0.056
488 to 0.076, and the average size of negative innovations increased from -0.049 to -0.073. Moreover,
489 both the maximum and the minimum of the innovations increased.

490 A third and more plausible explanation is that the structure of the U.S. automobile industry

491 has changed. In the 1970s, U.S. auto manufacturers were simply not producing any small, energy-
492 efficient cars, leaving consumers with no choice but to buy small cars from abroad. Thus, the U.S.
493 auto industry was hit particularly hard by rising energy prices and falling demand for large cars. In
494 contrast, by the late 1980s and 1990s the differences between domestic and foreign auto producers
495 had been greatly reduced, as domestic auto manufacturers offered small and energy efficient cars
496 of their own, while foreign manufacturers were beginning to branch out into the market for jeeps,
497 SUVs, vans and pickup trucks. Thus, the U.S. auto industry became relatively less vulnerable to
498 energy price increases than in the 1970s.

499 This point is illustrated by comparing the responses of new domestic and foreign automobiles
500 in each subsample (see Figure 5). Whereas in the first subsample expenditures on new domestic
501 automobiles drop by -4.2% after two months and by -2.6% in the long run, in the second half the
502 short-run response drops to -1.1% and the long-run response to -0.5%. The strongly significant short-
503 run decline in the first sample is only marginally significant in the second sample. In contrast, in the
504 first half of the sample, after one month expenditures on new foreign automobiles rise significantly
505 by 2.0%, followed by an insignificant decline of -1.5% after five months and a long-run response of
506 -0.5%. In the second half of the sample, the initial increase in the response has become small and
507 insignificant, the decline after 5 months has shrunk to -0.6% and the long-run response to -0.2%.
508 While it is still true that the consumption of new domestic autos is more responsive to energy price
509 shocks than the consumption of new foreign autos, the differences are much smaller than they used
510 to be.

511 There is also a fourth and complementary explanation. As the U.S. automobile industry re-
512 structured itself after the energy price increases of the 1970s, the share of domestically produced
513 automobiles in total U.S. real expenditures on new cars declined (from 88% in 1970 to 60% in 1988
514 and 57% in 2006), as did the employment share of the industry (from a peak of 1.3% in 1973 to
515 0.9% in 1988 and 2005).¹⁶ Thus, the relative importance of the auto industry for the U.S. economy
516 and the potential for spillovers from the automobile industry to other sectors has declined relative
517 to the 1970s, further reducing the precautionary savings effect.

518 While these observations help explain our results, they cannot be the primary explanation of
519 the observed decline because they are specific to the United States, whereas the reduced sensitivity
520 to energy price shocks is a global phenomenon. Perhaps the single most important explanation of
521 the observed global decline in the responses to energy prices shocks is a change in the composition
522 of these shocks, as discussed in Kilian (2009). Kilian shows that, to the extent that more recent

¹⁶See <http://bea.gov/bea>. There are no data on the share of the automobile industry in real value added prior to 1987. The current share of 1.1% is only slightly lower than in 1987.

523 energy price shocks have been associated almost exclusively with unexpected increases in global
524 demand, their effect has been cushioned by the stimulative effect of higher global demand on the
525 U.S. economy.¹⁷

526 **6 Conclusion**

527 On the basis of the evidence presented in this paper, the standard view of how energy price shocks
528 affect the U.S. economy has to be reconsidered. The conventional wisdom is that a fall in energy
529 prices will have only weak effects on output and employment, as the increase in aggregate demand
530 will be offset by the reallocation effect of changing expenditure patterns. In contrast, when the
531 price of energy increases, both effects work in the same direction, amplifying the response of output
532 and unemployment. This explanation rationalized both a sharp contraction following energy price
533 increases, and the absence of an economic expansion following energy price decreases. While we did
534 find evidence of changing expenditure patterns, as required for the existence of a reallocation effect,
535 the absence of statistically significant departures from symmetry in the responses to positive and
536 negative energy price shocks suggests that reallocation effects are not a quantitatively important
537 channel of transmission. One possible explanation is the comparatively small share of the U.S.
538 automobile industry in domestic real GDP and employment. Without this allocative channel it
539 is difficult to rationalize the severe economic downturns of 1974 and 1979/80 as a consequence of
540 adverse energy price shocks.

