Lower Oil Prices and the U.S. Economy: Is This Time Different?

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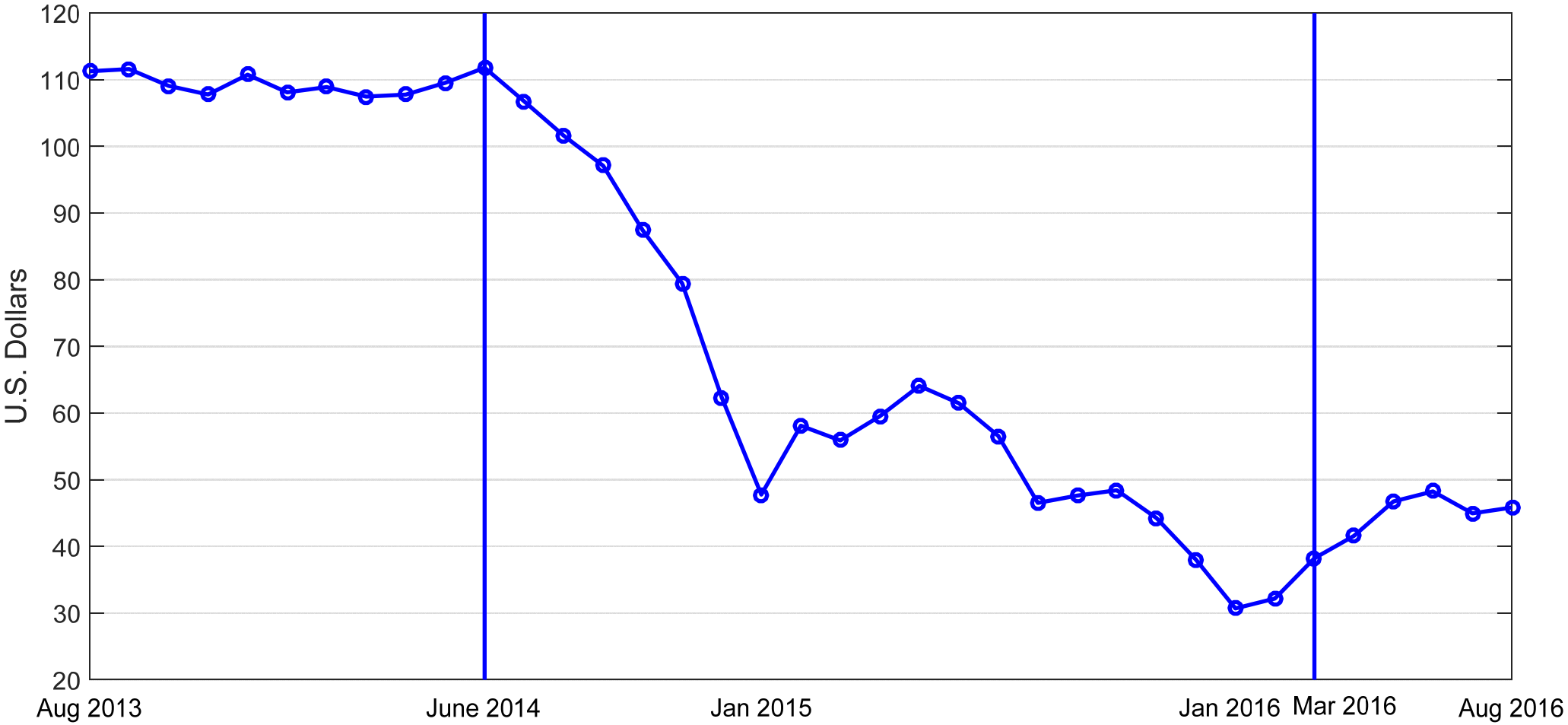
Brent Price of Crude Oil: 2013-2016



A Look at the Facts

	Average Growth at Annual Rates (%)	
	2012Q1-2014Q2	2014Q3-2016Q1
Real GDP	1.8	2.2
Private Consumption	1.9	2.9
Nonresidential Investment	5.1	1.5
Oil-related investment	7.2	-48.2
Non-oil related investment	4.9	4.6
Exports	3.2	0.7
Imports	2.3	2.9

NOTES: Oil-related investment includes investment in petroleum and natural gas structures as well as mining and oil field machinery.

Should We Have Been Surprised?

1. Unexpected declines in the real price of imported crude oil lower firms' costs of producing domestic goods and services.

Why then have we not seen a strong economic expansion?

2. Unexpected declines in the real price of imported crude oil also increase the demand for domestic goods and services, as consumers spend less of their income on motor fuel.

Did the actual growth in private real consumption match expected growth?

a. Or was growth held back because the decline in the global price of crude oil was not fully passed on to retail fuel prices?

b. Did consumers choose not to spend their income gains, but to pay off their debts or increase their savings instead?

c. Were consumers perhaps reluctant to buy new automobiles because of increased uncertainty about future gasoline prices, holding back overall economic growth?

3. Has the growth of the shale oil sector changed the transmission of oil price shocks to the U.S. economy?

a. Has reduced oil investment dragged down nonresidential investment in other sectors?

b. Has the recent decline of the shale oil sector slowed growth across oil-producing states, dragging down aggregate U.S. growth?

c. Have risky loans to oil companies undermined the stability of the banking system, disrupting financial intermediation?

d. Has the sustained decline in the real price of oil after 2014Q2 caused an economic slowdown by leaving assets and oil workers stranded in a sector that is no longer competitive?

How Does an Unexpected Oil Price Decline Affect the Economy?

1. Reduction in firms' costs of production (supply channel)

2. Increases in spending (demand channel)
   - Consumer spending
   - Business investment spending

Are Oil Price Shocks Cost Shocks?

A growing literature shows that the cost shock argument may be ignored for the bulk of U.S. industries with the exception of oil refiners (e.g., Lee and Ni 2002, Kilian and Park 2009).

