
Linking Oil Prices, Gas Prices, Economy, Transport, and Land Use

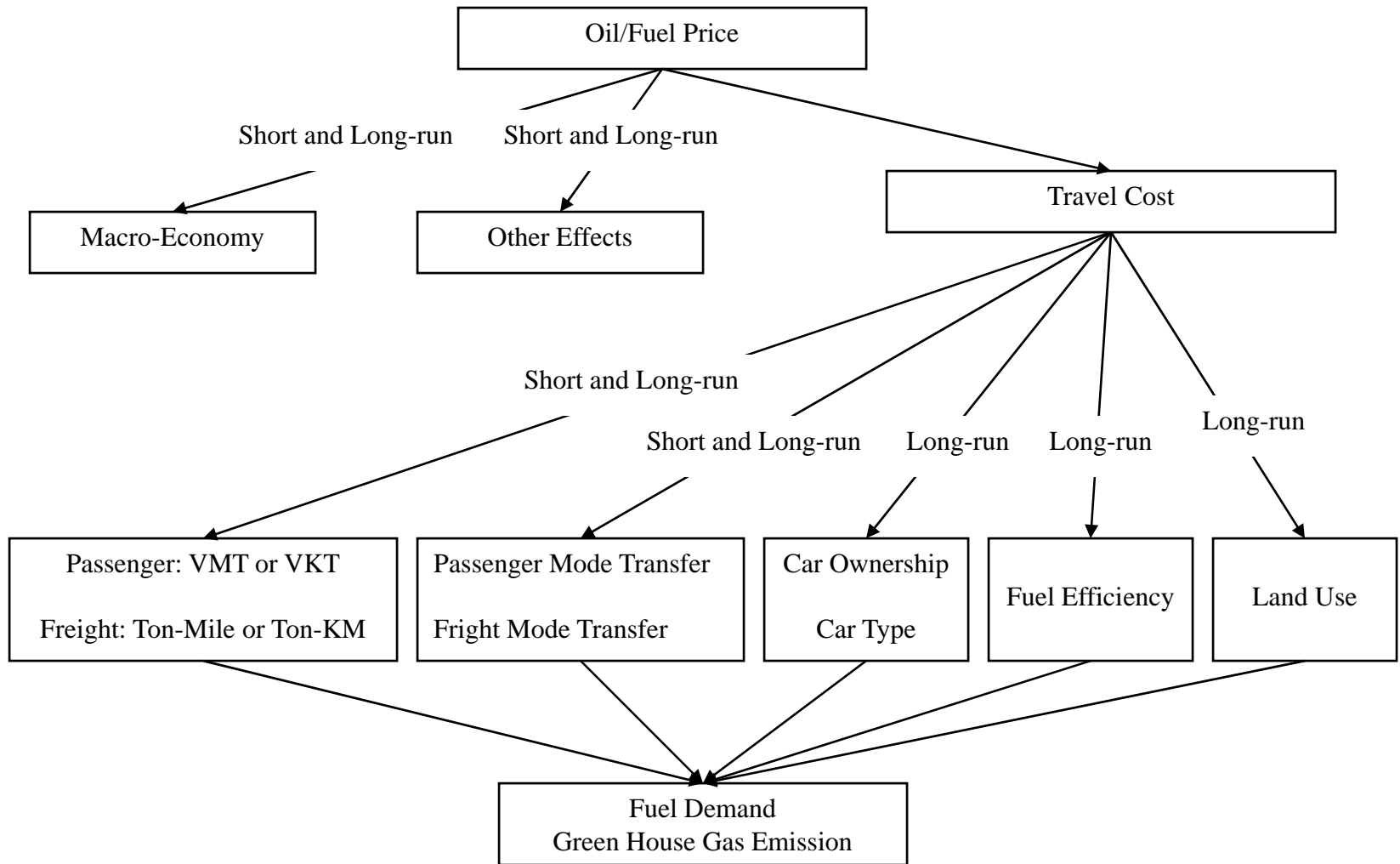
A Review of Empirical Findings

Hongwei Dong, Ph.D. Candidate

John D. Hunt, Professor

John Gliebe, Assistant Professor

Framework



Topics covered by this presentation:

- Oil price and macro-economy
 - Gas price and car travel
 - Gas price and public transit travel
 - Gas price and car ownership and efficiency
 - Gas price and land use
-

Definition

$$\textit{Demand Elasticity} = \frac{\% \text{ change in Demand}}{\% \text{ change in gas price}}$$

$$\textit{Cross - Elasticity} = \frac{\% \text{ change in Demand for Transit}}{\% \text{ change in Gas Price for Car}}$$

Short-run: within 1 year

Long-run: 3-5 years or more

Part 1. Oil Price and Economy

Demand and Supply Analysis:

- Demand side: higher oil price means consumers need to pay more on energy expenditure and strain their consumption on other goods.
 - Supply side: higher oil price pushes up inflation and raises the cost of production, forcing producers to reduce production.
-

-
- History: the oil price shocks were all followed by recessions:
 - 1973-1974
 - the late 1970s/early 1980s
 - the early 1990s
 - the 2008

 - Widely recognized: High oil price has negative effects on economic growth.
-

-
- Disagree on the magnitude and timing:
 - the impacts of the high oil price are reflected on economy significantly and immediately (Hamilton, 1983&2000; Mork, 1989)
 - it takes 5 quarters and the impacts are not that pivotal (Kilian, 2004).
-

- Impacts of oil price on GNP growth had a much smaller effect after 1973 (Hamilton 1983).

**Impacts of 10% Oil Price Increase on GNP Growth Rate
in the Following 4 Quarters (%)**

1st Quar	2nd Quar	3rd Quar	4th Quar	Data Period
-0.61	-0.82	-1.7	-1.77	1949:2 - 1972: 4
-0.23	-0.38	-0.78	-1.15	1973:1 - 1980:3

Source: Hamilton, 1983

- Price declines had a much smaller effects on economic growth than price increases (Mork 1989).

**Impacts of 10% Oil Price Changes on GNP Growth Rate
in the Following 4 Quarters (%)**

	1st Quar	2nd Quar	3rd Quar	4th Quar	Data Period
Oil price increases	-0.31	-0.15	-0.49	-0.49	1949:1 - 1986: 1
Oil price decreases	-0.003	0.037	0.01	0.027	1986:2 - 1988:2

Source: Mork, 1989

Part 2. Gas Price and Car Travel

-
- To response to the fuel price changes, car travelers can change their travel behavior in many ways:
 - Number of trips per day
 - Distance of the trips
 - Mode of the trips
 - Car ownership
 - Fuel efficiency of the car
 - ...
-

- With 10% fuel price increase, the car travel (VMT) will decrease by 1-2% in short-run and 2.5-3% in the long term (EU countries and North America).

Average Fuel Price Elasticities of Car Travel

	Short-run	Long-run	Reference
Vehicle-km (total)	-0.10	-0.29	Goodwin et al. (2004)
Vehicle-km (per vehicle)	-0.10	-0.30	
Vehicle-km (total)	-0.16	-0.26	de Jong and Gun (2001)
Number of car trips	-0.16	-0.19	

- Gas price elasticity has been decreasing in history.

Average Fuel Price Elasticities of Car Travel at Different Periods

	Short-run	Long-run	Static
Pre-1974	n/a	n/a	-0.54
1974-81	n/a	n/a	-0.32
Post-1981	-0.10	-0.29	-0.24

Source: Goodwin et al., 2004 (Table 12)

- Are gas price elasticities of car travel the same for all trip purposes?

Average Fuel Price Elasticities of Car Travel by Trip Purposes

	By number of car trips		By car-km	
	Short-run	Long-run	Short-run	Long-run
Commuting	-0.20	-0.14	-0.12	-0.23
Home-Based Business	-0.06	-0.07	-0.02	-0.20
Non home-based Business	-0.06	-0.17	-0.02	-0.26
Education	-0.22	-0.40	-0.09	-0.41
Other	-0.20	-0.15	-0.20	-0.29
Total	-0.16	-0.19	-0.16	-0.26

Source: de Jong and Gun, 2001 (Table 1 & 2)

- Gas price influences traffic volume on highway on weekdays only when the transit is also available (CA, 2003-2006).