541 Even in the absence of asymmetric effects such as the reallocation effect, however, the cumulative
542 effects on real consumption associated with energy price shocks are quantitatively important. We
543 showed that the responses of real consumption aggregates are too large to reflect the effects of
544 unanticipated changes in discretionary income alone. Our analysis suggests that the excess response
545 can be attributed to shifts in precautionary savings and to changes in the operating cost of energy-
546 using durables. The latter finding is consistent with evidence that an unexpected loss in purchasing
547 power due to rising energy prices has a significantly negative impact on a wide array of consumer
548 expectations. Specifically, rising energy prices tend to make consumers pessimistic about the state
549 of the economy and about their own personal financial situation. They also cause consumers to
550 expect worsening future economic conditions, and they heighten concerns about current buying
551 conditions. Thus, deteriorating consumer confidence is likely to be an important additional link in

¹⁷Possible competing explanations include structural changes in the form of reduced real wage rigidities or improved monetary policy (see, e.g., Blanchard and Gali 2008; Herrera and Pesavento 2009). It remains to be shown that these alternative explanations can account for the U.S. experience as well as the cross-country differences in economic performance following major oil price shocks.

552 the relationship between energy price shocks and household consumption.

553 A one-time 1% increase in energy prices in a given month is associated with a statistically signif-
554 icant decline in real total consumption of -0.15% a year later. Historical decompositions suggested
555 that the energy price shocks of 1974, 1979-81, 1990, and 2003-2007 were an important factor in ex-
556 plaining U.S. real consumption growth, but by no means the dominant factor. In particular, energy
557 price shocks were shown to have contributed substantially both to the decline in consumption in
558 1979, amidst sharply rising energy prices, and to its recovery in 1986 after the collapse of OPEC.
559 This result runs counter to the conventional wisdom that the U.S. economy's response to the decline
560 in energy prices in 1986 was muted, whereas its response to the 1979 energy price increases was
561 strong. We showed that this perception is at odds with the largely symmetric pattern of real con-
562 sumption growth in 1979 and 1986. This pattern contrasts sharply with the asymmetric pattern of
563 real GDP growth in 1979 and 1986 for reasons discussed in Edelstein and Kilian (2007b).

564 Our analysis also shed light on the declining importance of energy price shocks for the U.S.
565 economy. We documented the extent to which consumption aggregates have become less responsive
566 to energy price shocks since the mid-1980s after controlling for fluctuations in the energy share. The
567 effect of an unanticipated 1% increase in energy prices on total real consumption one year later drops
568 from -0.30% in the first half of the sample to only -0.08% in the second half. We traced the declining
569 importance of energy price shocks relative to the 1970s in part to changes in the composition of
570 U.S. automobile production and to the declining overall importance of the U.S. automobile sector,
571 but noted that much of this apparent regression instability is likely to be driven by changes in the
572 composition of energy price shocks, as discussed in Kilian (2009).

573 The sharp rise in gasoline prices after 2002 has renewed interest in the question of how much
574 higher energy prices affect consumer expenditures. Our analysis allows us to assess the overall
575 effect of such a price increase on household consumption. Suppose, for example, that gasoline prices
576 unexpectedly and permanently increased by 25 cents per gallon (which translates into a 6.85%
577 increase in the overall price of energy, assuming all other energy prices remain unchanged). If a
578 typical household spends \$200 a month on gasoline at the January 2007 price of \$2.29 per gallon,
579 this would raise the household's gasoline bill by almost \$22 a month, if the household continued to
580 consume the same amount of gasoline. In response to such a shock, a typical household with about
581 \$4000 to spend per month will have cut back its expenditures one year later by \$35 based on the
582 full-sample estimates (or by \$17 based on the post-1987 estimates). Most of the adjustment will
583 take place in the first six months following the gasoline price increase. Given a share of consumption
584 in GDP of about 72%, this implies that, all else equal, real GDP will have fallen by 0.63% one year
585 after the shock. This example illustrates that it takes repeated surprise increases in gasoline prices to

586 generate large effects on household consumption, but over time the effects will add up. The regression
587 models investigated in this paper are useful not only for understanding historical episodes. Their
588 predictive power for understanding the post-2007 period has recently been investigated by Hamilton
589 (2009b).

