Gasoline Demand Elasticities
2007 EIA Energy Outlook, Modeling
Data Conference

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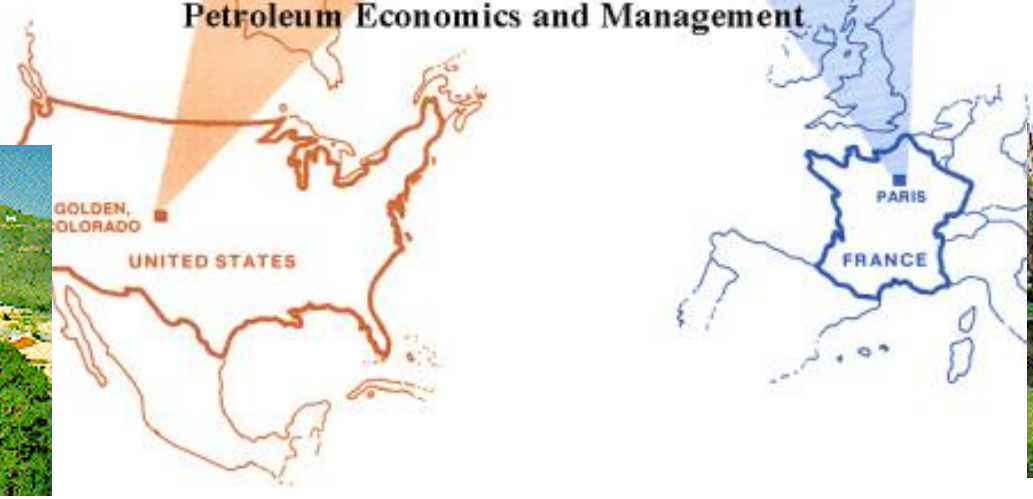
ifp

Joint International Graduate Degree Program in Petroleum Economics and Management



Coming Attractions-
Gasoline Demand Survey Update

"Find a relationship that survives long enough to be useful." Hendry and Juselius (2001)

1. **Study in Context**
2. **What are Elasticities?**
3. **Why are They Important?**
4. **Demand Methodologies**
5. **Summary of Survey Work to Date**
6. **Demand for Transportation Fuels**