New evidence:

a. Industry-level analysis of excess stock returns

b. Growth in the U.S. transportation sector

a. Industry-level analysis of excess stock returns

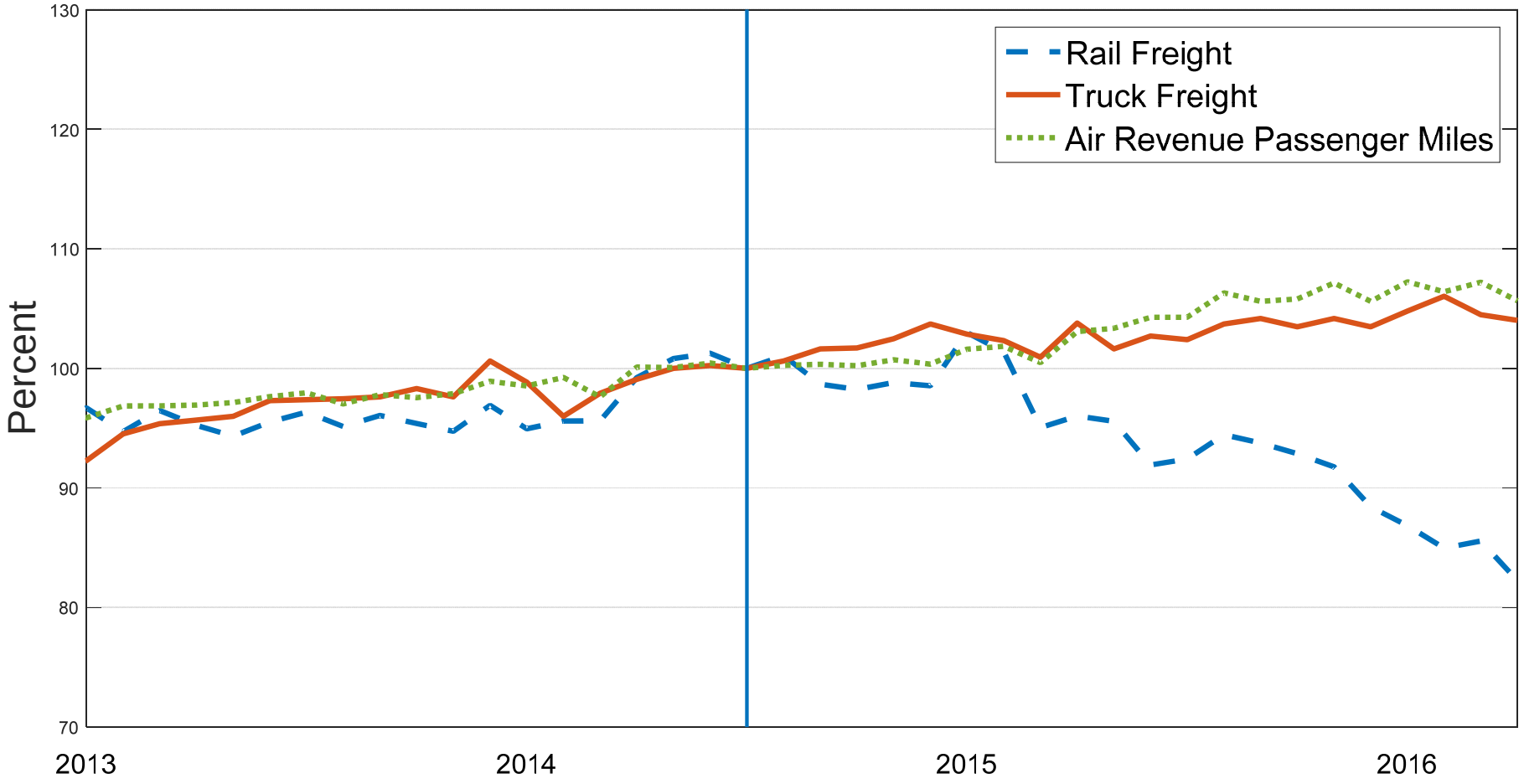
Sectors dependent on oil as an input did at best only marginally better than average:

Petroleum & gas (-28%)
Chemicals (-6%), Rubber & plastics (+4%)
Logistics (+2%)

Sectors sensitive to consumer demand did far better than average:

Candy & soda (+7%), Beer & liquor (+10%), tobacco (+16%)
Tourism (+11%), Restaurants, hotels & motels (+8%)
Retail sales (+14%), Amazon (+38%), Home Depot (+32%)
Apparel (+11%)

b. The U.S. Transportation Sector



NOTES: Indices of U.S. rail freight carloads, truck tonnage, and air revenue passenger miles computed from data provided by the Bureau of Transportation Statistics. The vertical line marks June 2014, the month before the oil price decline unfolded.

Do Oil Price Shocks Shift U.S. Aggregate Demand?

Yellen (2011):

"… higher oil prices lower American income overall because the United States is a major oil importer and hence much of the proceeds are transferred abroad. … Thus, an increase in the price of crude oil acts like a tax on U.S. households, and … tends to have a dampening effect on consumer spending."

Textbook View:

Shocks to real price of imported crude oil are terms-of-trade shocks. They cause changes in discretionary spending which have a multiplier effect on real GDP. The same process works in reverse when the price of oil drops.

What most textbooks are missing:

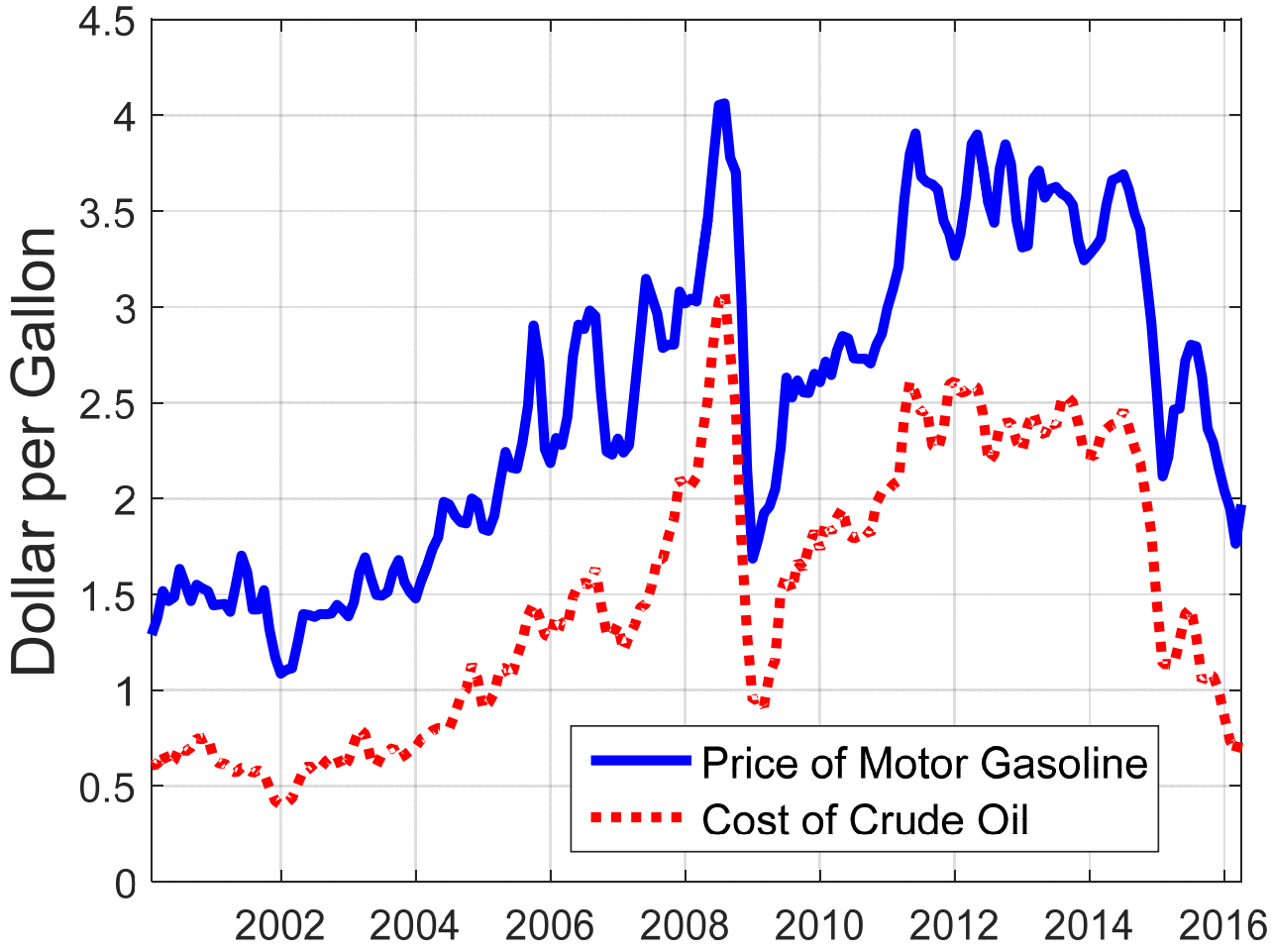
- ⇨ Almost no one buys crude oil, but many firms and households purchase fuels
- ⇨ Private investment and consumption may respond differently
- ⇨ Some countries have domestic oil production, so oil-sector and non-oil sector investment may respond differently

From the Oil Tax to the Gasoline Tax

Focus on the change in the real price of gasoline triggered by the shock to the real price of imported crude oil:

1. As the real price of crude oil increases, so does the real price of gasoline. The extent of this price increase depends on the cost share of crude oil in producing gasoline.
2. Because the demand for gasoline is price-inelastic, consumers spend more on gasoline than before the gasoline price increase.
3. To the extent that the revenue from gasoline sales is transferred abroad and not returned to the U.S. economy, consumers' aggregate discretionary income (defined as after-tax real income minus real gasoline expenditures) falls, resulting in lower domestic aggregate demand.
4. This reduction in aggregate demand causes a decline in real GDP.

U.S. Price of Gasoline and Cost of Crude Oil per Gallon, 2000.1-2016.3



NOTES: Source: *Gasoline Pump Components History* reported in the EIA's *Gasoline and Diesel Fuel Update.*

Evidence of Pass-Through from Oil Price to Gasoline Price by Episode

Percent	January 2007-July 2008	July 2008-December 2008	December 2008-April 2011	June 2014-March 2016
Change in U.S. Retail Gasoline Price	+81.3	-58.5	+125.3	-46.7
Change in the Cost of Crude Oil Used in Producing a Gallon of U.S. Gasoline	+155.0	-69.2	+175.4	-68.2
Change in the Brent Price of Crude Oil	+147.2	-69.9	+208.5	-65.8
Average Cost Share of Crude Oil in U.S. Gasoline Production	63.3	65.2	64.6	51.4
Expected Change in U.S. Gasoline Price	+98.1	-45.1	+113.3	-35.0

NOTES: Computed based on the *Gasoline Pump Components History* reported in the EIA's *Gasoline and Diesel Fuel Update.* The expected percent change in the U.S. price of gasoline is constructed by weighting the percent change in the dollar cost of crude oil used in producing a gallon of gasoline by the average cost share of oil.

Measuring Shocks to Consumers' Purchasing Power

Edelstein and Kilian (2009) measure the increase in consumer purchasing power arising from lower gasoline prices by

$$PP_t = -\frac{C_t^{gas} P_{t+1}^{gas} \big/ P_{t+1}^{PCE} - C_t^{gas} P_t^{gas} \big/ P_t^{PCE}}{C_t^{ngas} P_t^{ngas} \big/ P_t^{PCE}}.$$

which can be approximated by

$$- \underbrace{\left(\frac{C_t^{gas} P_t^{gas}}{C_t P_t^{PCE}} \right)}_{\text{gasoline share in consumer spending}} \cdot \underbrace{\left(\frac{P_{t+1}^{gas} \big/ P_{t+1}^{PCE} - P_t^{gas} \big/ P_t^{PCE}}{P_t^{gas} \big/ P_t^{PCE}} \right)}_{\text{\% change in real price of gasoline}}.$$

- By construction, $PP_t > 0$, if the real price of gasoline falls, and $PP_t < 0$, if the real price of gasoline rises.

Why Changes in Purchasing Power are Shocks

Consumers employ a no-change forecast of the real price of gasoline (Anderson et al. 2011; Baumeister and Kilian 2016, 2017).

Hence, any change in purchasing power associated with higher or lower gasoline prices is a surprise to consumers.

- ⇨ Changes in purchasing power (PP_t) may be viewed as shocks to discretionary income or, equivalently, to consumers' purchasing power.

How Much Consumption Stimulus?

- PP_t = percent change in the real gasoline price (weighted by the expenditure share of gasoline in total consumption)

  Δc_t = growth rate of consumption

- Baseline regression model:

$$\Delta c_t = \alpha + \sum_{i=1}^{6} \beta_i \, \Delta c_{t-i} + \sum_{i=0}^{6} \gamma_i PP_{t-i} + u_t$$

- PP_t is assumed to be predetermined (see Kilian and Vega 2011).

- This model allows the import oil content of gasoline to be less than 1 when computing the cumulative effect of purchasing power shocks on consumption.