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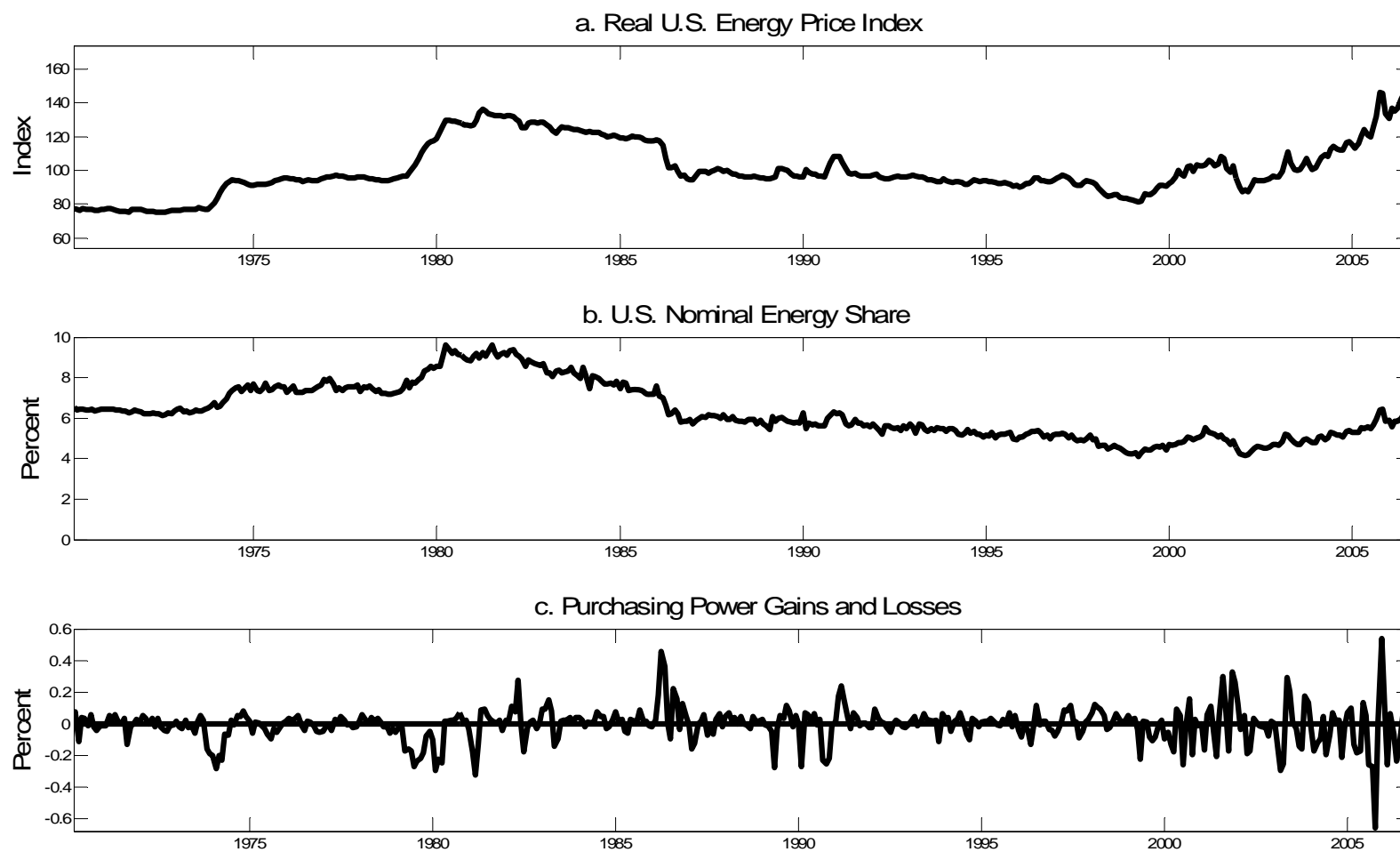
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**Table 1: One-Year Energy Price Elasticities: U.S. Real Consumer Expenditures
1970.2-2006.7**