Nasser Al Dossary

Scope of Study - Critical Review
All Econometric Demand Elasticities

All countries - all products

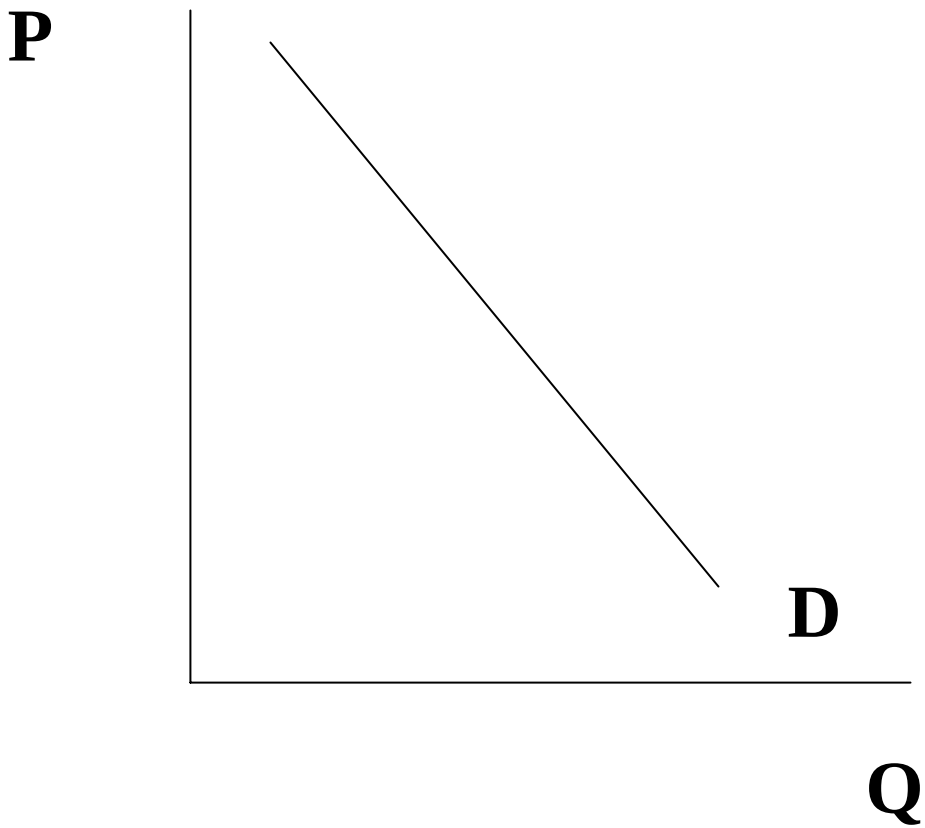
- **>1500 studies**

Levels of aggregation

- **E, C, El, O, Ng, Biomass**
- **O – tr & ntr**
- **O – G, K, D, Fo-lt, Fo-hv**
- **Sector r, c, i, e, tr, ii**

On line data base

Demand Elasticities



Demand Elasticities – What Are They?

How consumption responds to a variety of variables?

e.g. price elasticity

Consumption response to prices?

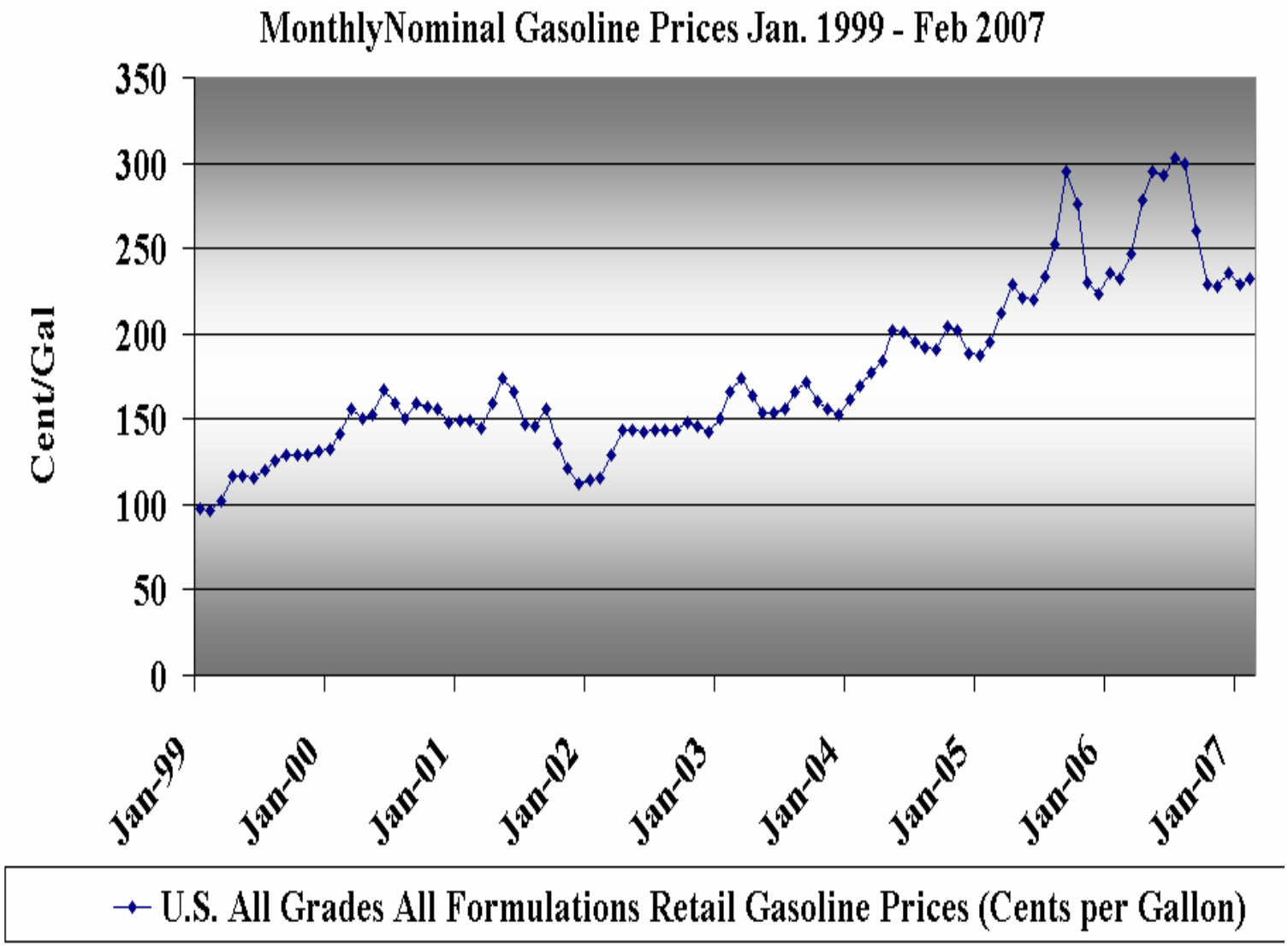
$$\varepsilon_X = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta X}{X}}$$

