

Mining Demand and Supply Data with Methods of Economic Statistics

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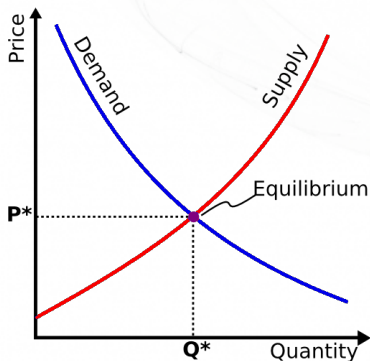
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Demand and Supply Curves

Quantity demanded: the amount of a good that consumers are willing to buy (downward sloping).

Quantity supplied: the amount of a good that firms want to sell at a given price (upward sloping).



Price Elasticity

A measure to show the responsiveness of the quantity demanded/supplied of a good or service to a change in its price:

$$\epsilon = \frac{\frac{dQ}{Q}}{\frac{dP}{P}}.$$

- ▶ Q is the **quantity demanded** $\Rightarrow \epsilon < 0$
- ▶ Q is the **quantity supplied** $\Rightarrow \epsilon > 0$

Slope and elasticity are different concepts!

Special Types of Price Elasticity

Consumers/providers are equally sensitive to price changes whatever the price may be.

Constant:

$$\epsilon = b \Rightarrow Q(P) = AP^b$$

Elasticity of demand usually decreases with price, elasticity of supply usually increases with price!

Directly proportional:

$$\epsilon = aP \Rightarrow Q(P) = Ae^{aP}$$

Linear:

$$\epsilon = aP + b \Rightarrow Q(P) = Ae^{aP} P^b$$

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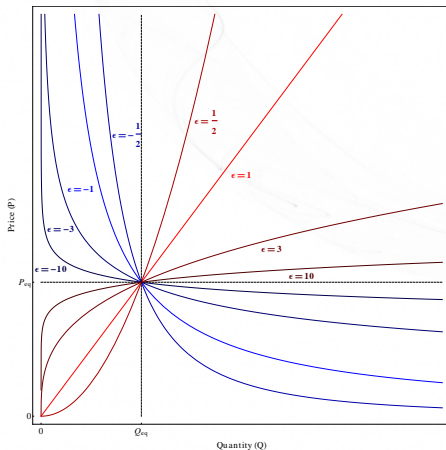
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Linear:

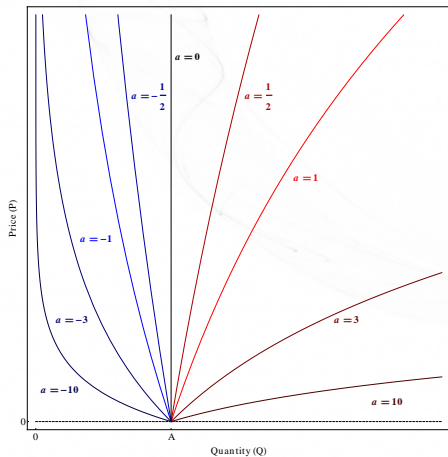
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Demand and Supply Curves

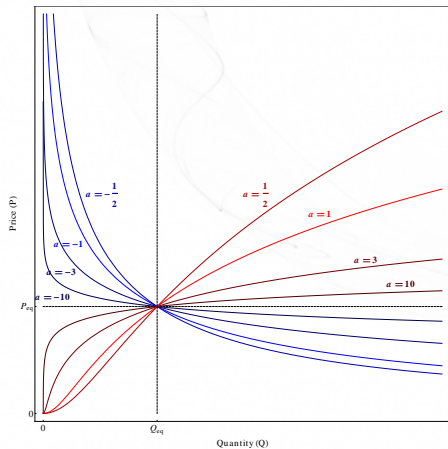
Constant price elasticity: $Q(P) = AP^b$



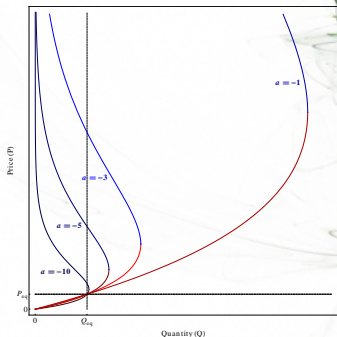
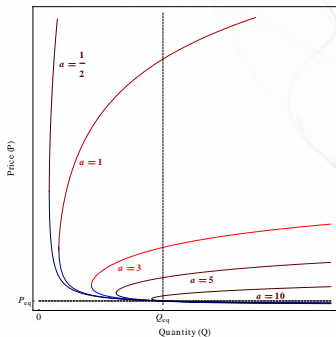
Directly proportional price elasticity: $Q(P) = Ae^{aP}$



Linear price elasticity: $Q(P) = Ae^{aP}P^b$, $ab > 0$



Linear price elasticity: $Q(P) = Ae^{aP} P^b$, $ab < 0$



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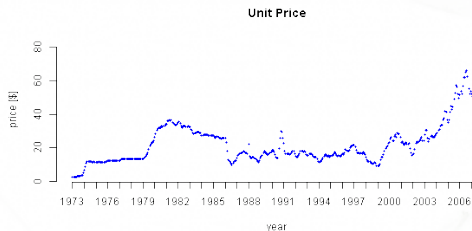
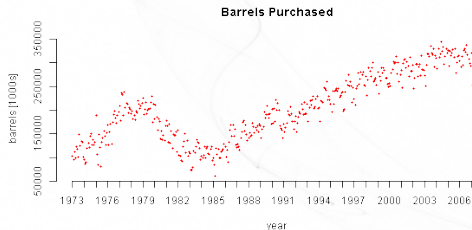
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U.S. Oil Imports Data