**Estimated Effects of a 20% Increase in Gas Price
on Relative Traffic Volume**

	Weekends	Weekdays
Average effect	0.0006 (not sig.)	-0.002
No rail option	0 (not sig.)	0 (not sig.)
With parallel rail	0.0006 (not sig.)	-0.0345

Source: CBO, 2008 (Table 1-1)

- car travelers show different levels of sensitivity to fuel price, depending on time of day and locations.

Gasoline Price Elasticities of Car Traffic Volume

	Within 2 years	After two years
Urban offpeak	-0.27	-0.36
Urban peak	-0.09	-0.24
Rural	-0.16	-0.19

Source: Kennedy and Wallis, 2007

Part 3. Gas Price and Public Transit

- Gas price cross-elasticity are different among U.S. cities and modes.

Fuel Price Cross- Elasticity of Transit Ridership in U.S. Cities

Transit modes	Dallas City	DC	LA	SF	Average
Motor Bus	0.54	0.31	0.22	n/a	0.24
Light Rail	0.11	n/a	0.06	n/a	0.07
Heavy Rail	n/a	0.40	0.11	0.23	0.27
Commuter Rail	0.49	n/a	0.21	0.37	0.27
All cities/all modes					0.24

Source: Haire and Machemehl, 2006 (Table 4)

- The impacts of the gas price on transit demand vary for different purposes but tend to be stable across different historic periods.

Gas Price Cross-Elasticity on Transit Boardings by Period in U.S.

Period	Aggregate	Heavy Rail	Light Rail	Commuter Rail	Bus
Pre-9/11	0.12	0.19	0.32	0.00	0.06
9/11-Iraq War	0.12	0.19	0.38	0.01	0.08
Iraq War	0.12	0.18	0.35	-0.01	0.06
Katrina	0.12	0.17	0.27	0.00	0.04

Source: Currie and Phung, 2007 (Table 2)

- People's response to gas price in terms of transit travel behavior are different between short term and long term in EU.

Fuel Price Cross-Elasticities of Transit Travel in European Union by Trip Purposes

Trip Purpose	Number of Transit Trips		Traveller Kilometers by Transit	
	Short-run	Long-run	Short-run	Long-run
Commuting		0.12		0.26
Home-Based Business	0.17	0.03		
Non home-based Business	0.17			
Education		0.14		
Other	0.48	0.07		
Total	0.33	0.07	0.07	0.10

Source: de Jong and Gun, 2001 (Table 5 & 6)

Recent study in Swiss by Weis et al. (2010)

- If fuel prices should again increase dramatically, certain inertia in both short term mode choice and long term mobility tool ownership and mileage distribution (fleet choice) is present.
 - Respondents are more sensitive to public transport price increases than to rising fuel prices.
-

Part 4. Gas Price and Car Ownership and Efficiency

Car ownership

Romilly et al. (1998):

- Short-run motoring cost elasticity is -0.3 and a long-run motoring cost elasticity is -2.2 on car ownership in Britain from 1953 to 1994 in Britain.

Johansson and Schipper (1997)

- long-run fuel price elasticity is only -0.1 using the data from 12 OECD countries for the time period 1973-1992.
-

- People with different income levels have different sensitivities to costs (in UK).

Running Cost Elasticity on Car Ownership

Income level	Short-run	Long-run
Low	-0.35	-0.92
Middle	-0.19	-0.51
High	-0.14	-0.38

Source: Dargay and Vythoulkas, 1999 (Table 4)

Fuel efficiency

- Average effects summarized by Goodwin et al. (2004):
 - In short-run, if the gas price increase by 10%, fuel efficiency of the car rises about 1.5%.
 - In the long-run, if the gas price increase by 10%, fuel efficiency of the car rises about 4.0%.
-

-
- Rebound effects (Small and Dender 2007)
 - short-run rebound effect is 4.5%:
 - If fuel efficiency of the car is increased by 100%, the fuel consumption will be reduced by 95.5%
 - Long-run rebound effect is 22.2%:
 - If fuel efficiency of the car is increased by 100%, the fuel consumption will be reduced by 77.8%
-