$$\frac{\Delta Q}{Q} = \varepsilon_X \frac{\Delta X}{X}$$

$$\frac{\Delta X}{X} = \varepsilon_X \frac{\Delta Q}{Q}$$

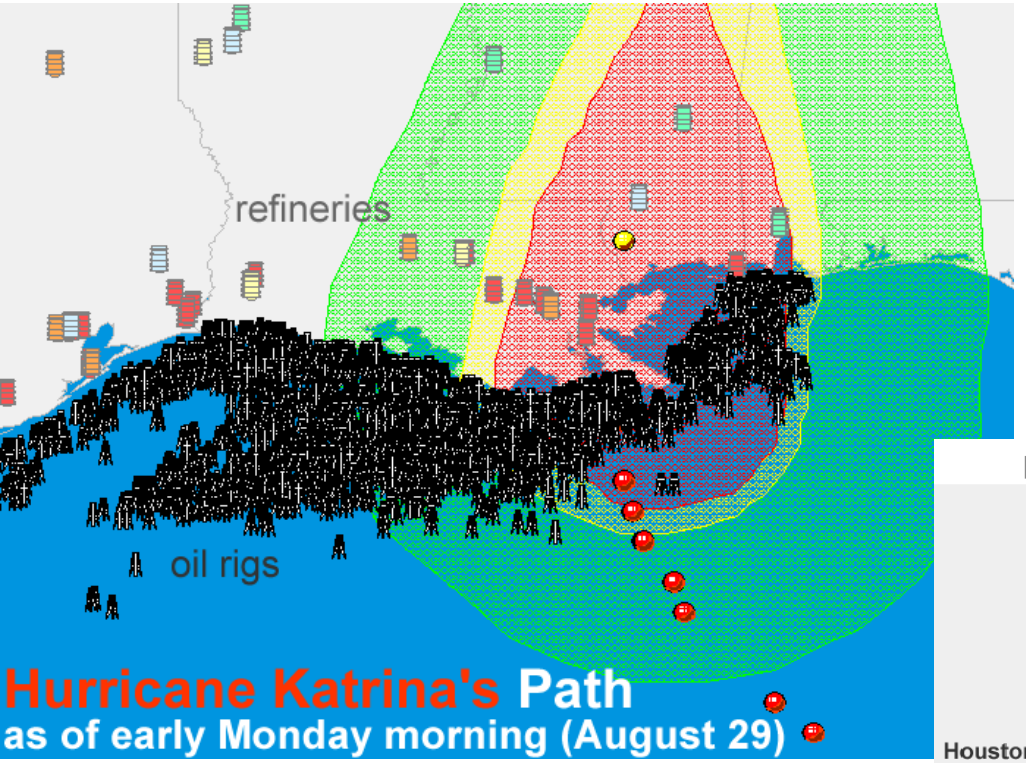
Elasticities –Why Important?

