Lecture 5
Supply and Demand II

15.011/0111 Economic Analysis for Business Decisions
Oz Shy

Price sensitivity of demand

THE WALL STREET JOURNAL.

Starbucks to Raise Prices for Packaged Coffee

June 20, 2014

Smucker, Folgers and Starbucks each last raised their prices on grocery-store shelves…

"As coffee prices were coming down, the retail pricing gap to commodities widened a bit," [Kraft's CFO] Teri List-Stoll said. Still, consumers don't seem to balk at higher coffee prices, she said.

Price sensitivity of demand

The New York Times

5 Problems McDonald's Is Facing in the US

OCT. 21, 2014

PRICE SENSITIVITY

Raising prices without driving away customers has been tricky for McDonald's. At one time, for instance, the popular Dollar Menu included a Big N' Tasty, which was made with a quarter-pound of beef. But over the years, McDonald's has had to swap out items as costs for beef and cheese have climbed.

Price sensitivity of demand: The elasticity concept can explain that

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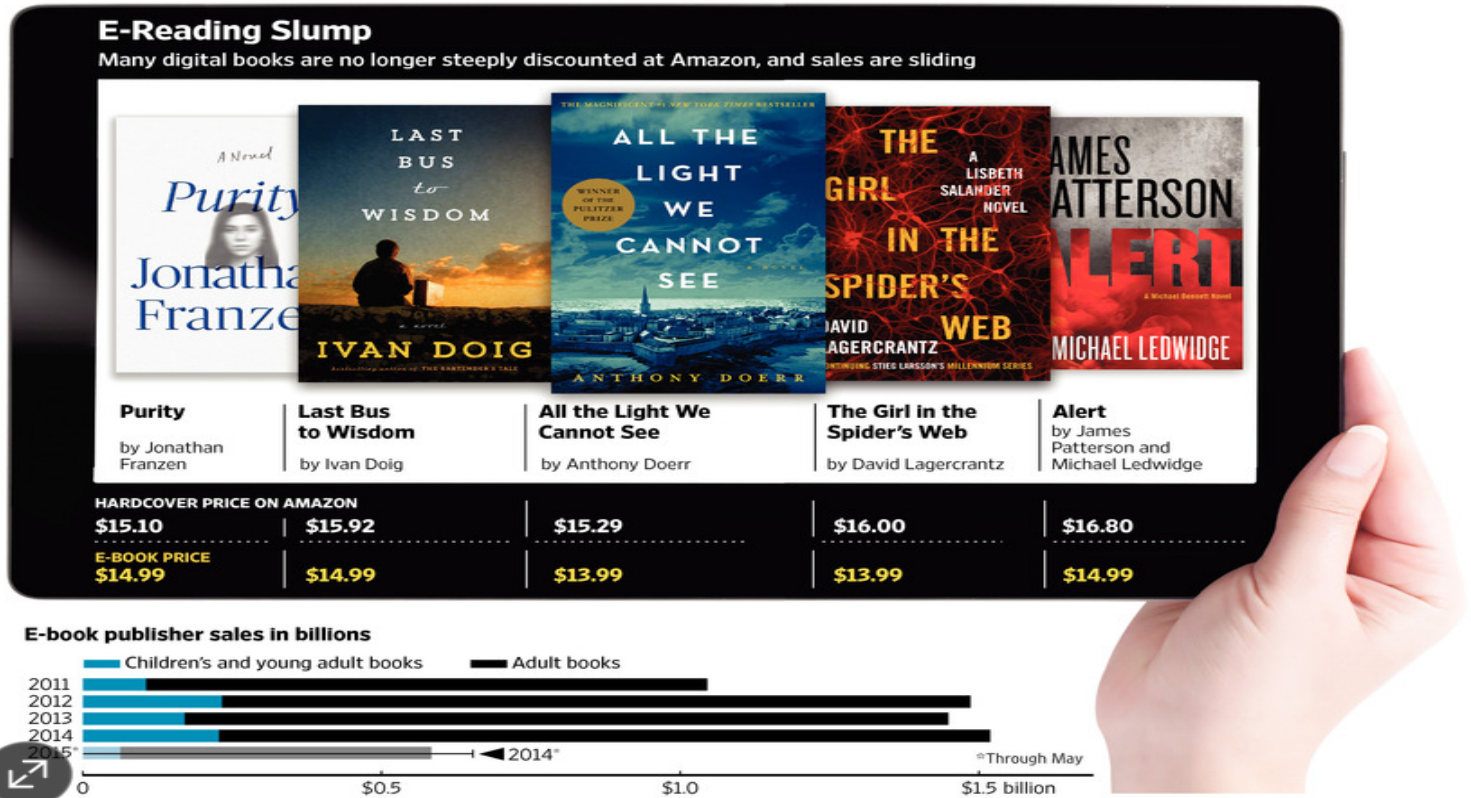
E-Book Sales Fall After New Amazon Contracts