Energy Consumption	-0.45
Total Consumption	-0.15
Nondurables	-0.11
Services	-0.10
Durables	-0.47
Motor Vehicles	-0.84
Other Durables	-0.19

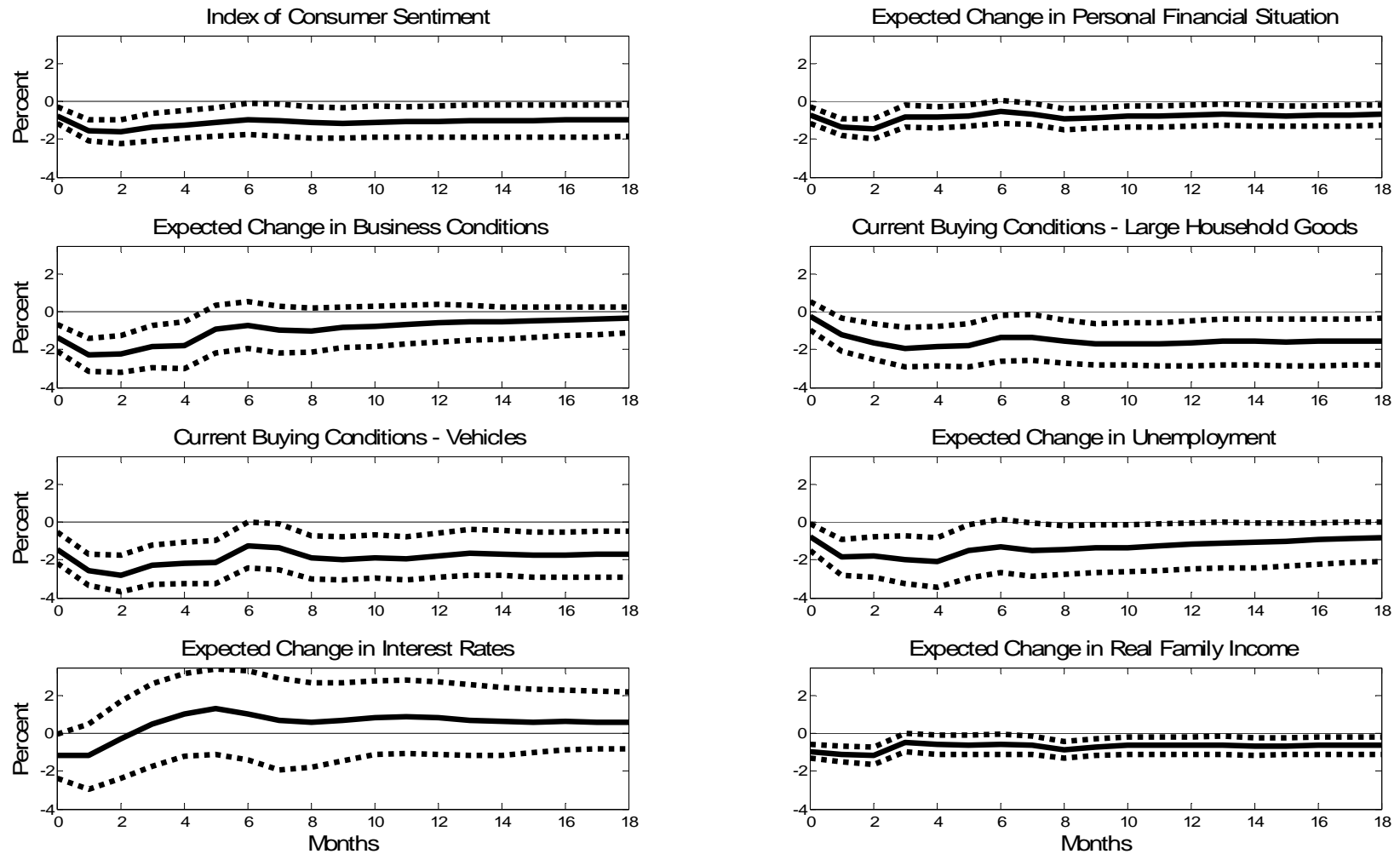
NOTES: VAR estimates based on the purchasing power loss associated with a change in weighted retail energy prices. The elasticities have been computed based on the average share of energy in the sample period. Boldface indicates statistical significance at the 5% level.