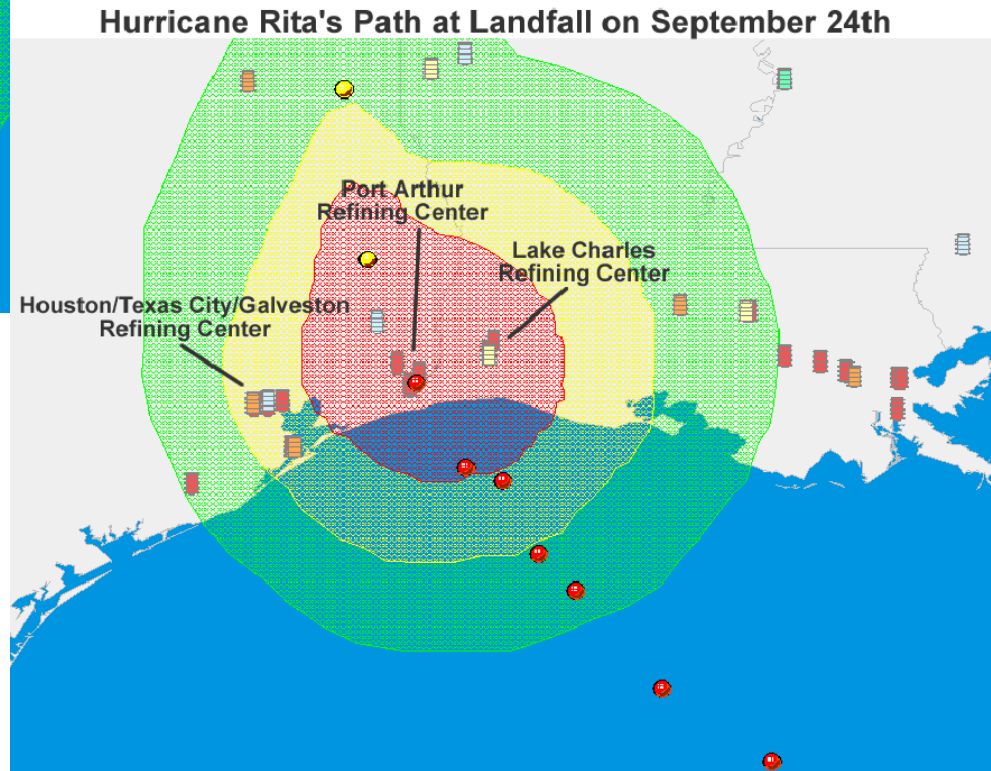
$$\frac{\Delta Q}{Q} = \varepsilon_x \frac{\Delta P}{P}$$



How Easily a Market Can Respond to Disruption,

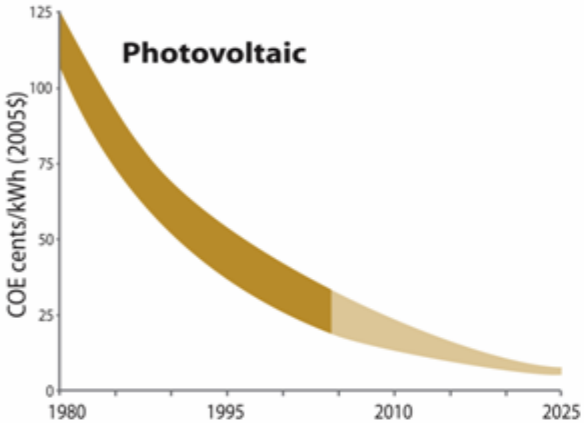
$$\frac{\Delta P}{P} = \varepsilon_x \frac{\Delta Q}{Q}$$