Prices rise, but revenue takes a hit



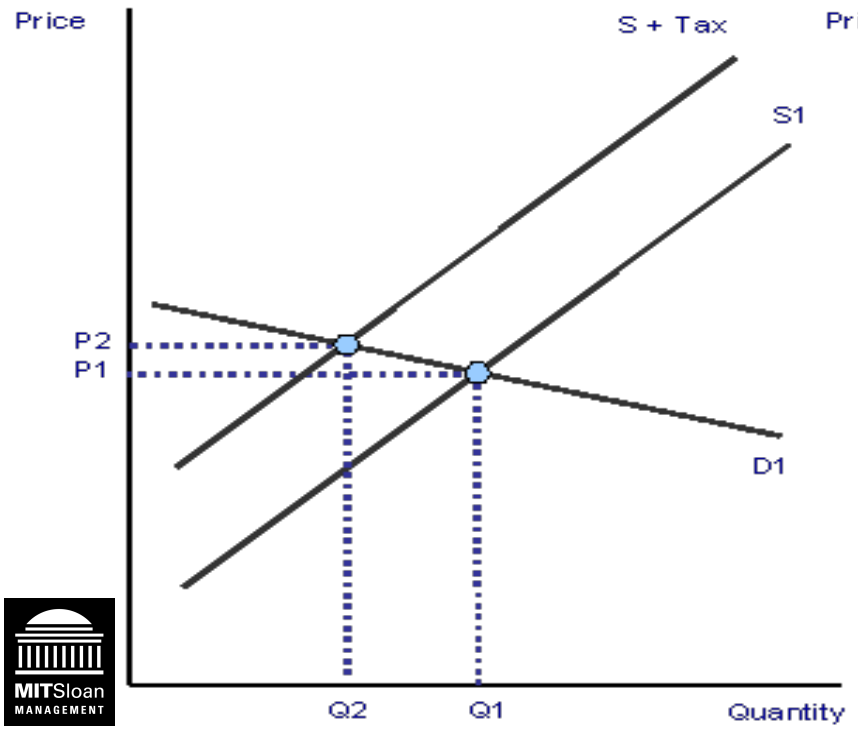
Price sensitivity of demand

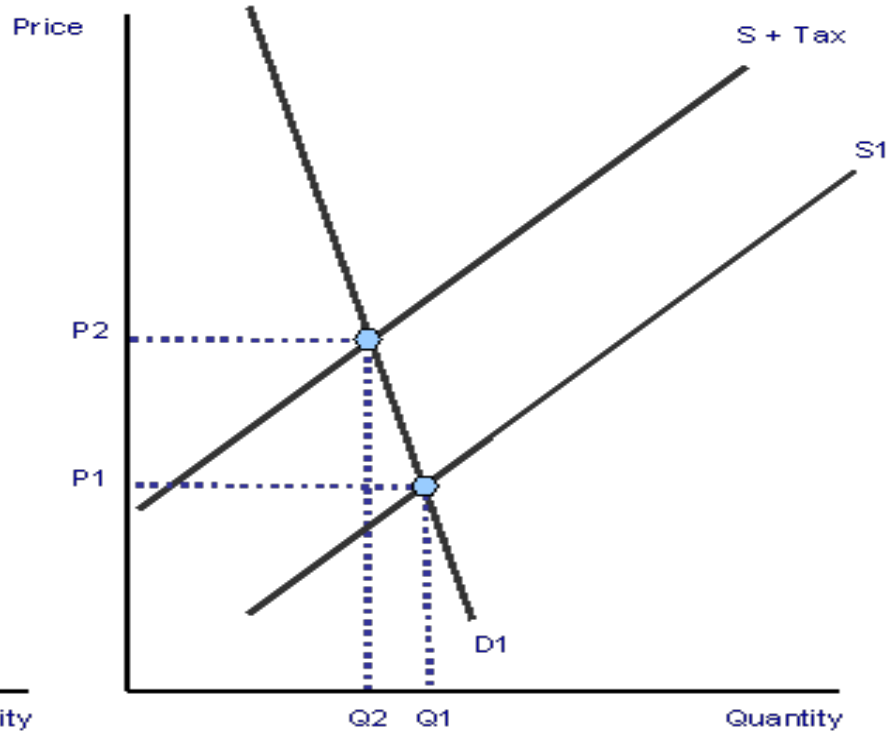
The slope of the demand curve tells us something about price sensitivity

-Flatter: more price sensitive

-Steeper: less price sensitive

Problem with this measure: unit-dependency





Own price elasticity of demand

Percentage change in quantity demanded for a one percent change in price

$$E = \frac{\%\Delta Q}{\%\Delta P} = \frac{\Delta Q / Q}{\Delta P / P} = \frac{dQ}{dP}\frac{P}{Q}$$

- Elasticity is a negative number (negative slope).
