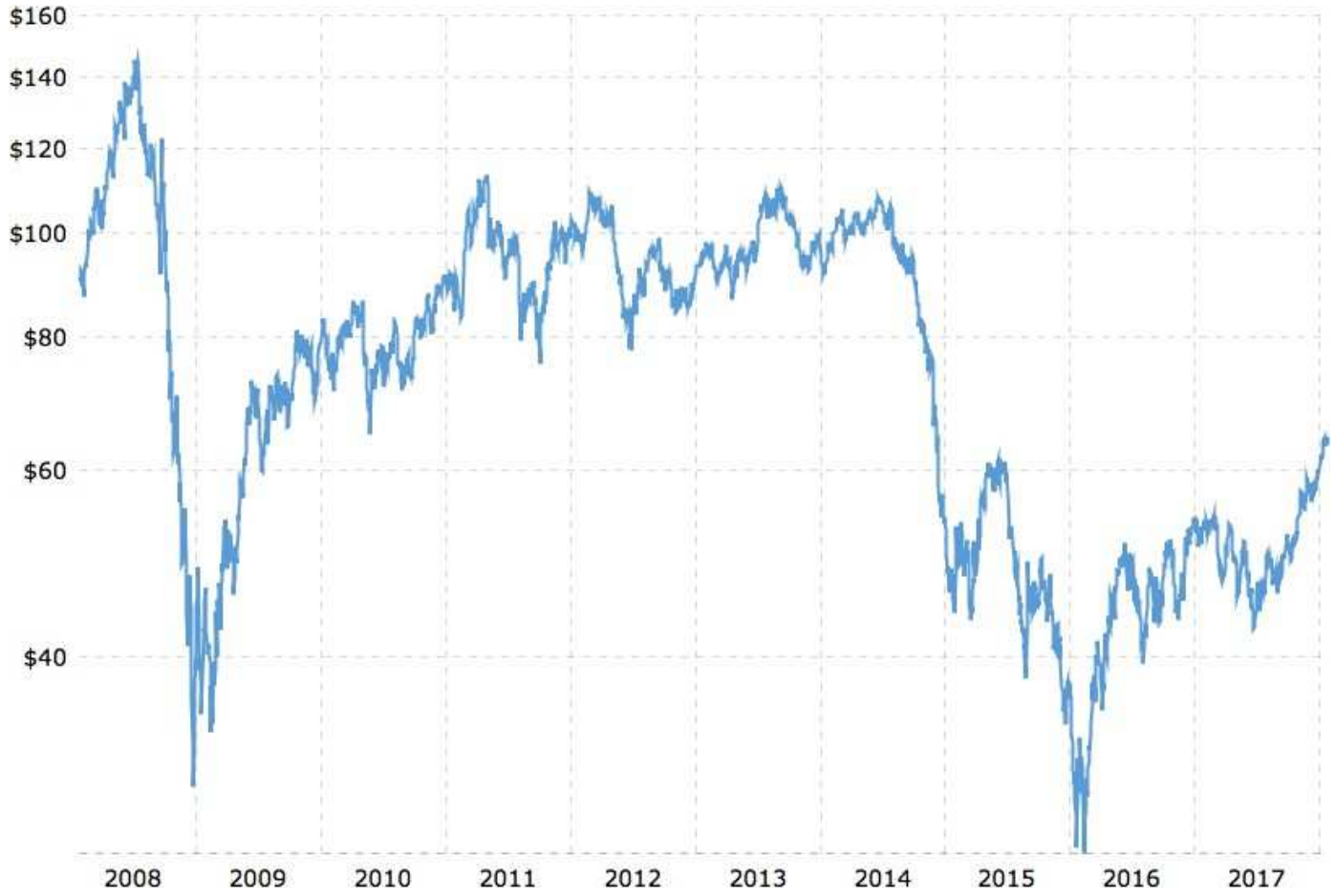
Chapter 2
Demand and Supply Analysis

Outline

1. Competitive Markets
   - Definition
   - Assumptions of the model
2. The Market Demand Curve
3. The Market Supply Curve
4. Competitive Market Equilibrium
5. Elasticity

Monthly Crude Oil Prices in US dollars



Oil Market
Why do oil price fluctuate?

1. Fall in Demand
   - Weak economic activity
   - Increased efficiency
   - Substitute toward other fuels
2. Geopolitical Reasons
   - Middle East trying to fold market to keep prices low to make it hard for substitutes
   - Wars in middle east
3. Increase Production in America
   - Decreased oil imports to become more “energy independent”

Competitive Markets

Definition: Markets were sellers and buyers are small and numerous, so they take the market price as given when they decide how much to buy and sell.

Competitive Market Assumptions

1. **Fragmented market:** many buyers and sellers
   - Implies buyers and sellers are price takers
2. **Undifferentiated Products:** consumers perceive the product to be identical so don't care who they buy it from
3. **Perfect Information about price:** consumers know the price of all sellers
4. **Equal Access to Resources:** everyone has access to the same technology and inputs.
   - Free entry into the market, so if profitable for new firms to enter into the market they will

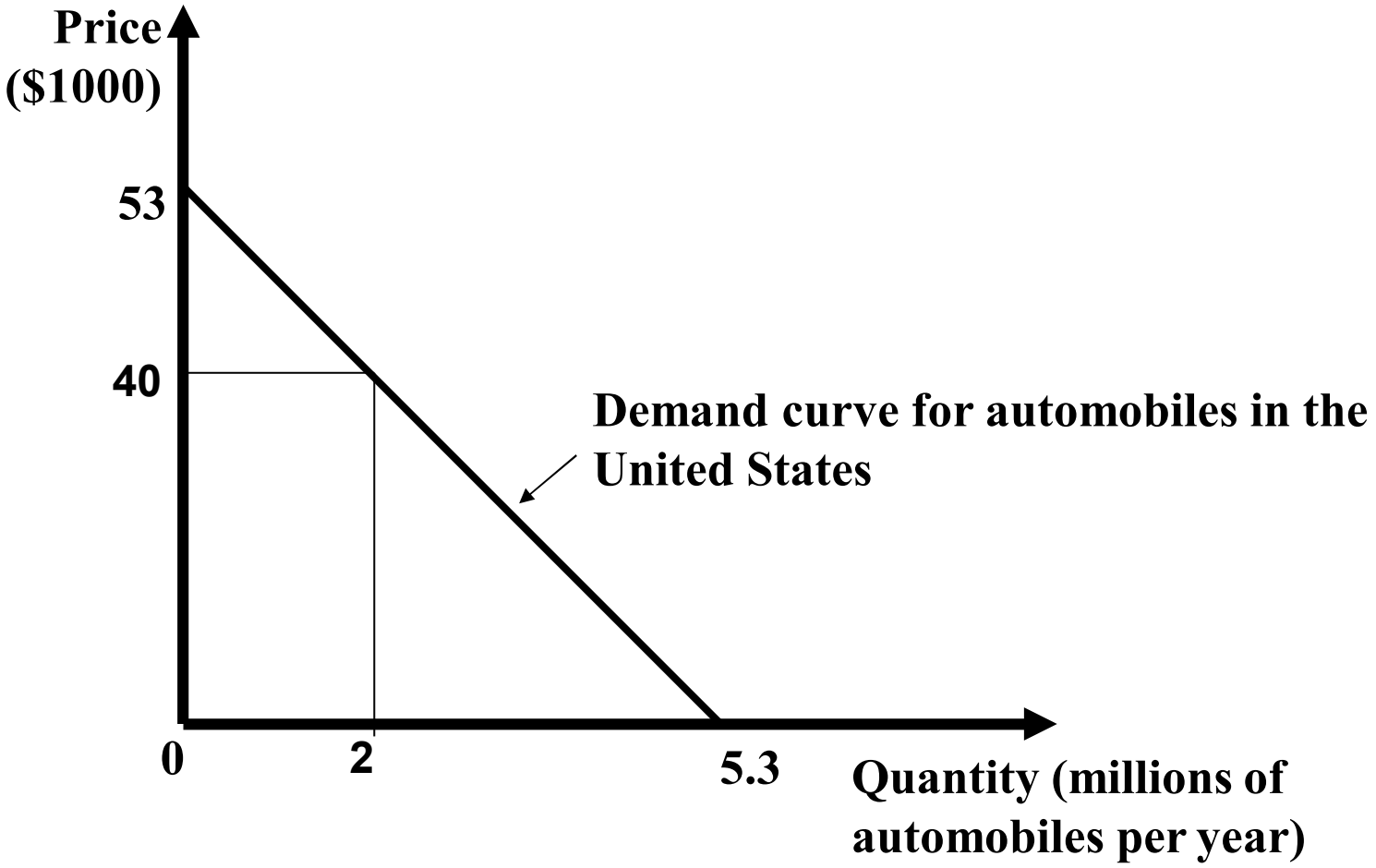
Market Demand

- Market Demand function: Tells us how the quantity of a good demanded by the sum of all consumers in the market depends on various factors.
  - $Q^d = Q(p, p_o, I, \ldots)$
- The Demand Curve: Plots the aggregate quantity of a good that consumers are willing to buy at different prices, *holding constant other demand drivers such as prices of other goods,* consumer income, quality.
  - $Q^d = Q(p)$
- Example – Market Demand for Automobiles in the United States

$$Q^d = 5.3 - 0.1P$$

Market Demand – Example

Demand for New Automobiles in the US



Market Demand

Note

- On a graph:
  - P, price, is ALWAYS on vertical axis and Q on horizontal axis.
- When writing out a demand function:
  - we write demand as Q as a function of P… If P is written as function of Q, it is called the inverse demand.
  - Demand Function: $Q^{d=}100-2P$
  - Inverse Demand Function: $P=50 - Q^{d}/2$

Market Demand

Law of Demand

- **Law of Demand** states that the quantity of a good demanded decreases when the price of this good increases.
  - Empirical regularity
- **The demand curve *shifts*** when factors other than own price change…
  - If the change increases the willingness of consumers to acquire the good, the demand curve shifts **right**
  - If the change decreases the willingness of consumers to acquire the good, the demand curve shifts **left**

Market Demand

Some Demand Shifters – What are some?

- Price of related goods (Substitutes / Complements
- Income
- Number of buyers
- Tastes
- Expectations

Market Demand
Rule

- A movement **along** the demand curve for a good can only be triggered by a change in the price of that good.
  - We assume everything else but price is held fixed
- Any change in another factor that affects the consumers' willingness to pay for the good results in a **shift** in the demand curve for the good

Market Supply

Market Supply Function: Tells us how the quantity of a good supplied by the sum of all producers in the market depends on various factors.

$$Q^s = Q(p, p_o, w, r \ldots)$$

P_o = price of other goods,

w= wage rate, r=rental rate

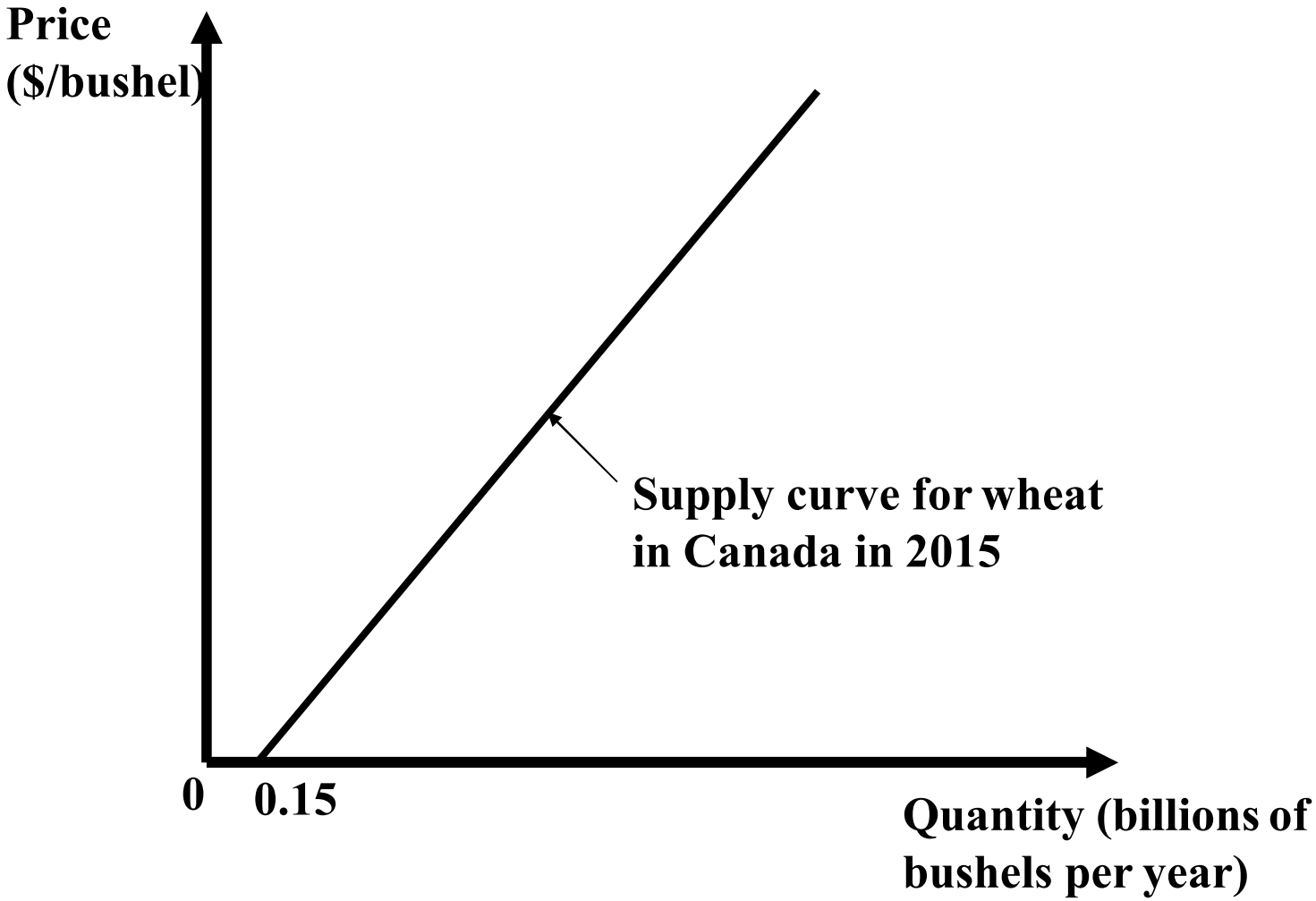
Market Supply Curve: Plots the aggregate quantity of a good that will be offered for sale at different prices.

$$Q^s = Q(p)$$

Example – Market Supply for wheat in Canada

$$Q^s = 0.15 + P$$

Market Supply
E.g. Supply Curve for Wheat in Canada



Market Supply

- The **Law of Supply** states that the quantity of a good offered increases when the price of this good increases.
  - Empirical regularity
- The supply curve **shifts** when factors other than own price change…
  - If the change increases the willingness of producers to offer the good at the same price, the supply curve shifts **right**
  - If the change decreases the willingness of producers to offer the good at the same price, the supply curve shifts **left**

Market Supply

Supply Shifters

- Price of related products
- Input prices
- Number of sellers
- Technology
- Expectations

Market Supply
Rule

- A move **along** the supply curve for a good can only be triggered by a change in the price of that good.
- Any change in another factor that affects the producers' willingness to sell the good results in a **shift** in the supply curve for the good.

Market Supply
E.g. Canadian Wheat

Supply Curve: $Q^S = p + .05r$

- Q^S = quantity of wheat (billions of bushels)
- p = price of wheat (dollars per bushel)
- r = average rainfall in western Canada,May – August (inches per month)

Questions:

1. What is the quantity of wheat supplied at price of $2 and rainfall of 3 inches per month?
   - 2.15

Market Supply
E.g: Canadian Wheat

$Q^S = p + .05r$

2. How do you write the supply curve if rainfall is 3 inches per month?

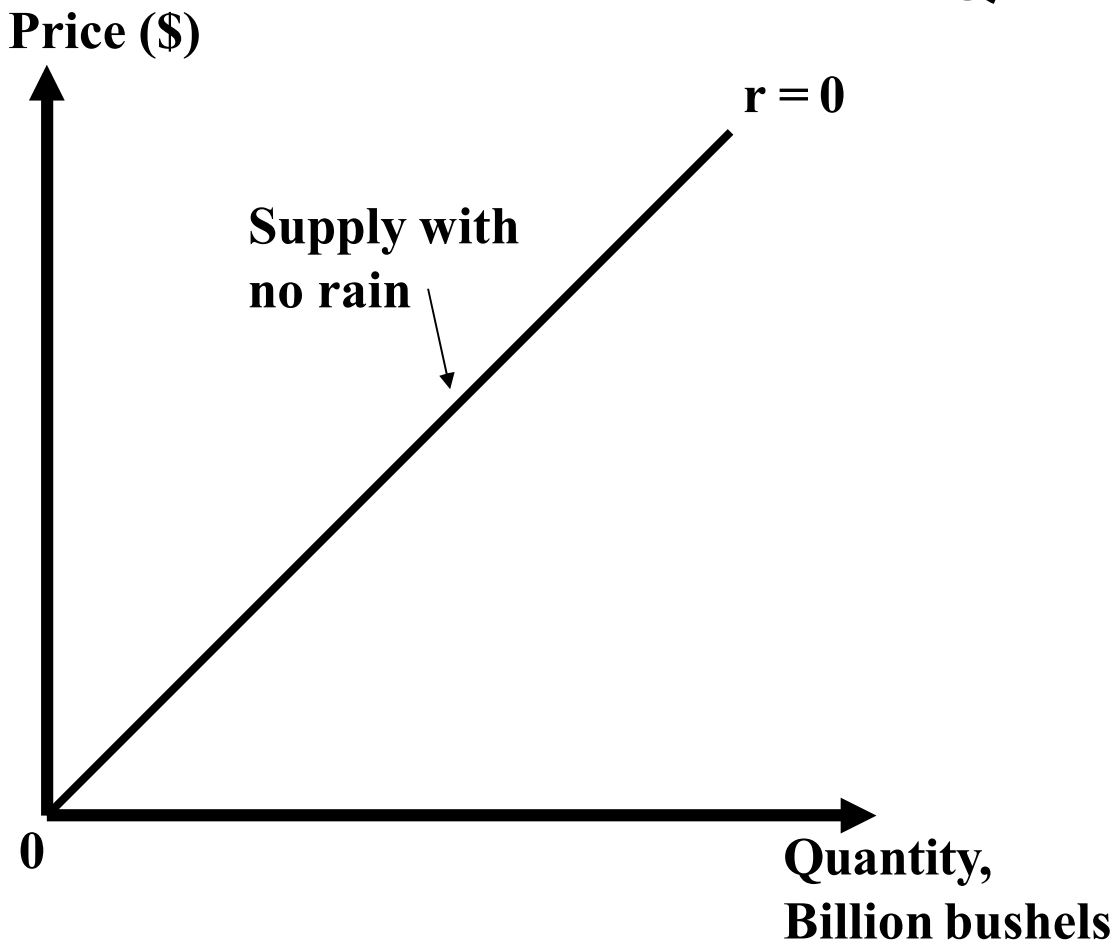
$$Q^S = p + 0.5(3)$$

$$Q^S = p + 0.15$$

3. As rainfall increases how does it shift the supply curve? (e.g., r = 4 => Q = p + 0.2)
   - To the right

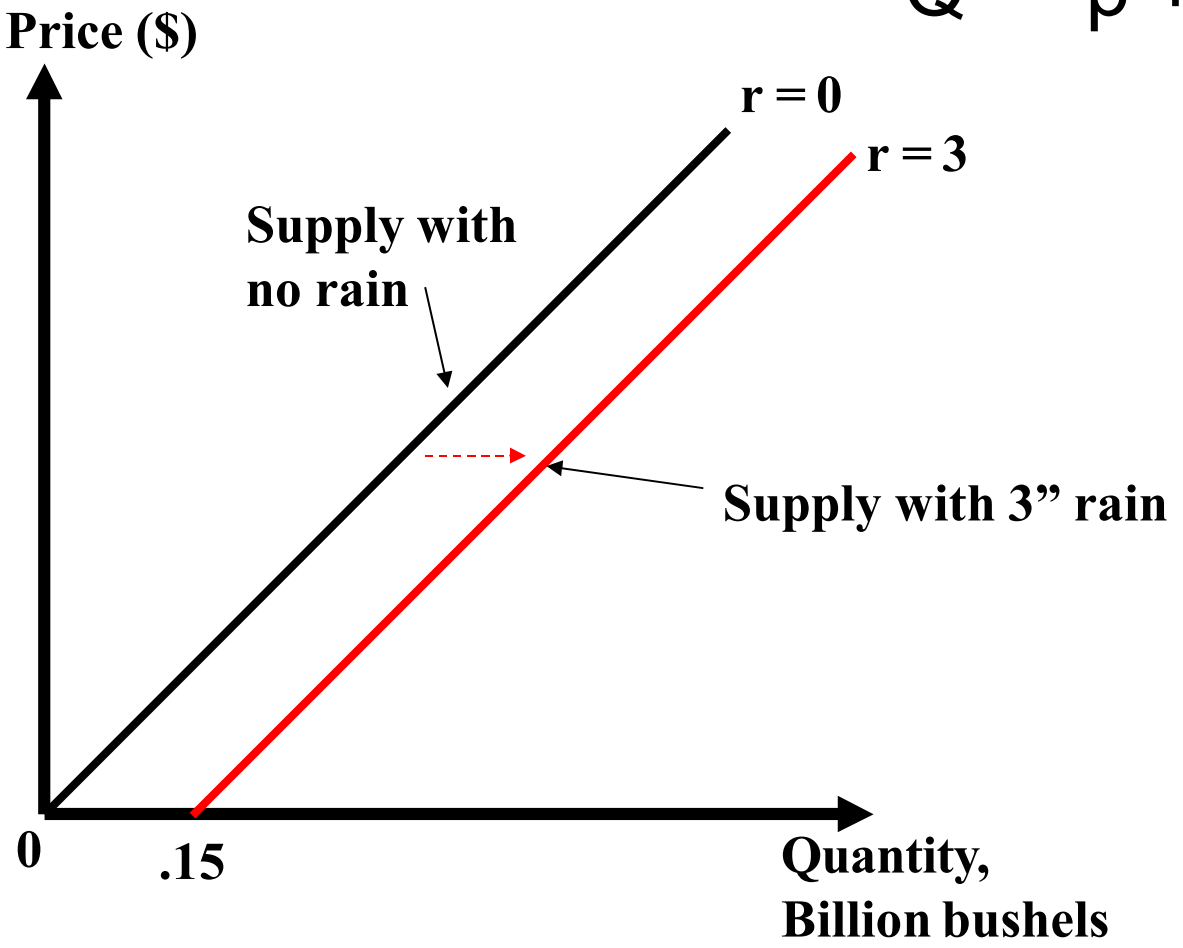
Market Supply
E.g: Canadian Wheat

$$Q^S = p + .05r$$



Market Supply
E.g: Canadian Wheat

$$Q^S = p + .05r$$

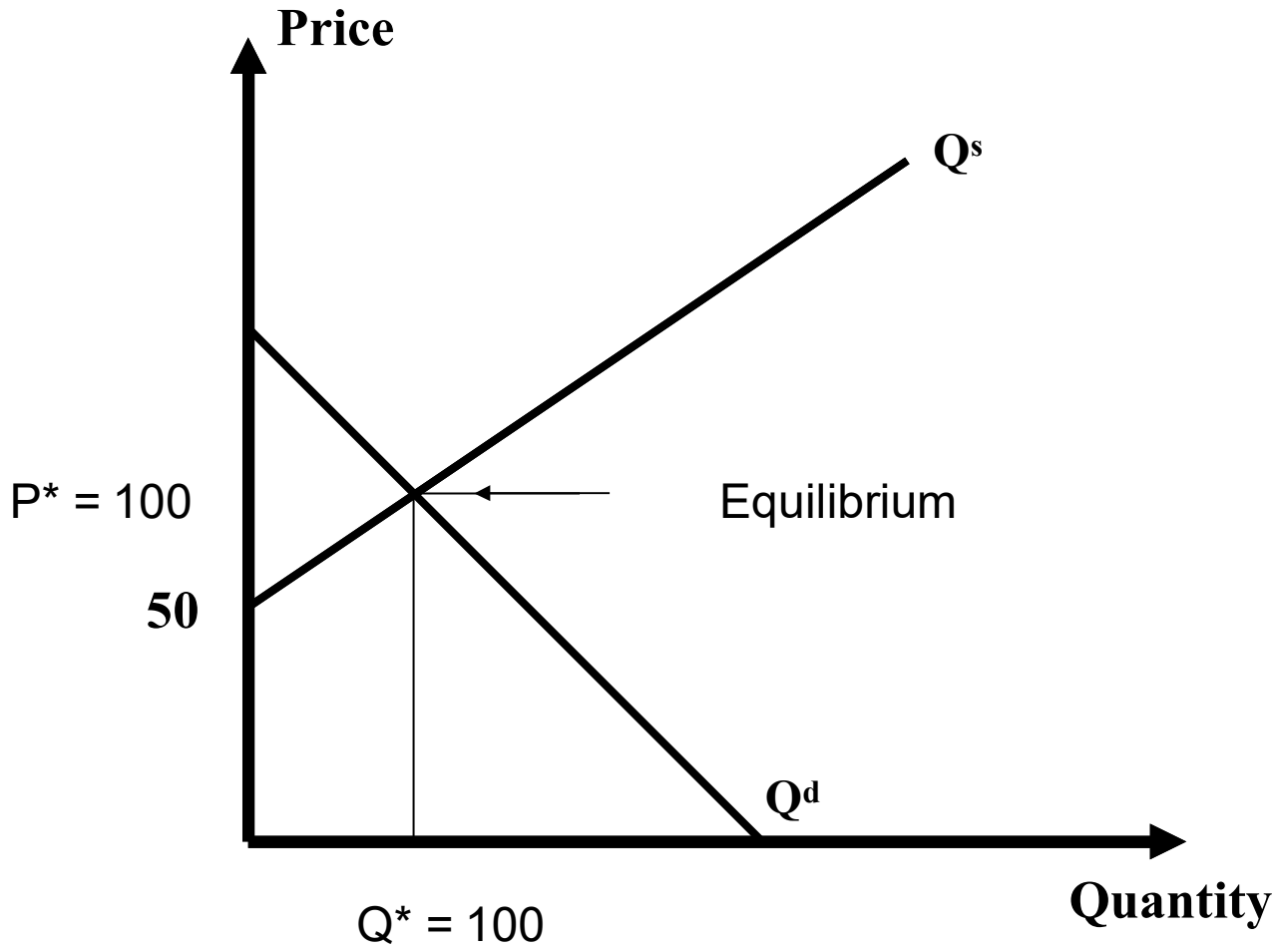


Market Equilibrium

Definition: A **market equilibrium** is a price such that, at this price, the quantities demanded and supplied are the same.

Demand and supply curves intersect at equilibrium

Competitive Market Equilibrium



Market Equilibrium

Practice: Finding Equilibrium Price and Quantity for Cranberries

Set-Up:

$Q^d = 500 - 4p$

$Q^S = -100 + 2p$

- p = price of cranberries (dollars per barrel)
- Q = demand or supply in millions of barrels per year

Questions:

1. Find the equilibrium price of cranberries?

Clicker question

What is the P and Q in equilibrium if the market demand and supply is like below

$Q^d = 500 - 4p$

$Q^S = -100 + 2p$

A. Q=100 and P=50

B. Q=100 and P=100

C. Q=50 and P=50

D. Q=50 and P=100

Market Equilibrium

Practice: Finding Equilibrium Price and Quantity for Cranberries

- Step 1: Set supply equal to demand ($Q^d = Q^s$)

$$500 - 4p = -100 + 2p$$

- Step 2:Now solve for P:

$$600=6P^*$$

$$P^* = \$100$$

- Step 3: Plug P* back into either Q^d **OR** Q^s
  - Plugging into Q^d: 500-4(100)=100
  - Plugging into Q^s: -100+2(100)=100
  - Q*=100

Market Equilibrium

Practice: Finding Equilibrium Price and Quantity for Cranberries

Now lets see how to graph supply and demand

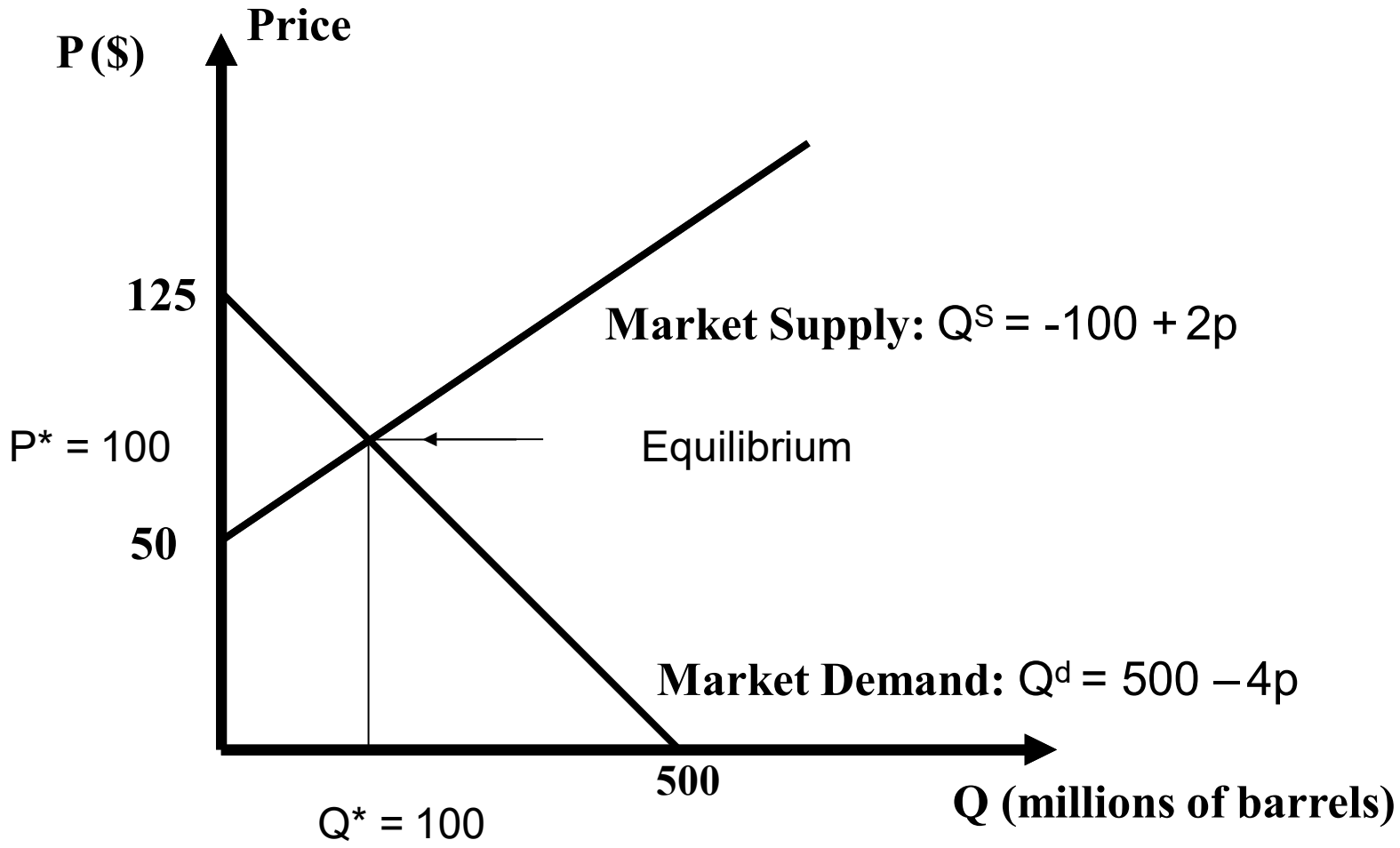
- Some folks like to rewrite so Q is on the RHS (inverse demand or supply function)

$$Q^d = 500 - 4p \text{ OR } p = 125 - Q^d/4$$

$$Q^S = -100 + 2p \text{ OR } p = 50 + Q^S/2$$

- But, I like to find the intercepts when I know I have a straight line …
  - if $Q^d = 0$ $p = 125$, if $p = 0$ $Q^d = 500$
  - If $Q^S = 0$ then $P = 50$

Practice: Finding Equilibrium Price and Quantity for Cranberries



Elasticity – now we will learn about rubber bands well kind of ….