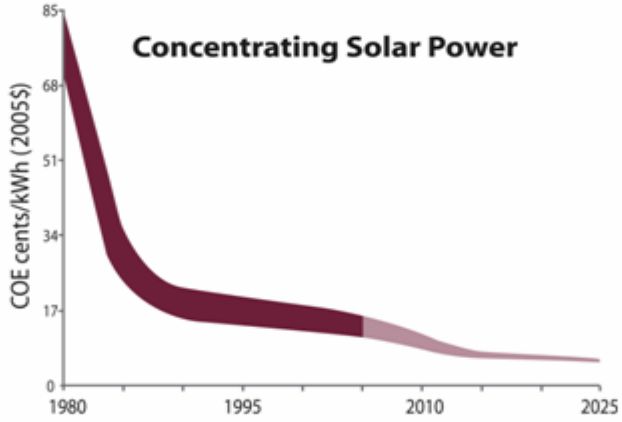


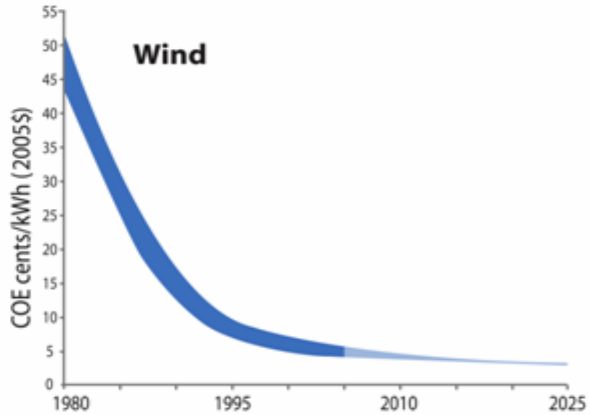


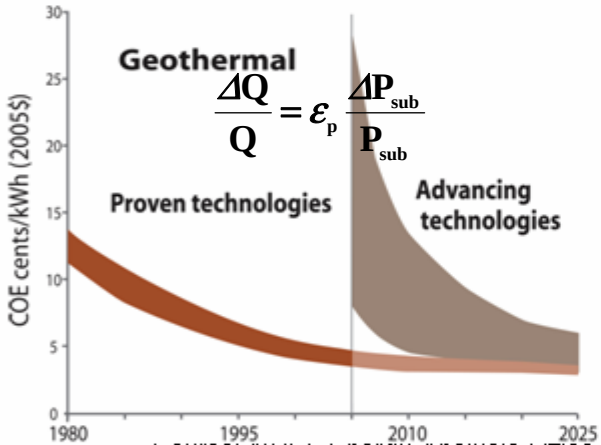
Renewable Energy Cost Trends

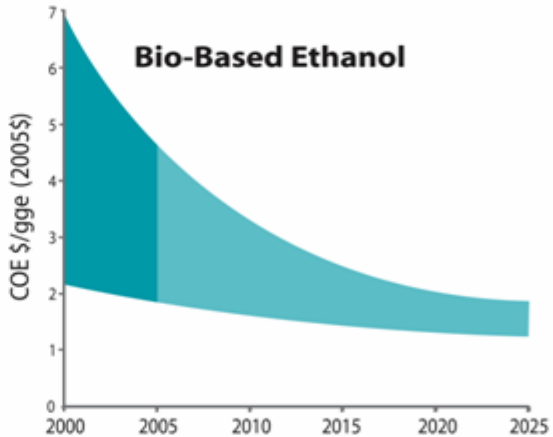
Levelized cost of energy in constant 2005$[1]