- For this reason we often use absolute value
- Larger (absolute) magnitude, more sensitive, more elastic
- $|E_d|>1$ is Elastic, $|E_d|<1$ is Inelastic
- Remark: Elasticity is a function of Q and P
- And may vary when we move over the demand curve

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Elasticity of demand: Example

$$E(4) = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{\frac{8-4}{4}}{\frac{30-40}{40}} = -4$$

$$E(0) = \frac{\frac{4-0}{0}}{\frac{40-50}{50}} = -\infty$$

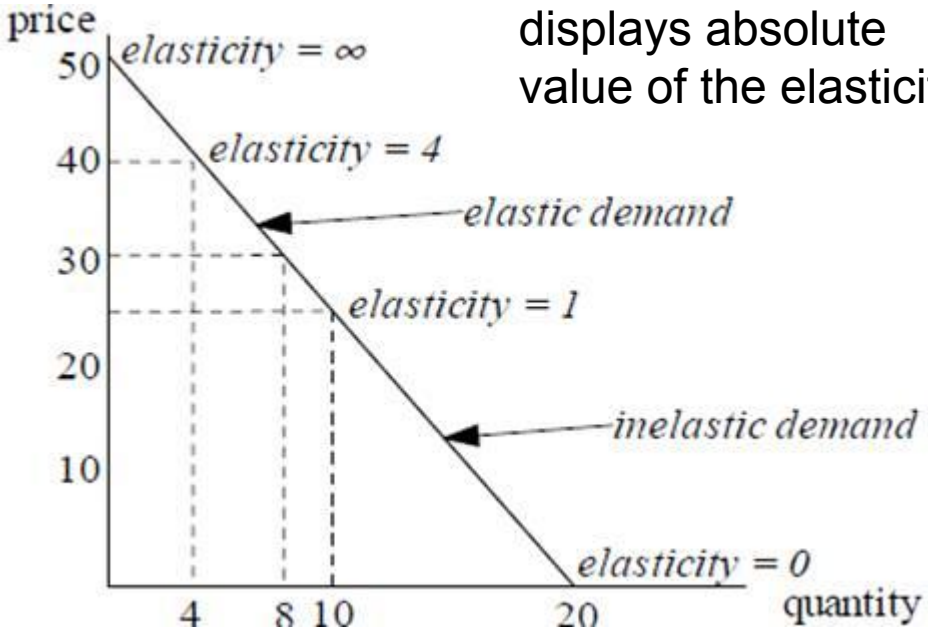
Using Calculus:

$$E(4) = \frac{dQ}{dP} \cdot \frac{P}{Q} = -\frac{2}{5} \cdot \frac{40}{4} = -4$$