What is Elasticity?

- Tells us how much one variable changes (in percent terms) with a 1 percent change in a different variable. The change can be an increase or a decrease.
- Elasticity, $\epsilon_{\#,\%} = \frac{\%\,()*+,-\ \#}{\%\,()*+,-\%} = \frac{.+/0,-+0123*4}{.50,-+0123*4}$
- **Examples**
  - How much quantity demand changes with an increase in price
  - How much output changes with a decrease in capital
  - How much wages change with an increase in labor

Elasticity

Some elasticity get special names and attention

Elasticity of Demand (own price elascity of demand): A measure of the rate of change in the quantity demanded with respect to price, holding all other determinants of demand constant.. In other words, it is the percent change in quantity demand from a 1 percent change in price.

$$\epsilon_{6/,7} = \frac{percent\ change\ in\ quantity}{percent\ change\ in\ price} = \frac{\%\ \triangle Q^d}{\%\ \triangle P}$$

Where Q^d is a demand function.

Elasticity continued

- ***How do we calculate it?*** I'm not good at memorizing so I start with the definition on the last page

$$\epsilon_{6/,7} = \frac{\%\ \triangle Q^d}{\%\ \triangle P}$$

$$\epsilon_{6/,7} = \frac{\triangle Q^d/Q}{\triangle P/\mathrm{P}}$$

$$\epsilon_{6/,7} = \frac{\triangle Q^d}{\triangle P}\frac{P}{Q^d}$$

$$\boldsymbol{\epsilon_{Q^d,P} = \frac{\partial Q^d}{\partial P}\frac{P}{Q^d}}$$

Elasticity: examples

$$\frac{\%\otimes Q^d}{\%\otimes P} = \frac{\otimes Q / Q}{\otimes P / P} = \frac{\partial Q^d}{\partial P} * \frac{P}{Q}$$

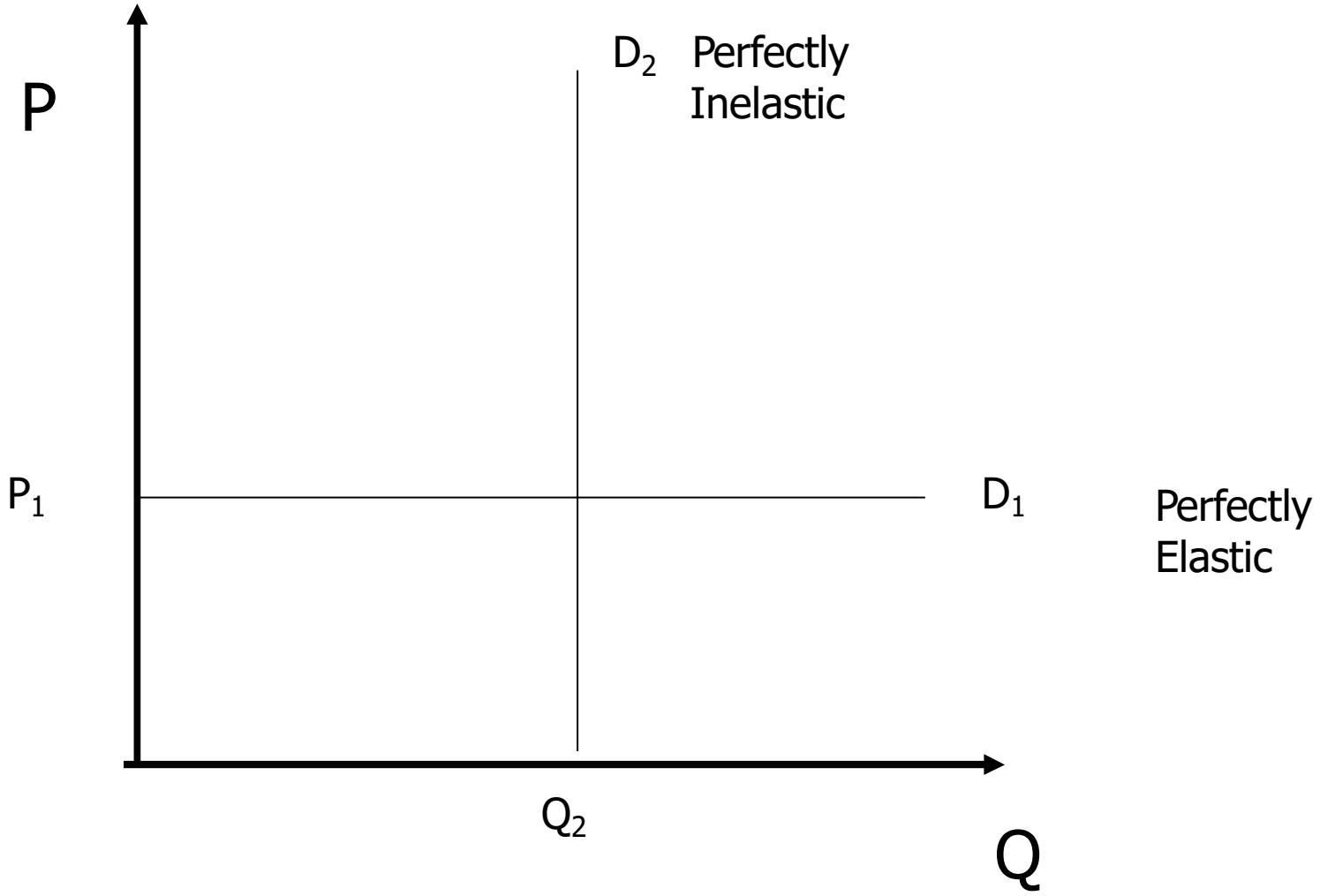
But we have to know what this means – explain it in plain English.

- E.g. elasticity = -2 (imagine it is -2/1)
  - If the price goes up by 1 percent demand will be reduced by 2 percent
- E.g. elasticity = -0.5 (imagine it is 0.5/1)
  - If the price goes up by 1 percent demand will be reduced by .5 percent percent.

How do we classify elasticity? ….think rubber bands

- When a one percent change in price leads to a *greater than* one-percent change in quantity demanded, the demand curve is **elastic**. ($\varepsilon_{Q,P} < -1$)
  - In general elastic if ($\varepsilon > |1|$)
- When a one-percent change in price leads to a *less than* one-percent change in quantity demanded, the demand curve is **inelastic**. ($0 \geq \varepsilon_{Q,P} > -1$)
  - In general inelastic if ($\varepsilon < |1|$)
- When a one-percent change in price leads to an *exactly* one-percent change in quantity demanded, the demand curve is **unit elastic**. ($\varepsilon_{Q,P} = -1$)
  - In general unit elastic if ($\varepsilon = |1|$)

How Elastic are These Curves?



Elasticity Estimates: Price Elasticity of Demand for Selected Grocery Products

Category	Estimated $\varepsilon_{Q,P}$
Soft Drinks	-3.18
Canned Seafood	-1.79
Canned Soup	-1.62
Cookies	-1.6
Breakfast Cereal	-0.2
Toilet Paper	-2.42
Laundry Detergent	-1.58
Toothpaste	-0.45
Snack Crackers	-0.86
Frozen Entrees	-0.77
Paper Towels	-0.05
Dish Detergent	-0.74
Fabric Softener	-0.73

Which products is demand elastic and which is demand inelastic?

Elasticity Versus Slope

- **Slope:** is the ratio of absolute changes in quantity and price. (= $\Delta Q/\Delta P$).
  - Measures the absolute change in quantity demanded (in units of quantity) due to a one-unit change in price.
  - $Q^d=a-bP$
    - a is the intercept, -b is the slope
- **Elasticity:** is the ratio of relative (or percentage) changes in quantity and price.
  - Measure percentage change in quantity demanded due to one-percent change in the price of the good

Elasticity Versus Slope

- Why elasticity is more useful?
  - it is unitless so allows us to easily compare across countries and goods
    - Units of quantities will be different for different goods. How to compare snow boards to oranges.
    - Prices are different across different countries. More difficult to compare Euro to US $

What Affects Elasticity?

- Availability of Substitutes:
  - Demand is more(less) elastic when there are more(fewer) substitutes for a product.
  - E.g: Demand for all beverages less elastic than demand for Coca-Cola
    - There are substitute for Coca-Cola, drink Pepsi
    - It is harder to find a substitute for soda if you love soda.
- % of Income Spent on Product
  - Demand is more(less) when the consumer's expenditure on the product is large(small)
- Necessity Products
  - The demand is less price elastic when the product is a necessity
- Market Level vs Brand-Level Price
  - Demand tends to be more elastic for a particular brand of a good, than for the good in general

Linear Demand

Slope, choke price, elasticity

General Form: $Q^d = a - bp$

- a, b are positive constants
- p is price

Notice that:

- b is the **slope**
- a/b is the **choke price:** price at which quantity demanded is zero
  - Set Q=0 and solve for P
  - Solve for inverse demand (intercept): $P=a/b-Q^d/b$

Linear Demand Curve

Slope, choke price, elasticity

- Elasticity is:

$$\varepsilon_{Q,P} = (\Delta Q/\Delta p)(p/Q) \quad \textit{…definition…}$$

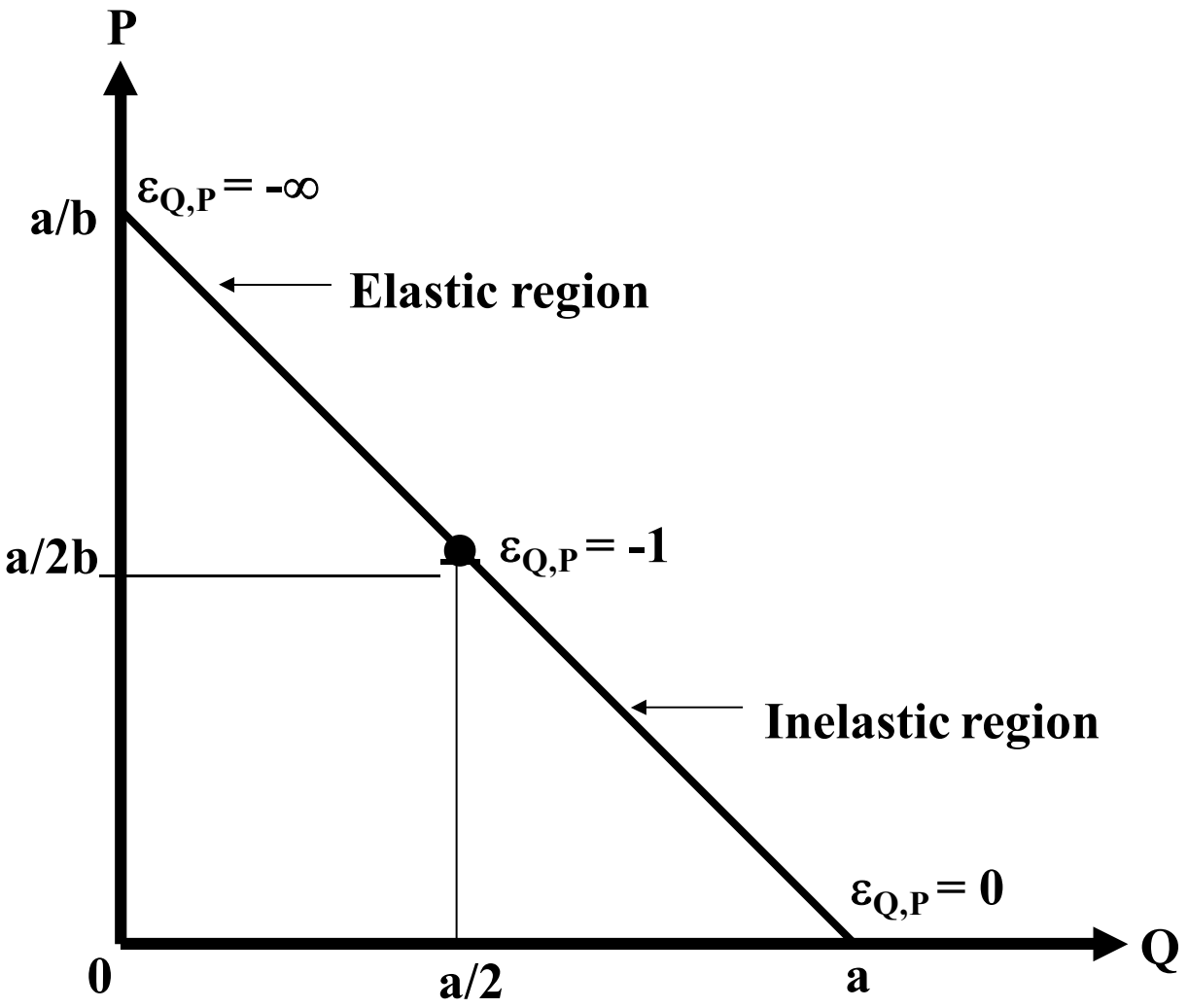
$$= -b(p/Q)$$

Note that:

- When Q=0, elasticity is $-\infty$
- When p=0, elasticity is 0

- so…elasticity falls from 0 to $-\infty$ along the linear demand curve, but slope is constant.

Elasticity with a Linear Demand Curve



Problem: Determining Elasticity

Linear demand curve

if $Q^d = 400 - 10p$, and $p = 30$, what is the elasticity of demand w.r.t own price?

$$\varepsilon_{Q,P} = (-b)(P)/(Q)$$

$$Q = 400 - 10\,(30) = 100$$

$$\varepsilon_{Q,P} = (-10)(30)/(100) = -3 \quad \textit{"elastic"}$$

Or use calculus

$$\frac{\partial Q^d}{\partial P} * \frac{P}{Q^d} = -10 * \frac{30}{400 - 10P} = -10 * \frac{30}{400 - 10(30)} = -3$$

- Why is elasticity negative?
  - demand curve downward sloping.

Problem: Determining Elasticity

Constant elasticity demand curve

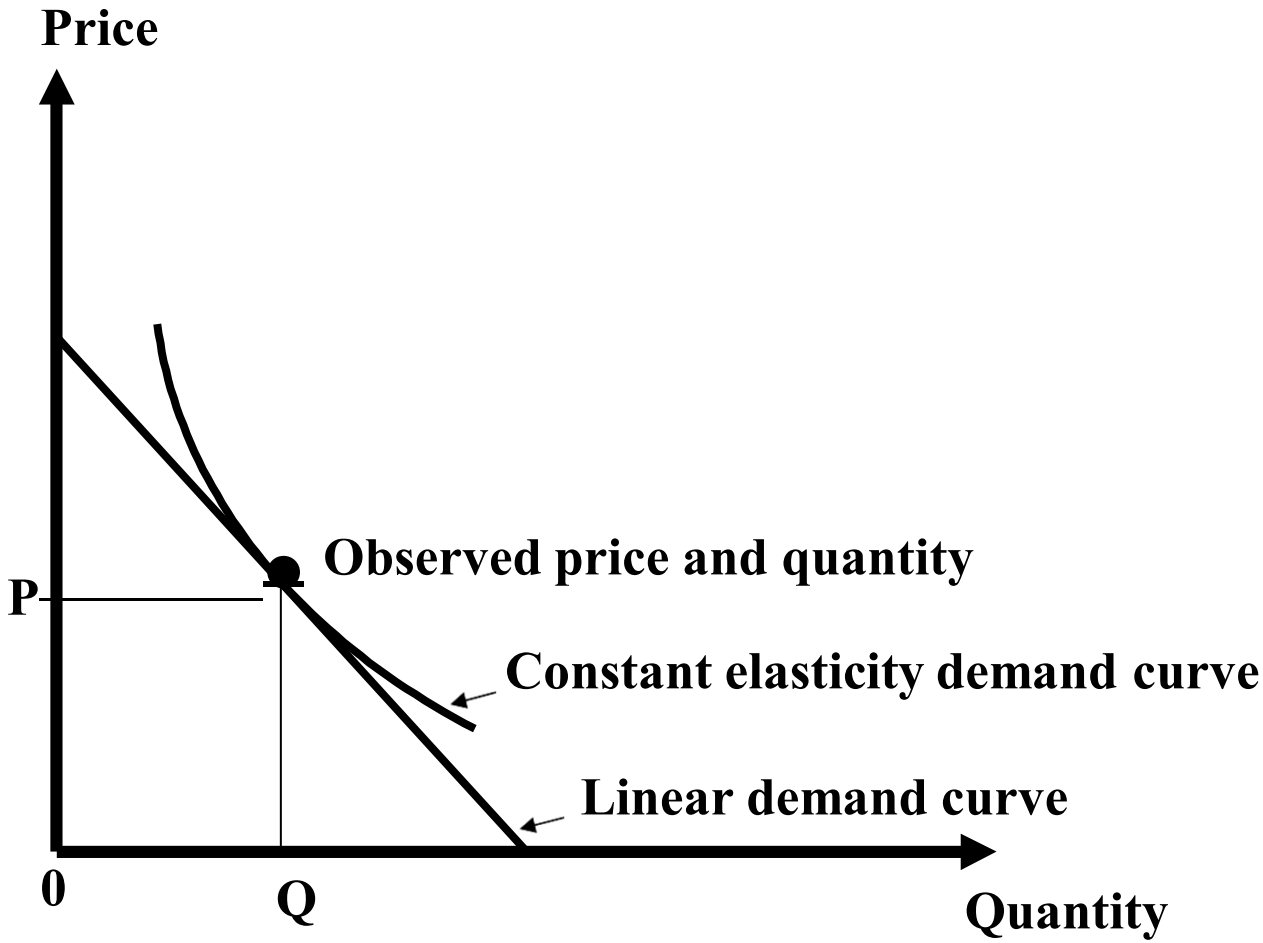
Constant Elasticity Fn (general form): $Q^d = Ap^{\varepsilon}$

- ε = elasticity of demand and is negative
- p = price
- A = constant

Example: *If demand can be expressed as QP = 100, what is the price elasticity of demand?*

- $Q=100P^{-1}$, so elasticity is -1

Constant Elasticity Demand Curve



Importance of Brands

Model	Price	Estimated $\varepsilon_{Q,P}$
Mazda 323	$5,039	-6.358
Nissan Sentra	$5,661	-6.528
Ford Escort	$5,663	-6.031
Lexus LS400	$27,544	-3.085
BMW 735i	$37,490	-3.515

- Demand for individual models is highly elastic
- Market-level price elasticity of demand for automobiles -1 to -1.5
- Compact automobiles have lots of substitutes Luxury cars have less substitutes
  - ➢ Demand for compact cars more elastic than luxury cars.

Example: Price Elasticities of Demand for Automobile Makes, 1990.

Other Common Types of Elasticities

- Other Elasticities -- Elasticity of "X" with respect to "Y": $(\Delta X/\Delta Y)(Y/X)$
  - X and Y could be anything
- **Price elasticity of supply:** $(\Delta Q^S/\Delta p)(p/Q^S)$
  - measures curvature of supply curve
- **Income elasticity of demand:** $(\Delta Q^d/\Delta I)(I/Q^d)$
  - measures degree of shift of demand curve as income changes.
- **Cross price elasticity of demand:** $(\Delta Q^d/\Delta P_o)(P_o/Q^d)$
  - measures degree of shift of demand curve when the price of a substitute changes

The Cross-Price Elasticity of Cars

		PRICE			
		Sentra	**Escort**	**LS400**	**735i**
Demand	**Sentra**	-6.528	0.454	0.000	0.000
	Escort	0.078	-6.031	0.001	0.000
	LS400	0.000	0.001	-3.085	0.032
	735i	0.000	0.001	0.093	-3.515

Practice Questions:

- What is the cross price elasticity of demand of the Sentra with respect to Escort?
  - 0.454
- If the price of the Escort increases by 10 %, what will happen to the demand for the Sentra?
  - The demand for Sentra will increase by 4.54 %

Elasticities of Demand for Coke/Pepsi

Elasticity	Coke	Pepsi
Price elasticity of demand	-1.47	-1.55
Cross-price elasticity of demand	0.52	0.64
Income elasticity of demand	0.58	1.38

Practice Question:

- What will happen to the demand for coke if income increases by 10%?
  - If income increases by 10%, the demand for coke will increase by 5.8%

Part IV. Pricing strategies and market

Chapter 8. Group pricing and personalized pricing

Case. How to sell this book?

- Suppose it's the only IO book on the market
  - Profits we can make depend on
    - *Information* we have on consumers
    - *Instruments* we can use to design tariffs
  - If limited information and instruments
    - Only available strategy: uniform price
  - If more information → **price discrimination**
    - Ideally, know exactly what each consumer is willing to pay
    - If not, identify characteristics related to willingness to pay and segment market into several groups
      (e.g., US market vs. European market)
      → **Personalized and group pricing** (Chapter 8)

Case. How to sell this book? (cont'd)

- If more information → price discrimination (cont'd)
  - If no identifiable characteristics, design different versions and induce consumers to self-select
    (e.g., hard-back vs. paperback)
    → Menu pricing (Chapter 9)
- If more instruments → several possibilities
  - Sell different versions (menu pricing)
  - Sell at different prices over time
    (e.g., discount future prices, condition prices on purchase history)
    → Intertemporal pricing (Chapter 10)
  - Set a special price for a bundle of product
    (e.g., book + instructor manual + CD-rom with slides and exercises)
    → Bundling and tying (Chapter 11)
- More information & more instruments → higher profits

Case. How to sell this book?

(cont'd)

What if other IO books on the market?

- More information or more instruments *don't necessarily translate into more profits*.
- Why?
  - Competitors can use the same strategies.
  - Competition can be exacerbated for some groups of consumers.
- We study
  - Effects of imperfect competition
  - Impacts on welfare

Chapter 8. Learning objectives

- Be able to distinguish between the 3 types of price discrimination.
- See how personalized and group pricing allow a monopolist to extract more consumer surplus and, thereby, to increase profits.
- Understand how to set different prices for different groups.
- Understand that in oligopoly settings, the positive surplus extraction effect of price discrimination may be outweighed by a negative competition enhancing effect.

Definition

- 2 varieties of a good are sold (by the same seller) to 2 buyers at different net prices
  - Net price = price (paid by the buyer) – cost associated with product differentiation
- Feasibility?
  - Market power
  - No arbitrage
    - Consumers find it impossible or too costly
    - 'Physical arbitrage' → transfer of the good itself between consumers
    - 'Personal arbitrage' → transfer of demand between different packages aimed at different consumers (see Chapter 9)

Typology

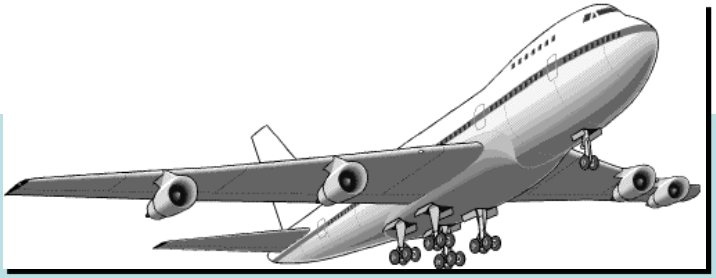
Information that seller has about consumers' willingness to pay

perfect

limited

- **Personalized pricing** (1st degree)
  - Individualized price for each unit purchased by each buyer → *full surplus extraction*
- **Group pricing** (3rd degree)
  - Segmentation based on indicators related to consumers' preferences → *different prices per group*
- **Menu pricing** (2nd degree)
  - No observable indicators → *use of self-selecting devices* (target a specific package for each class of buyers)
- **Uniform price**

Case. Airline fares



- Favorable context
  - Great heterogeneity across consumers
  - Limited arbitrage opportunities
  - Negligible marginal cost (up to capacity)
- Discount fares based on restrictions
  - Restrictions fostering self-selection
    - Purchase in advance, Saturday-night stayover, surcharge for one-way tickets, ...
  - Restrictions based on observable characteristics
    - Family, age, students
- Strategy of low cost carriers
  - Eliminate above restrictions (except intertemporal pricing)
  - New form of geographical group pricing (see Chapter 9)

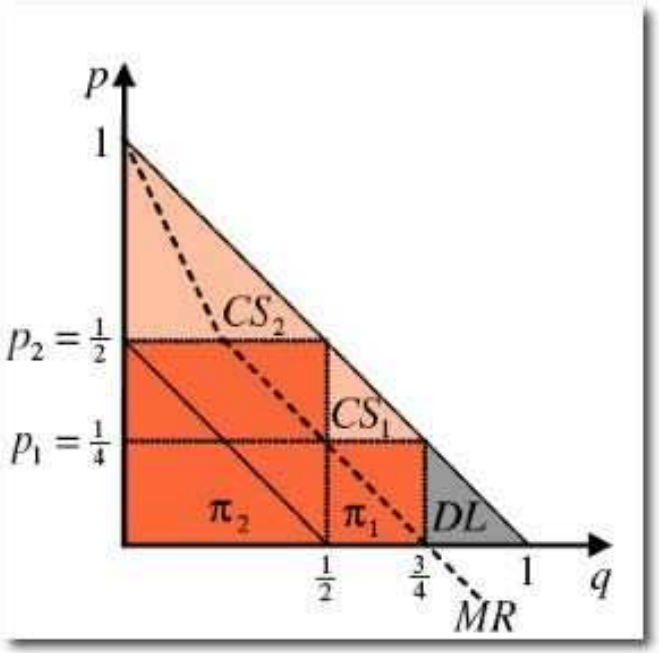
Group & personalized pricing in monopoly

- Monopolist ↑ profits when it obtains more refined information about consumers' reservation prices
- Model
  - Unit mass of consumers with unit demand
  - Valuation θ uniformly distributed over $[0,1]$
  - Buy if $\theta \geq p \rightarrow$ demand: $q = 1 - p$
  - Zero marginal cost; profits: $p\,(1 - p)$
  - If uniform price: $p^u = 1/2,\ \pi^u = 1/4,\ CS^u = 1/8,\ DL^u = 1/8$
  - Not satisfactory:

Group & personalized pricing in monopoly (cont'd)

- Refined information
  - Partition $[0,1]$ into N subintervals of equal length
  - Monopolist knows from which group each consumer comes & can charge a different price for each group
  - Take N = 2
    - $[0,1/2] \rightarrow q_1 = 1/2 - p_1$
    - $[1/2,1] \rightarrow q_2 \in \arg\max\{\pi, 1 - p_2\}$

$$\pi(2) = \frac{1}{4} + \frac{1}{16} > \pi^u$$
$$CS(2) = \frac{1}{8} + \frac{1}{32} > CS^u$$
$$DL(2) = \frac{1}{32} < DL^u$$



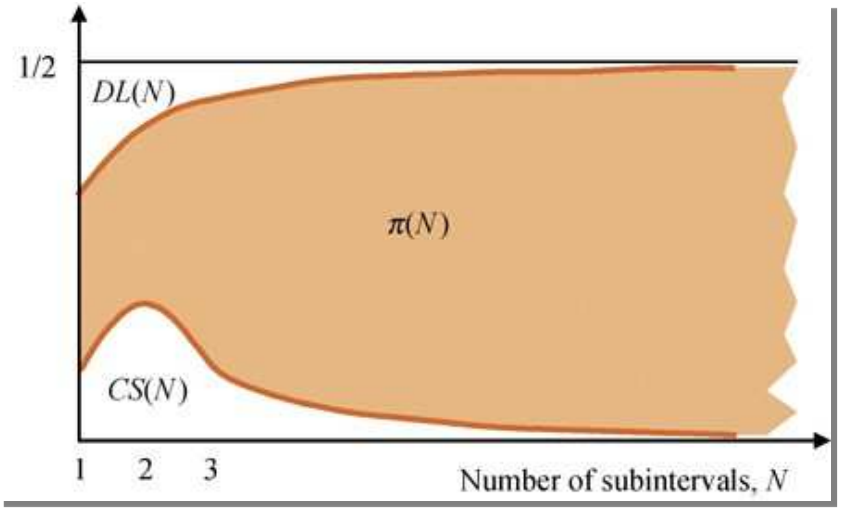
Group & personalized pricing in monopoly (cont'd)

- Refined information (cont'd)
  - N subintervals

$$\pi(N) = \frac{1}{2} - \frac{2N-1}{4N^2}$$

$$CS(N) = \frac{4N-3}{8N^2}$$

$$DL(N) = \frac{1}{8N^2}$$



- **Lesson**: If information about consumers' reservation prices ↑, monopolist ↑ profits. Under personalized prices, monopolist captures entire surplus and deadweight loss vanishes.