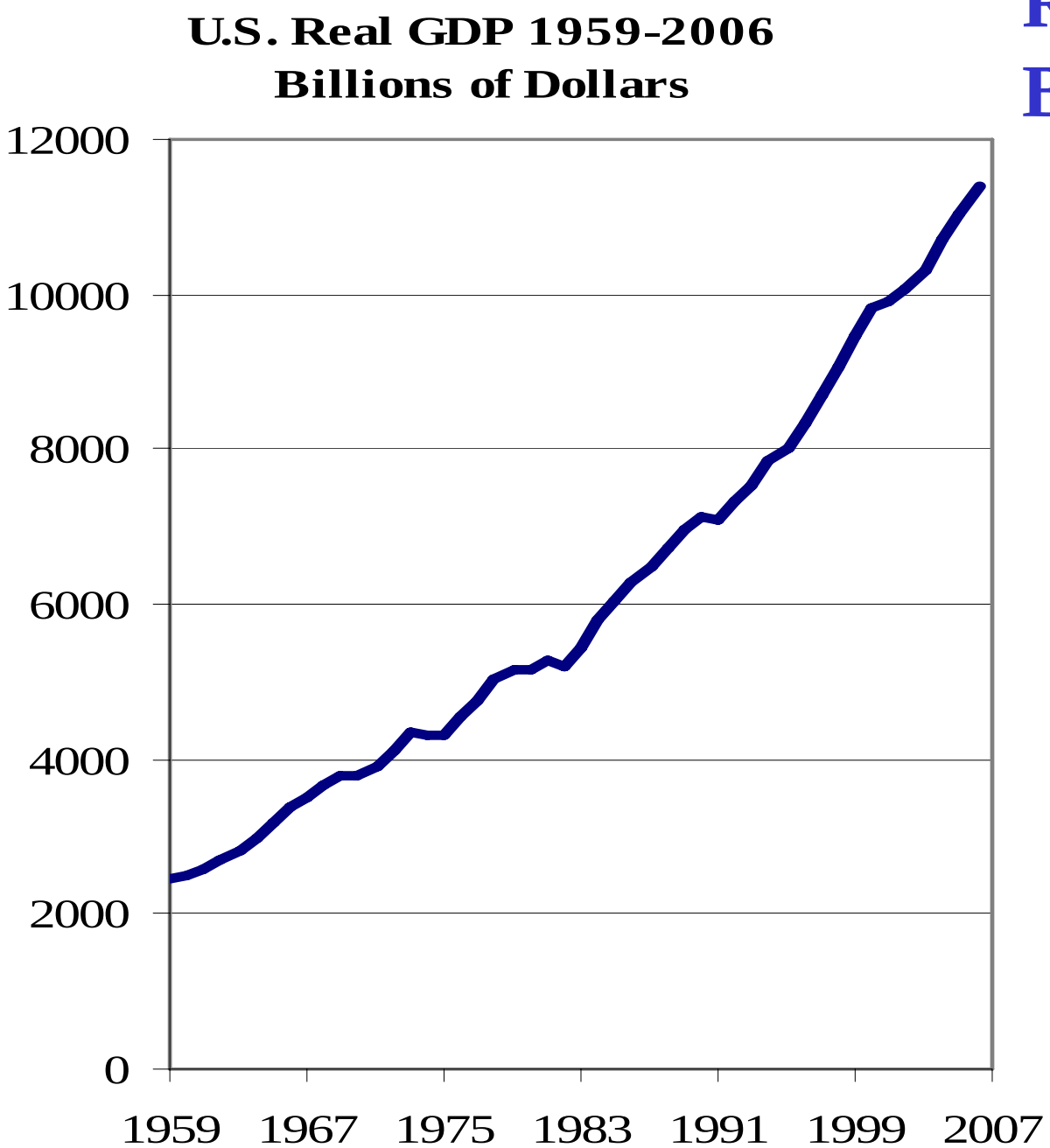
Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2005.ppt)

[1]These graphs are reflections of historical cost trends NOT precise annual historical data. DRAFT November 2005

Renewable phase in

$$\frac{\Delta Q}{Q} = \varepsilon_p \frac{\Delta P_{sub}}{P_{sub}}$$

Responses to the Business Cycle



$$\frac{\Delta Q}{Q} = \varepsilon_X \frac{\Delta Y}{Y}$$

Estimation Issues: $Q_i = \beta_o + \beta_P P_i + \beta_Y Y_i$

Is P exogenous?

Is equation identified?

Is equation correctly specified?

- **correct variables, correct functional form**
- **statistical tests**
- **recent – cubic splines, nonparametric**

Is relationship stable and symmetric?

- **statistical tests**

Aggregation Issues

Measuring Short Run and Long Run

1. **Lags**
2. **Vehicle Stock and Use Choice**
3. **Data: Cross Sections versus Time Series**

Short Run and Long Run Using Lags

$$Q_t = \alpha + \sum_{i=0}^{J} \beta P_{t-i} + \sum_{i=0}^{K} \delta Y_{t-i} + \sum_{i=1}^{K} \delta Q_{t-i}$$

Time Series Issues

Variables are non-stationary

spurious regression

lose consistency

lagged endogenous

Non-stationarity

Three causes of non-stationarity

$$y_t = \mu + y_{t-1} + \beta t + \varepsilon_t$$

drift — **random walk** — **time trend**

First difference – make stationary I(1)

run

may lose variation – lower efficiency

Non-stationarity

All integrated of order 1 or same order

linear combination I(0) stationary

cointegrated

OLS consistent (super)

measure long run relationship

error correction model

short run deviations

Endogenous RHS

$$Q_t = \alpha + \sum_{i=0}^{J} \beta P_{t-i} + \sum_{i=0}^{K} \delta Y_{t-i} + \sum_{i=1}^{K} \delta Q_{t-i}$$

biased and inconsistent

time series – all could be endogenous

system approach – vector autoregression

cointegration may save the day

may be > 1 cointegrating relationships

Stock Changes (LR) Utilization (SR)