Note: The 2 methods may not yield exactly the same results

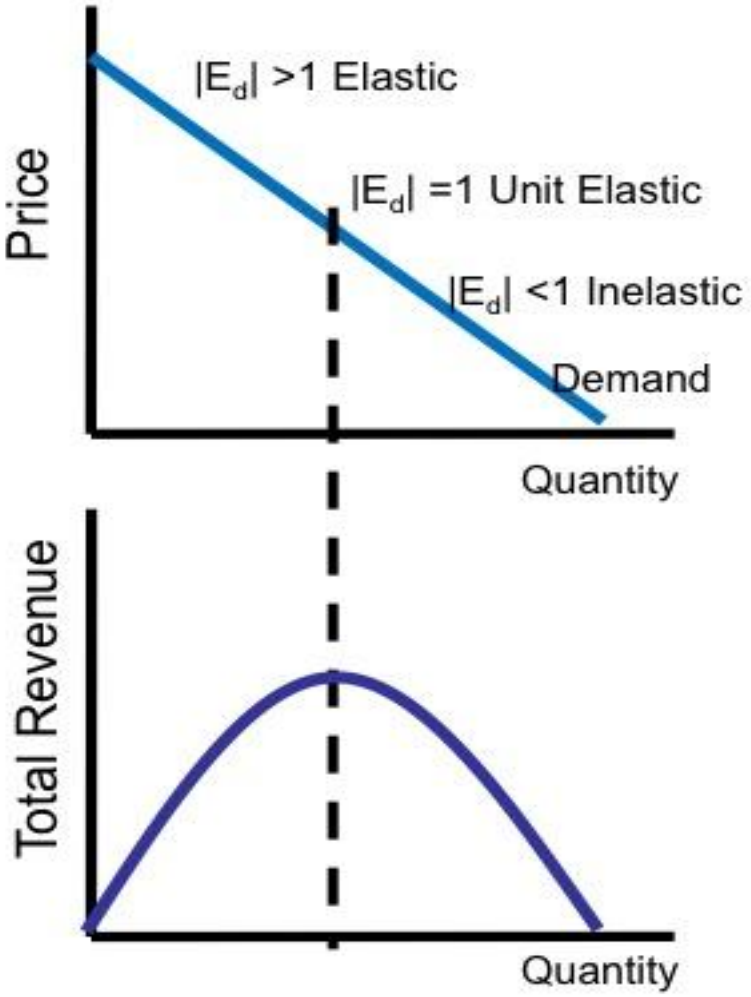
$$P = 50 - \frac{5}{2}Q \Leftrightarrow Q = 20 - \frac{2}{5}P$$

Note: The graph displays absolute value of the elasticities



The relationship between elasticity and consumer expenditure (firms' revenue)

- Elastic
  - P increase decreases TR
  - P decrease increases TR
- Unit elastic
  - Price increase or decrease doesn't change total revenue.
- Inelastic
  - P increase increases TR
  - P decrease decreases TR



Measure Elasticities with Data

Elasticity:	Coke	Pepsi
Own-price:	-1.47	-1.55
Cross-price*:	0.52	0.65
Own-advertising**:	0.25	0.32
Cross-advertising***:	-0.06	-0.62

Demand for i depends on all prices and advertising levels. Formally, we write:

$$Q_i^d = D(p_i, A_i; p_j, A_j)$$

*Cross-price

$$E^i_{P_j} = \frac{\Delta Q_i}{\Delta P_j} \cdot \frac{P_j}{Q_i}$$

**Dir-advertising

$$E^i_{A_i} = \frac{\Delta Q_i}{\Delta A_i} \cdot \frac{A_i}{Q_i}$$

***Cross-advertising

$$E^i_{A_j} = \frac{\Delta Q_i}{\Delta A_j} \cdot \frac{A_j}{Q_i}$$

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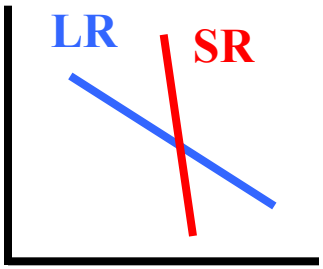
Source: Gasmi, Laffont and Vuong, "Econometric Analysis of Collusive Behavior in a Soft Drink Market," Journal of Economics and Management Strategy 1 (Summer, 1992) 278-311.