Group pricing and localized competition

- Extension of Hotelling model
  - 2 firms (MC $= 0$) located at extreme points of $[0,1]$
  - Mass 1 of consumers uniformly distributed on $[0,1]$
  - Utility of consumer x (assuming linear transport costs):

$$r - \tau x - p_1 \text{ if she buys 1 unit of good 1,}$$
$$r - \tau(1-x) - p_2 \text{ if she buys 1 unit of good 2.}$$

  - Information (exogenously and freely accessible to both firms) partitions $[0,1]$ into N subintervals of equal length
    - Let $N = 2^k$, with $k = 0, 1, 2, \ldots$
    - k measures the quality of information

Group pricing and localized competition

(cont'd)

- 3-stage game
  1. Firms decide to acquire information of quality k or not
  2a. Firms choose their regular price
  2b. Firm(s) with information target(s) specific discount to consumer segments
- Pricing decisions (stages 2a and 2b) $\rightarrow$ 4 subgames
  - Neither firms acquires information
    - Same as linear Hotelling model (see Chapter 5)
    - $\pi^{NI,NI} = \tau/2$
  - Both firms acquire information
  - Firm i acquires information; firm j doesn't

Group pricing and localized competition (cont'd)

- Both firms acquire information
  - Prices set for segment m?

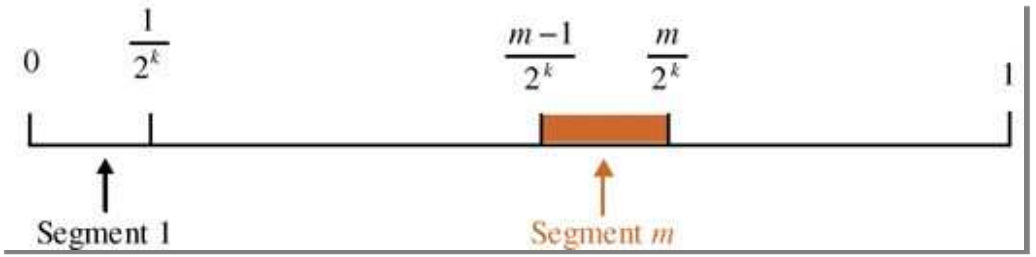
$$\max_{p_{1m}} \pi_{1m} = p_{1m}(\hat{x}_m - (m-1)/2^k)$$
$$\max_{p_{2m}} \pi_{2m} = p_{2m}(m/2^k - \hat{x}_m)$$
$$\text{with } \hat{x}_m = (\tau - p_{1m} + p_{2m})/(2\tau)$$

$$\Rightarrow p_{1m} = \frac{\tau(2^k - 2m + 4)}{3 \times 2^k}, \; p_{2m} = \frac{\tau(2m + 2 - 2^k)}{3 \times 2^k}$$
$$\rightarrow \hat{x}_m = \frac{2_k + 4m - 2}{6 \times 2^k}$$

  - Interior solution only for the two middle segments:

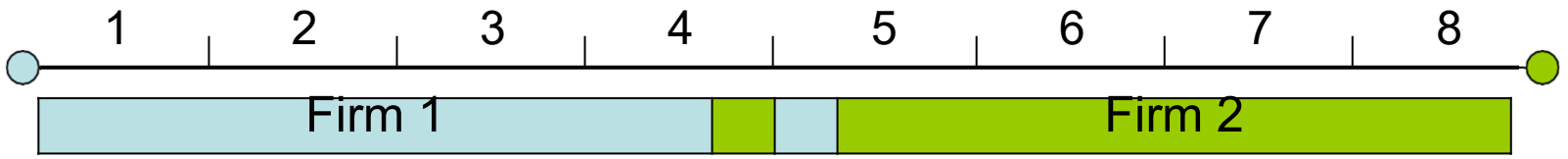
$$(m-1)/2^k < \hat{x}_m < m/2^k \Leftrightarrow 2^{k-1} - 1 < m < 2^{k-1} + 2$$

    - Poaching occurs in these 2 segments
    - Otherwise, closest firm gets the whole segment



Group pricing and localized competition (cont'd)

- Both firms acquire information (cont'd)
  - Example with $k = 3$ (8 segments)



- We can compute $\pi^{I,I}(k)$
- Properties
  - **U-shaped** $\rightarrow$ interplay between 2 effects of improved information: higher competition (dominates for low k) and surplus extraction (dominates for large k)

$\pi^{I,I}(k) < \pi^{NI,NI}(k) = \tau/2$ for all k

Group pricing and localized competition (cont'd)

- Only one firm acquires information
  - Equilibrium: asymmetric version of previous subgame
    - Suppose firm 1 has information
    - 3 groups of segments, from left to right
      - 1st group: firm 1 acts as a constrained monopolist
      - 2nd group: both firms have positive demand
      - 3rd group: firm 2 acts as a constrained monopolist
    - Differences with case where they both have information
      - 1st group is larger
      - Only firm 1 poaches consumers in 2nd group
    - Illustration with $k = 3$ (8 segments)

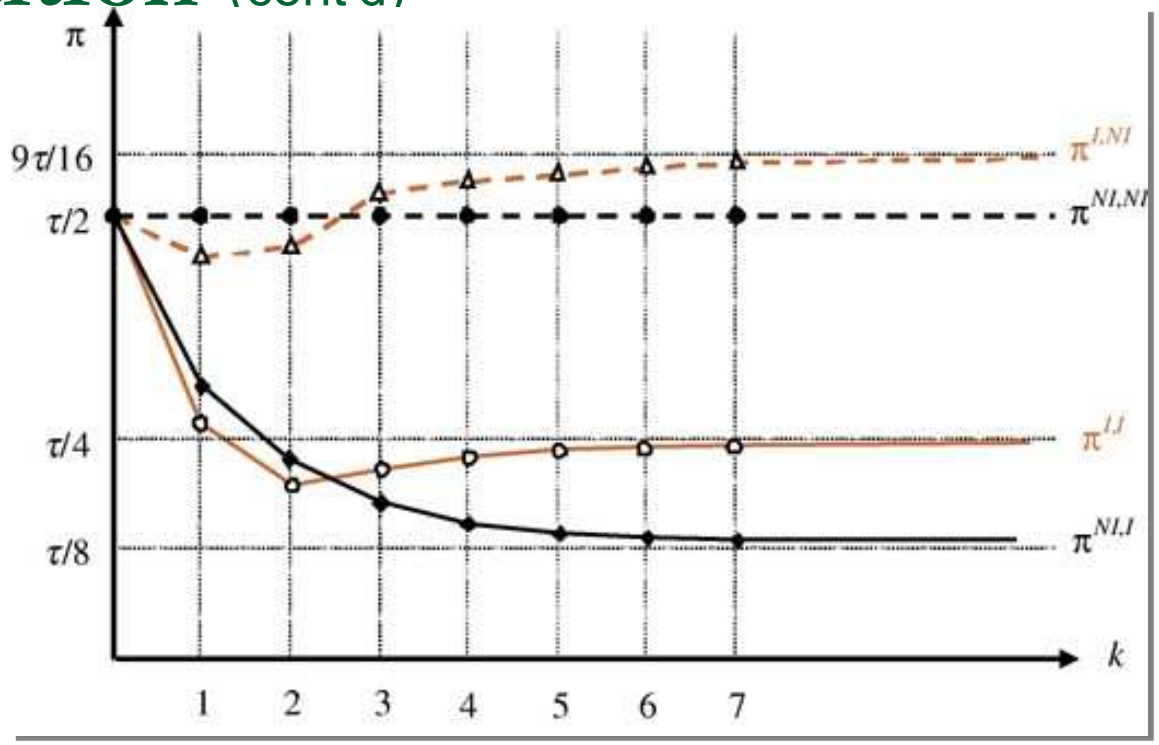
Group pricing and localized competition (cont'd)

- Only one firm acquires information (cont'd)
  - We can compute $\pi^{I,NI}(k)$ and $\pi^{NI,I}(k)$
  - Profits of informed firm are U-shaped
    - Same 2 effects as before
    - But, eventually, $\pi^{I,NI}(k) > \pi^{NI,NI}(k)$
  - Profits of uninformed firm ↓ with quality of information
- Information acquisition decision (stage 1)

	NI	I
NI	π^{NI}, π^{NI}	π^{NI}, π^{I}
I	π^{I}, π^{NI}	π^{I}, π^{I}

Group pricing and localized competition (cont'd)

- Information acquisition decision (cont'd)



- $k < 3 \rightarrow NI$ is a dominant strategy
- $k \geq 3 \rightarrow I$ is a dominant strategy $\rightarrow$ prisoner's dilemma

Group pricing and localized

- **Lesson**: In a competitive setting, customer-specific information impacts firms in 2 conflicting ways:
  - firms can extract more surplus from each consumer;
  - price competition is exacerbated.

  When the quality of information is sufficiently large, the former effect dominates the latter. Then, firms use the information and price discriminate at equilibrium. However, they may well be better off if they could jointly agree not to use information.

Personalized pricing and location decisions

- Two-stage game
  - Firms choose their location on the Hotelling line.
  - Firms compete with personalized prices (i.e., there is Bertrand competition in each and every location)
- Equilibrium
  - Price schedules at stage 2:
    - Firm with the lowest cost prevails → price = other firm's MC
    - Otherwise, price = firm's own MC

$$p_1^*(x) = p_2^*(x) = \max\left\{\tau|x-l_1|, \tau|x-l_2|\right\}$$

    - → π_1 = (total transportation cost of firm 2 as a monopolist) − (total transportation cost of the two firms together)

Personalized pricing and location decisions (cont'd)

- Equilibrium (cont'd)
  - Location at stage 1
    - To maximize profits, a firm must choose a location generating the largest decrease in total transportation costs.
    - $\rightarrow$ no deviation if both firms locate at the transportation cost minimizing points:

$$l_1^* = 1/4, \; l_2^* = 3/4$$

- **Lesson**: When both firms set personalized prices and locations are endogenous, firms choose the socially optimal locations.

Group pricing in monopoly: basic argument

- Extension of multi-product monopoly (see Chapter 2)
  - Monopolist can sell its product on k separate markets
  - $Q_i(p_i)$: distinct demand curve for market i
  - $C(q)$: monopolist's total cost (q: total quantity)
  - Monopolist chooses vector of prices to maximize

$$\Pi(p_1, p_2, \ldots, p_k) = \sum_{i=1}^{k} p_i Q_i(p_i) - C\left(\sum_{i=1}^{k} Q_i(p_i)\right)$$

  - For any i, markup is given by inverse elasticity rule:

$$\frac{p_i - C'(q)}{p_i} = \frac{1}{\eta_i} \rightarrow \text{if } \eta_i > \eta_j, \text{ then } p_i < p_j$$

- **Lesson**: A monopolist optimally charges less in market segments with a higher elasticity of demand.

Case. International price discrimination in the textbook market

- Differences in book prices, US vs. elsewhere (Cabolis *et al.*, 2006)
  - No difference for general audience books
  - Textbooks substantially more expensive in the US
- Why?
  - No cost factor (most textbooks are printed in the US)
  - $\rightarrow$ must be due to different demand elasticities
  - Demand less elastic in the U.S. because teachers require a single comprehensive textbook per course (not so much the tradition in European universities)
  - Arbitrage is prevented: *"International edition. Not for sale in the US"*

Oligopolistic international pricing

- Effects of competition?
  - Geographical price discrimination exists in oligopolistic industries (e.g., car industry; see Case 8.4)
  - **But**, strategic motives may lead firms to set a uniform price on all geographical segments.
  - Why?
    - Suppose firm active on several market segments.
    - Some segments are more competitive than others.
    - Commitment to set same price everywhere → price ↑ on competitive market segments → softened price competition → profits ↑ on these segments.
    - May outweigh benefit of adapting prices to local conditions.
    - (See specific model in book)

Case. Pricing by supermarkets in the UK

- Inquiry of UK Competition Commission
  - April 1999 to July 2000
- Among 15 leading supermarket groups
  - 8 priced uniformly
  - 7 adjusted prices to local conditions
    - For a limited number of products
    - Average level of difference between minimum and maximum prices for each product: 4.3 to 19.2%

Review questions

- In which industries do we observe group pricing? Provide two examples.
- Does an increase in competition lead to more or less (third-degree) price discrimination? Discuss.
- How does the ability to geographically price discriminate affect location decisions of firms?
- What is an empirical regularity concerning international price discrimination?

Part IV. Pricing strategies and market

Chapter 9. Menu pricing

Slides

Industrial Organization: Markets and Strategies

Paul Belleflamme and Martin Peitz

Chapter 9. Learning objectives

Learning objectives

- Be able to make a clear difference between menu pricing and group pricing.
- Understand how a monopolist sets menu prices and under which conditions menu pricing leads to higher profits than uniform pricing.
- Assess the welfare effects of menu pricing.
- Analyze quality- and quantity-based menu pricing in oligopolistic settings.

Menu vs. group pricing

- Group (and personalized) pricing
  - Seller can infer consumers' willingness to pay from observable and verifiable characteristic (e.g., age)
- Menu pricing
  - Willingness to pay = private information
  - Seller must bring consumer to reveal this information.
  - How?
    - Identify product dimension valued differently by consumers
    - Design several versions of the product along that dimension
    - Price versions to induce consumers' self-selection

      → **Menu pricing** (a.k.a. versioning, 2nd-degree price discrimination, nonlinear pricing)

      → *Screening problem*: uninformed party brings informed parties to reveal their private information

Case. Menu pricing in the information economy

- Versioning based on **quality**
  - 'Nagware': software distributed freely but displaying ads or screen encouraging users to buy full version
    → annoyance = discriminating device

- Versioning based on **time**
  - Books: first in hardcover, later in paperback
  - Movies: first in theaters, next on DVD, finally on TV.
    → price decreases as delay increases

- Versioning based on **quantity**
  - Software site licenses
  - Newspaper subscription
    → quantity discounts

Case. Geographical pricing by LCCs

- Low Cost Carriers have abandoned many of the price discrimination tactics of the airline industry
  - 'Point-to-point' tickets, 'no-frills' flights
- But, geographical price discrimination on their website (Bachis and Piga, 2006)
  - Example: London-Madrid flight
    - 1st leg for British traveller, fare offered in £
    - Return leg for Spanish traveller, fare offered in €
  - If booking occurs at same time and no price discrimination, then ratio of prices = exchange rate
  - Yet, difference of at least 7£ for 450 000 observations
  - Despite possibility of arbitrage.

Monopoly menu pricing

- Quality-dependent prices
  - Consumer's indirect utility when buying one unit of quality s at price p: $U(\theta, s) - p$ (utility $= 0$ if not buying)
  - U increases in s and in θ (taste parameter)
  - Suppose 2 types of consumers
    - 'Low type', in proportion λ, with taste parameter θ_1
    - 'High type', in proportion $1-\lambda$, with taste parameter $\theta_2 > \theta_1$
    - High types care more about quality than low types: $U(\theta_2, s) > U(\theta_1, s)$
    - High types value more any *increase* in quality than low types: $U(\theta_2, s_2) - U(\theta_2, s_1) > U(\theta_1, s_2) - U(\theta_1, s_1)$ for $s_2 > s_1$ $\rightarrow$ *Single-crossing property*
  - Monopolist can produce s_1 and s_2 at constant marginal costs c_1 and c_2.

Monopoly menu pricing (cont'd)

- Quality-dependent prices: a numerical example
  - Monopolist produces software in 2 versions:
    - Basic version and Pro version (higher quality, with advanced computing functionalities); $c_{basic} = c_{pro} = 0$
  - 120 potential consumers
    - λ universities (high type) and $120 - \lambda$ businesses (low type)
    - Willingness to pay:

	Universities	Businesses
Pro	**9**	**3**
Basic	**5**	**2**

    - Single-crossing: $U(\theta_2, s_2) - U(\theta_2, s_1) = 4 > U(\theta_1, s_2) - U(\theta_1, s_1) = 1$

Monopoly menu pricing (cont'd)

	Universities λ	Businesses $120 - \lambda$
Pro	**9**	**3**
Basic	**5**	**2**

- A numerical example (cont'd)
  - Optimal uniform pricing
    - Sell Pro version.
    - Either at $p_{pro} = 9 \rightarrow q_{pro} = \lambda$ & $\pi^{uni} = 9\lambda$
    - Or at $p_{pro} = 3 \rightarrow q_{pro} = 120$ & $\pi^{uni} = 360$
    - So, $\pi^{uni} = \max\{9\lambda, 360\}$
  - If seller can tell universities and businesses apart → personalized pricing
    - Sell Pro version at $p_{pro} = 9$ to universities and at $p_{pro} = 3$ to businesses → $\pi^{pers} = 9\lambda + 3(120 - \lambda) = 360 + 6\lambda$
  - If seller **cannot** tell universities and businesses apart → menu pricing
    - Use the 2 versions to induce self-selection: sell Pro version to universities and Basic version to businesses
    - Problem: find incentive compatible prices

Monopoly menu pricing (cont'd)

	Universities λ	Businesses $120-\lambda$
Pro	**9**	**3**
Basic	**5**	**2**

- A numerical example (cont'd)
  - Let's find menu prices by trial and error
  - 1st trial: charge each group its reservation price
    - $p_{pro}=9$ and $p_{basic}=2$
    - Problem: universities prefer Basic version as it yields larger surplus: $9-9<5-2 \rightarrow$ self-selection is not achieved
    - Self-selection (or incentive compatibility) constraint: price difference $\leq$ premium universities are willing to pay for upgrading to the Pro version: $p_{pro}-p_{basic} \leq 9-5=4$
  - 2nd trial: charge universities their reservation price and compute incentive compatible price of Basic version
    - $p_{pro}=9$ and $p_{basic}=9-4=5$
    - Problem: businesses don't buy!
    - Participation constraint: price of Basic version $\leq$ businesses' reservation price: $p_{basic} \leq 2$

Monopoly menu pricing (cont'd)

- A numerical example (cont'd)

	Universities λ	Businesses $120-\lambda$
Pro	**9**	**3**
Basic	**5**	**2**

- Optimum
  - Combining the 2 constraints: $p_{basic}=2$ and $p_{pro}=2+4=6$
  - Profits: $\pi^{menu}=6\lambda+2(120-\lambda)=240+4\lambda$
- Menu vs. group pricing
  - Lower profits under menu pricing: $\pi^{menu}-\pi^{pers}$ $=-(120+2\lambda)<0$
  - Inducing self-selection induces 2 costs:
    - Businesses are offered a low-quality product instead of a high-quality one $\rightarrow$ loss: $(120-\lambda)(2-3)=-(120-\lambda)$
    - Universities are sold the high-quality product at a discount; they are left with an 'information rent' $\rightarrow$ loss: $\lambda(6-9)=-3\lambda$
    - Total loss: $-(120-\lambda)-3\lambda=-(120+2\lambda)$

Monopoly menu pricing:

- **Lesson**: Consider a monopolist who offers 2 pairs of price and quality to 2 types of consumers. Prices are chosen so as to fully appropriate low-type's consumer surplus. High-type consumers obtain a positive surplus ('information rent') as they can always choose the low-quality instead.

Monopoly menu pricing (cont'd)

	Universities λ	Businesses $120 - \lambda$
Pro	**9**	**3**
Basic	**5**	**2**

- A numerical example (cont'd)
  - Menu vs. uniform pricing
    - Menu pricing *may* improve profits.
    - Scenario 1: $\lambda > 40 \rightarrow$ firm only sells to universities under uniform pricing $\rightarrow \pi^{uni} = 9\lambda$
      - Cannibalization: universities now pay less for Pro version $\rightarrow$ *loss* of $\lambda(6-9) = -3\lambda$
      - Market expansion: businesses now buy Basic version $\rightarrow$ *gain* of $(120 - \lambda)2$
    - Net gain if $-3\lambda + (120 - \lambda)2 > 0 \Leftrightarrow \lambda < 48$
    - *If so, menu pricing also increases welfare* (firm and universities strictly better off; businesses as well off)

Monopoly menu pricing (cont'd)

	Universities λ	Businesses $120-\lambda$
Pro	**9**	**3**
Basic	**5**	**2**

- A numerical example (cont'd)
  - Menu vs. uniform pricing (cont'd)
    - Scenario 2: $\lambda < 40 \rightarrow$ firm sells to everyone under uniform pricing $\rightarrow \pi^{uni} = 360$
      - No market expansion in this case, but 2 opposite effects.
      - Businesses buy Basic instead of Pro version $\rightarrow$ *loss* of $(120-\lambda)(2-3)$
      - Universities pay more for Pro version $\rightarrow$ *gain* of $\lambda(6-3)$
      - Net gain if $-(120-\lambda)+3\lambda > 0 \Leftrightarrow \lambda > 30$
      - *If so, menu pricing reduces welfare* (firm better off, but universities worse off; businesses as well off)

Monopoly menu pricing:

- **Lesson**: Menu pricing is optimal (i) if proportion of high-type consumers is neither too small nor too large, and (ii) if going from low to high quality increases surplus proportionally more for high-type consumers than for low-type consumers.

- **Lesson**: Menu pricing improves welfare if selling the low quality leads to an expansion of the market; otherwise, menu pricing deteriorates welfare.

Monopoly menu pricing: further results

- If monopolist optimally chooses different qualities to implement menu pricing

$$\max_{s_1,s_2}(1-\lambda)\left[U(\theta_1,s_1)-c(s_1)\right]+\lambda\left[U(\theta_2,s_2)-(U(\theta_2,s_1)-U(\theta_1,s_1))-c(s_2)\right]$$

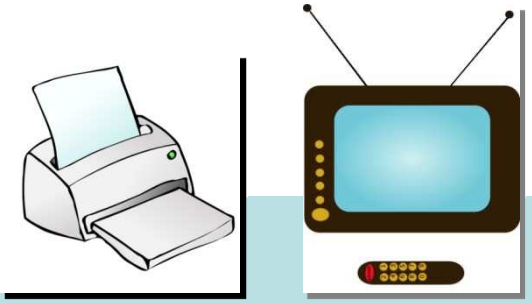
$$\frac{\partial \Pi}{\partial s_1}=0 \Leftrightarrow c'(s_1)=\frac{\partial U(\theta_1,s_1)}{\partial s_1}-\frac{\lambda}{1-\lambda}\left(\frac{\partial U(\theta_2,s_1)}{\partial s_1}-\frac{\partial U(\theta_1,s_1)}{\partial s_1}\right)$$

$$\frac{\partial \Pi}{\partial s_2}=0 \Leftrightarrow c'(s_2)=\frac{\partial U(\theta_2,s_2)}{\partial s_1}$$

- **Lesson**: High-type consumers are offered the socially optimal quality, while low-type consumers are offered a quality that is distorted downward compared to the first best.

Monopoly menu pricing: further results

- Damaged good strategy may be profitable
  - Firm intentionally damages portion of the goods to price discriminate.



Case. Damaged goods

- IBM LaserPrinter E → identical to original printer, but software limited printing to 5 rather than 10 pages/minute
- Sony MiniDisc 60' → curbed 74' disc
- Sharp DVD players → DVE611 and DV740U are almost similar, but DV740U does not allow user to play output encoded in PAL format on NTSC televisions (a critical button is hidden on the remote)

Monopoly menu pricing: further results (cont'd)

- Extension to time - & quantity-dependent prices
  - Previous quality model
    - Suppose linear utility: $U(\theta, s) = \theta s$
    - Cost of producing on unit of given quality: $c(s_i)$
  - Transposition to time-dependent prices
    - Let $s = e^{-rt}$, where t = date when the good is produced and delivered, and r = interest rate

$$\max_{t_1,t_2}(1-\lambda)\left[\theta_1 e^{-rt_1} - c(e^{-rt_1})\right] + \lambda\left[\theta_2 e^{-rt_2} - (\theta_2-\theta_1)e^{-rt_1} - c(e^{-rt_2})\right]$$

  - Transposition to quantity-dependent prices
    - Consumers can buy a certain quantity q_i at price p_i
    - Unit price may depend on quantity purchased (nonlinear pricing).Let $q_i = c(s_i) \rightarrow s_i = c^{-1}(q_i) = V(q_i)$

$$\max_{q_1,q_2}(1-\lambda)\left[\theta_1 V(q_1) - q_1\right] + \lambda\left[\theta_2 V(q_2) - (\theta_2-\theta_1)V(q_1) - q_2\right]$$

Menu pricing under imperfect competition

- Monopoly setting gives useful insights.
- But, we want to know how menu pricing is affected by - and affects - competition.
  - E.g.: airline travel
  - Empirical studies suggest that competition tends to reinforce price discrimination
    - Borenstein (1991): number of stations offering leaded gas ↓ → difference between margins on unleaded and leaded gas ↓
- 2 extensions of Hotelling model
  - Quality-based menu pricing
  - Two-part tariffs (quantity-based menu pricing)

Menu pricing under imperfect competition (cont'd)

- Competitive quality-based menu pricing
  - Sketch of the model
    - 2 firms located at the extremes of Hotelling line
    - Each firm can sell high-end & low-end versions of some good
    - Mass 1 of consumers uniformly distributed on the line
      - Heterogeneous in terms of transportation costs
      - Heterogeneous in terms of valuation of quality
  - Main results (see details in book)
    - Multiple equilibria in pricing game → Coexistence of:
      - 'Discriminatory' equilibrium: both firms offer 2 versions, consumers self-select (high types buy high-end version, low types buy low-end version)
      - 'Non-discriminatory' equilibrium: both firms produce only the high-end version

Menu pricing under imperfect competition (cont'd)

- Competitive quality-based menu pricing (cont'd)
  - Comparison with monopoly
    - Here, monopolist would optimally choose uniform pricing → introducing a competitor may lead to menu pricing by both firms.
    - Incentive compatibility constraints may not be binding in duopoly.
  - Comparison with group pricing in duopoly
    - Contrary to group and personalized pricing in a duopoly, firms may prefer to coordinate on the situation where they both price discriminate.

Menu pricing under imperfect competition (cont'd)

- Competitive quantity-based menu pricing
  - Sketch of the model
    - 2 firms located at the extremes of Hotelling line
    - Each firm sets a two-part tariff: $T_i(q) = m_i + p_i q$
      - m_i : fixed fee; p_i : variable fee
      - E.g., telephony: subscription fee + price per minute
    - Mass 1 of consumers uniformly distributed on the line
      - One-stop shoppers, variable demand (consumers can consume any quantity from the firm they patronize)
  - Main results (see details in book)
    - Unique symmetric equilibrium: firms offer tariffs $T(q) = \tau + cq$
      - τ : transport cost parameter; c : firms' marginal cost
    - Competition with two-part tariffs improves welfare compared to competition with linear tariffs.

Review questions

- Suppose a firm can target two groups of consumers by a menu of prices with different qualities but that it can also offer different prices to different consumer groups. What should it do?
- When does menu pricing dominate uniform pricing in monopoly? Discuss the countervailing effects.
- How does competition affect the use of menu pricing? Discuss.
- What are the effects of competition on quantity-based menu pricing?

Part IV. Pricing strategies and market

Chapter 11. Bundling

Slides

Industrial Organization: Markets and Strategies

Paul Belleflamme and Martin Peitz

Chapter 11. Learning objectives

Learning objectives

- Identify the difference between bundling (mixed and pure) and tying.
- Understand how a monopolist can use bundling and tying as a price discrimination device.
- Analyse the effects of bundling on competition in oligopolistic markets.
- Understand how bundling, depending on the circumstances, leads to a softer or a tougher price competition.

Selling different products in a single package

- Definitions
  - Bundling → fixed proportions
    - *Pure* bundling: only the package is available
    - *Mixed* bundling: combined products are also sold separately
    - Example: software suite
  - Tying → proportions might vary in the mix of goods
    - Example: printer and cartridges
- Rationales
  - Strong complementarities between goods
  - Supply side: cost efficiencies
  - Demand side:
    - Entry-deterrent strategy → see Chapter 16
    - Price discrimination device → what we study here.