Gallons = Miles/(Miles/Gallon)

log (Gallons) = log(Miles) – log(Miles/Gallon)

$$\frac{\partial \log(\text{Gallons})}{\partial \log(\text{Price})} = \frac{\partial \log(\text{Miles})}{\partial \log(\text{Price})} - \frac{\partial \log(\text{Miles/Gallon})}{\partial \log(\text{Price})}$$

Rebound effect (Cafe standards)

MPG ↑ Cost per mile↓ Miles ↑

cancelling some of efficiency gains

Greening, Greene, and Difiglio (2000) – 10% sr and up to 30% long run

Cross Section (LR) - Time Series (SR)

Cross section

- **adjusted to large differences**
- **price and income**

Time series

- **how much adjustment in periodicity of data**

Table 1 Gasoline Demand Elasticity Surveys

	# Studies	Study Years	Psr	Plr	Ysr	Ylr
Taylor (1977)	7	70-76	(0.10,-0.50)	(-0.25,-1.00)		
Bohi (1981)	11	74-78	-0.20	-0.70		near 1
Kouris (1983) Country CSTS	7	75-83	(-0.10,-0.20)			
Kouris (1983) US TS	7	72-83	(-.20,-.40)	-0.70		
Bohi and Zimmerman (1984)	10	79-82	-0.20	inelastic	0.40	elastic
Dahl (1986)	69	69-84	-0.12 (m,q)		0.31 (m,q)	
			-0.29 (a)	-1.02	0.47 (a)	1.38
Dahl and Sterner (1991a, 1991b)	~100	66-88	-0.26	-0.86	0.48	1.21
Goodwin (1992)	12		-0.27	(-0.71,-0.84)	nr	nr
Dahl (1995)	14	89-93	-0.20	-0.60		<1
Espey (1996) U.S.	41	69-90		-0.65		0.91
Espey(1998)	95	66-97	-0.16	-0.81	0.32	0.90
Graham and Glaister (2002)	113	66-00	(-0.20,-0.30)	(-0.60,-0.80)	(0.30,0.50)	(0.50,1.50)
Hanly, Dargay, Goodwin (2002)	69	72-01	-0.25	<-0.60	0.40	>1.00
Dahl (2006)	4					

Notes: Numbers in parenthesis indicate authors range of estimates (a) = annual, (m,q) = monthly and quarterly, CSTS = cross section time series dats, TS = time series data, <-0.60 means more elastic

Espy 96' Meta-analysis on Gasoline Elasticities

Determine effects on gasoline demand elasticities by

- **Functional form**
- **Lag structure**
- **Estimation technique**
- **Other study differences**

Analysis on US studies without household panel data

Price Elasticity Results of Espy 96’

Explains 1/3 to 1/2 variation in long run elasticities

No significant from non-price & income variables

Static & dynamic no significanty difference long run estimates

Per capita or per household demand less elastic than total demand or demand per vehicle

Price Elasticity Results of Espy 96’

No difference in LR estimates for monthly, quarterly, or annual data

No difference in linear or log linear models

No difference national or state cross section time series

Cross section time series of non-US find 50% more elastic price response

Price Elasticity Results of Espy 96’

Random coefficient techniques < elastic price response

Demand was more price elastic prior to 1974

Other

Hughes, Knittel, and Sperling (2006

– monthly, static

	Price	Income
1/75-1/80	-0.30	0.47
3/01-3/06	-0.04	0.53

Income Elasticity Results Espy 96

Vehicle ownership lowers the elasticity

Non-price and income variables do not lower elasticity

Linear models are not different than non-linear

Monthly and quarterly data find a smaller long run income response

Income Elasticity Results Espy 96

Higher income elasticity (10% significance level)

- **Per capita**
- **Per household**
- **Per vehicle**

Income elasticity less elastic before 1974 (10%)

No difference national and cross section time series of states

Random coefficient find more elastic income response

Global Demand for Transportation Fuels

Nasser Aldossary (PhD Candidate)

Scope: Estimate elasticities (price, income) 45 countries.

Methodology: Building an econometrics model for each country.

Fuels of focus: Gasoline and Diesel.