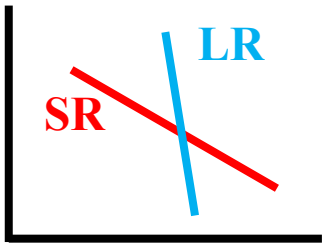
Elasticity rules of thumb

- Competitive markets, many substitutes ⇒ more elastic
- Necessities ⇒ less elastic
- Luxury goods ⇒ more elastic

Short-run vs. Long-run elasticities

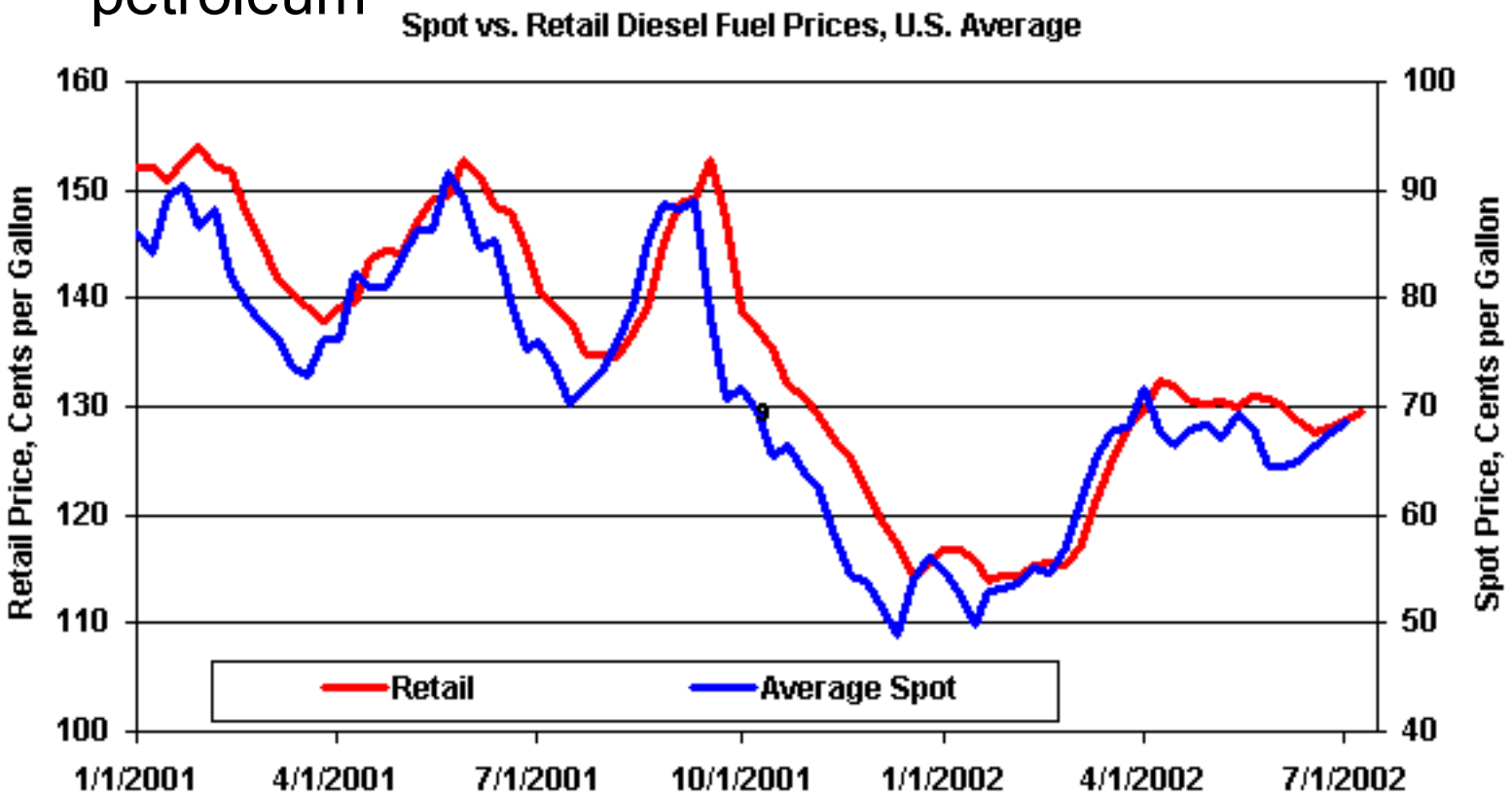
- For nondurable goods, SR<LR elasticity
  - Habits, persistence, adjustment costs
  - Adjustment of related durables (supplies)
  - (Can't wait)
- For durable goods, SR>LR elasticity
  - Purchase timing
  - Adjustment of stock
  - (Delay buying until it breaks)