**Figure 1: U.S. Real Price of Energy, Energy Share and Changes in Purchasing Power
1970.1-2006.7**



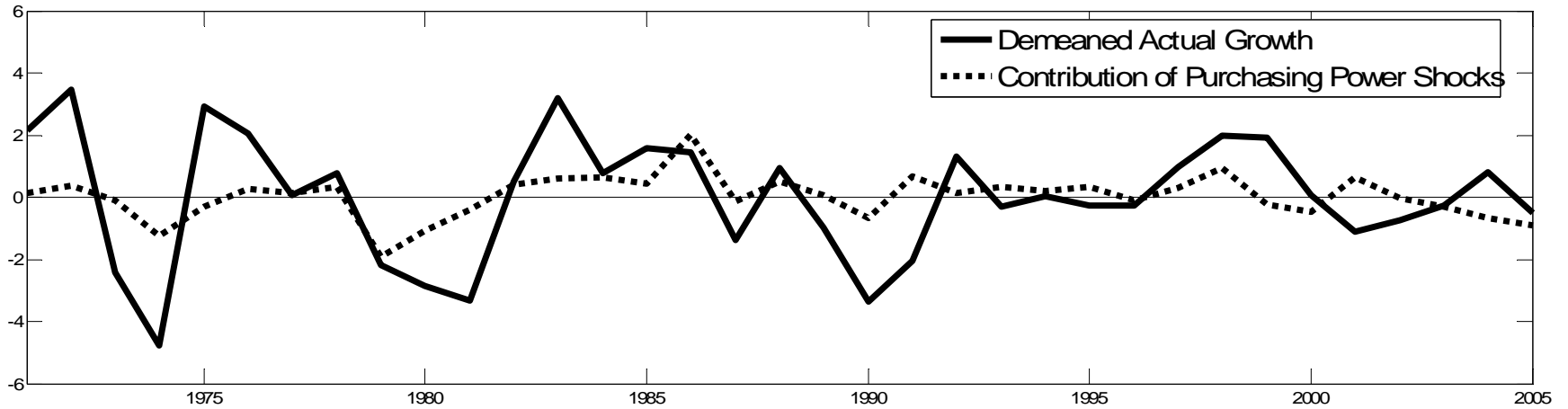
NOTES: (a) Inflation-adjusted chain indices of the retail price of different forms of energy consumption based on expenditure data provided by the BEA. (b) Monthly nominal expenditures share energy consumption computed based on expenditure data provided by the BEA. (c) Purchasing power gains in percent computed as weighted average of change in retail energy prices weighted by their respective share in total consumption. A negative value indicates a loss in consumer purchasing power.