Sensitivity analysis

The baseline PP_t measure may be refined by allowing for changes in the U.S. dependence on oil and gasoline imports.

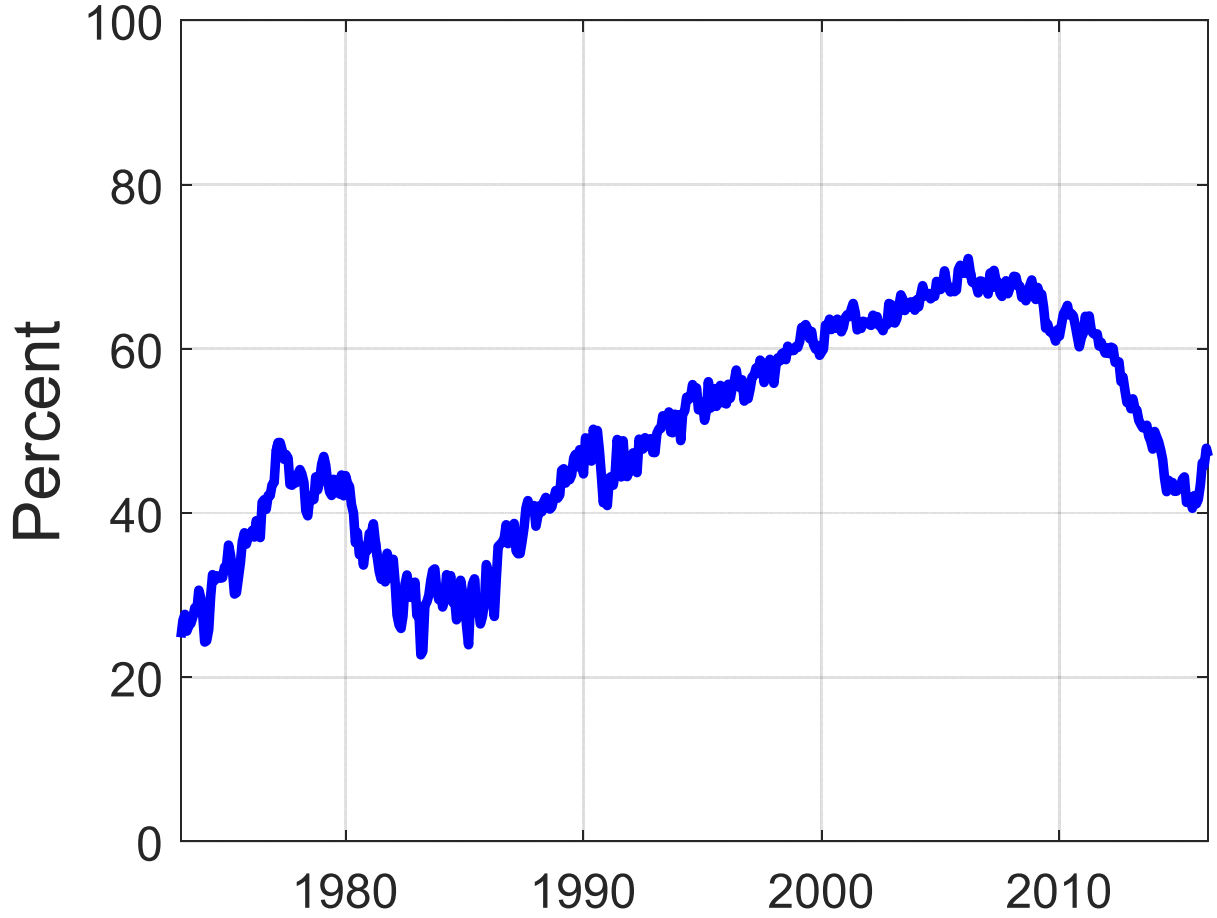
$$-\frac{C_t^{gas} P_t^{gas}}{C_t P_t^{PCE}} \cdot \left(\frac{P_{t+1}^{gas} / P_{t+1}^{PCE} - P_t^{gas} / P_t^{PCE}}{P_t^{gas} / P_t^{PCE}} \right) \cdot \left(s_t^{gasoline\ imports} + (1 - s_t^{gasoline\ imports}) s_t^{net\ oil\ imports} \right),$$

where:

$s_t^{gasoline\ imports}$ = seasonally adjusted share of U.S. motor gasoline imports in total U.S. motor gasoline consumption

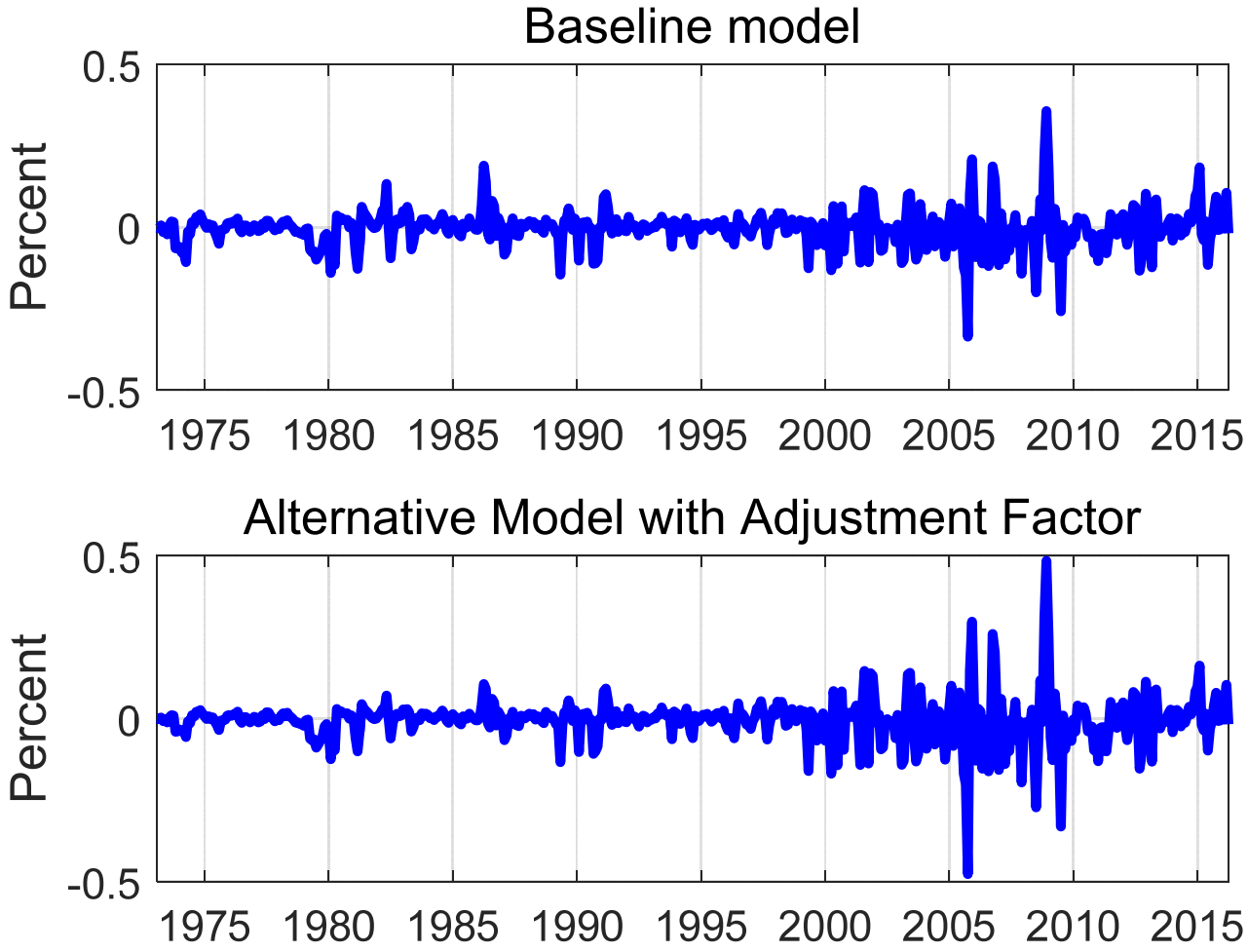
$s_t^{net\ oil\ imports}$ = seasonally adjusted share of U.S. net crude oil imports in the total use of crude oil by the U.S. economy (use = domestic production + imports – exports)