Case. Bundling in the information economy

- Content
  - Subscriptions to cable TV, to magazines
  - CDs (bundle of songs), newspapers (of articles)
  - Software: ‘office suite’, integration of various functionalities into the same software platform
  - Theatres forced to buy ‘good’ and ‘bad’ movies from the same distributor
- Infrastructure
  - Computer systems
  - Audio equipment (mixed bundling)
  - Photocopier (machine + maintenance)
  - Early IBM computers (machine + punch-cards $\rightarrow$ tying)

Formal analysis of monopoly bundling

- Bundling ≈ menu pricing
  - If bundle price < sum of prices of components → non linear pricing with quantity discounts
  - Twisted form of menu pricing: set unique price for several goods to ↓ consumer heterogeneity
- Illustration
  - 2 products (produced at zero cost), 2 consumers
  - Valuations

	Product 1	Product 2
Consumer 1	3	2
Consumer 2	2	3

Negative correlation
But result holds more generally

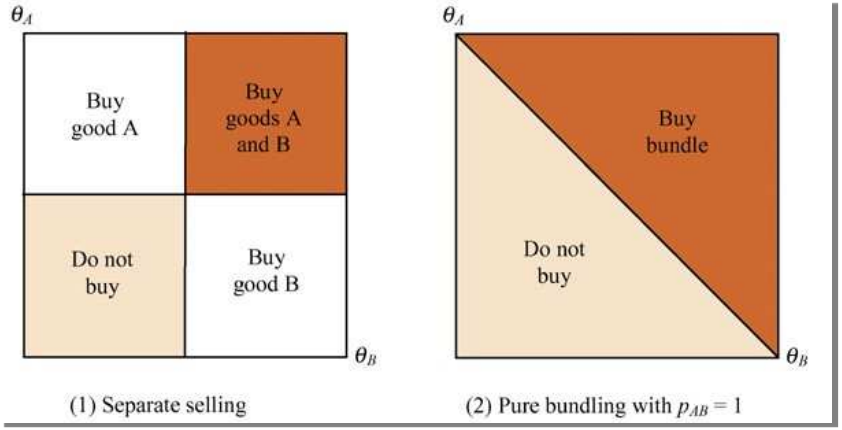
  - Separate sales: $p_1 = p_2 = 2,\ \pi = 8$
  - Bundling: $p = 5,\ \pi = 10$

Formal analysis of monopoly bundling (cont'd)

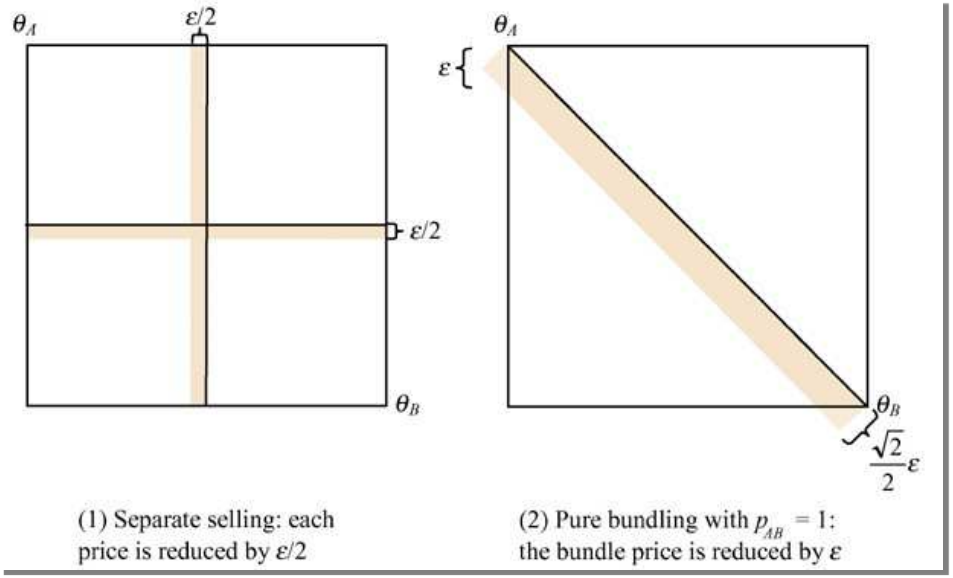
- Model
  - Monopoly producing 2 goods, A and B, at zero cost.
  - Unit mass of consumers
    - Preferences (θ_A, θ_B) uniformly distributed over the unit square $\rightarrow$ valuations for A & B are independent and uniform on [0,1]
    - Strict additivity: Valuation for bundle = $\theta_A + \theta_B$
  - 3 tactics: separate selling, pure & mixed bundling
- Pure bundling = device to offer a discount
  - Separate selling: $p^s_A = p^s_B = 0.5 \rightarrow \pi^s = 0.25 + 0.25 = 0.5$
  - Pure bundling
    - Possible to replicate previous strategy: $p_{AB} = 1$
    - But, identity of buying consumers changes

Formal analysis of monopoly bundling (cont'd)

- Pure bundling = device to offer a discount (cont'd)
  - More marginal consumers ⇒ more incentives to ↓ bundle price than to ↓ separate prices



(1) Separate selling (2) Pure bundling with $p_{AB} = 1$



(1) Separate selling: each price is reduced by $\varepsilon/2$

(2) Pure bundling with $p_{AB} = 1$: the bundle price is reduced by ε

Formal analysis of monopoly bundling (cont'd)

- Pure bundling = device to offer a discount (cont'd)
  - So, incentive to set $p_{AB} < 1$
  - Monopolist's problem: $\max p_{AB}\left(1 - \frac{1}{2}(p_{AB})^2\right)$

Mass of consumers with $\theta_A + \theta_B > p_{AB}$

  - Optimum: $p^b_{AB} = \sqrt{\frac{2}{3}} \approx 0.82 < 1 \rightarrow \pi^b = \frac{2}{3}\sqrt{\frac{2}{3}} \approx 0.544 > 0.5$

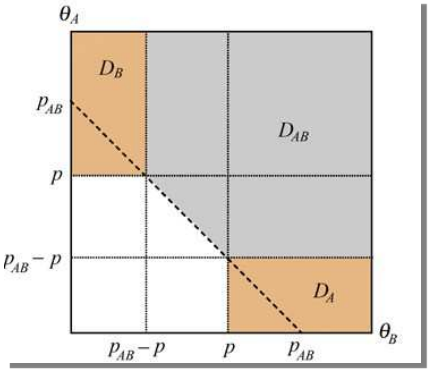
- **Lesson**: If consumers have heterogeneous but uncorrelated valuations for 2 products, then the monopolist ↑ its profits under pure bundling compared to separate selling. It ↑ its demand by selling the bundle cheaper than the combined price under separate selling.

Formal analysis of monopoly bundling (cont'd)

- Mixed bundling
  - Firm sells bundle (at p_{AB}) + A & B separately (at p_A, p_B)
  - Demands when $p_A = p_B = p$

$$D_A(p, p_{AB}) = D_B(p, p_{AB}) = (1-p)(p_{AB}-p)$$

$$D_{AB}(p, p_{AB}) = (1-p_{AB}+p)^2 - \tfrac{1}{2}(2p-p_{AB})^2$$



  - Optimum: $p_A^m = p_B^m = \frac{2}{3}, p_{AB}^m = \frac{1}{3}(4-\sqrt{2}) \approx 0.86 \rightarrow \pi^m \approx 0.549$

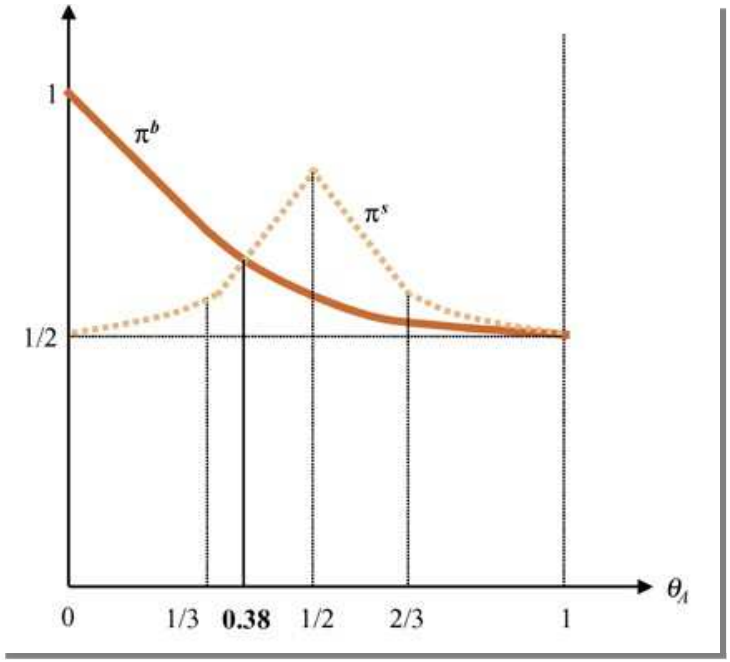
- **Lesson**: Mixed bundling allows the monopolist to increase its profits even further than pure bundling. Here, bundle is more expensive than under pure bundling and individual components are more expensive than under separate selling.

Formal analysis of monopoly bundling (cont'd)

- Extensions
  - Interrelated products
    - Valuation of the bundle: $\theta_{AB} = (1+\gamma)(\theta_A + \theta_B)$
      - $\gamma < 0 \rightarrow$ substitutes
      - $\gamma > 0 \rightarrow$ complements
    - Result: the advantage that pure bundling has over separate selling tends to ↓ as the synergies between the 2 products become stronger.
  - Correlated values
    - Previous result: pure bundling improves profit over separate selling when the 2 products are independently valued.
    - Here, suppose θ_A uniformly distributed over [0,1] and $\theta_B = \rho\theta_A + (1-\rho)(1-\theta_A)$
      - $\rho = 1 \rightarrow$ values are perfectly positively correlated
      - $\rho = 0 \rightarrow$ values are perfectly negatively correlated
    - Compare pure bundling and separate selling

Formal analysis of monopoly bundling

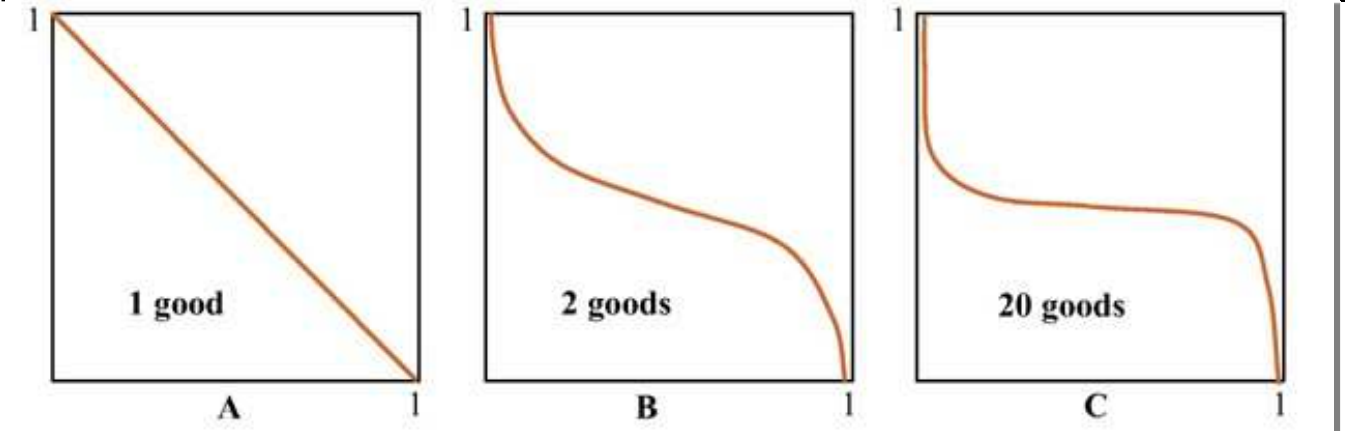
- Extensions (cont'd)
  - Correlated values (cont'd)
    - Objective when selling a bundle: attract consumers who place a relatively low value on either of the 2 products but who are willing to pay a reasonable sum for the bundle.
    - Works if reservation prices for individual products are sufficiently different.



- **Lesson**: Profits are higher under pure bundling than under separate selling if and only if the correlation between the values for the 2 products is negative, or sufficiently weak if positive.

Formal analysis of monopoly bundling

- Extensions (cont'd)
  - Larger number of products (cont'd)
    - Assume θ_A & θ_B independently distributed uniformly on [0,1]
    - If sold separately, linear demand curve for each product.
    - If bundle, shape of demand curve changes → more elastic around $p_{AB} = 1$ (i.e., $p_A = p_B = 1/2$) and less elastic near $p_{AB} = 0$ or 2.
    - Effect more pronounced if more goods added to the bundle.



Demand for bundles of 1, 2 and 20 goods with i.i.d. valuations uniformly distributed over [0,1]. The vertical axis measures price per good; the horizontal axis measures the quantity of bundles as a fraction of total population. (Source: Bakos and Brynjolfsson, 1999)

Formal analysis of monopoly bundling

- Extensions (cont'd)
  - Larger number of products (cont'd)
    - More products in the bundle → distribution for the valuation of the bundle is more concentrated around the mean of the underlying distribution → demand is more elastic around the mean → monopolist is able to capture an increasing fraction of the total area under the demand curve.
    - Works well for goods with low (zero) marginal costs
      - Information goods: software (addition of functionalities, site licensing), subscriptions (newspaper, magazines, ...)

- **Lesson**: As more products are included in a bundle, the demand curve for the bundle becomes flatter. This tends to reduce consumer surplus and deadweight loss.

Tying and metering

- Why is tying a price discrimination device?
  - It enables the monopolist to charge more to consumers who value the good the most.
  - Tying is useful for metering purposes.
- Model
  - Monopoly produces printers and ink cartridges.
  - Unit mass of consumers; differ in quantity of ink cartridges they need in a period of time: $q = Q / k$
    - Q: number of copies consumers make
    - k: measures # of copies one can print with 1 ink cartridge
    - q: uniformly distributed on [0,1]
  - Prices: p_p (printers) and p_c (cartridges)
  - Consumers can outsource printing: cost γ for k copies

Tying and metering

(cont'd) Equilibrium

- Consumer purchases a printer if and only if

$$p_p + p_c q \leq \gamma q \Leftrightarrow q \geq \frac{p_p}{\gamma - p_c} \equiv \hat{q}$$

- $\rightarrow$ Demands are

$$Q_p(p_p, p_c) = 1 - \hat{q} = 1 - \frac{p_p}{\gamma - p_c}$$

$$Q_c(p_p, p_c) = \int_{\hat{q}}^{1} q\,dq = \frac{1}{2}\left(1 - \left(\frac{p_p}{\gamma - p_c}\right)^2\right)$$

- Assuming zero cost of production, profits are

$$\pi = p_p Q_p(p_p, p_c) + p_c Q_c(p_p, p_c)$$

Tying and metering

- Equilibrium (cont'd)
  - FOC w.r.t p_p:

$$\frac{d\pi}{dp_p} = \left(1 - \frac{2p_p}{\gamma - p_c}\right) - p_c \frac{p_p}{(\gamma - p_c)^2} = 0 \Leftrightarrow p_p = \frac{(\gamma - p_c)^2}{(2\gamma - p_c)}$$

  - Evaluated at this value of p_p, FOC w.r.t p_c is positive
    $\rightarrow$ set p_c almost equal to γ
    $\rightarrow$ optimal p_p is almost equal to zero
    $\rightarrow$ profit is almost equal to γ /2 (2x what can be achieved in the absence of metering, i.e. when forced to set $p_c = 0$)

- **Lesson**: A monopolist can profitably use tying as a metering device to obtain a larger payment from consumers who use the tied product more intensively. The monopolist charges a low price for the primary product and a high price for the usage of the tied product.

Case. Popcorn in movie theatres

- Why does popcorn cost so much at the movies?
  - Theatres optimally choose to shift profits from admission tickets to concessions because they can 'meter' the surplus extracted from a customer by how much of the aftermarket good they demand.
  - If true, positive correlation between willingness to pay for movies and demand for concessions.
  - Hartmann and Gil (2008) confirms this conjecture by analysing a data set with approximately 5 years of weekly attendance, box office revenue and concession revenue for a chain of 43 Spanish movie theatres.

Competitive bundling

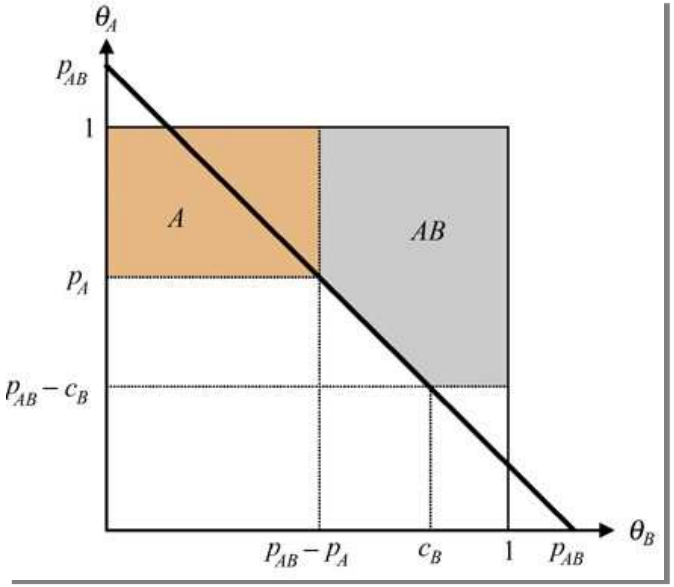
- Bundling is often used by competing firms.
- Motivation?
  - Entry deterrence → analyzed in Chapter 16
  - Price discrimination → new question: how does the surplus extraction gains of bundling balance with its competitive effects?
- 2 settings
  - 2 independent goods, one produced by duopoly and the other by a competitive industry
    → bundling softens price competition because it allows firms to differentiate their products
  - 2 perfect complements (components of a system)
    → bundling intensifies competition because it ↓ variety

When bundling softens price competition

- Model
  - Unit mass of consumers
    - Preferences (θ_A, θ_B) uniformly distributed over the unit square
    - Strict additivity: Valuation for bundle = $\theta_A + \theta_B$
  - Firms
    - Good A produced by firms 1 and 2 at $c_A < 1$
    - Good B produced by perfectly competitive industry at $c_B < 1$
    - Firms 1 and 2 are also able to produce good B.
      - No incentive to sell it separately (because zero profit)
      - Question: incentive to bundle B with A?
  - 2-stage game
    - Choice of marketing strategy: 'A only' (**S**pecialization), 'bundle only' (**P**ure **B**undling) , or 'A & bundle' (**M**ixed **B**undling)
    - Price competition

When bundling softens price competition (cont'd)

- Subgame perfect equilibrium
  - 2nd stage
    - Firms earn zero profit at the Nash equilibrium of 5 of the 9 subgames: (S,S), (PB, PB), (MB, MB), (S, MB) & (MB, S)
    - Subgames (S, PB) & (PB, S):
      - one firm chooses p_A; the other firm chooses p_{AB}
      - Demands (see figure)



✓ Equilibrium may not exist.

✓There may exist equilibria where one firm specializes, the other firm chooses pure bundling and both firms make positive profits (each firm would like the other to bundle products so that price competition is reduced).

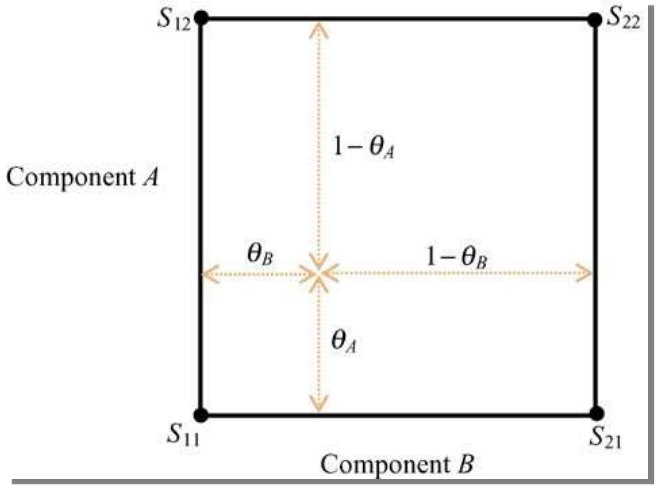
When bundling softens price competition (cont'd)

- Subgame perfect equilibrium
  - 2nd stage (cont'd)
    - Subgames (PB, MB) & (MB, PB):
      - Bundle sold by both firms → price driven down to marginal cost → firm having chosen PB makes zero profit
      - Firm having chosen MB makes positive profit but lower than if it had chosen S.
  - 1st stage: MB is a weakly dominated strategy

- **Lesson**: Consider a homogeneous primary good produced by a duopoly and a secondary good produced competitively. In equilibrium, one firm specializes in the primary good and the other bundles the 2 goods. Both make positive profits though they produce homogeneous goods and compete in price. Bundling acts here as a product differentiation device, which reduces price competition in the primary market. Bundling ↓ welfare.

When bundling toughens price competition

- Model
  - Goods A & B are perfect complements.
    - Firms 1 and 2 produce each both components.
    - Equivalent components are differentiated.
  - Unit mass of consumers
    - (θ_A, θ_B) uniformly distributed over the unit square.
    - Meaning: consumer's location on the square, with the 4 possible 'systems' located at the 4 corners.



S_{11} & $S_{22} \rightarrow$ 'pure systems' (made of components produced by same firm)

S_{12} & $S_{21} \rightarrow$ 'hybrid systems' (made of components produced by different firms)

When bundling toughens price competition (cont'd)

- Model
  - 2-stage game
    - Marketing strategy: Separate selling, Pure or Mixed Bundling
    - Price competition
- Main results
  - Pure bundling is dominated by separate selling.
    - Separate selling ↑ variety: more systems available → potential for market expansion
    - Firms have larger incentives to cut prices under pure bundling than under separate selling (because they internalize the complementarities between the 2 components).
  - Dominant strategy?
    - Mixed bundling when the market is not covered
    - Separate selling when the market is covered.

When bundling toughens price

- **Lesson**: Suppose 2 competing firms sell compatible components of a system.
  - Separate selling always dominates pure bundling.
  - If consumers have a relatively low reservation price for their ideal system, both firms end up choosing mixed bundling but they would be better off if they could agree to adopt separate selling instead.
  - If the reservation price is relatively high, both firms select separate selling at the equilibrium.
  - In general, bundling of perfectly compatible components intensifies competition.

Review questions

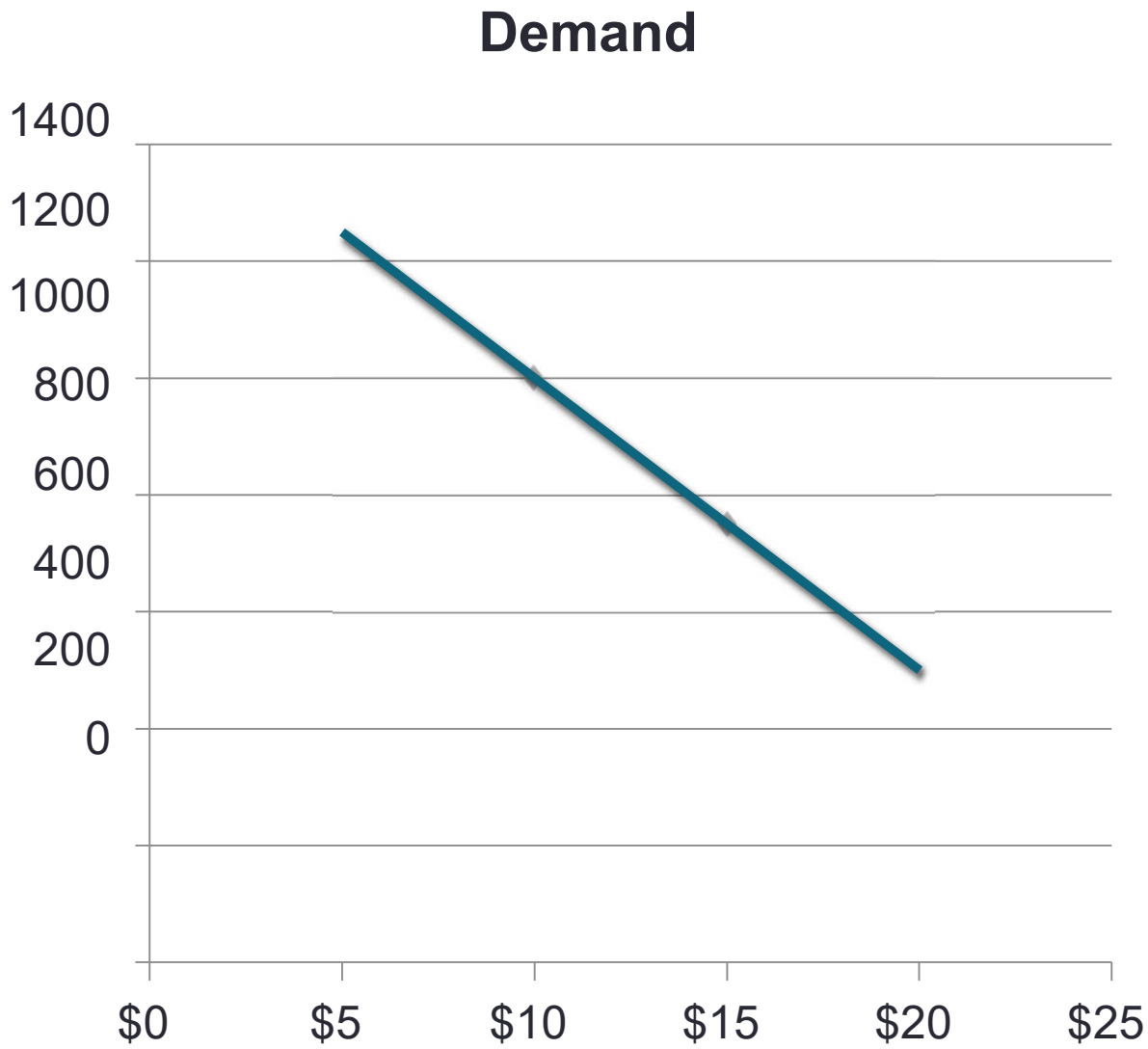
- What is the meaning of pure and mixed bundling? Give a real-world example for each practice.
- What is the intuition that bundling (pure or mixed) can increase profits compared to separate selling?
- How can bundling reduce competition?
- Can bundling increase competition? Explain.

PRICING ANALYTICS

Creating Linear & Power Demand Curves

Demand Curve

Curve describing how many units of product the market demands for every possible price point



Demand Curves

- Used to estimate price that should be charged for maximum profits
- The best price for a product maximizes margins – not unit sales

12 units * $5 = **$60**
50 units * $1 = $50

Estimating Best Price

- Need two things to estimate best price:
  - Variable cost to produce one unit of product
  - Product's demand curve

Estimating Best Price

- **COG**: variable cost to produce one unit of product
- **p**: price we charge customers for 1 unit of product
- **D(p)**: customer demand, in units of product, at price p
- Profit margin formula:

$$\textbf{Margin} = (\textbf{p} - \textbf{COG}) * \textbf{D}(\textbf{p})$$

Profit margin per unit

Demand for product

Demand Curves

- Demand curves are subject to frequent change
- Affected by:
  - Competitive pressures
  - Customer sentiment
  - Macroeconomic factors

Price Elasticity

- The amount demand decreases if prices increased by 1%
- Product is **price elastic** if its elasticity > 1
  - Decreasing price of product will increase revenue
- Product is **price inelastic** if its elasticity < 1
  - Decreasing price of product will decrease revenue

Price Elasticity

- Examples of price elasticity values in Boston MSA:

Product/Service	Elasticity
Salt	0.09
Coffee	0.20
Beer	0.95
LCD monitors	1.73
Restaurant meals	2.90
Travel to Ireland	5.27

- Good pricing decisions require understanding of products' price elasticity

Demand Curves

- Two most popular types of demand curves:
  - Linear demand curves
  - Power demand curves

Linear Demand Curves

- Straight-line relationship between price and demand

$$D = a - bp$$

  - **D**: units of product demanded by customers
  - **p**: per-unit price
  - **a** and **b**: adjust curve to fit product's price elasticity
- Excel can auto-calculate **a** and **b** for us

Power Demand Curves

- Arc that shows relationship between price and demand, when product's price elasticity isn't affected by product's price

$$D = ap^b$$

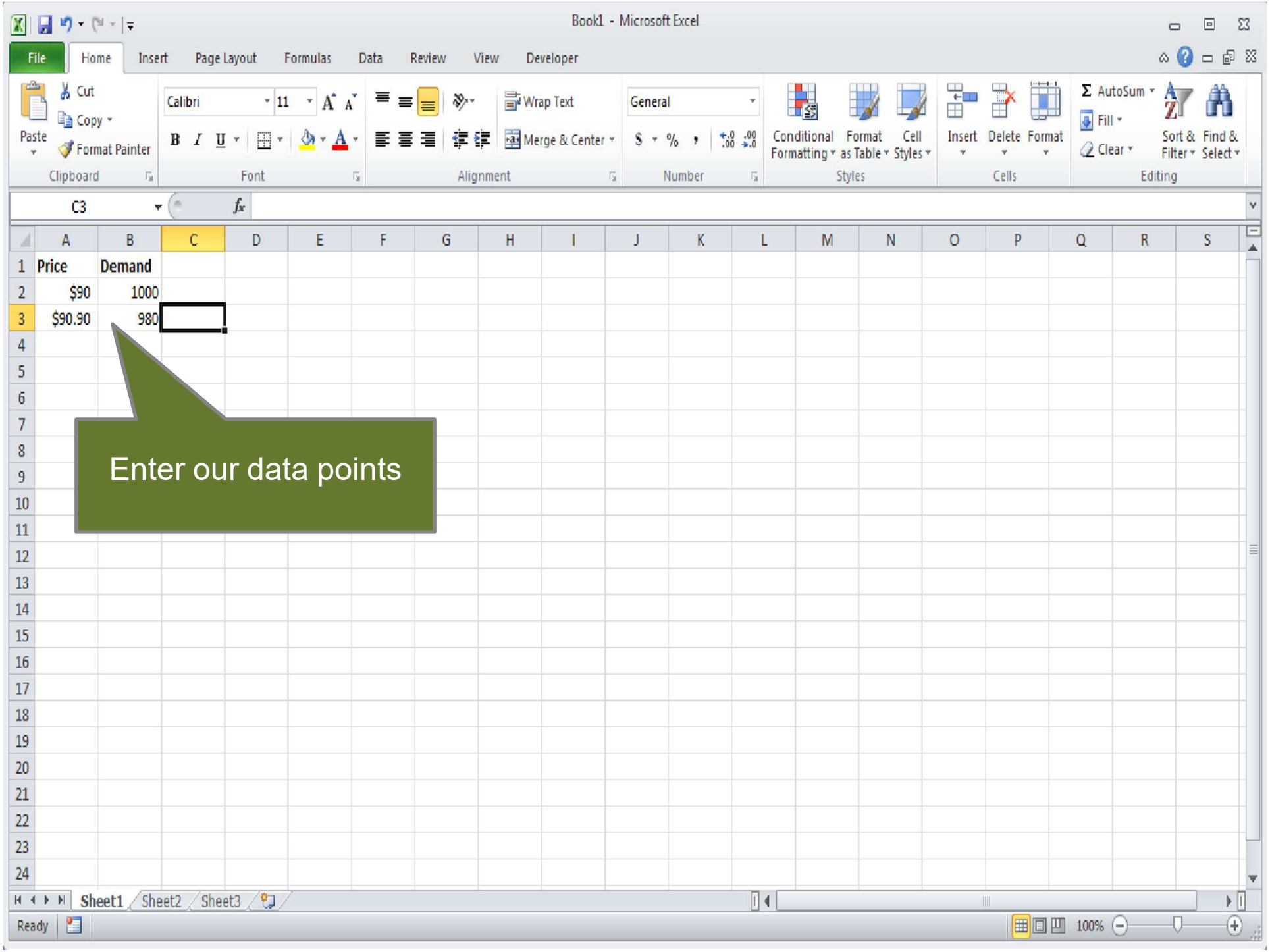
  - **D**: units of product demanded by customers
  - **p**: per-unit price
  - **a** and **b**: adjust curve to fit product's price elasticity
  - **b** is additive inverse of price elasticity (ex: **b** = -2 if elasticity = 2)
- Excel can auto-calculate **a** for us

Which Curve to Use?