Data set: Monthly U. S. Oil Imports 1973-2007 (unit price not adapted to inflation)



U.S. Oil Imports Data

Basic facts:

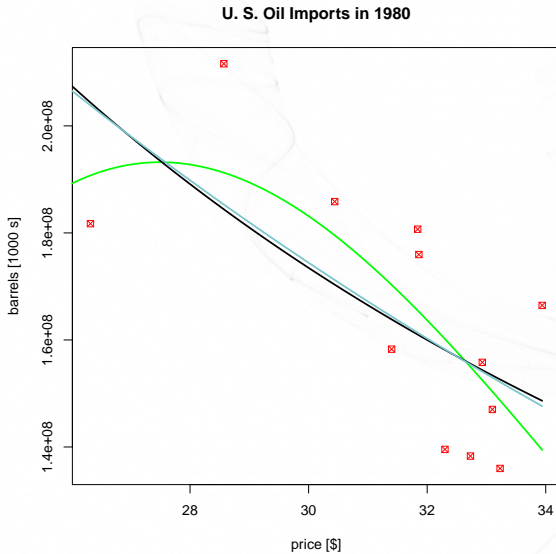
- ▶ petroleum (crude oil and petroleum products),
- ▶ oil imports peaked in 2005 when they supplied 60 % of the consumption,
- ▶ declination due to increased domestic oil production and reduced consumption,
- ▶ largest sources of imported oil: Canada, Saudi Arabia, Mexico, Venezuela, Russia,
- ▶ most visible peak of imported oil quantity during the creation of the strategic petroleum reserve (started in 1975 after the 1973-74 oil embargo).

Data Mining Approach

Goal: extract interesting patterns and dependencies

1. Least-squares regression for yearly data

	$\epsilon = b$	$\epsilon = aP$	$\epsilon = aP + b$
1973	-	-	$-1.44P + 5.57$
1974	0.71	$0.08P$	$0.95P - 8.06$
1980	-1.25	$-0.04P$	$-0.50P + 13.69$
1987	1.58	$0.10P$	$1.36P - 20.07$
1990	-0.41	$-0.02P$	$-0.00P - 0.40$
1992	0.77	$0.05P$	$-0.40P + 7.23$
1994	0.64	$0.05P$	$0.20P - 2.15$
1997	-0.73	$-0.04P$	$-0.23P + 3.65$
2001	-	-	$-0.36P + 6.93$
2003	-0.83	$-0.03P$	$-0.28P + 6.88$
2006	0.43	$0.01P$	$0.09P - 4.74$



Findings:

- ▶ the goodness of fit and the statistical significance of the estimated parameters are high enough ($p < 0.05$) only for 11/35 years,
- ▶ the means of the models' coefficients of determination R^2 are 0.56, 0.57 and 0.63, respectively,
- ▶ local peaks of purchased quantity resulted in linear price-elasticity models atypical for demand,
- ▶ a sequence of highly insignificant models between 1975 and 1985.

Data Mining Approach

2. Monthly price elasticities

We have defined monthly price elasticities as

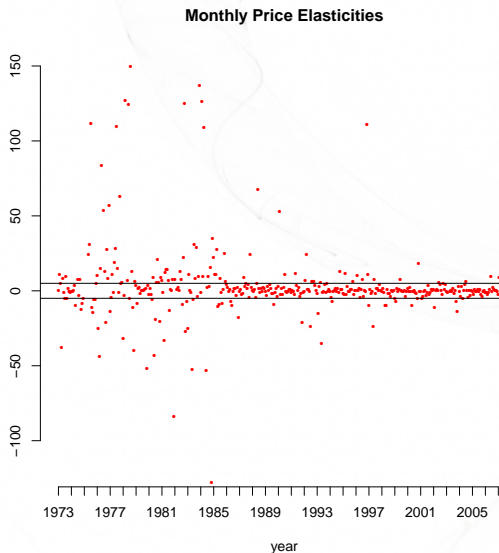
$$\epsilon_i = \frac{\frac{Q_i - Q_{i-1}}{Q_i}}{\frac{P_i - P_{i-1}}{P_i}}$$

and monthly elasticity slopes as

$$a_i = \frac{\epsilon_i - \epsilon_{i-1}}{P_i - P_{i-1}}$$

Aim: detect stable/unstable time intervals!

The responsiveness of the imported oil quantity to a change in its price stabilized with years.



Conclusions

- ▶ A data mining approach for demand and supply data (demand/supply functions) was introduced.
- ▶ Demand/supply regression analysis can help searching for interesting patterns and dependencies.
- ▶ An 11-year period of highly unstable U.S. oil imports data was detected—the creation of the U.S. petroleum reserve.
- ▶ Local peaks of purchased quantity resulted in linear price-elasticity models atypical for demand.
- ▶ Monthly price elasticities have been introduced as a method for detecting stable time intervals.
- ▶ A stabilization of the monthly price elasticities —after the creation of the petroleum reserve.

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