Pass-through issues: Examples

(1) The effect of a 5% increase in excise tax on cigarette prices
(2) Foreign exchange increase on the price of Swiss cheese
(3) The retail price effect of an increase in the price of raw petroleum



Estimating Supply & demand functions: Regressions

Year	Demand (Qd)	Price (P)	Income (I)
1981	68.75	13	3000
1982	63.74	14	3000
1983	44.20	20	3000
1984	42.03	21	3000
1985	91.83	13	4000
1986	85.17	14	4000
1987	59.20	20	4000
1988	56.31	21	4000

So, we have some (time-series) data on quantity demanded as a function of price and income for 8 years

How do we "fit" the data into a "drawable" line? Or a curve?

Possible missing data: Prices of substitutes and complements, other demographics

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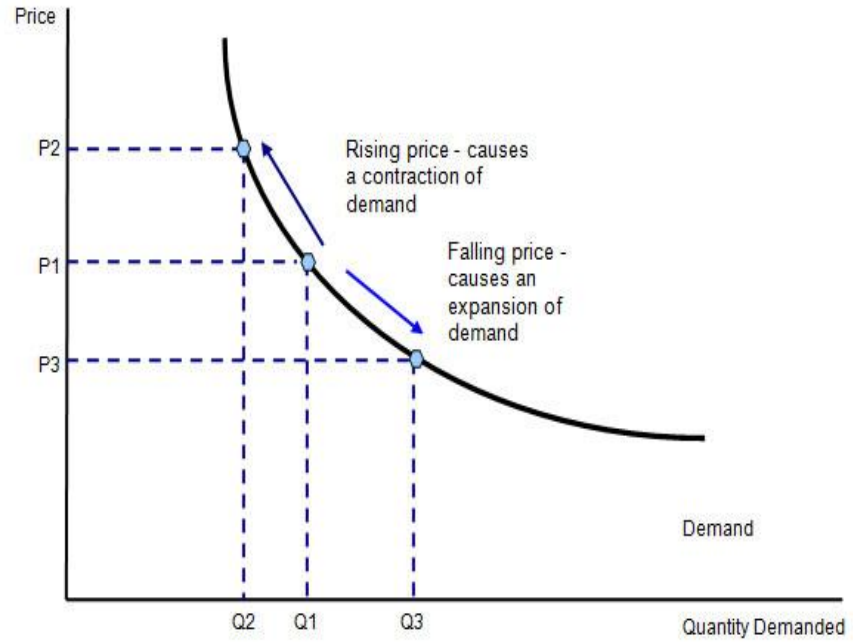
Estimating demand functions: Regressions