**Figure 2: Response of Consumer Expectations to Purchasing Power Shocks
1978.1-2006.5**



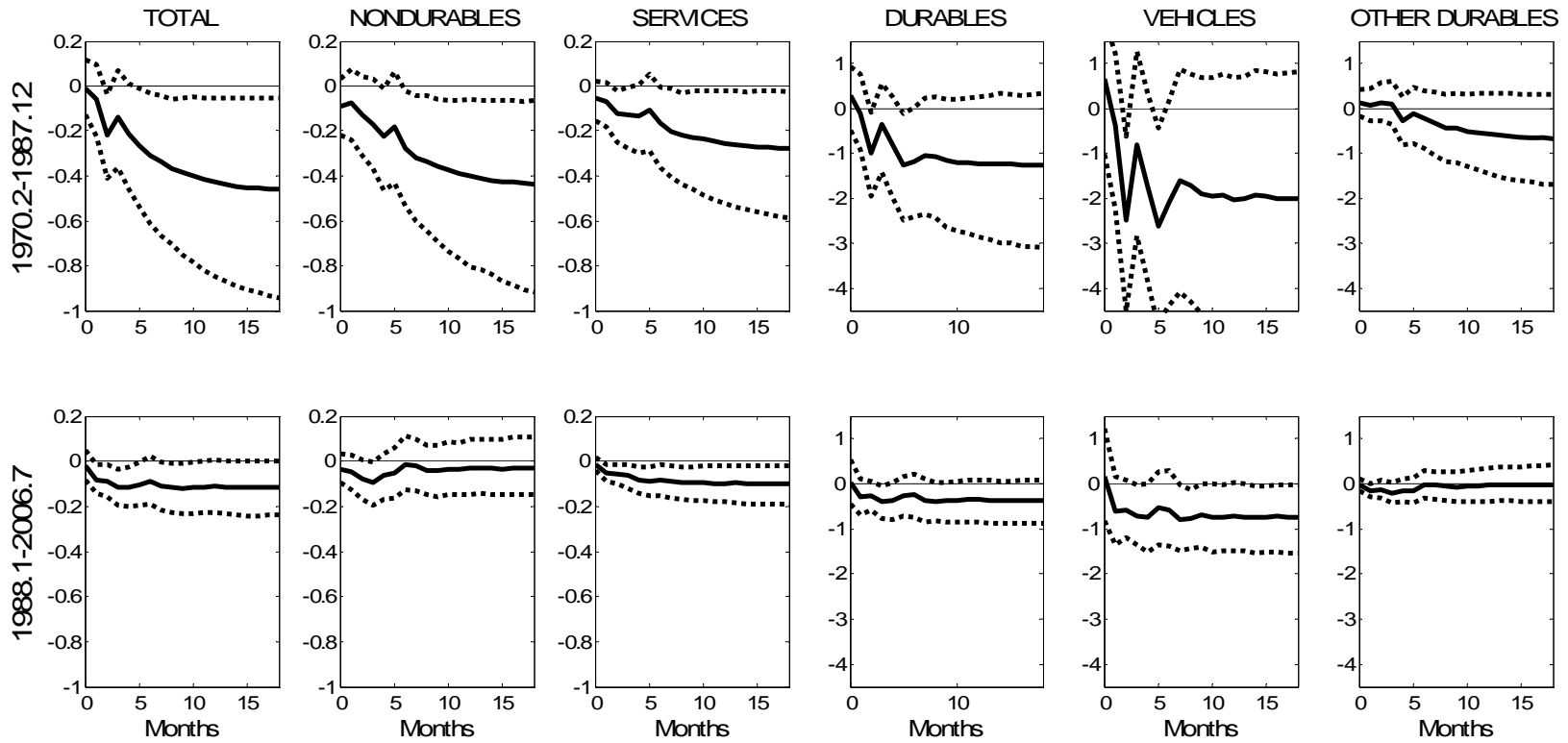
NOTES: VAR estimates based on the purchasing power loss associated with an unanticipated change in weighted retail energy prices. All series are constructed such that a fall in the index indicates a worsening of conditions from the consumer's point of view.

Figure 3: Contribution of Purchasing Power Shocks to U.S. Real Consumption Growth
Annual Averages, 1971-2005