- Price elasticity properties tell us which curve is appropriate
- Linear demand curve: if product's price elasticity changes as price changes
- Power demand curve: if product's price elasticity remains constant as price changes

Constructing Linear Demand Curves

- Scenario:
  - We're selling polo shirts for Ralph Lauren
  - Current price per unit **p** = $90
  - Current demand **D** = 1,000 shirts
  - Price elasticity of product: 2.0
- We need two points to construct our line:
  - We already know ($90, 1000) is on the curve
  - Increase price by 1% ($0.90), demand will decrease by 2% (20 shirts)
  - Calculated point on curve: ($90.90, 980)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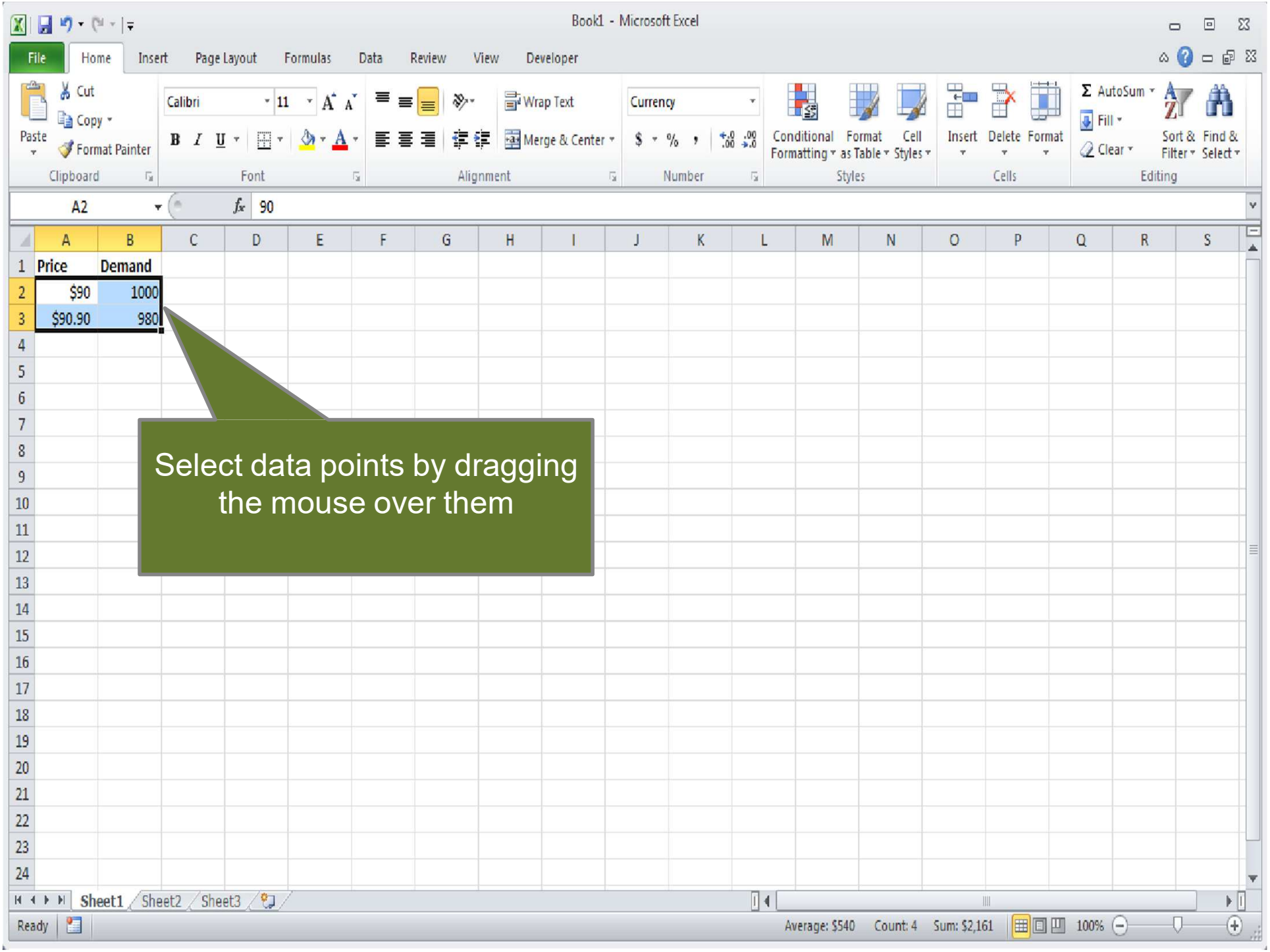
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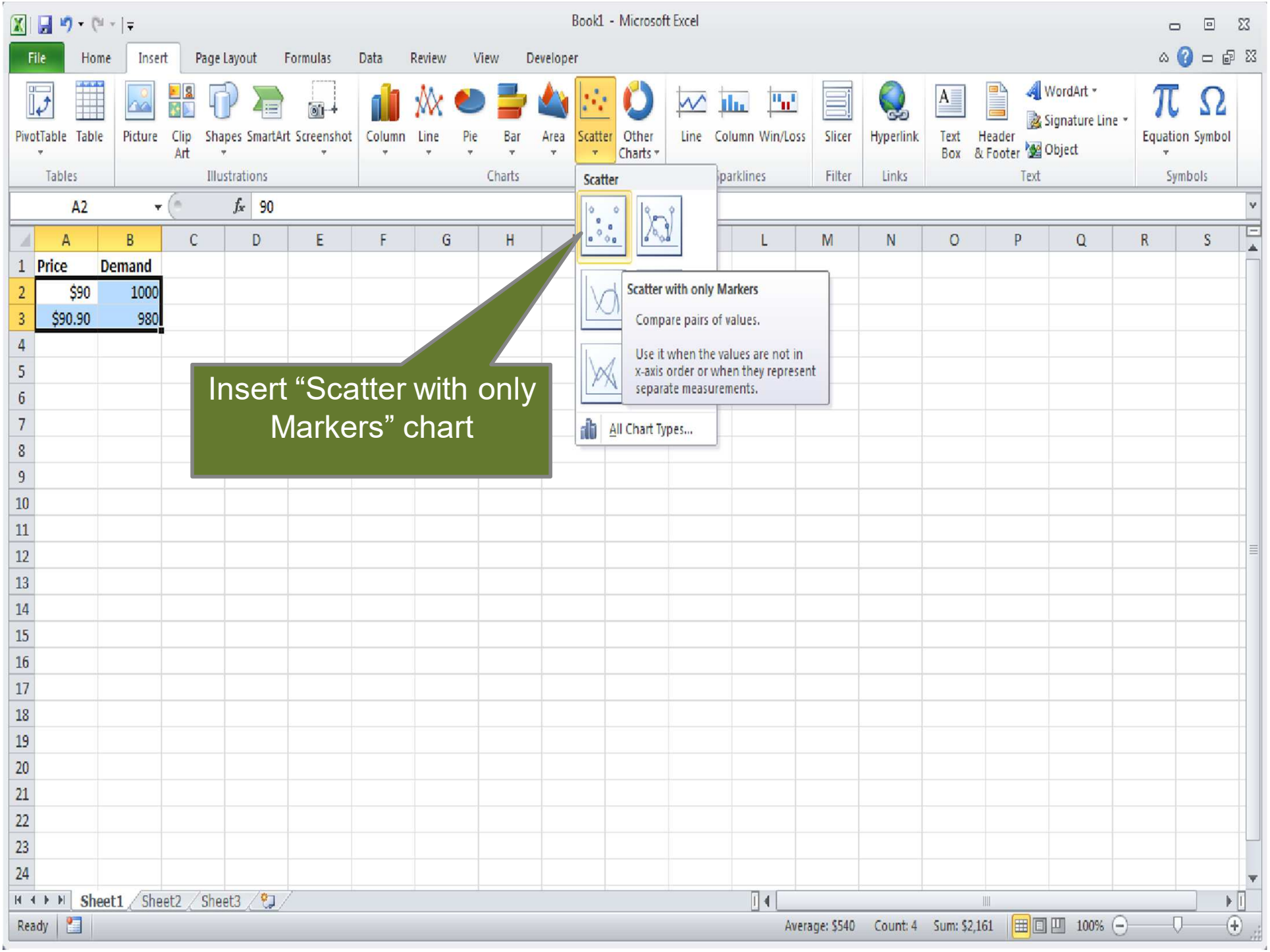
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Scatter
Scatter with only Markers
Compare pairs of values.
Use it when the values are not in x-axis order or when they represent separate measurements.
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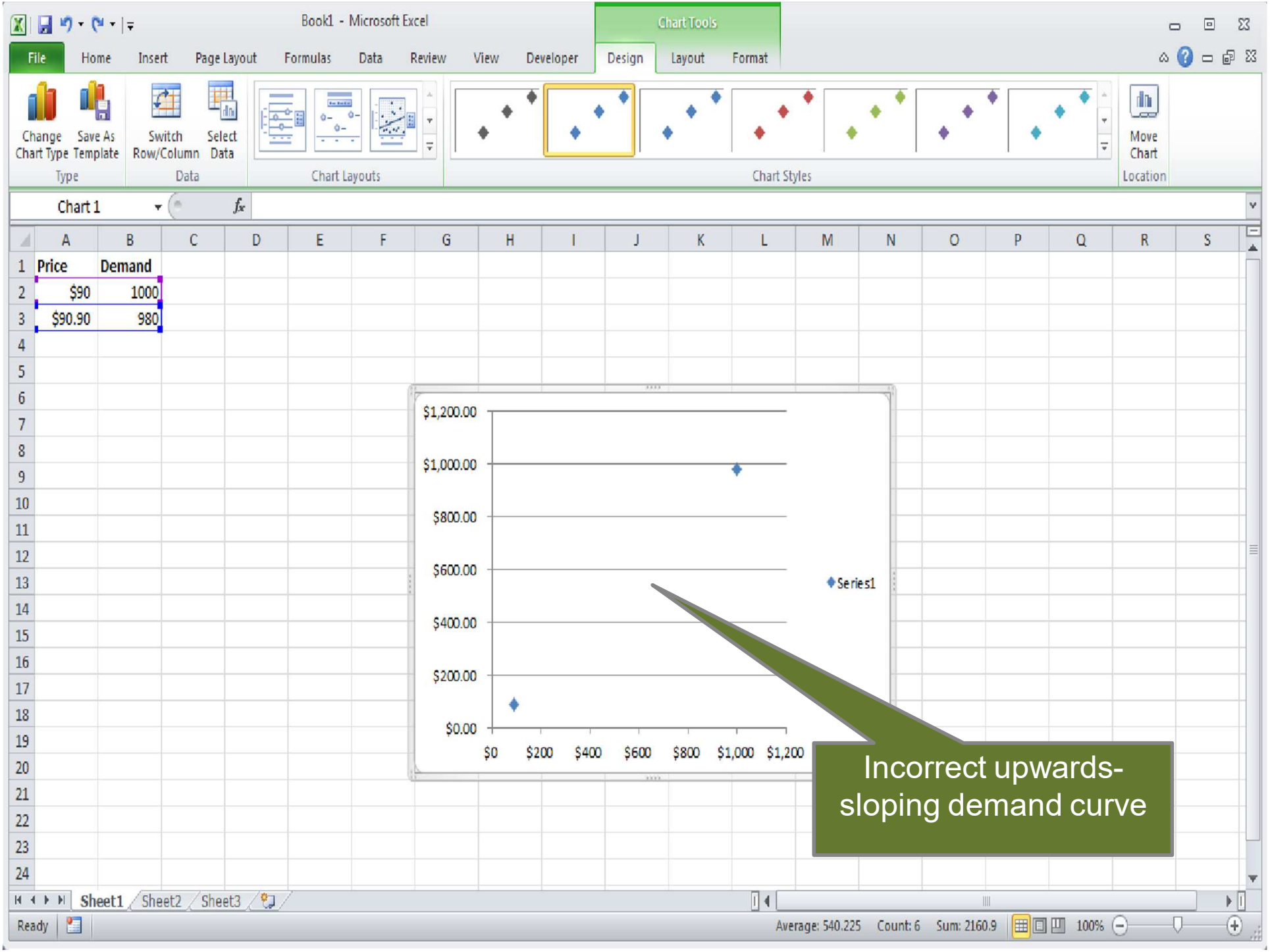
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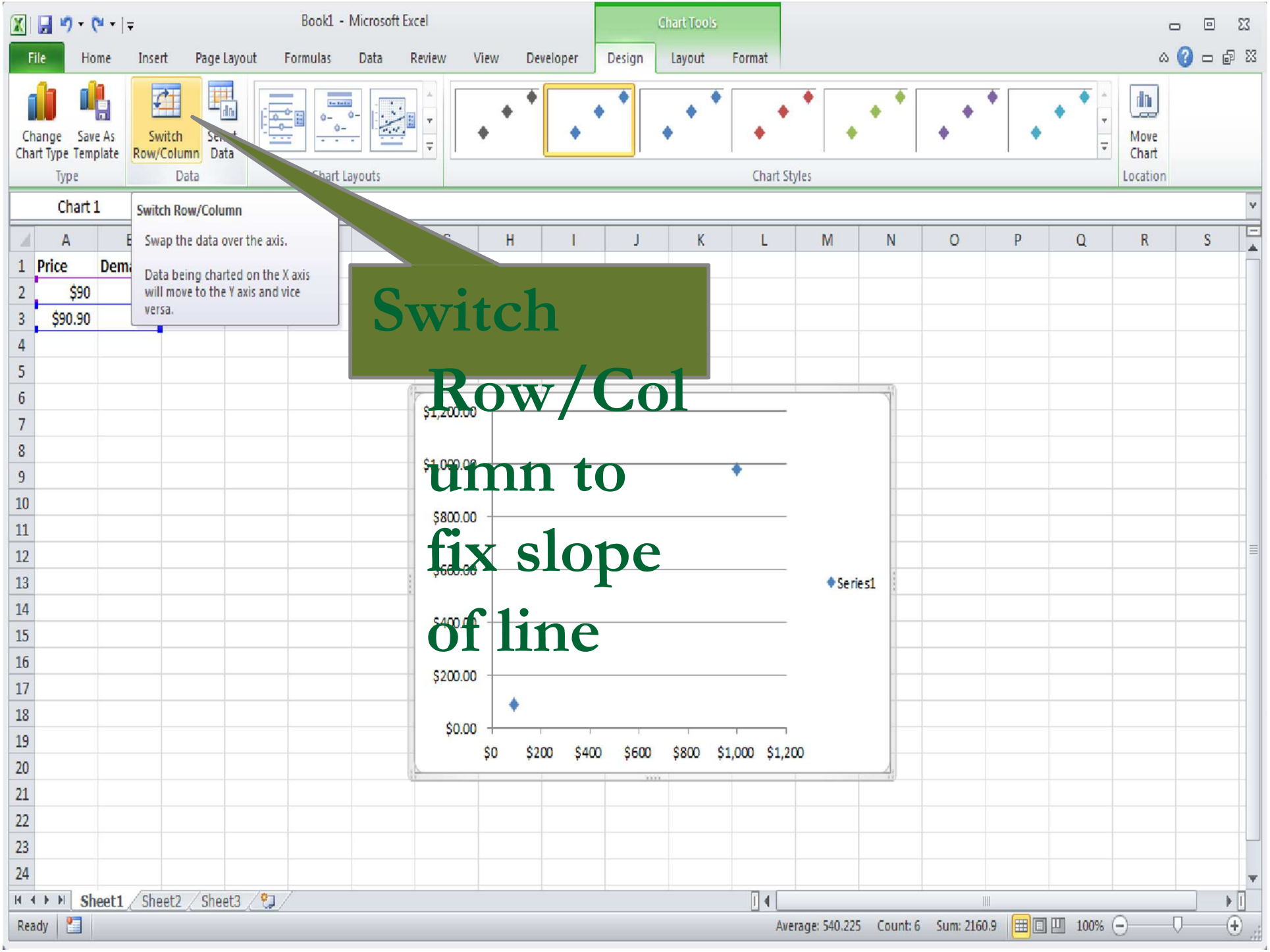
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Data being charted on the X axis will move to the Y axis and vice versa.
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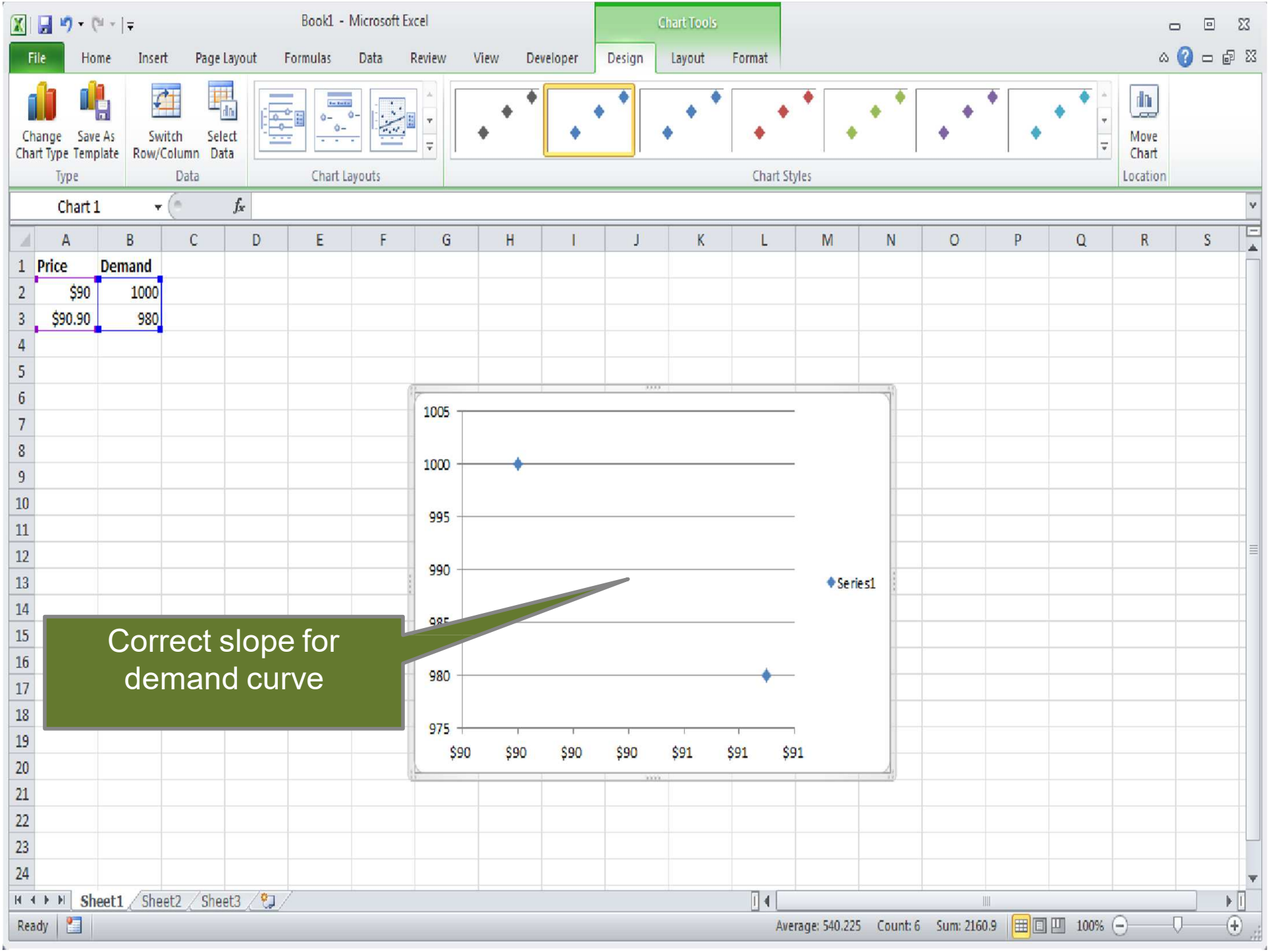
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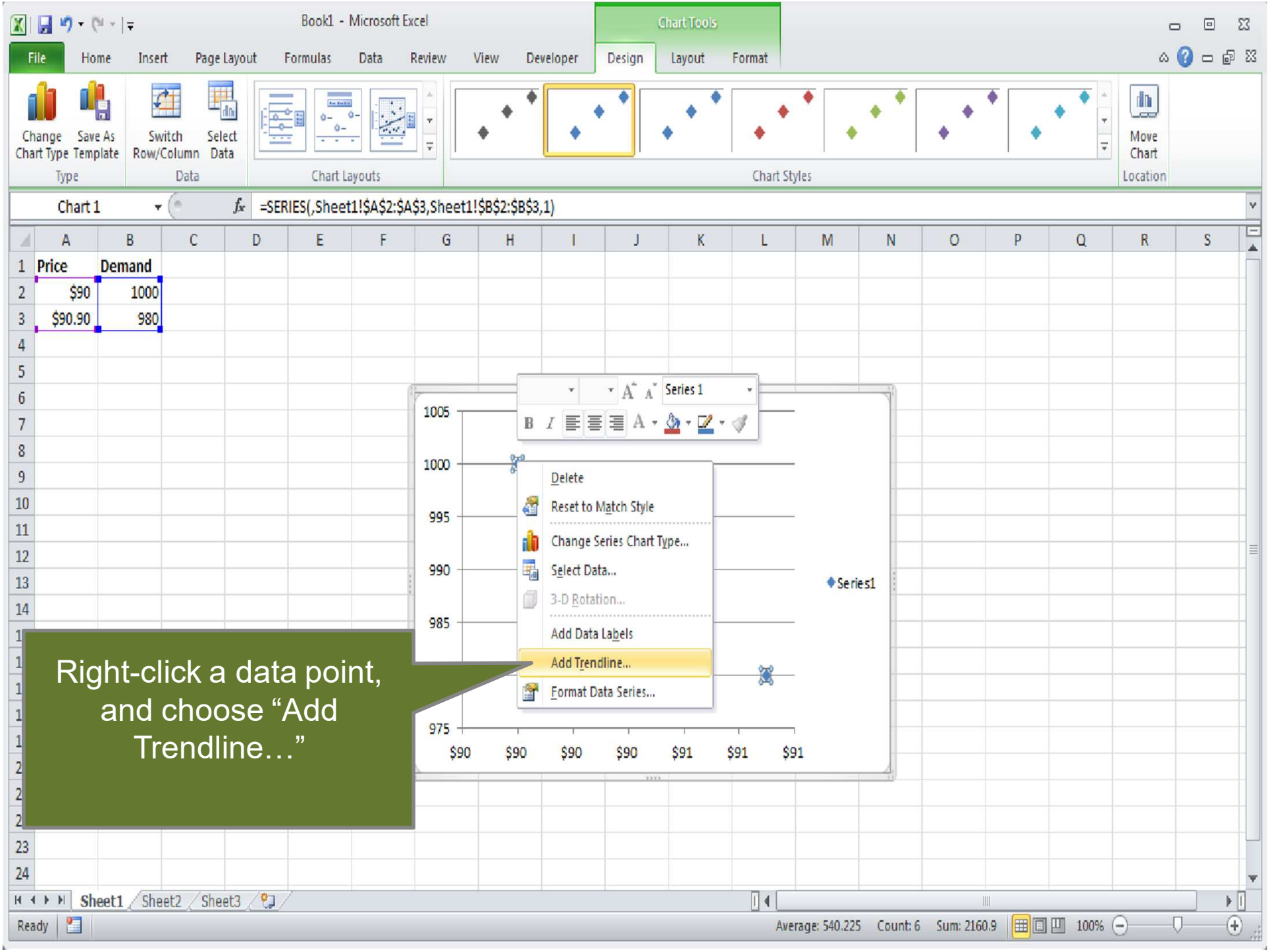
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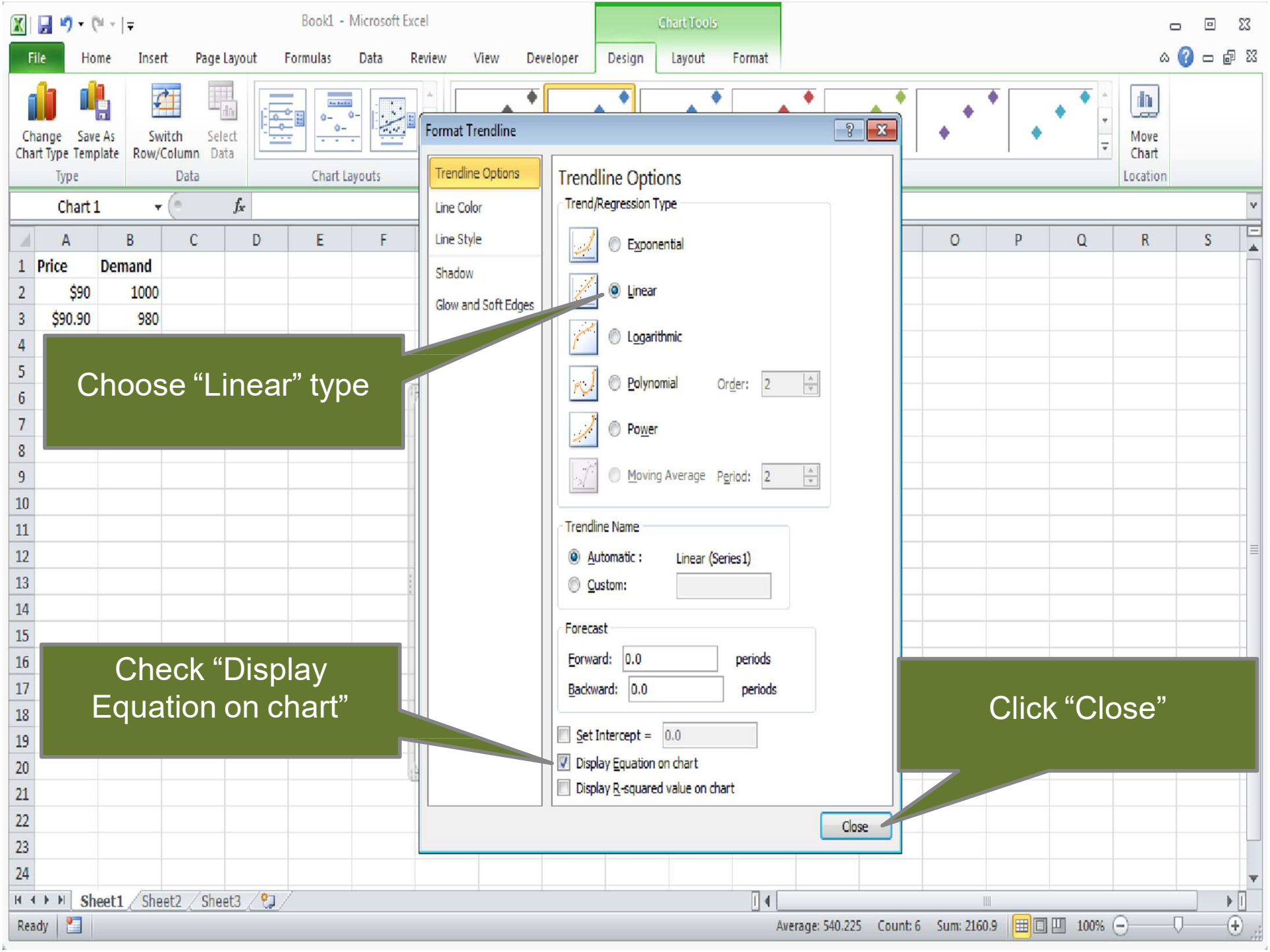
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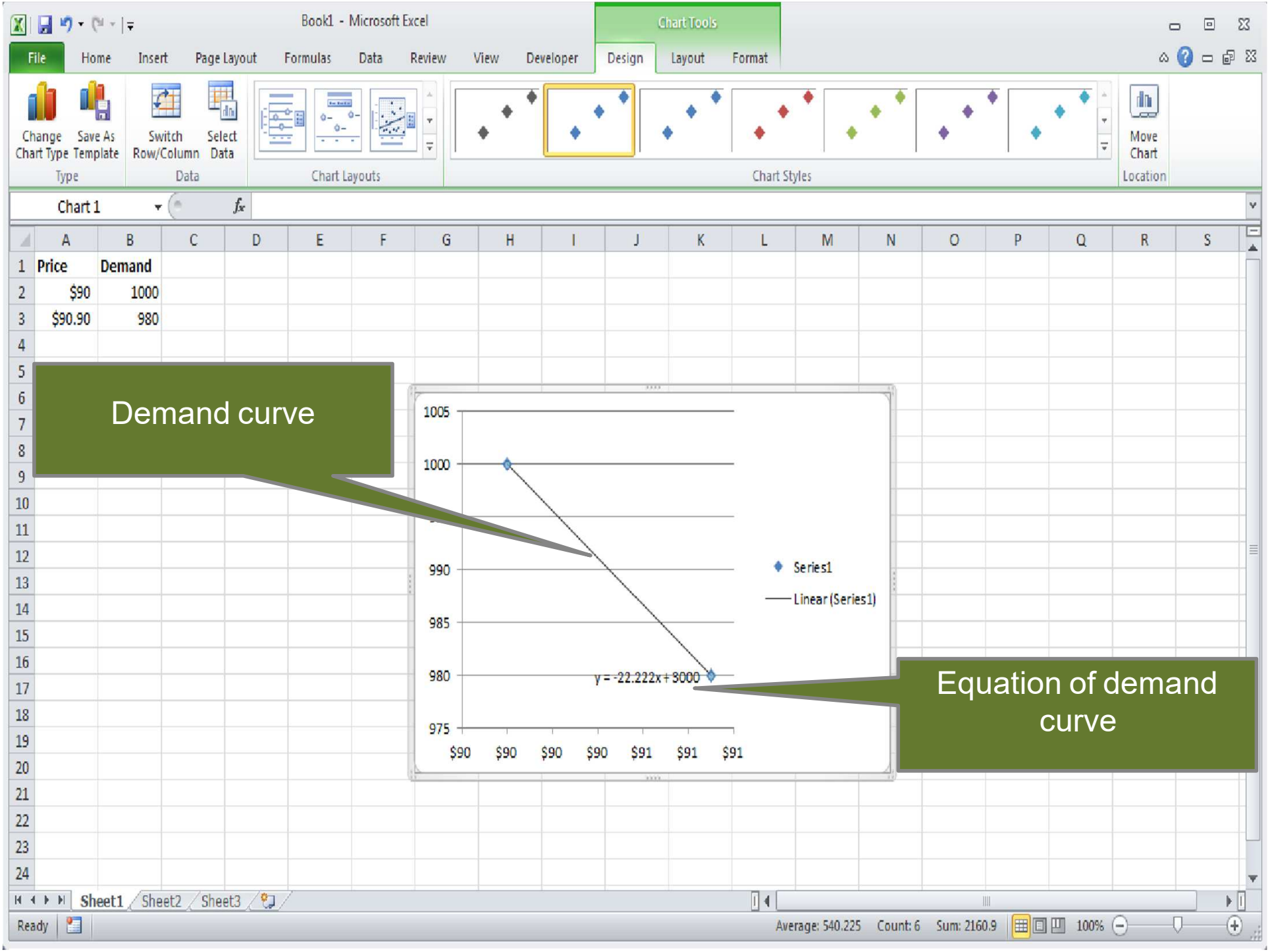
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Demand curve
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Linear (Series1)
y = -22.222x + 8000
Equation of demand curve
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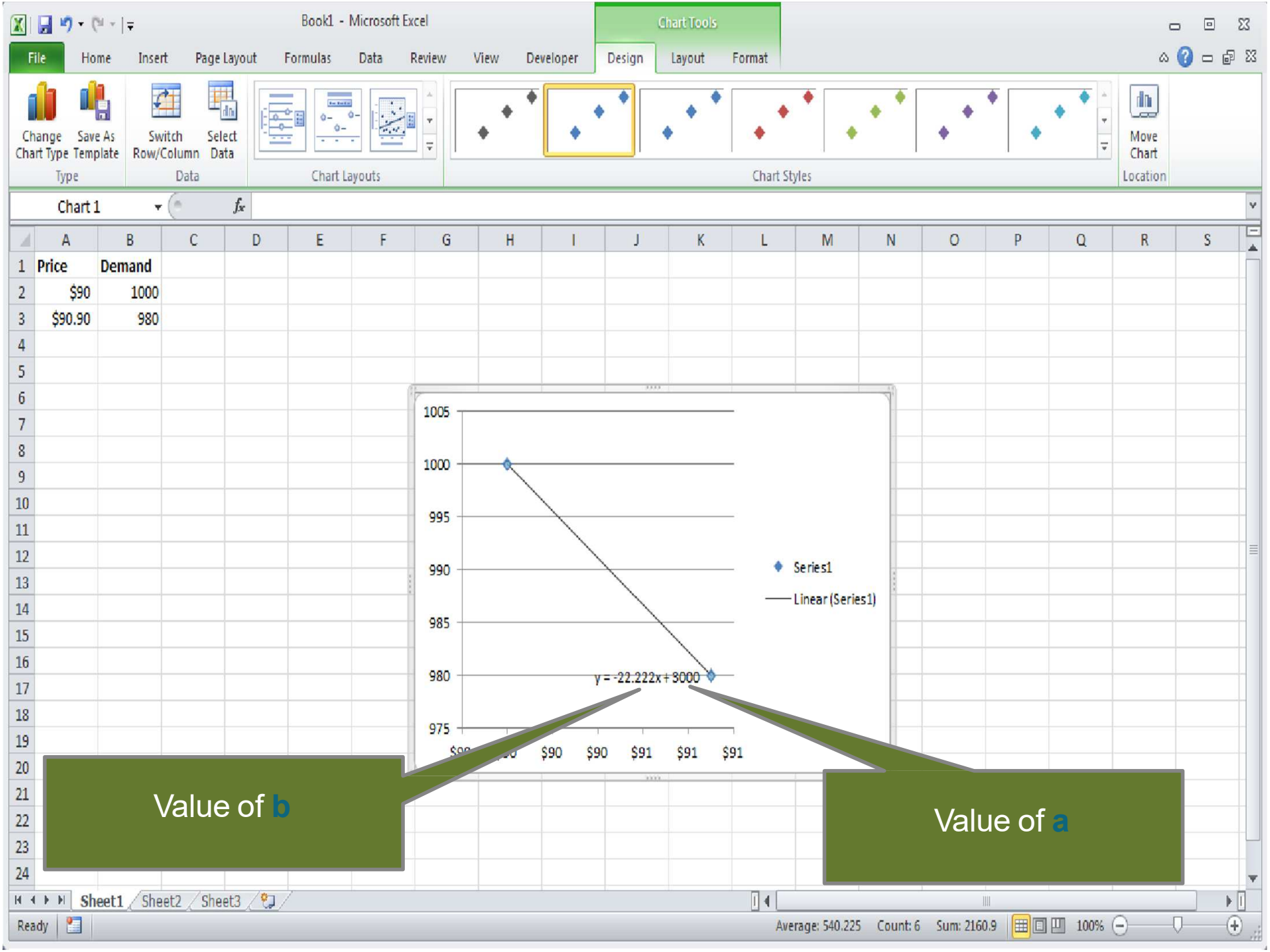
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Data
Chart Layouts
Chart Styles
Move Chart
Location
Chart 1
Price
Demand
$90
1000
$90.90
980
1005
1000
995
990
985
980
975
$90
$90
$91
$91
$91
Series1
Linear (Series1)
y = -22.222x + 8000
Value of b
Value of a
Sheet1
Sheet2
Sheet3
Ready
Average: 540.225
Count: 6
Sum: 2160.9
100%