Exponential demand estimation

For: $Q^d = a \cdot P^{-b} \cdot I^c$ use:

$$\log(Q^d) = \log(a) - b \cdot \log(P) + c \cdot \log(I)$$

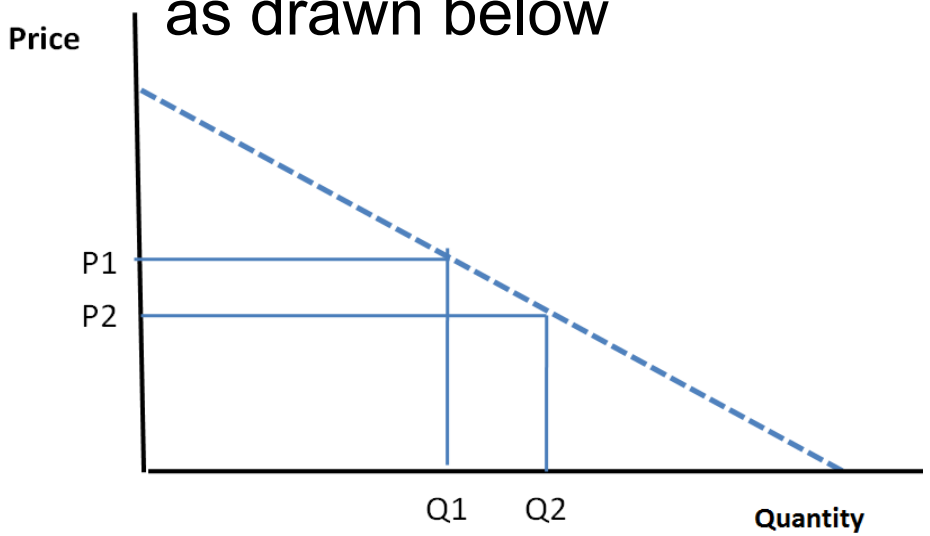
"-b" is the price elasticity



Linear estimation

$$Q^d = a - b \cdot P + c \cdot I$$

"a" is the Q-axis intercept
"-b" is the slope from the Q-axis (-1/b from the P-axis, as drawn below



Regressing quantity on price & income, and w/ income omitted

You can use “Excel” or other statistical software.
Here is R (public domain software) code:

```
(year=c(1981,1982,1983,1984,1985,1986,1987,1988))
(quant=c(68.75,63.74,44.20,42.03,91.83,85.17,59.20,56.31))
(price=c(13,14,20,21,13,14,20,21))
(income=c(3000,3000,3000,3000,4000,4000,4000,4000))
```

```
# Linear regression
linear_reg=lm(quant ~ price + income)
summary(linear_reg)

# Linear regression with income omitted
linear_reg_no_income=lm(quant ~ price)
summary(linear_reg_no_income)
```

Regressing quantity on price & income: Results (slope circled in red)

```
Call:
lm(formula = quant ~ price + income)

Residuals:
      1       2       3       4       5       6       7       8
-1.3496 -2.5047  1.0847  2.7696  3.2829  0.4778 -2.3628 -1.3979

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 64.870800   8.053965   8.055 0.000477 ***
price       -3.854900   0.266401 -14.470 2.84e-05 ***
income       0.018448   0.001884   9.793 0.000189 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.664 on 5 degrees of freedom
Multiple R-squared:  0.9839, Adjusted R-squared:  0.9774
F-statistic: 152.6 on 2 and 5 DF,  p-value: 3.296e-05
```

Regressing quantity on price (income omitted variable): Results

```
Call:
lm(formula = quant ~ price)

Residuals:
     Min       1Q   Median       3Q      Max
-11.7284  -8.7476   0.2034   8.2948  12.5067

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  129.437     18.970   6.823 0.000486 ***
price         -3.855      1.092  -3.529 0.012389 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 10.92 on 6 degrees of freedom
Multiple R-squared:  0.6748, Adjusted R-squared:  0.6206
F-statistic: 12.45 on 1 and 6 DF,  p-value: 0.01239
```