Adjustment Factor for the U.S. Dependence on Gasoline and Crude Oil Imports, 1973.1-2016.3



Notes: Authors' calculations based on data in the U.S. Energy Information Administration's *Monthly Energy Review*. This adjustment factor measures the extent to which U.S. consumer gasoline expenditures are transferred abroad.

Purchasing Power Shocks under Alternative Specifications, 1973.1-2016.3



Notes: The adjustment factor is shown in Figure 1. The purchasing power shock used in the baseline model without loss of generality has been scaled by the average adjustment factor of 0.49, so the magnitude of the shocks can be compared directly.

The D.C. Consensus Is a Special Case of Our Approach

Council of Economic Advisers (2014, p. 25):

$$\left(\frac{(M_t^{oil} - X_t^{oil})P_t^{oil}}{Y_t P_t^Y}\right) \cdot \left(\frac{P_{t+1}^{oil} - P_t^{oil}}{P_t^{oil}}\right),$$

where Y_t is real GDP, and P_t^Y is the GDP deflator.

This result can be derived as a special case of our approach if:

1. $C_t = Y_t$, which amounts to imposing that $I_t = G_t = X_t - M_t = 0$.
2. Gasoline and oil are the same good.
3. There is no inflation, so real and nominal oil price coincide.
4. The change in U.S. oil inventories is zero such that $C_t^{oil} = Y_t^{oil} + M_t^{oil} - X_t^{oil}$.

The Private Consumption Stimulus

- In the baseline model, the cumulative effect of purchasing power shocks on U.S. real private consumption since June 2014 is **1.2%.**

- Allowing for changes in the U.S. dependence on oil and gasoline imports does not affect the substantive conclusions for June 2014-March 2016.

<u>Key question:</u>
Is the linear model of private consumption adequate or is the transmission of oil price shocks asymmetric?

Why Asymmetric Responses to Oil Price Shocks?

Two mechanisms may generate asymmetric responses:

1. Higher uncertainty about future oil and gasoline prices
(Bernanke 1983, Pindyck 1991, Kellogg 2014)

2. Costly reallocation of resources in response to relative price shocks
(Hamilton 1988, Bresnahan and Ramey 1993)

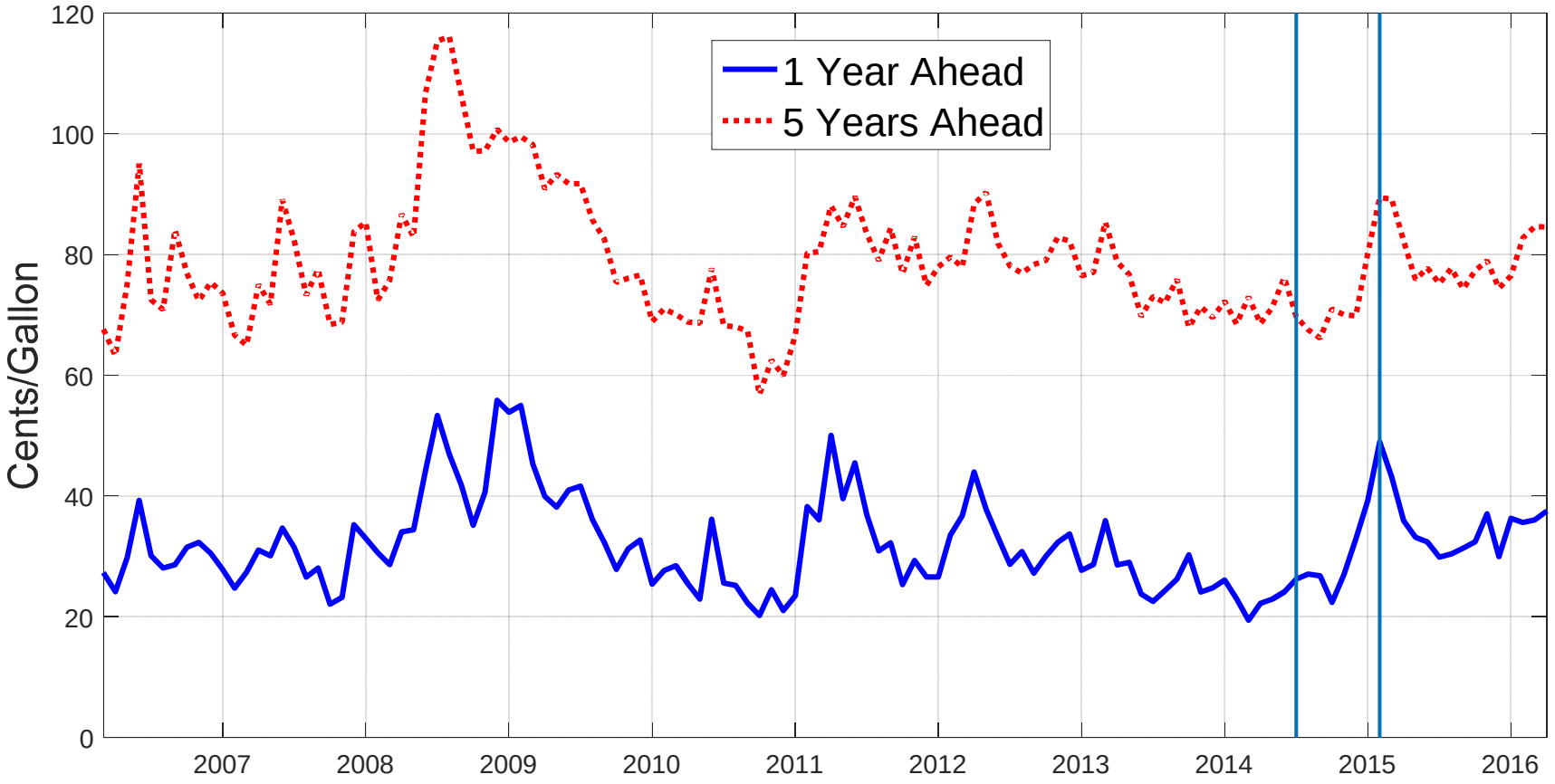
In these models:

- Unexpected oil price increases have large negative effects on growth
- Unexpected oil price decreases tend to have little or no effect on growth

Hence, the linear model of consumption responses, which implies symmetric responses, would be misleading.

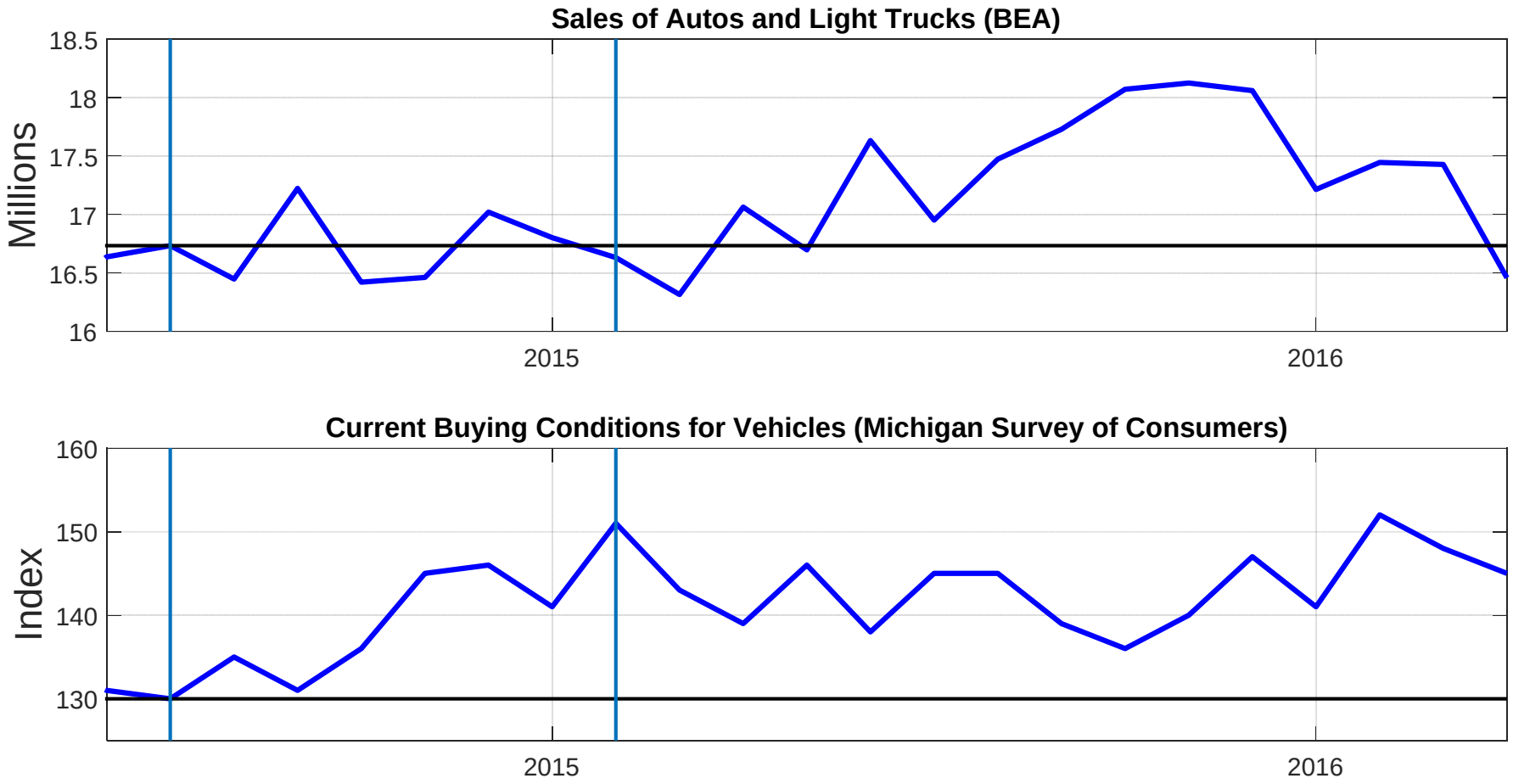
1. Did Uncertainty Slow Automobile Purchases?