Part 5. Gas Price and Land Use

-
- Few empirical studies on this topic
 - land use changes occur more slowly than changes in travel behavior
 - the costs of transportation (especially the goods shipping costs) have declined much
 - The changes in the transportation system and cost in current days are trivial and their impacts tend to be just marginal
-

-
- Hunt et al. (1994) conducted a stated preference experiment in Calgary, Alberta, Canada and reported that:
 - travel time to work worth approximately 18 \$ / hour, twice as important as travel time to shop
 - being within walking distance of a light rail transit station is worth about 160 dollars per month
-

-
- Cortright's study on major U.S. metro areas (2008) :
 - the higher price of gas since 2004 has most affected suburban housing values because of high gas price
 - while distant suburbs have seen the largest declines, housing values in close-in neighborhoods have held up better
 - gas price spike popped the housing bubble
-

Conclusions

- Caution needs to be used while explaining and using these research results, considering their different dataset, methodologies, time points, geographic areas, and so on
 - More empirical studies needs to be done to understand the impacts of transport cost on land use.
-

Reference:

- Hamilton J. (1983) Oil and the Macroeconomy Since World II, *Journal of Political Economy*, Vol. 91, No. 21, pp. 228-248.
 - Hamilton J. (2000) What Is An Oil Shock, NBER working paper 7755. URL: <http://www.nber.org/papers/w7755> , retrievable on Sept. 22, 2008.
 - Kilian L. (2008) Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the U.S. Economy? *The Review of Economics and Statistics*, May 2008, 90(2): 216-240.
 - Goodwin P., Dargay J. and Hanly M. (2004) Elasticity of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review, *Transport Reviews*, Vol. 24, No. 3, 261 – 274.
 - de Jong G. and Gunn H. (2001) Recent Evidence on Car Cost and Time Elasticities of Travel Demand in Europe, *Journal of Transport Economics and Policy*, 35 (2), pp. 137-160.
 - Congress of the US, Congressional Budget Office (2008) Effects of Gasoline Prices on Driving Behavior and Vehicle Markets, a CBO study.
 - Haire, A. and Machemehl, R. (2006) The Impact of Rising Fuel Prices on US Transit Ridership, TRB 2007 Annual Meeting.
-

-
- Currie G. and Phung J. (2008) Understanding Links between Transit Ridership and Auto Gas Prices – US and Australian Evidence, TRB 2008 Annual Meeting.
 - Small K. and Dender K. (2007) Fuel Efficiency and Motor Vehicle Travel: The declining Rebound Effect, *The Energy Journal*, Vol. 28, No. 1.
 - Hunt J.D., McMillan P. and Abraham J.E. (1994) Stated Preference Investigation of Influence on Attractiveness of Residential Locations. *Transportation Research Record*, 1466.
 - Cortright J. (2008) Driven to the Brink: How the Gas Price Spike Popped the Housing Bubble and Devalued the Suburbs.
 - Pagliara F. and Preston J. (2003) The Impact of Transport on Residential Location (Final Report), Transport Studies Unit, University of Oxford.
 - Kennedy D. and Wallis I. (2007) Impacts of Fuel Price Changes on New Zealand Transport, Land Transport New Zealand Research Report 331.
 - Dargay J. and Vythoulkas P. (1999) Estimation of a Dynamic Car Ownership Model: A Pseudo-Panel Approach, *Journal of Transportation Economics and Policy*, Vol. 33, Part 3, pp. 287-302.
 - **Weis**, C et al. (2010) Models of Mode Choice and Mobility Tool Ownership Beyond 2008 Fuel Prices, the 89th TRB conference.
-

Acknowledge

- This presentation is based on a literature review written by Hongwei Dong, Professor Hunt and Professor Gliebe when Hongwei Dong worked as an intern at Parsons Brinckerhoff Inc. during the summer 2008.
 - The authors thank Tara Weidner and Rick Donnelly at PB and Brian Gregor at ODOT for their valuable comments and help.
-