Constructing Linear Demand Curves

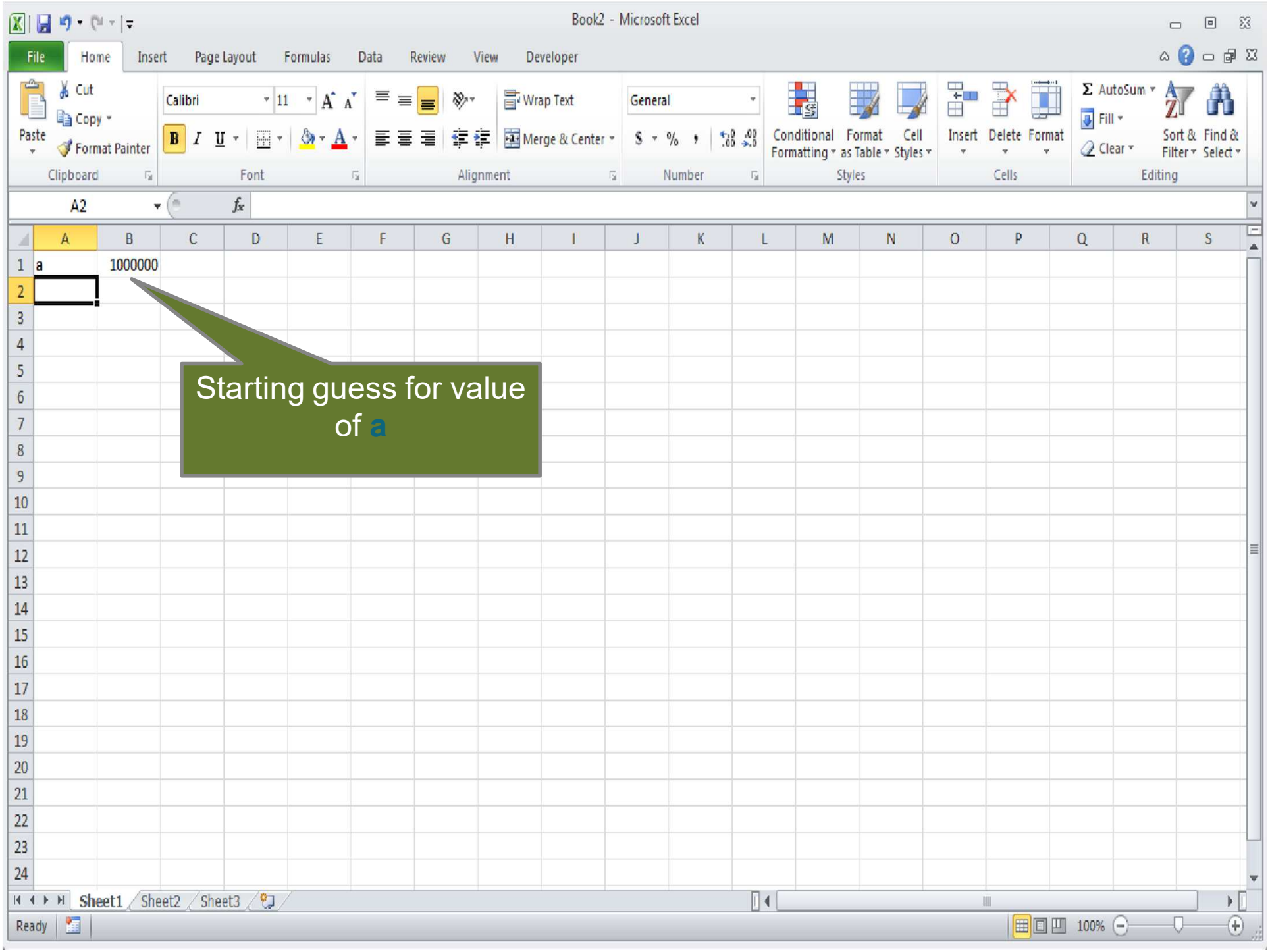
- Linear demand curve equation for this example:

$$D = 3000 - 22.2p$$

- Implication: Every $0.90 increase in shirt price is going to cost demand for ~22 shirts
- Error rate for linear demand curves increases with distance from current price point
- Pretty good approximation +/- 5% of current price

Constructing Power Demand Curves

- Use power demand curves when product's price elasticity doesn't change when price changes
- Same scenario:
  - We're selling polo shirts for Ralph Lauren
  - Current price per unit **p** = $90
  - Current demand **D** = 1,000 shirts
  - Price elasticity of product: 2.0
  - Price elasticity doesn't change when price changes
- Excel's Goal Seek function calculates value of **a** for us


Book2 - Microsoft Excel
File
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Review
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Developer
Cut
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General
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
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Cells
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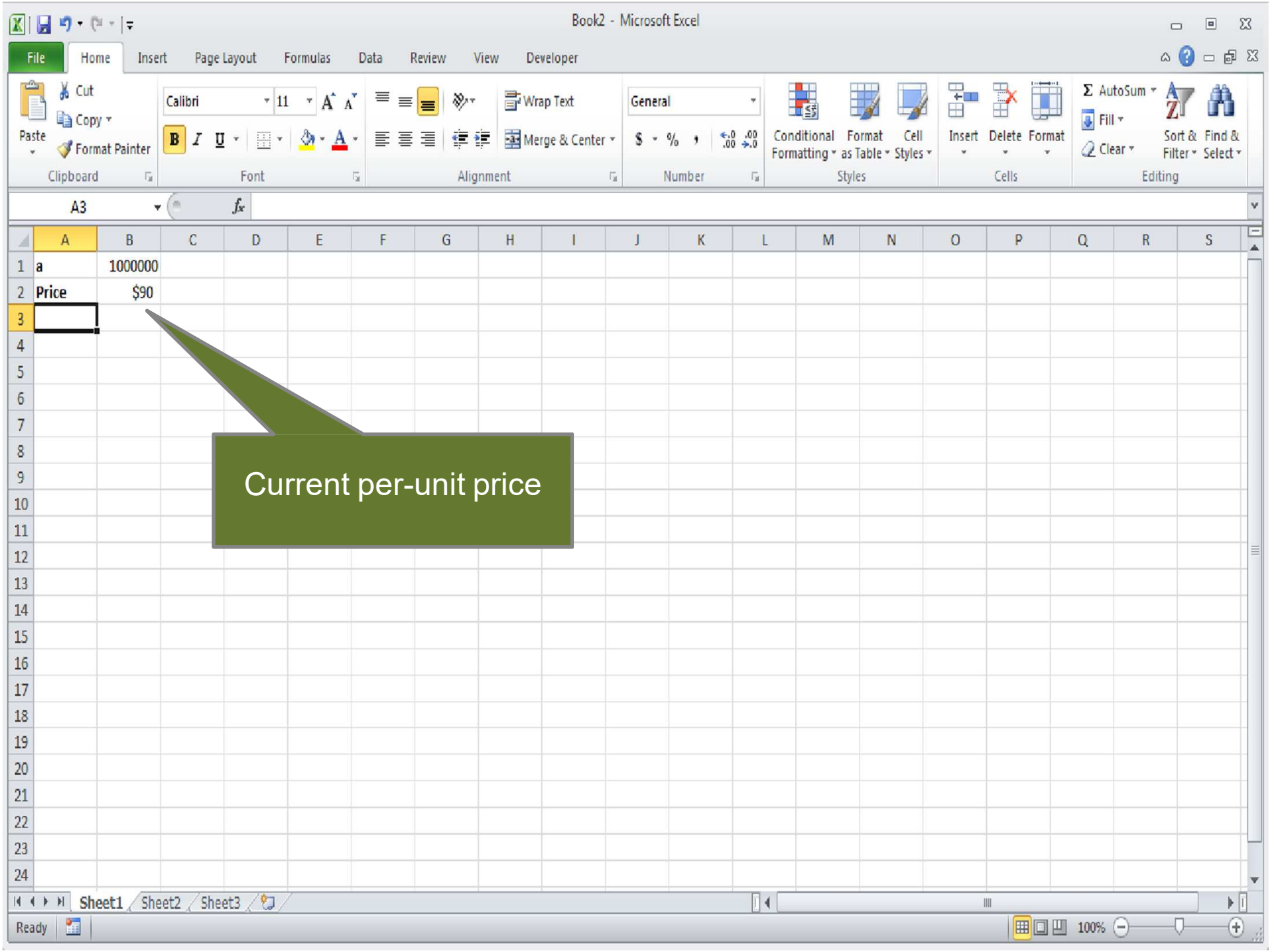
Find & Select
Editing
A2
a
1000000
Starting guess for value of a
Sheet1
Sheet2
Sheet3
Ready
100%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Format as Table
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AutoSum
Fill
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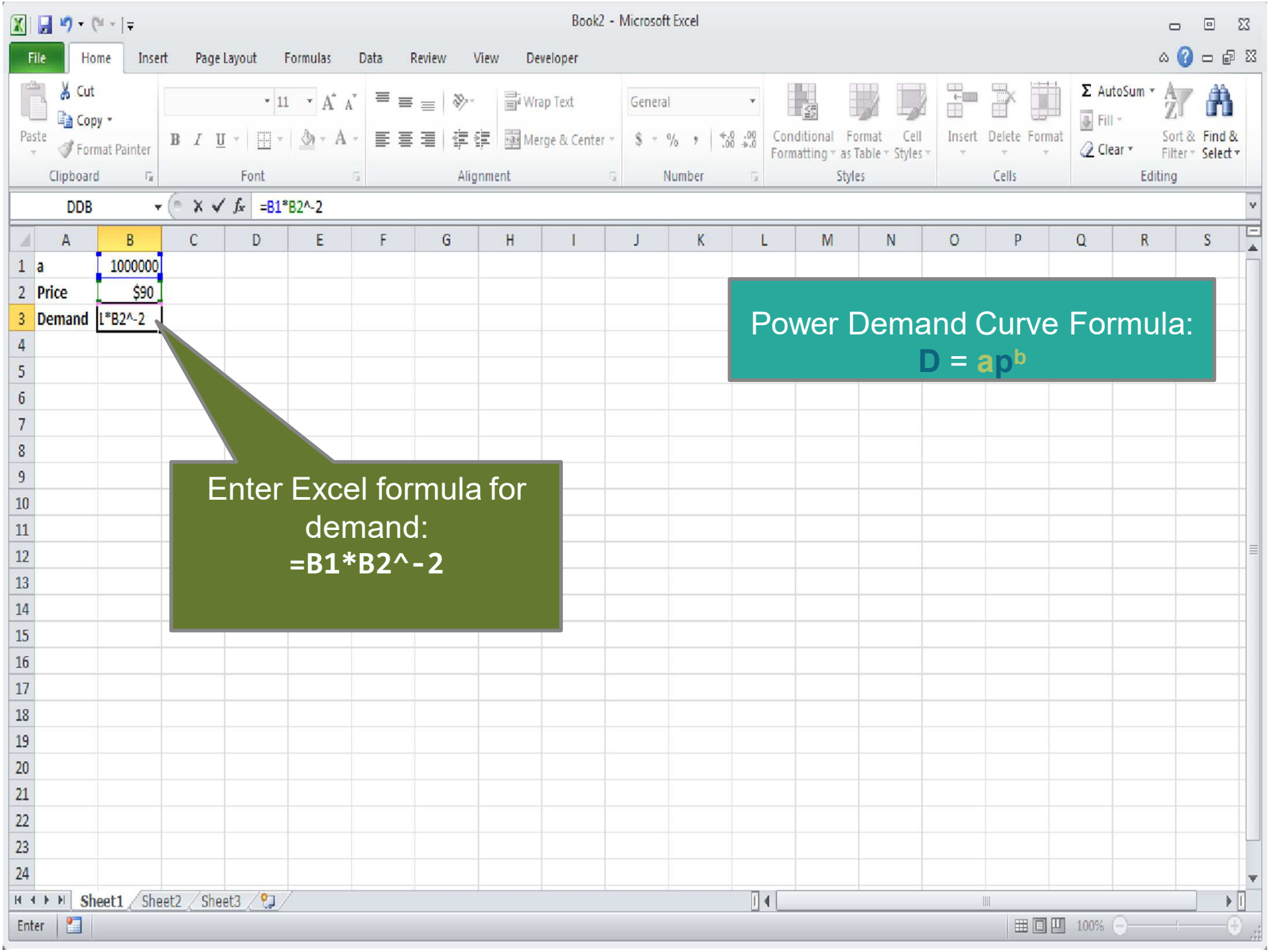
Editing
A3
a
1000000
Price
$90
Current per-unit price
Sheet1
Sheet2
Sheet3
Ready
100%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Conditional Formatting
Format as Table
Cell Styles
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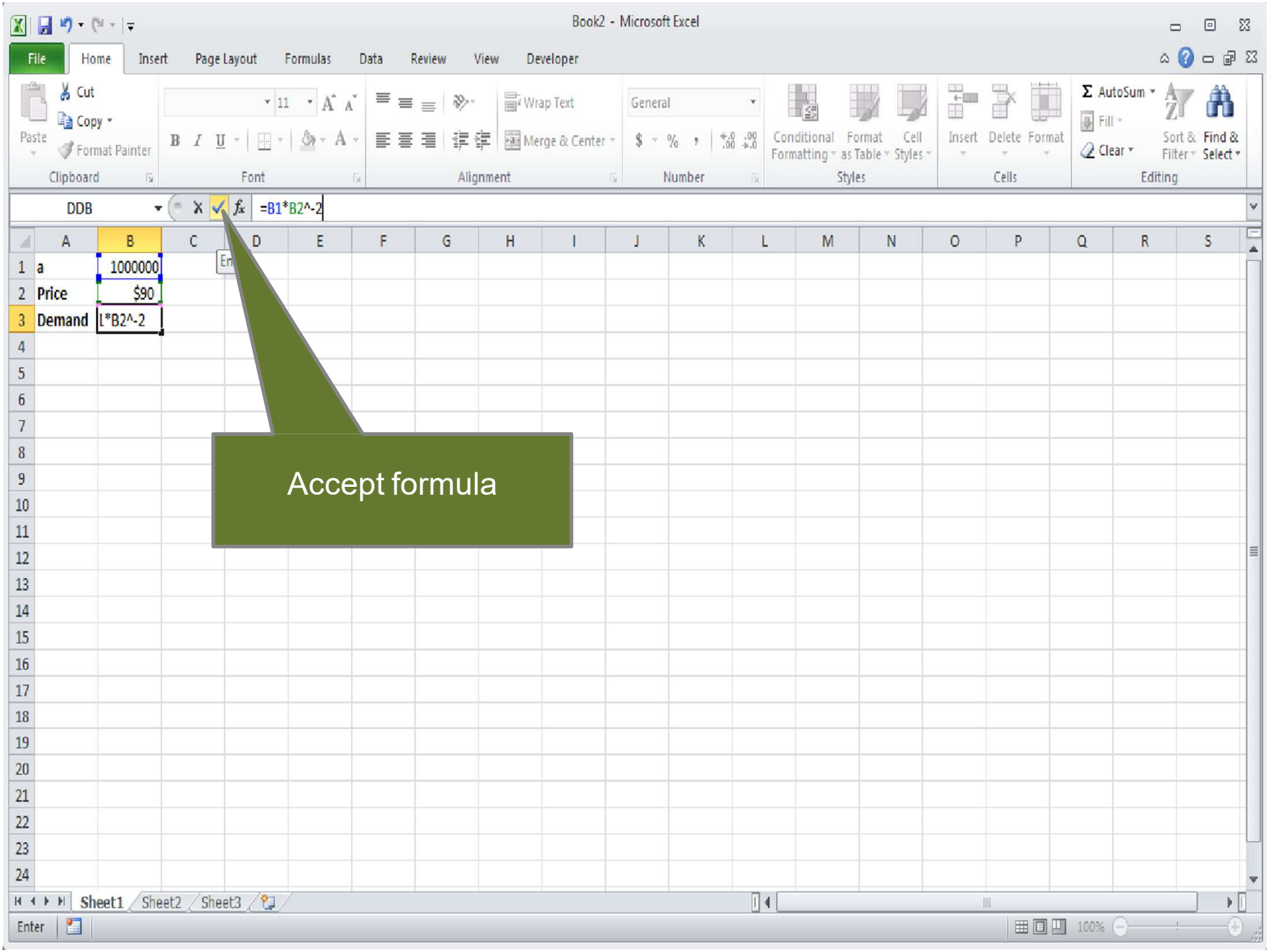
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
DDB
=B1*B2^-2
a
1000000
Price
$90
Demand
L*B2^-2
Power Demand Curve Formula:
D = ap^b
Enter Excel formula for demand:
=B1*B2^-2
Sheet1
Sheet2
Sheet3
Enter
100%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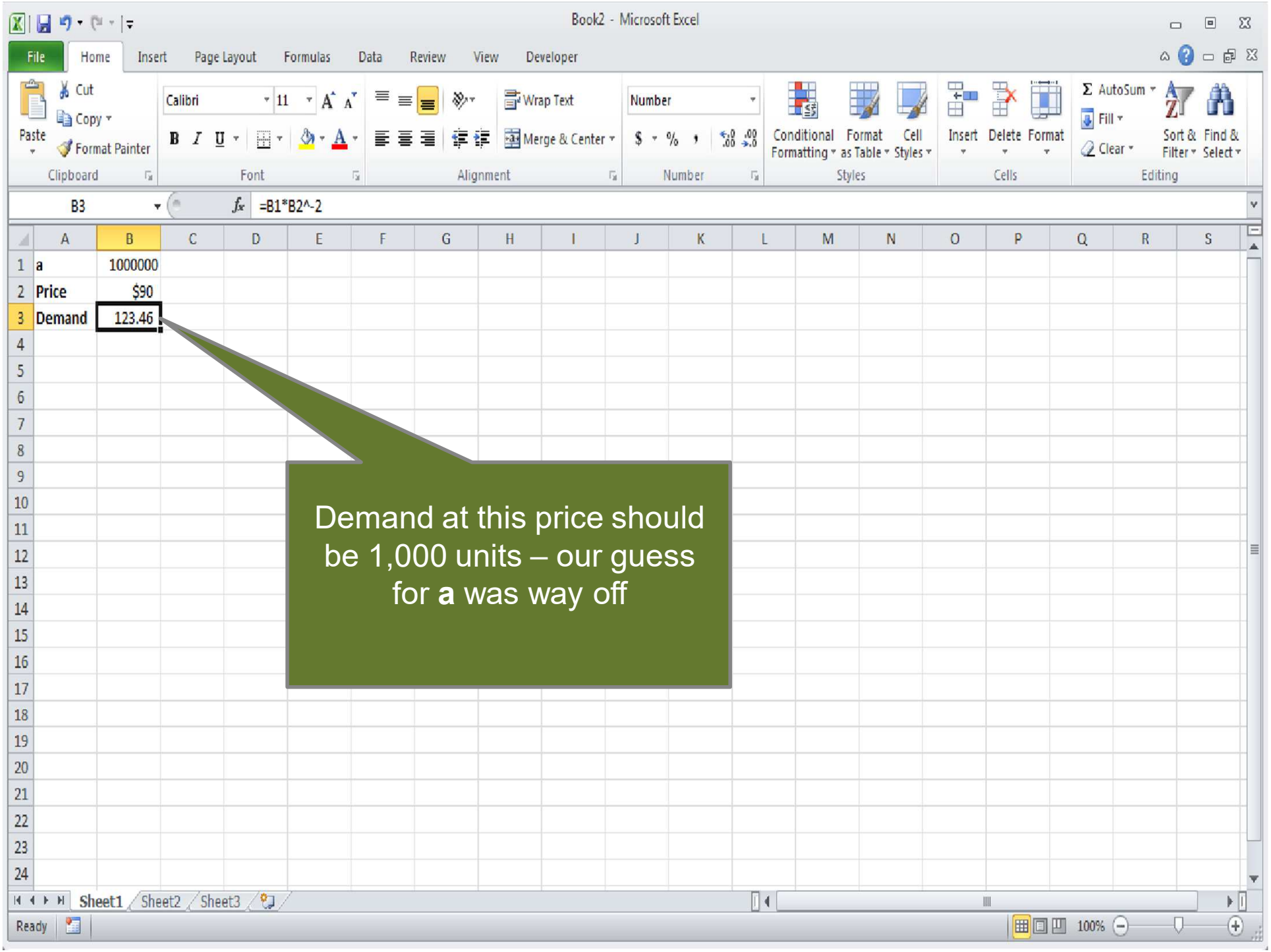
General
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
DDB
=B1*B2^-2
a
1000000
Price
$90
Demand
L*B2^-2
Accept formula
Sheet1
Sheet2
Sheet3
Enter
100%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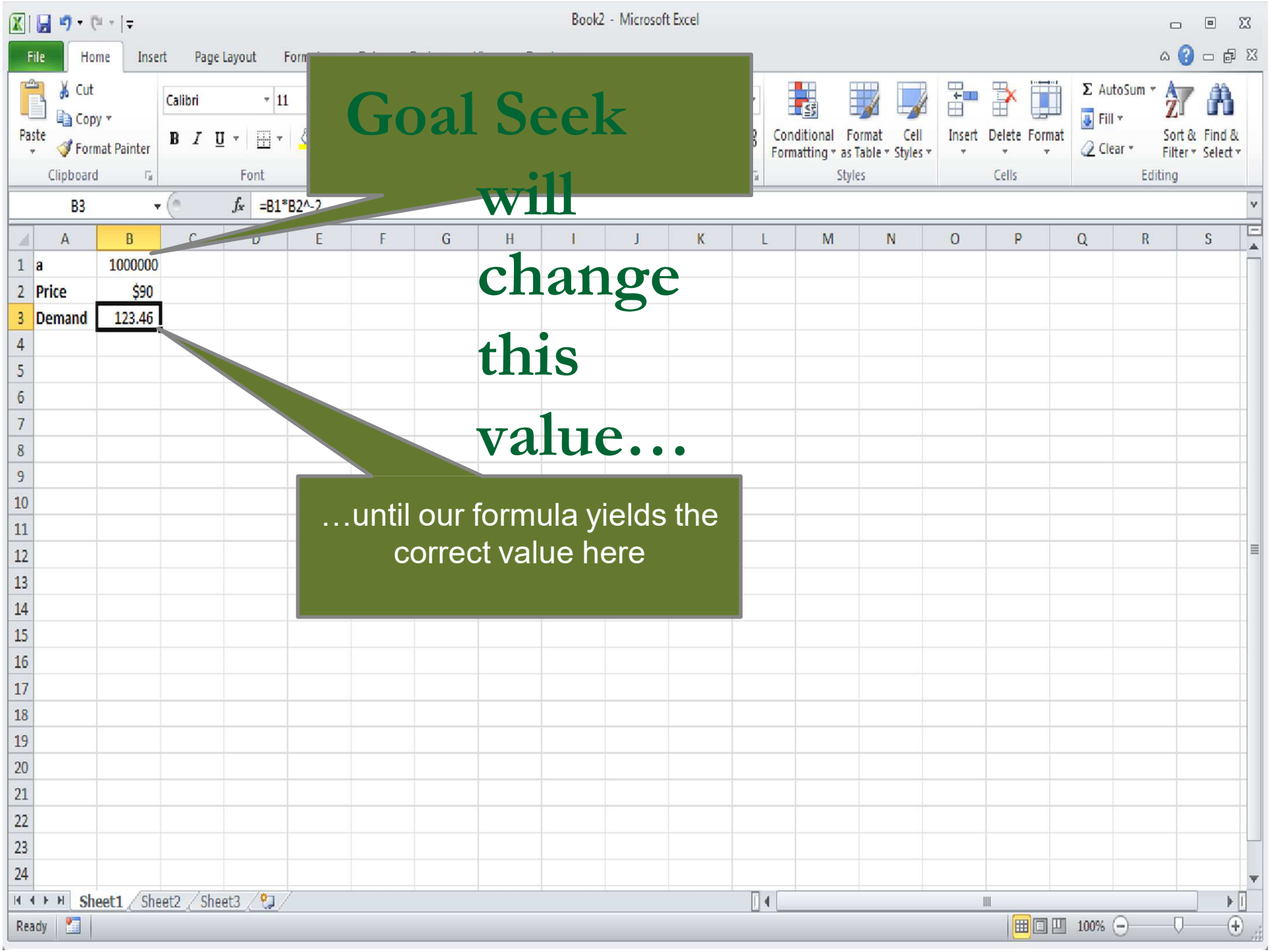
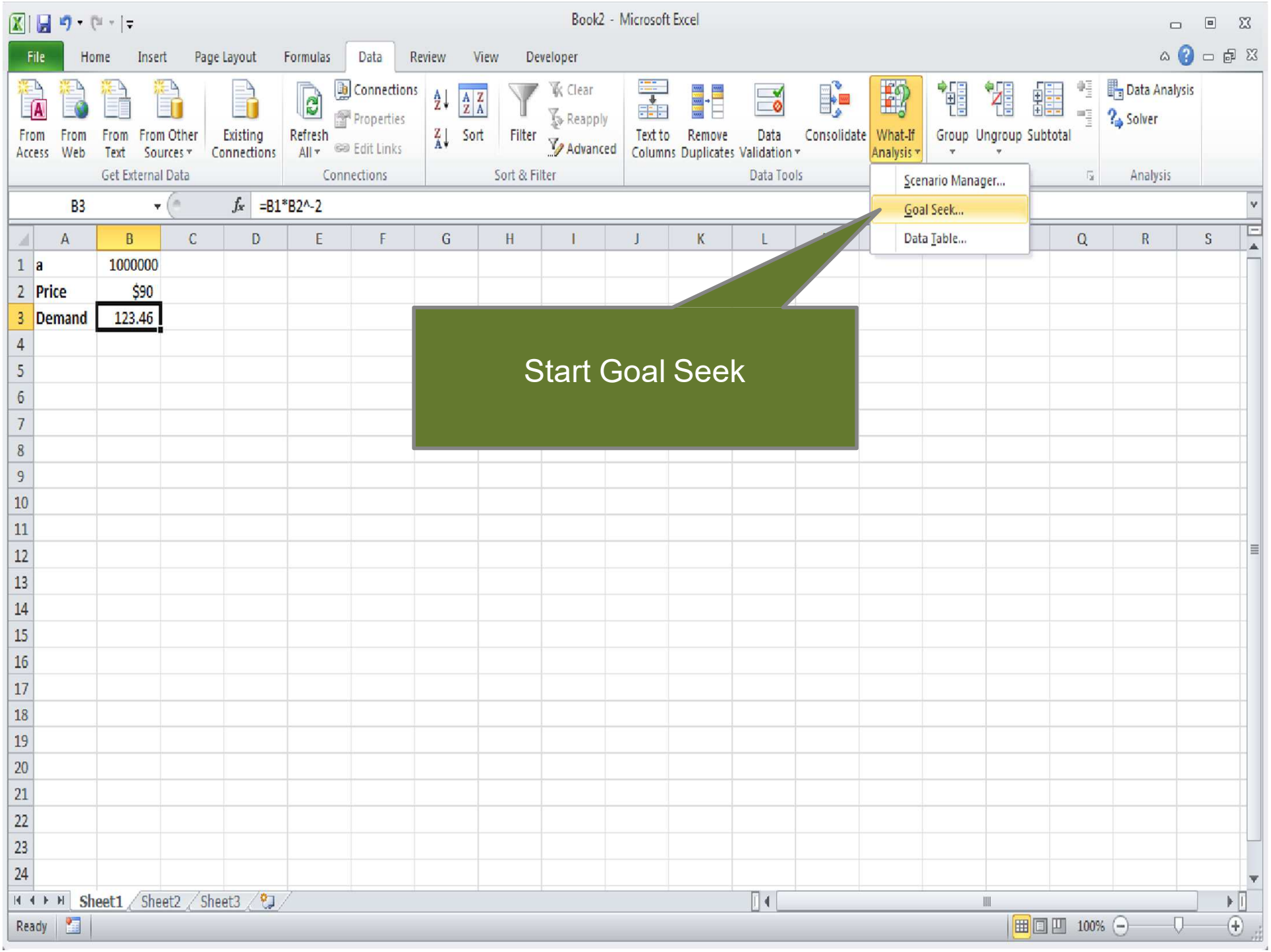
Number
Number
Conditional Formatting
Format as Table
Cell Styles
Styles
Insert
Delete
Format
Cells
AutoSum
Fill
Clear
Sort & Filter
Find & Select
Editing
B3
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Demand at this price should be 1,000 units – our guess for a was way off
Sheet1
Sheet2
Sheet3
Ready
100%