U.S. Consumers' Uncertainty about the Future Price of Gasoline



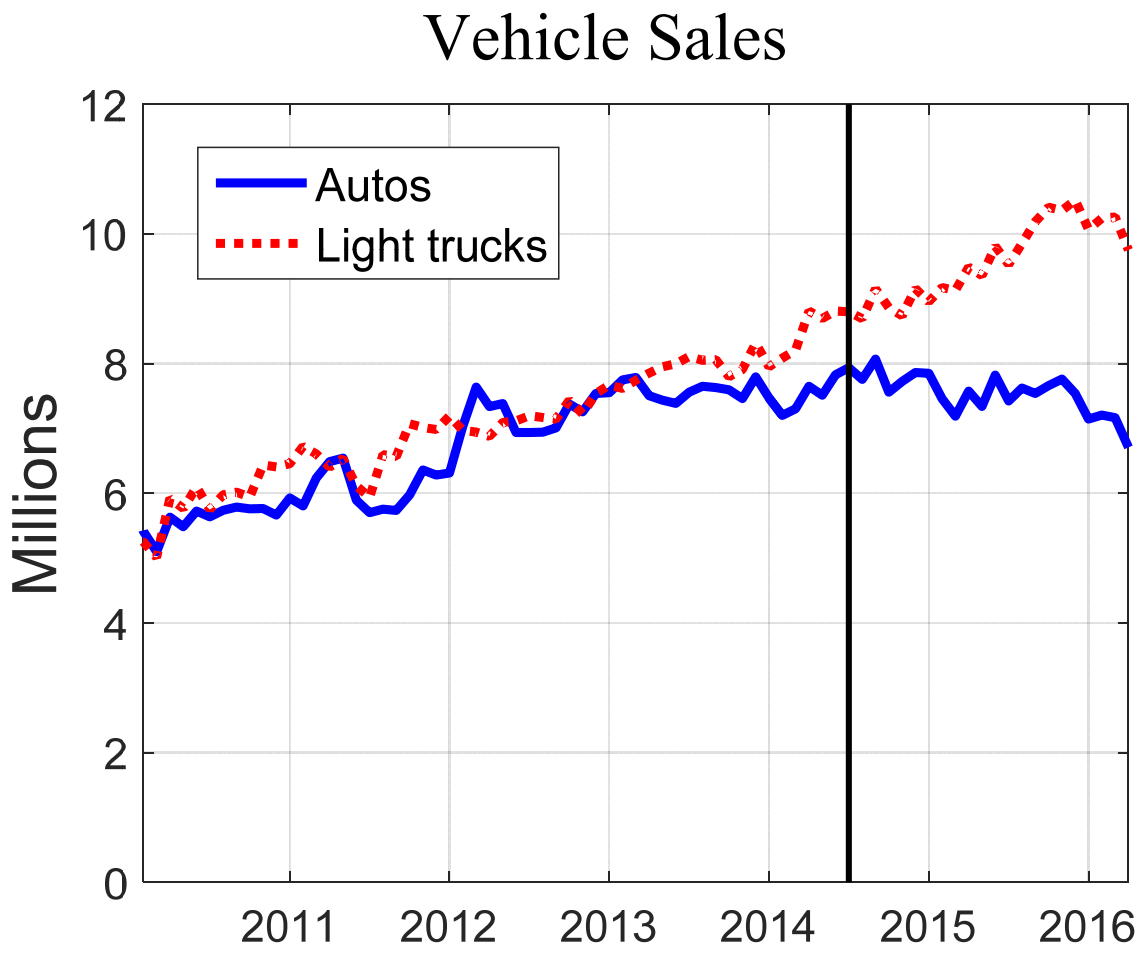
NOTES: Uncertainty is measured by the standard deviation of the responses of survey participants to the question about the expected change in the price of gasoline one year and five years ahead. The vertical bars correspond to June 2014 and January 2015, when uncertainty peaked.

Sales and Buying Conditions



NOTES: The vertical bars correspond to June 2014 and January 2015.

➔ No support for uncertainty hypothesis



NOTES: Aggregate of domestic and foreign sales. The vertical line marks June 2014.

➔ No support for uncertainty hypothesis

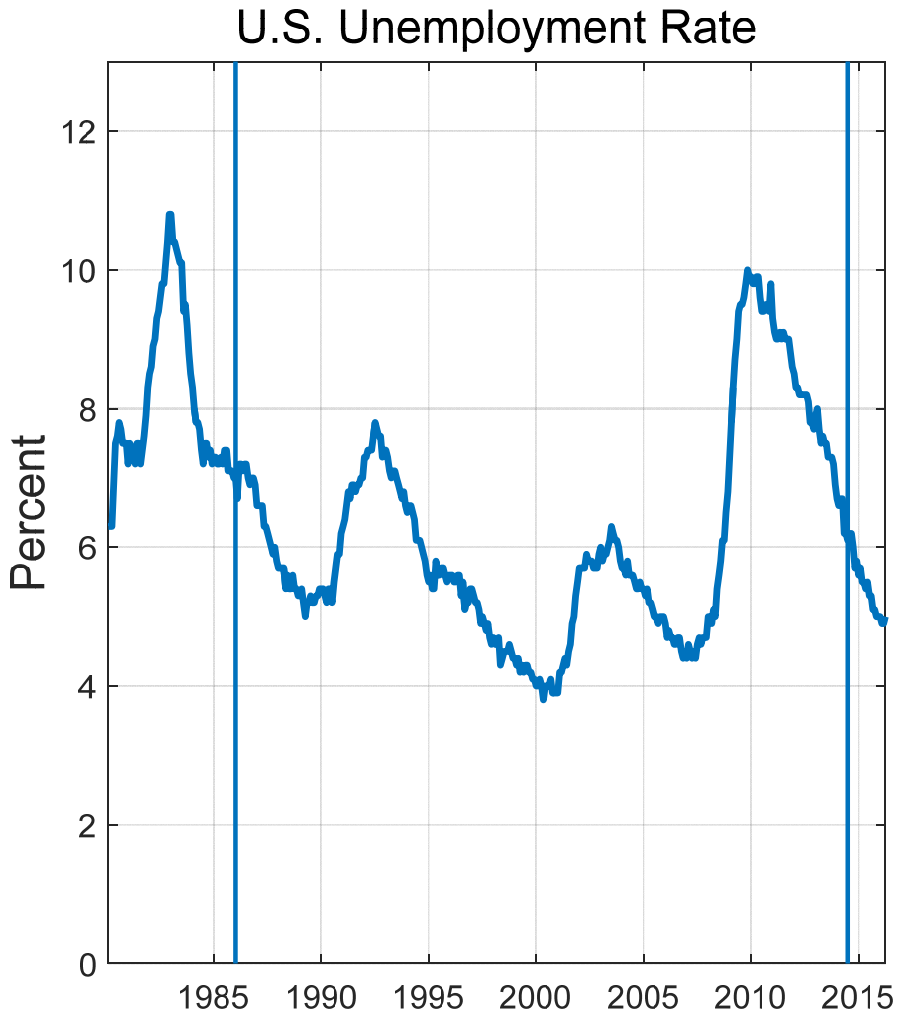
2. Frictions in the Reallocation of Capital and Labor?