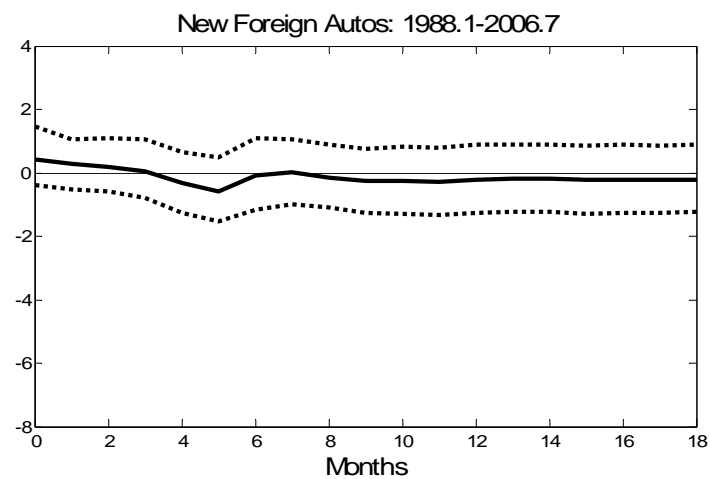
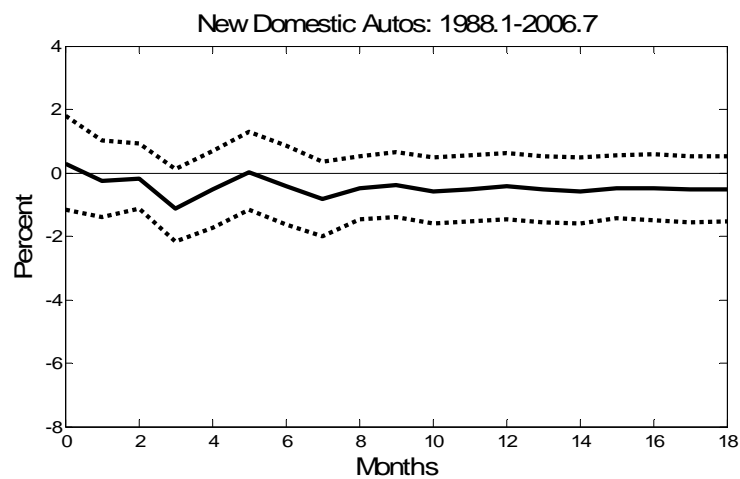
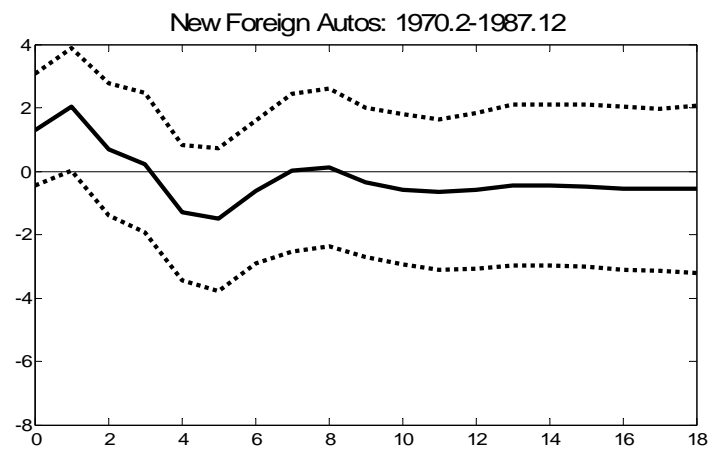
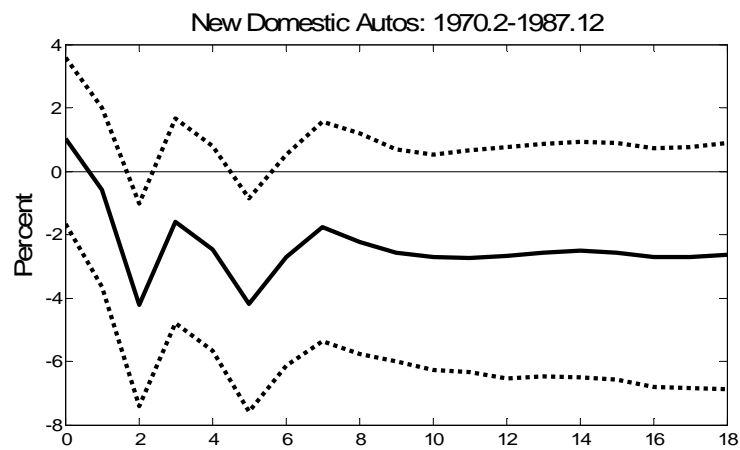
NOTES: Based on a historical decomposition of the full-sample quarterly VAR estimates. The results have been aggregated to annual frequency to improve the readability of the plot.

Figure 4: Selected Responses by Sample Period



NOTES: Split-sample VAR estimates for U.S. data based on the purchasing power loss associated with an unanticipated change in weighted retail energy prices.

Figure 5: Response of U.S. Consumer Expenditures on New Automobiles to Purchasing Power Shocks



NOTES: Split-sample VAR estimates based on the purchasing power loss associated with an unanticipated change in weighted retail energy prices.