Book2 - Microsoft Excel
File
Home
Insert
Page Layout
Clipboard
Font
Styles
Cells
Editing
B3
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Goal Seek will change this value…
…until our formula yields the correct value here
Sheet1
Sheet2
Sheet3
Ready
100%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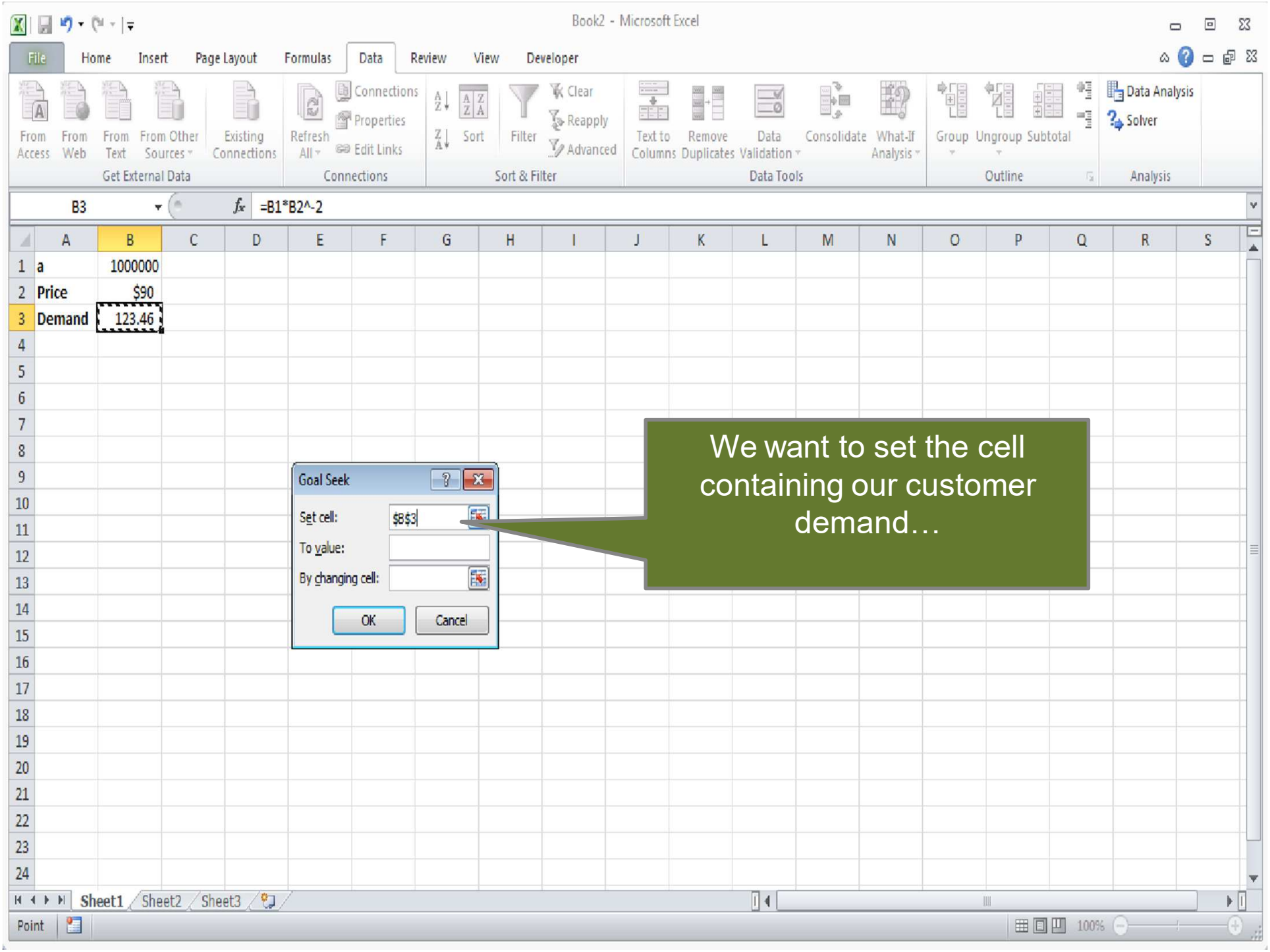
Reapply
Advanced
Sort & Filter
Text to Columns
Remove Duplicates
Data Validation
Consolidate
What-If Analysis
Group
Ungroup
Subtotal
Data Tools
Data Analysis
Solver
Analysis
Scenario Manager...
Goal Seek...
Data Table...
B3
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Start Goal Seek
Sheet1
Sheet2
Sheet3
Ready
100%


Book2 - Microsoft Excel
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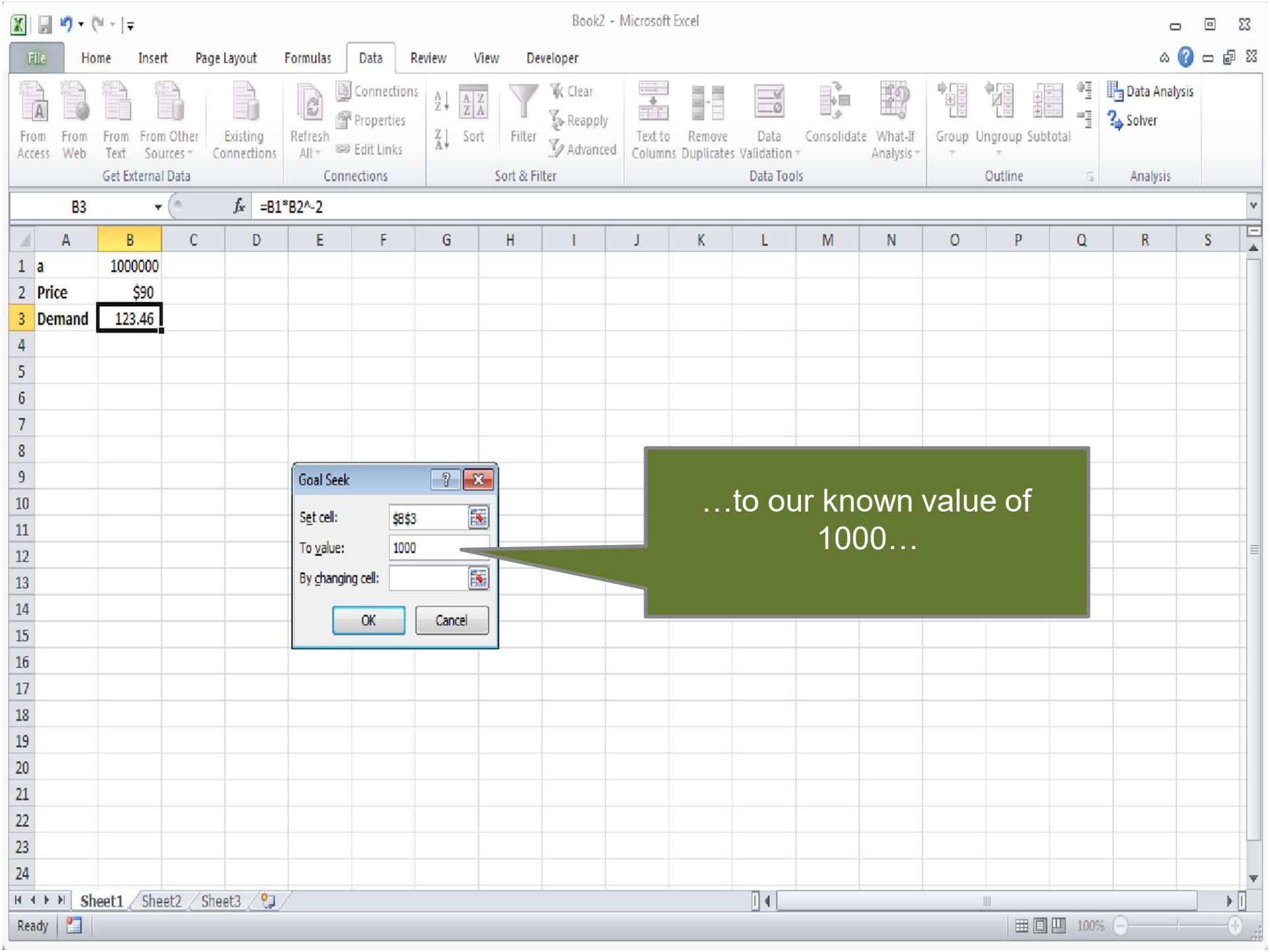
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
B3
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Goal Seek
Set cell:
$B$3
To value:
By changing cell:
OK
Cancel
We want to set the cell containing our customer demand…
Sheet1
Sheet2
Sheet3
Point
100%


Book2 - Microsoft Excel
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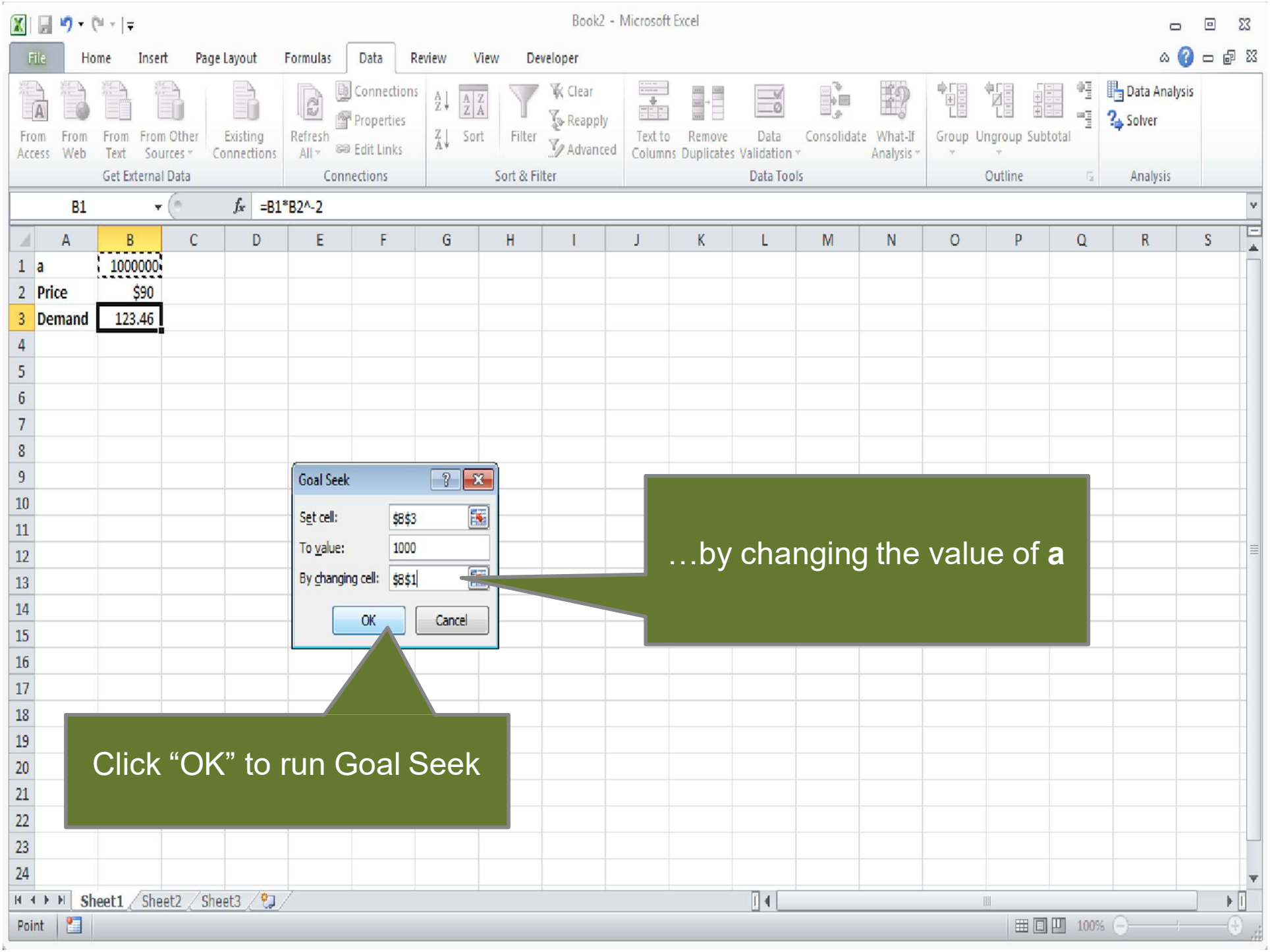
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
B3
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Goal Seek
Set cell:
$B$3
To value:
1000
By changing cell:
OK
Cancel
…to our known value of 1000…
Sheet1
Sheet2
Sheet3
Ready
100%


Book2 - Microsoft Excel
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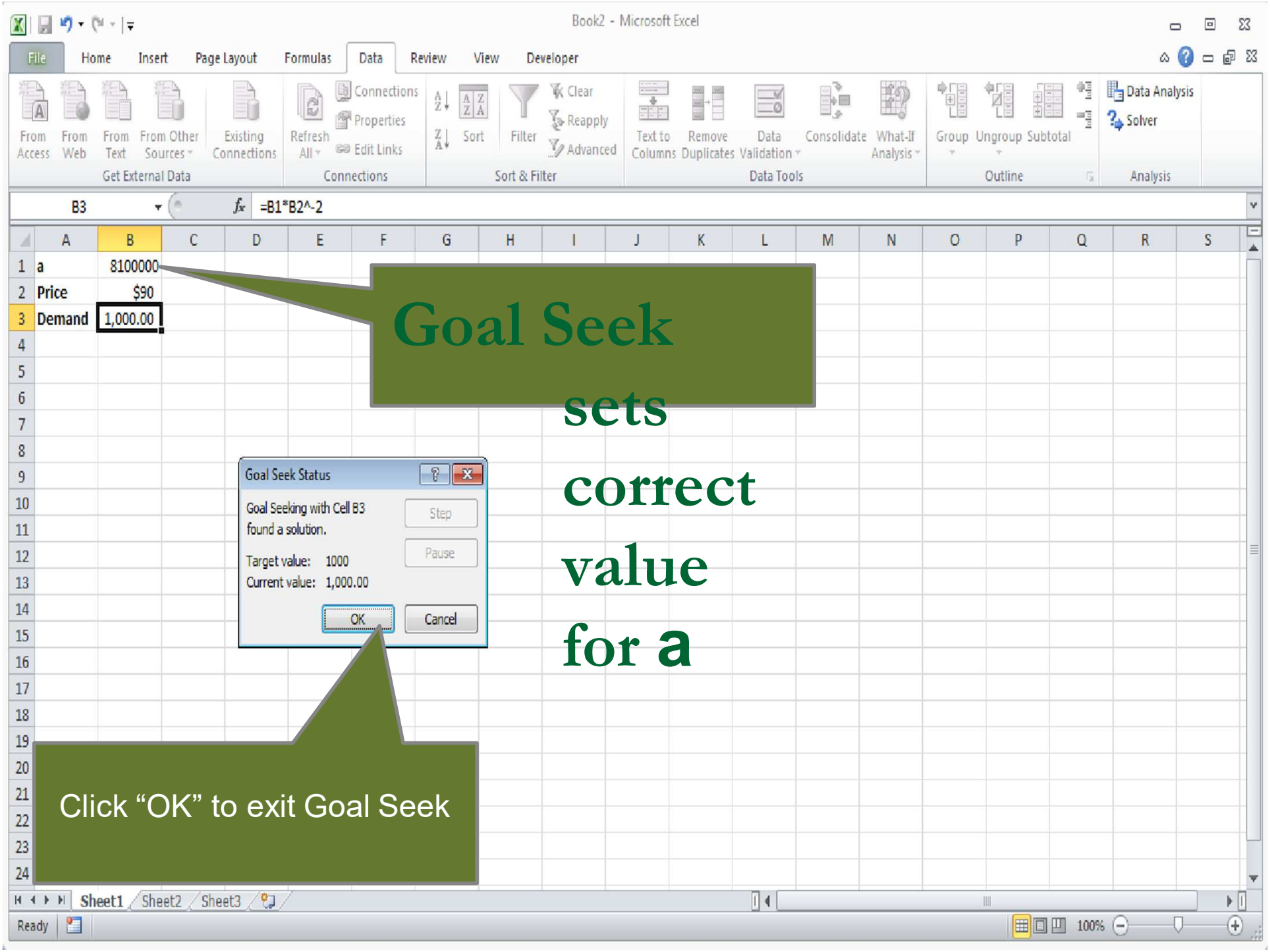
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
B1
=B1*B2^-2
a
1000000
Price
$90
Demand
123.46
Goal Seek
Set cell:
$B$3
To value:
1000
By changing cell:
$B$1
OK
Cancel
…by changing the value of a
Click “OK” to run Goal Seek
Sheet1
Sheet2
Sheet3
Point
100%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Page Layout
Formulas
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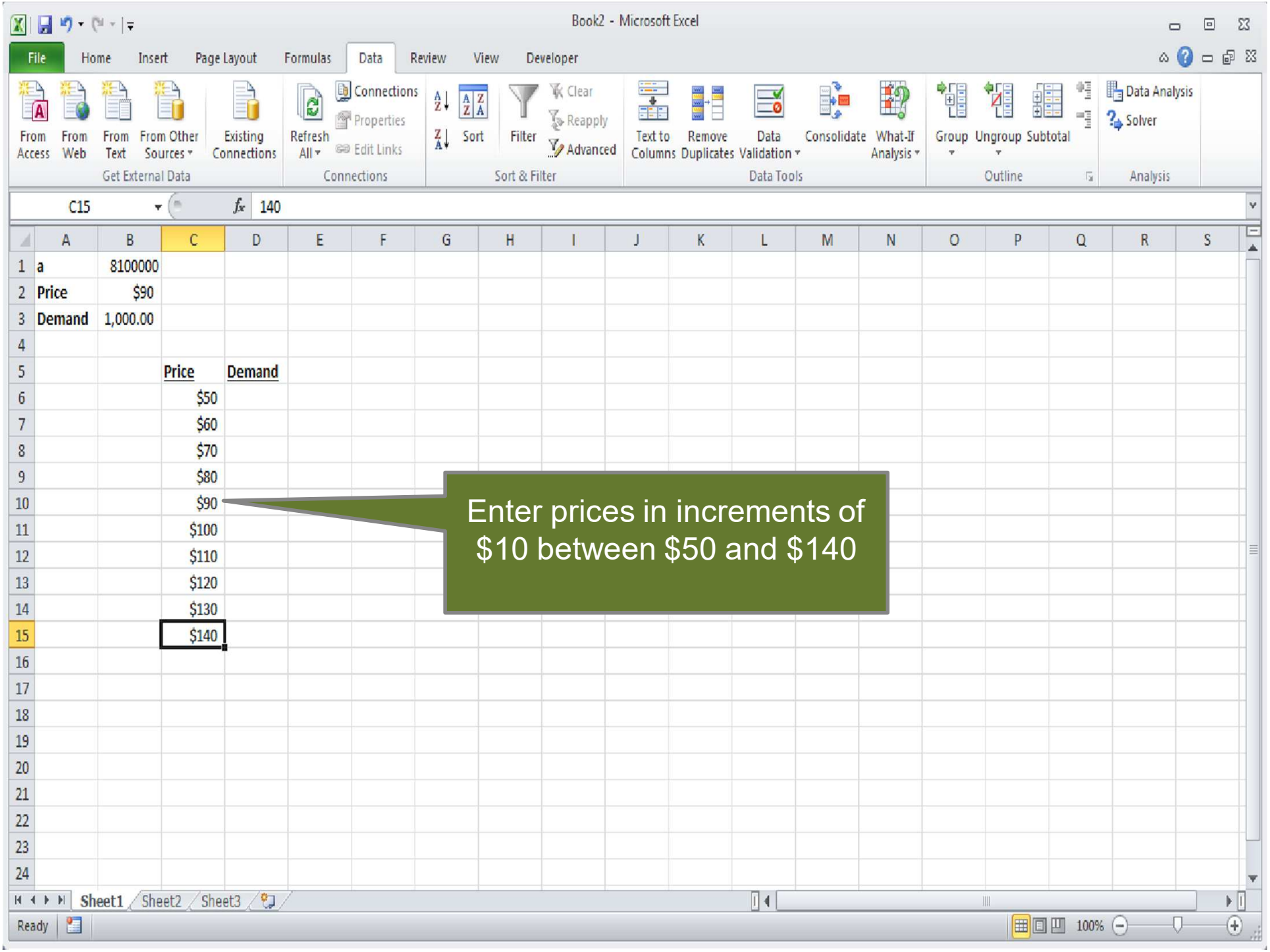
Review
View
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
B3
=B1*B2^-2
a
8100000
Price
$90
Demand
1,000.00
Goal Seek
sets
correct
value
for a
Goal Seek Status
Goal Seeking with Cell B3
found a solution.
Target value: 1000
Current value: 1,000.00
Step
Pause
OK
Cancel
Click “OK” to exit Goal Seek
Sheet1
Sheet2
Sheet3
Ready
100%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Get External Data
Refresh All
Connections
Properties
Edit Links
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Sort
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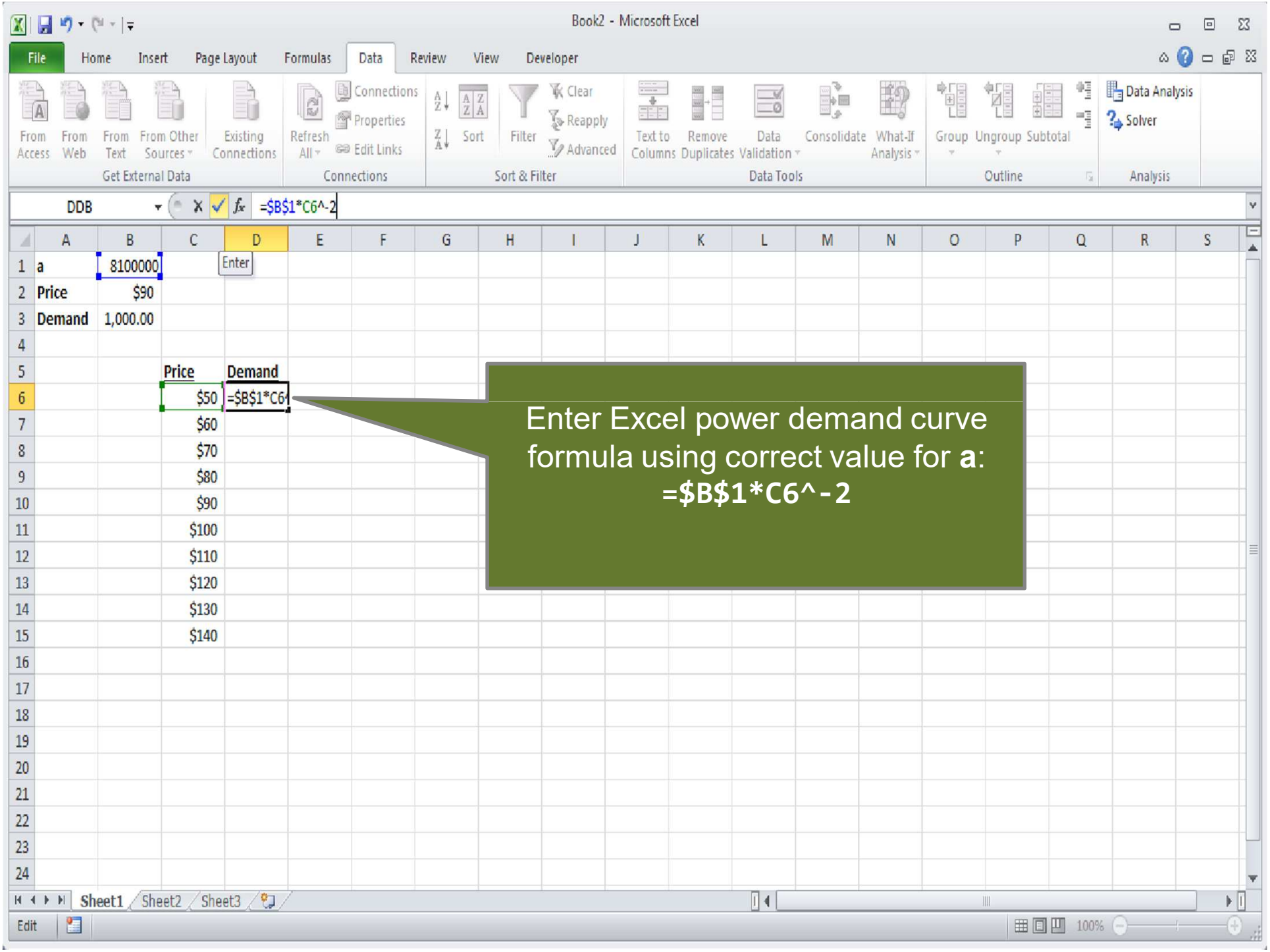
Reapply
Advanced
Sort & Filter
Text to Columns
Remove Duplicates
Data Validation
Consolidate
What-If Analysis
Data Tools
Group
Ungroup
Subtotal
Outline
Data Analysis
Solver
Analysis
C15
140
a 8100000
Price $90
Demand 1,000.00
Price Demand
$50
$60
$70
$80
$90
$100
$110
$120
$130
$140
Enter prices in increments of $10 between $50 and $140
Sheet1
Sheet2
Sheet3
Ready
100%