- Relative price shocks trigger a reallocation of capital and labor to more productive uses. Frictions impeding this reallocation may generate unemployment and, hence, a decline in real GDP.

$$\underbrace{V(L\downarrow, K\downarrow)}_{\textit{Value added production function}}\downarrow$$

- What is the direct evidence of labor and capital being underutilized?
- If there is unemployment of resources in response to the oil price shock, how much does this affect real GDP growth?

Let's talk about labor



➔ No evidence that frictional unemployment is important

Changes in Labor Market Indicators in U.S. Oil States, 2014.6-2016.3

	Labor force	Number of Employed	Number of Unemployed	Unemployment Rate in Percent	Percent Share of Mining and Logging Jobs in Employment
Alaska	-4,900	-3,200	-1,700	-0.4	-0.4
Montana	9,500	10,900	-1,500	-0.3	-0.5
New Mexico	-1,000	4,000	-5,100	-0.6	-0.9
North Dakota	**1,700**	**-400**	**2,100**	**0.4**	**-2.4**
Oklahoma	82,700	80,700	2,100	-0.1	-0.9
Texas	**270,600**	**351,100**	**-80,600**	**-0.8**	**-0.7**
Wyoming	-6,000	-8,800	2,800	1.0	-2.2

NOTES: Computed based on BLS data. The unemployment rate is defined as number of unemployed divided by the labor force.

- ➔ These declines in the unemployment rate cannot simply be explained by migration away from oil states.
- ➔ There is no evidence that frictional unemployment is important even in oil states.

Let's talk about capital

- Number of oil rigs down by 75% since October 2014. Petroleum railcar loads down by 30% since September 2014.
- Underutilization of capital extends to other sectors in oil states.
- How much does this underutilization of capital matter?

Percent Change at Annual Rates	2014Q3-2015Q4
Real GDP	2.4
Excluding Oil-Producing States	2.3
Oil-Producing States	2.7

➔ No evidence that underutilization of capital matters either.

➔ Reallocation hypothesis not supported.

The (Non-Oil) Business Investment Stimulus

- The magnitude of this investment stimulus largely depends on the consumption stimulus and there is no evidence of asymmetries in the consumption response, as shown earlier.

- After averaging the PP_t measure by quarter, we estimate:

$$\Delta inv_t^{ex\ oil} = \sum_{i=1}^{4} \beta_i \Delta inv_{t-1}^{ex\ oil} + \sum_{i=0}^{4} \gamma_i PP_{t-i} + u_t .$$

where $\Delta inv_t^{ex\ oil}$ denotes the quarterly growth rate of real private nonresidential investment (excluding structures and equipment investment by the oil sector).

- The estimated cumulative stimulus for $inv_t^{ex\ oil}$ between 2014Q2 and 2016Q3 is **2.2%.**

How Much Does the Oil Sector Matter?

- U.S. domestic crude oil production increased as a result of the fracking revolution starting in late 2008

- How different would growth have been without the oil sector?

Percent Change at Annual Rates	2014Q3-2015Q4
Real GDP (Value Added)	2.4
Excluding Mining Sector	2.4
Mining Sector	2.4

➔ Direct impact is negligible

➔ Other transmission channels?

Investment Spending by the Oil Sector

- Effect of lower oil-related investment on real investment growth

Percent Change at Annual Rates	2014Q3-2016Q1
Private Fixed Nonresidential Investment	1.5
Excluding Oil Investment	4.6
Oil Investment Only	-48.2

- Effect of lower oil-related investment on real GDP growth

Percent Change at Annual Rates	2014Q3-2016Q1
Real GDP	2.2
Excluding Change in Oil Investment	2.6

- There is no evidence of spillovers to investment in other sectors

Were There Structural Changes in the Transmission?

1. Financial contagion from risky oil loans (no)

2. Shift in consumers' behavior (no)

3. Increased exports of petroleum driven by shale oil production (small effect)

4. Consumption response to purchasing power shocks may evolve, depending on the composition of oil demand and supply shocks (not an issue for this episode).

Net Stimulus from Unexpectedly Low Real Oil Price

Effect on Real GDP of	Percent of Cumulative Real GDP Growth (2014Q3-2016Q1)
Private Consumption	0.70
Non-Oil Related Private Nonresidential Investment	0.22
Oil-Related Private Nonresidential Investment	-0.57
Petroleum Trade Balance	0.04
Net Stimulus	**0.39**

Is This Time Different From 1986?

- Recent oil price decline twice as large as in 1986
- Dependence on imported oil and gasoline was lower in 1986.
- Recent oil price decline reflected in part a global economic slowdown which also slowed growth of U.S. real exports
- Tax Reform Act 1986 (Edelstein and Kilian 2007)

Net Stimulus from Unexpectedly Low Real Oil Prices

Effect on Real GDP of	Percent of Cumulative Real GDP Growth	
	2014Q3-2016Q1	1986Q1-1987Q3
Private Consumption ……..	0.70	0.23
Non-Oil-Related Private Nonresidential Investment ……..	0.22	0.11
Oil Related Private Nonresidential Investment ……..	-0.57	-0.43
Petroleum Trade Balance …….	0.04	-0.41
Net Stimulus	**0.39**	**-0.51**

Five Lessons

1. It is widely documented that oil price shocks have at best modest effects on the economy. This episode is no exception.

2. It should be kept in mind that one of the reasons for the low real price of oil has been the slowing of the global economy (see Baumeister and Kilian 2016; Kilian 2017).

Controlling for the economic slowdown after June 2014, average U.S. real GDP growth would have been higher, but still modest.

3. The main reason why the economy did not grow faster is the sharp reduction in oil sector investment. This is not a new phenomenon (see Edelstein and Kilian 2007).

4. Oil investment depends not so much on the extent of the decline in the real price of oil, but on whether the real price of oil is expected to fall below the breakeven price, at which the cash flow of the investment is zero.

5. As long as the oil-producing sector in the domestic economy is quantitatively unimportant or the real price of oil is far from this threshold, standard linear models of the transmission of oil price shocks will be quite adequate.

If not, standard models of the transmission of oil price shocks to the U.S. economy may have to be adapted to account for the role of oil investment. The quantitative importance of this effect depends not on the share of oil in GDP, which in 2014 actually is roughly the same as in 1986, but on the oil investment share.