Sample years: 1978-2004

Total consumption of selected countries:

Gasoline 88% and 85% Diesel of world's consumption

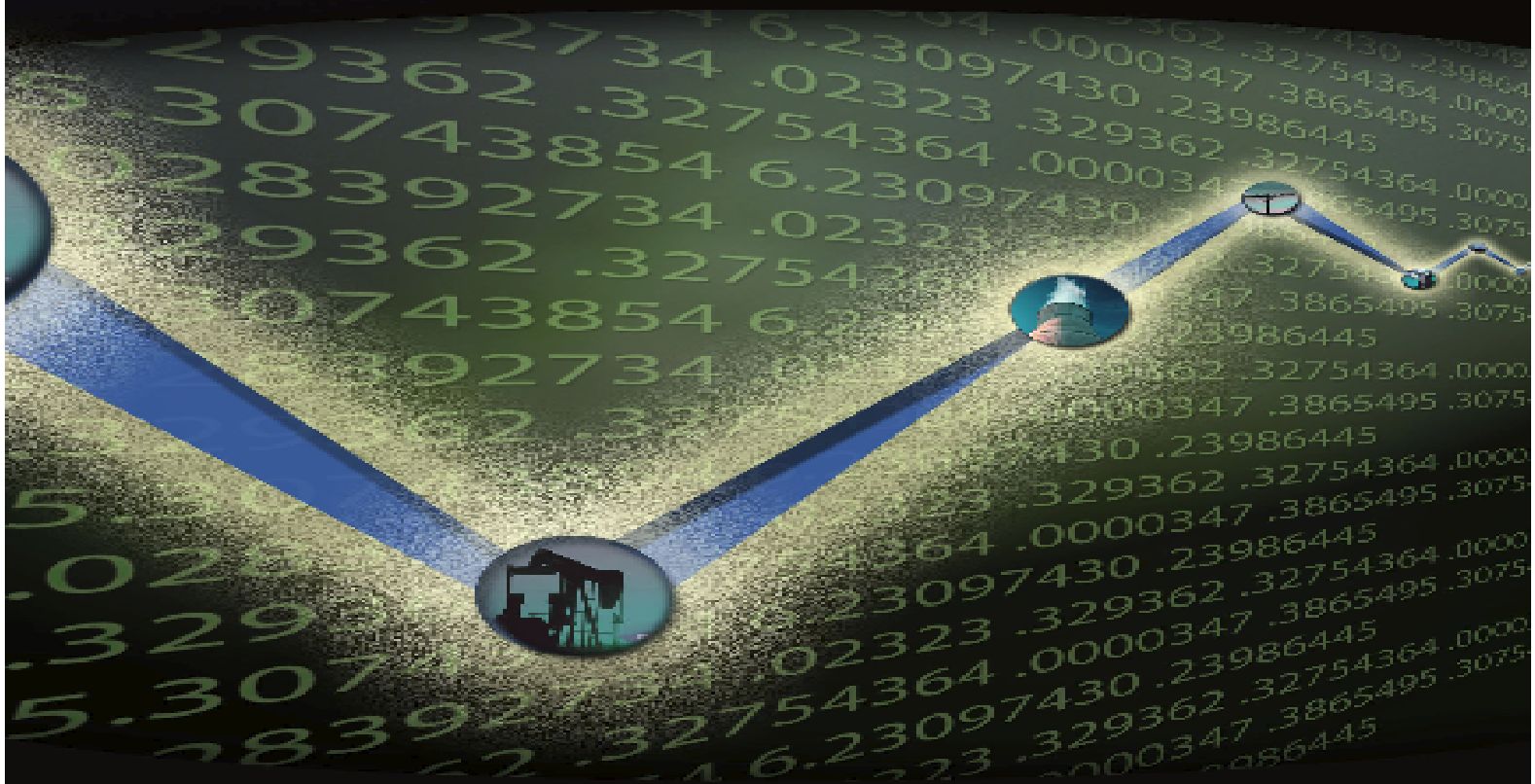
Sum Up

Numerous Surveys

- **conventional wisdom**
  - **little or no price response**
    - **all surveys conclude there is**
    - **most come to numerical conclusion**
  - **income near 1**
    - **not so inconsistent with surveys**
  - **my best guesses**
    - **ε_p(annual -0.2) ε_p(lr -0.6 to -0.8)**
    - **ε_p(annual 0.3 to 0.5) ε_p(lr <1)**

INTERNATIONAL ENERGY MARKETS

Understanding Pricing, Policies, and Profits



by Carol Dahl