Book2 - Microsoft Excel
File
Home
Insert
Page Layout
Formulas
Data
Review
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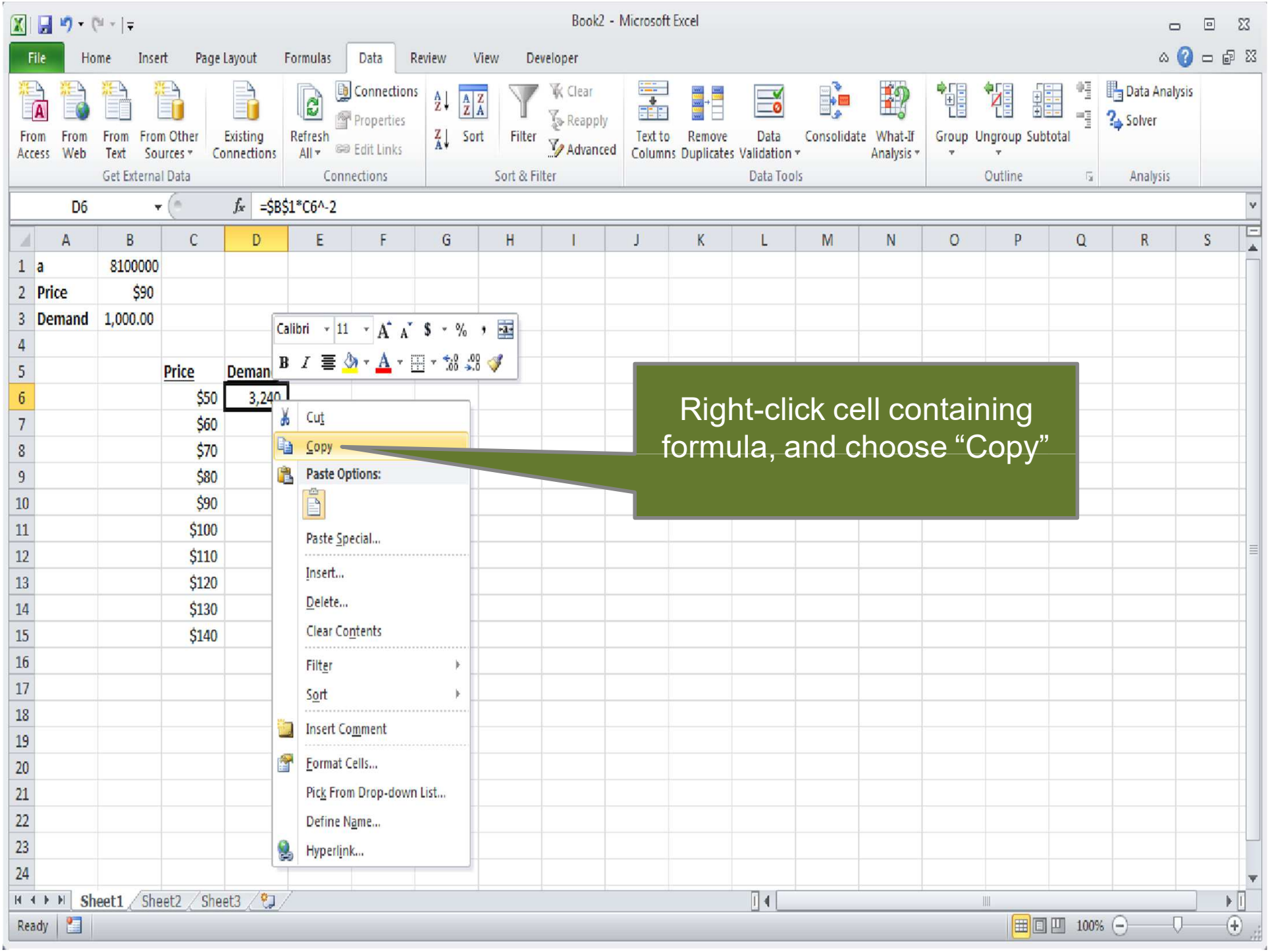
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
DDB
=$B$1*C6^-2
Enter
a
8100000
Price
$90
Demand
1,000.00
Price
Demand
$50
=$B$1*C6
$60
$70
$80
$90
$100
$110
$120
$130
$140
Enter Excel power demand curve formula using correct value for a:
=$B$1*C6^-2
Sheet1
Sheet2
Sheet3
Edit
100%


Book2 - Microsoft Excel
File
Home
Insert
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Formulas
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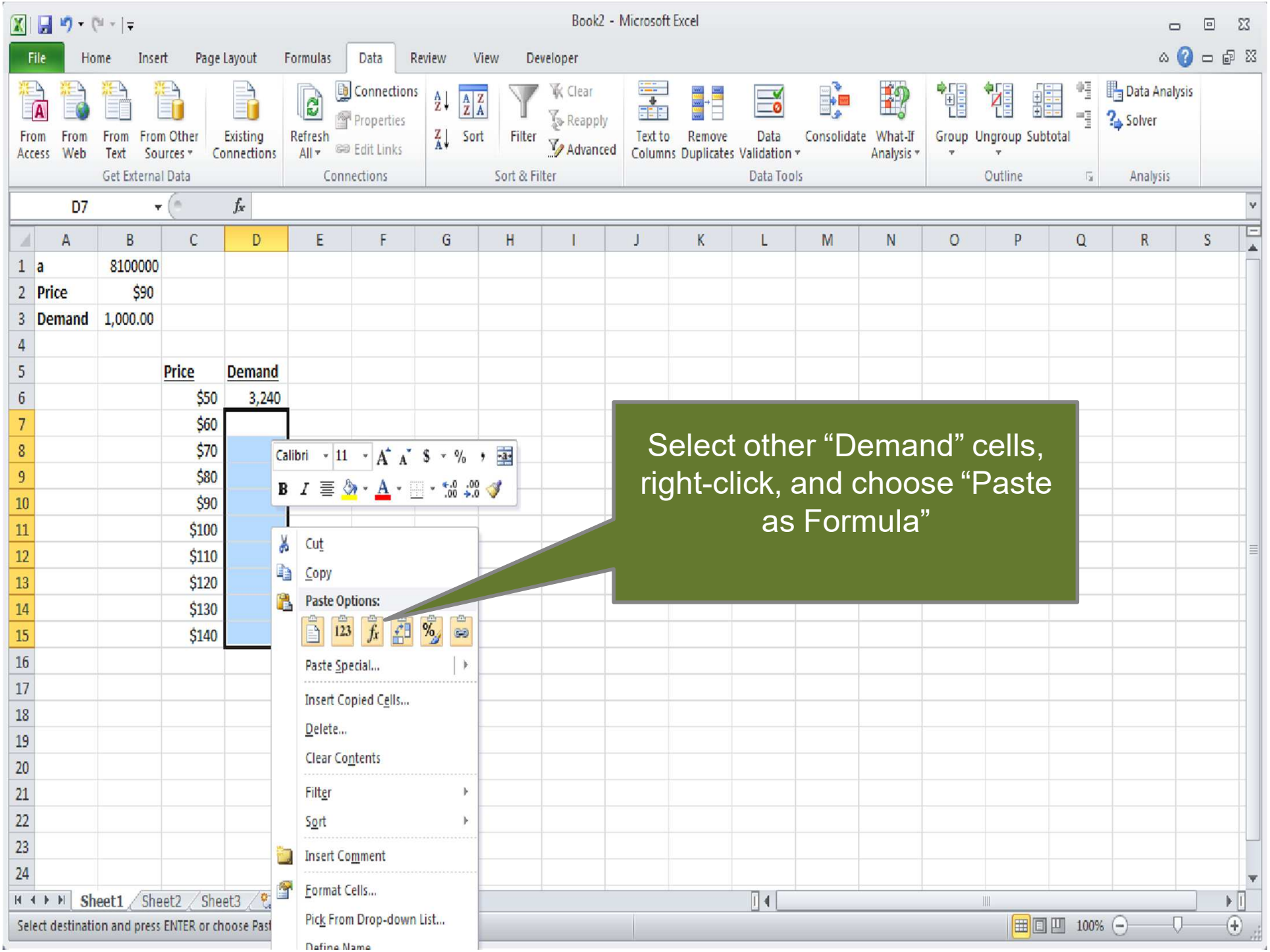
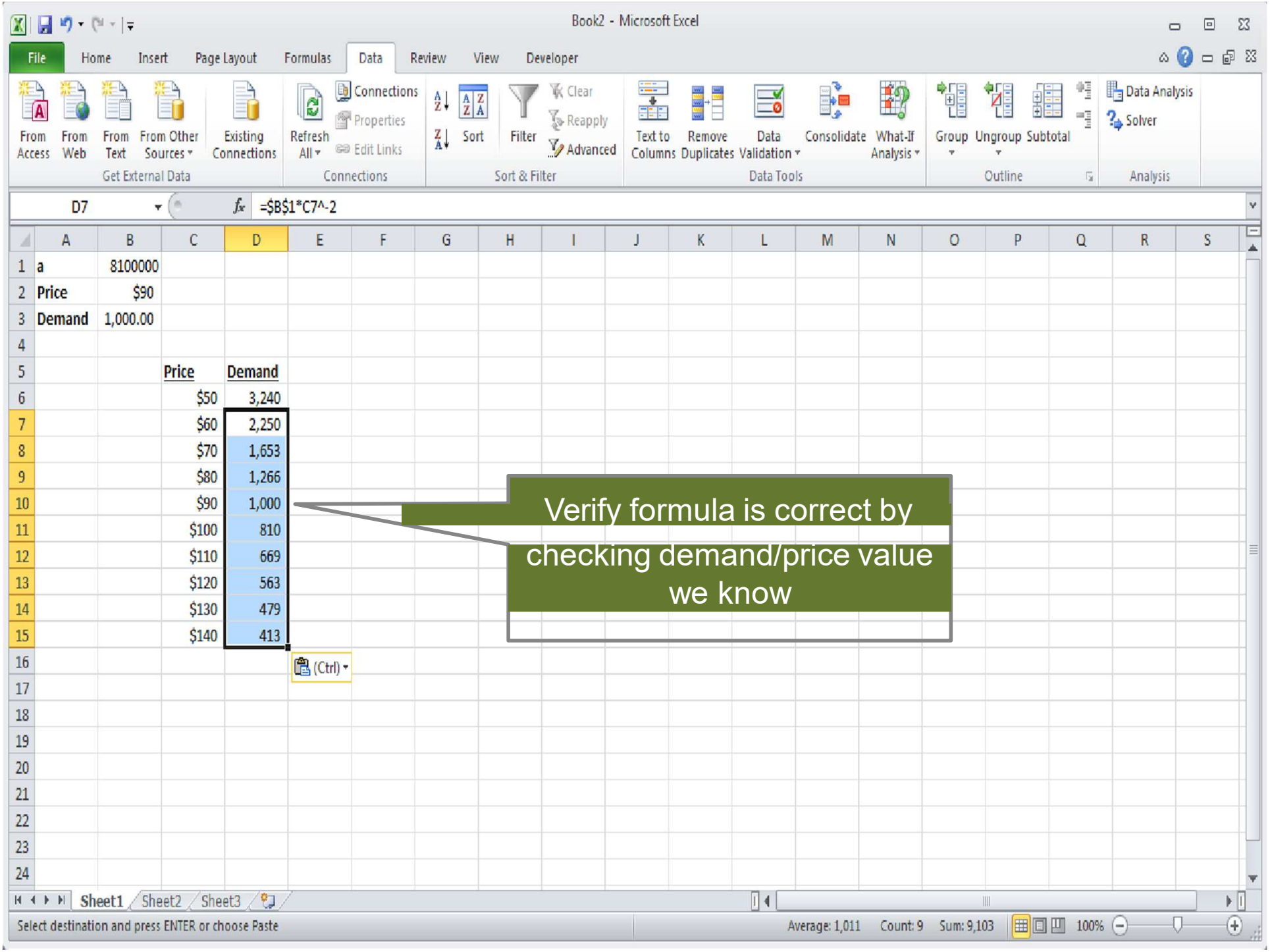
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
D6
=$B$1*C6^-2
a 8100000
Price $90
Demand 1,000.00
Price
Deman
$50 3,240
$60
$70
$80
$90
$100
$110
$120
$130
$140
Cut
Copy
Paste Options:
Paste Special...
Insert...
Delete...
Clear Contents
Filter
Sort
Insert Comment
Format Cells...
Pick From Drop-down List...
Define Name...
Hyperlink...
Right-click cell containing formula, and choose “Copy”
Sheet1
Sheet2
Sheet3
Ready
100%


Book2 - Microsoft Excel
File
Home
Insert
Page Layout
Formulas
Data
Review
View
Developer
Get External Data
Connections
Sort & Filter
Data Tools
Outline
Analysis
D7
a 8100000
Price $90
Demand 1,000.00
Price Demand
$50 3,240
$60
$70
$80
$90
$100
$110
$120
$130
$140
Cut
Copy
Paste Options:
Paste Special...
Insert Copied Cells...
Delete...
Clear Contents
Filter
Sort
Insert Comment
Format Cells...
Pick From Drop-down List...
Sheet1
Sheet2
Sheet3
Select destination and press ENTER or choose Past
100%
Select other “Demand” cells, right-click, and choose “Paste as Formula”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From Access
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From Text
From Other Sources
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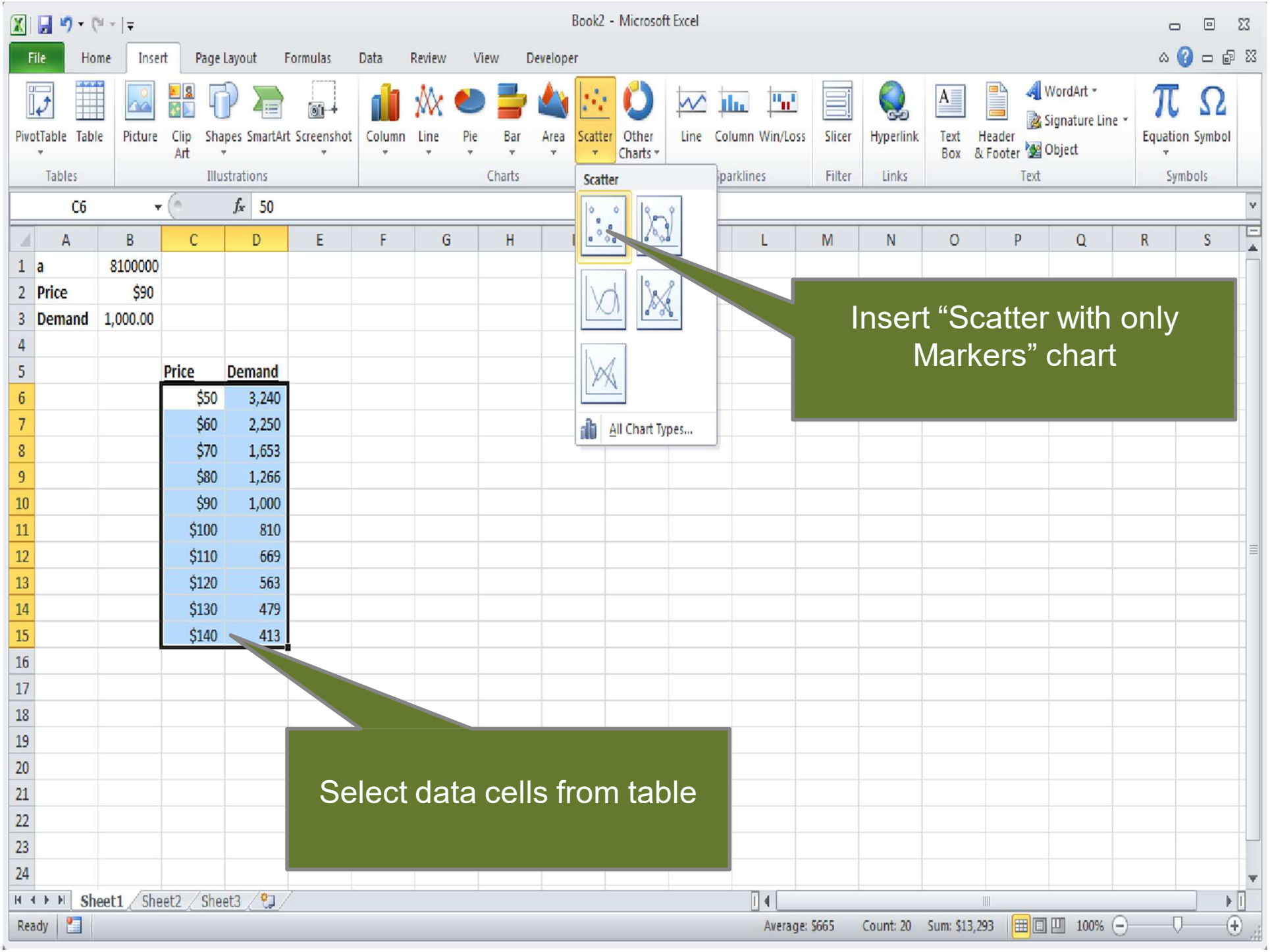
Outline
Data Analysis
Solver
Analysis
D7
=$B$1*C7^-2
a 8100000
Price $90
Demand 1,000.00
Price Demand
$50 3,240
$60 2,250
$70 1,653
$80 1,266
$90 1,000
$100 810
$110 669
$120 563
$130 479
$140 413
(Ctrl)
Verify formula is correct by checking demand/price value we know
Sheet1
Sheet2
Sheet3
Select destination and press ENTER or choose Paste
Average: 1,011
Count: 9
Sum: 9,103
100%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File
Home
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PivotTable
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Bar
Area
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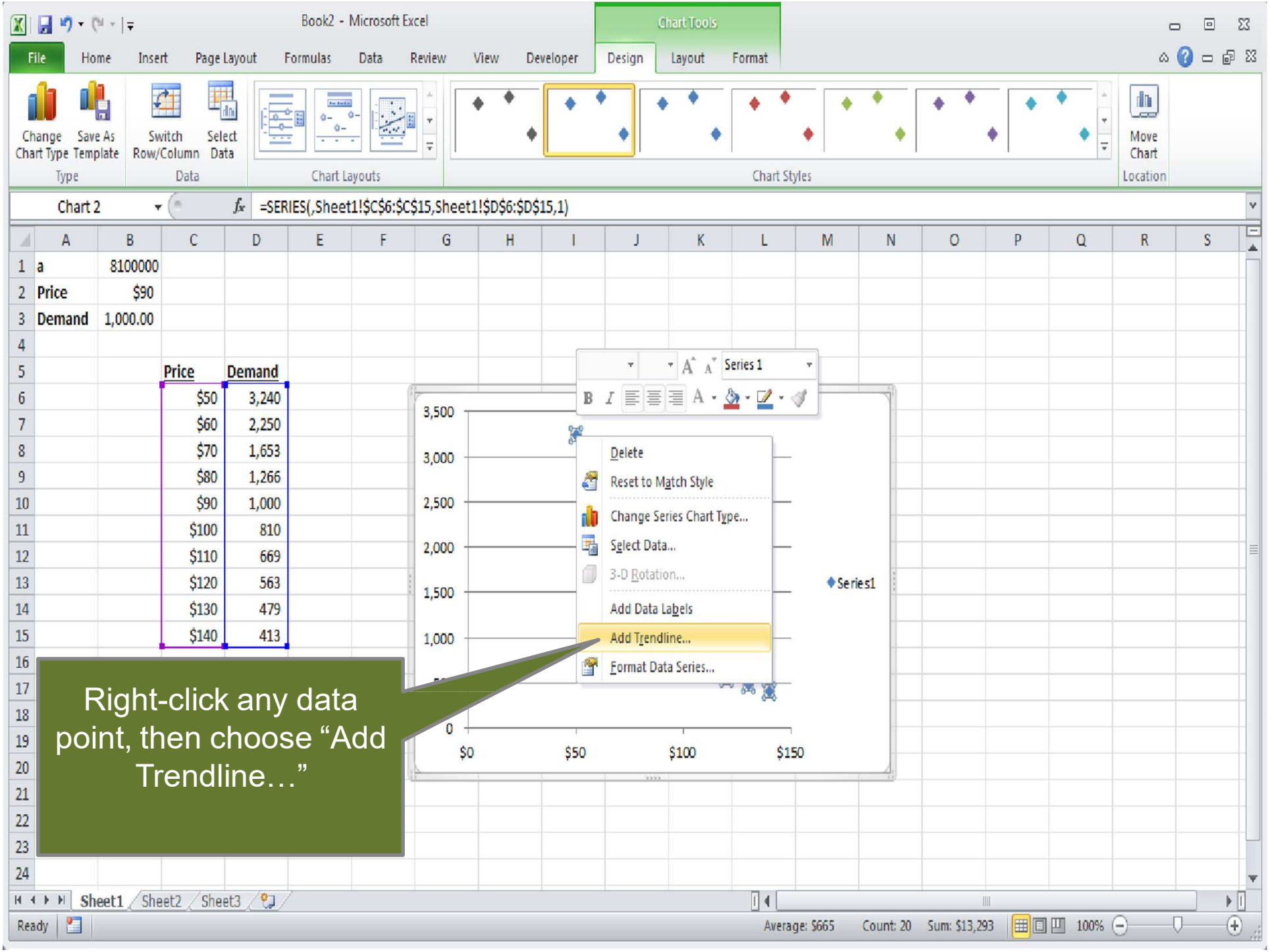
Slicer
Hyperlink
Text Box
Header & Footer
WordArt
Signature Line
Object
Equation
Symbol
Tables
Illustrations
Charts
Sparklines
Filter
Links
Text
Symbols
Scatter
All Chart Types...
C6
50
a 8100000
Price $90
Demand 1,000.00
Price Demand
$50 3,240
$60 2,250
$70 1,653
$80 1,266
$90 1,000
$100 810
$110 669
$120 563
$130 479
$140 413
Insert “Scatter with only Markers” chart
Select data cells from table
Sheet1
Sheet2
Sheet3
Ready
Average: $665
Count: 20
Sum: $13,293
100%

Chartofpoin


Book2 - Microsoft Excel
Chart Tools
File
Home
Insert
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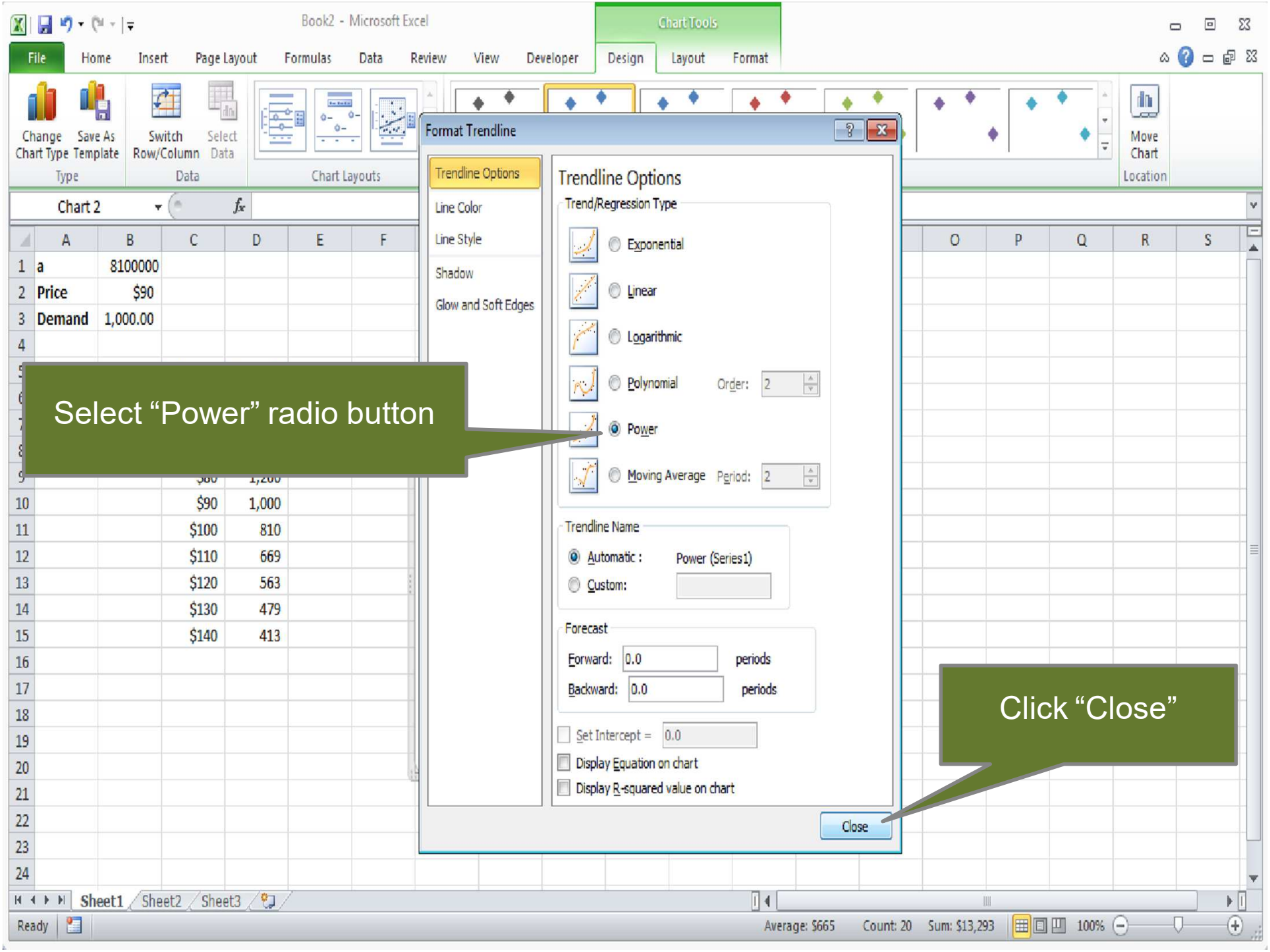
Developer
Design
Layout
Format
Change Chart Type
Save As Template
Type
Switch Row/Column
Select Data
Data
Chart Layouts
Chart Styles
Move Chart
Location
Chart 2
=SERIES(,Sheet1!$C$6:$C$15,Sheet1!$D$6:$D$15,1)
a 8100000
Price $90
Demand 1,000.00
Price Demand
$50 3,240
$60 2,250
$70 1,653
$80 1,266
$90 1,000
$100 810
$110 669
$120 563
$130 479
$140 413
Series 1
Delete
Reset to Match Style
Change Series Chart Type...
Select Data...
3-D Rotation...
Add Data Labels
Add Trendline...
Format Data Series...
Series1
3,500
3,000
2,500
2,000
1,500
1,000
0
$0
$50
$100
$150
Right-click any data point, then choose “Add Trendline…”
Sheet1
Sheet2
Sheet3
Ready
Average: $665
Count: 20
Sum: $13,293
100%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Change Chart Type
Save As Template
Type
Switch Row/Column
Select Data
Data
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Location
Chart 2
Format Trendline
Trendline Options
Line Color
Line Style
Shadow
Glow and Soft Edges
Trendline Options
Trend/Regression Type
Exponential
Linear
Logarithmic
Polynomial
Order: 2
Power
Moving Average
Period: 2
Trendline Name
Automatic :
Power (Series1)
Custom:
Forecast
Forward: 0.0
periods
Backward: 0.0
periods
Set Intercept = 0.0
Display Equation on chart
Display R-squared value on chart
Close
Select “Power” radio button
Click “Close”
a 8100000
Price $90
Demand 1,000.00
$90 1,000
$100 810
$110 669
$120 563
$130 479
$140 413
Sheet1
Sheet2
Sheet3
Ready
Average: $665
Count: 20
Sum: $13,293
100%

Book2 - Microsoft Excel

Chart Tools

File | Home | Insert | Page Layout | Formulas | Data | Review | View | Developer | Design | Layout | Format

Change Chart Type | Save As Template | Type

Switch Row/Column | Select Data | Data

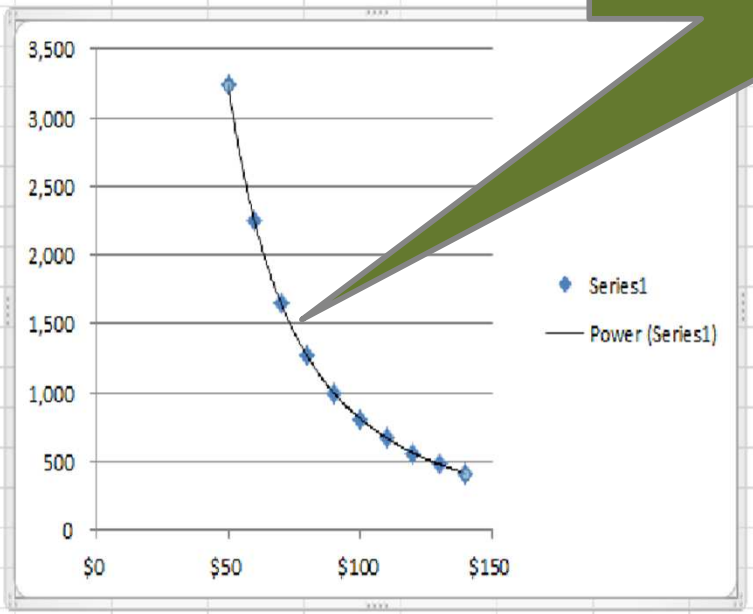
Chart Layouts

Chart Styles

Move Chart | Location

Chart 2

	A	B	C	D
1	a	8100000		
2	Price	$90		
3	Demand	1,000.00		
4				
5			Price	Demand
6			$50	3,240
7			$60	2,250
8			$70	1,653
9			$80	1,266
10			$90	1,000
11			$100	810
12			$110	669
13			$120	563
14			$130	479
15			$140	413



Power demand curve

Sheet1 | Sheet2 | Sheet3

Ready

Average: $665 | Count: 20 | Sum: $13,293 | 100%

Constructing Power Demand Curves

- Value of **a** determined to be 8,100,000

$$D = 8{,}100{,}000p^{-2}$$

- Price elasticity remains constant for every price on the demand curve