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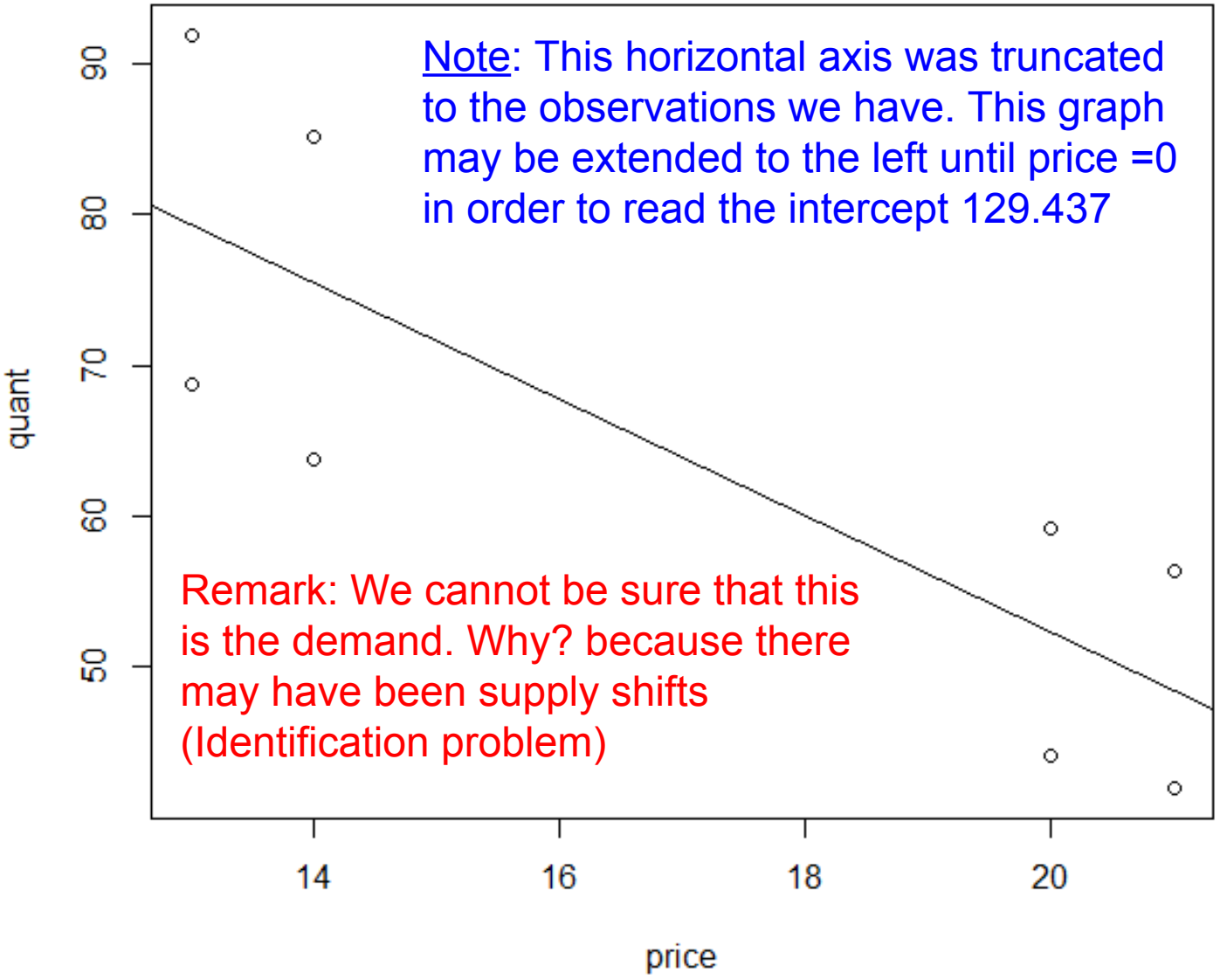
Regressing quantity on price (income omitted): Graphing the results



Note: This is a direct demand function (not an inverse demand)

Q as a function of P

Just flip the axes to get the inverse demand

Exponential demand estimation (elasticities are circled in red)

```
Call:
lm(formula = log(quant) ~ log(price) + log(income))

Residuals:
         1          2          3          4          5
 0.0006066  0.0007529 -0.0004648 -0.0008947 -0.0009272 -0.0004(

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.244848   0.018117  -68.71 1.24e-08 ***
log(price)  -1.022976   0.001472 -694.83 1.17e-13 ***
log(income)  1.011520   0.002164  467.48 8.50e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.0008803 on 5 degrees of freedom
Multiple R-squared:      1, Adjusted R-squared:      1
F-statistic: 3.507e+05 on 2 and 5 DF,  p-value: 1.357e-13
```