Seminar on Public Finance

Lecture #2: January 23

Economic Incidence of Taxation

Incidence: Statutory vs Economic

- Who bears the statutory incidence of a tax is a trivial question.
    - It is whoever physically pays the tax.
- While policy makers will point to the statutory incidence, it is not an indicator of who bears the burden of the tax.
- The economic burden of the tax is called the economic incidence.
- **Tax Shifting** is what happens when the economic incidence of the tax differs from the statutory incidence (almost always)
- Formally: **Economic incidence** is the burden of taxation measured by the change in resources available to any economic agent as a result of taxation.

Economic Incidence: Basics (1)

- Only people pay taxes
  - When the statutory incidence is placed on a firm that tax will be passed on; to owners, to customers, to suppliers, to employees, etc.
- Taxes change the prices of goods and as prices change so does the consumption of goods.
- Three basic rules
  1. The statutory burden of a tax does not describe who really bears the tax.
  2. The side of the market on which the tax is imposed is irrelevant to the distribution of tax burdens.
  3. Parties with inelastic supply or demand bear the burden of a tax.

Economic Incidence: Basics (2)

- Incidence analysis is a study of distribution but there are many dimensions that incidence can be studied over.
- Common forms of analysis:
  - Consumers vs Producers
  - Factors of production (capital, labor, land, etc)
  - Economic well-being (income or wealth distribution)
  - Regional incidence (between states or countries)
  - Intergenerational (generational accounting, e.g. w/ Social Security)

Economic Incidence: Basics (3)

- Incidence depends on how prices are determined
  - Industry structure matters
  - Short-run versus long-run responses matter
- Tax progressiveness can be measured in a number of ways
  - A tax is often classified as:
    - Progressive
    - Regressive
    - Proportional
  - Proportional taxes are straightforward: ratio of taxes to income is constant regardless of income level.
- Can compute in terms of
  - *Average* tax rate (ratio of total taxes total income) or
  - *Marginal* tax rate (tax rate on last dollar of income)

Economic Incidence: Basics (4)

- Can define progressive (and regressive) taxes in a number of ways.
- Define T as the economic burden of the tax, and Y as income.
  - A proportional tax: $T = mY$
  - A progressive tax: T/Y increases with income
  - A regressive tax: T/Y decreases with income
- Some tricky cases:
  - Flat tax structure $T = max\{m(y - A), 0\}$ - is progressive; T/Y starts at 0 and then asymptotes to m.
  - Medicare payroll tax is regressive, since it applies only to wage income (less true starting in 2013)

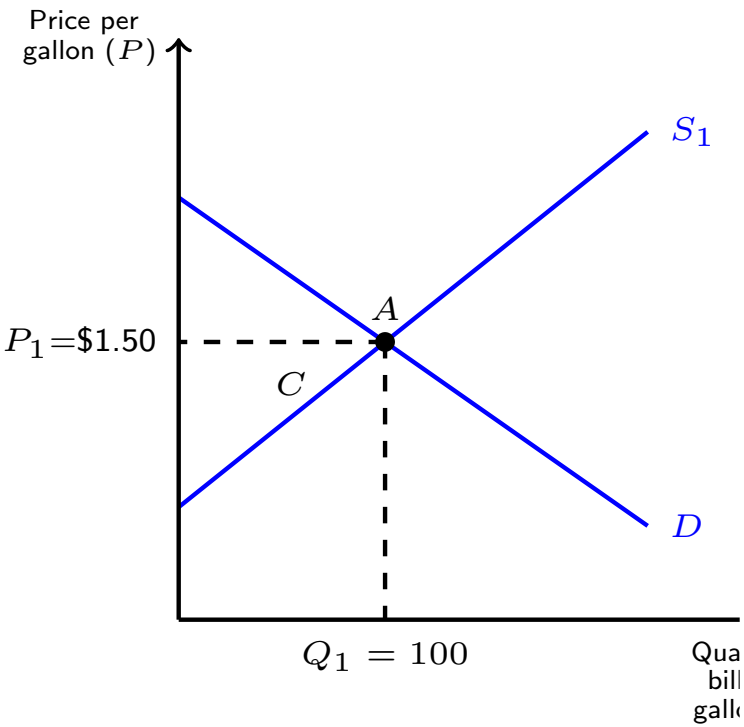
Economic Incidence: Basics (5)

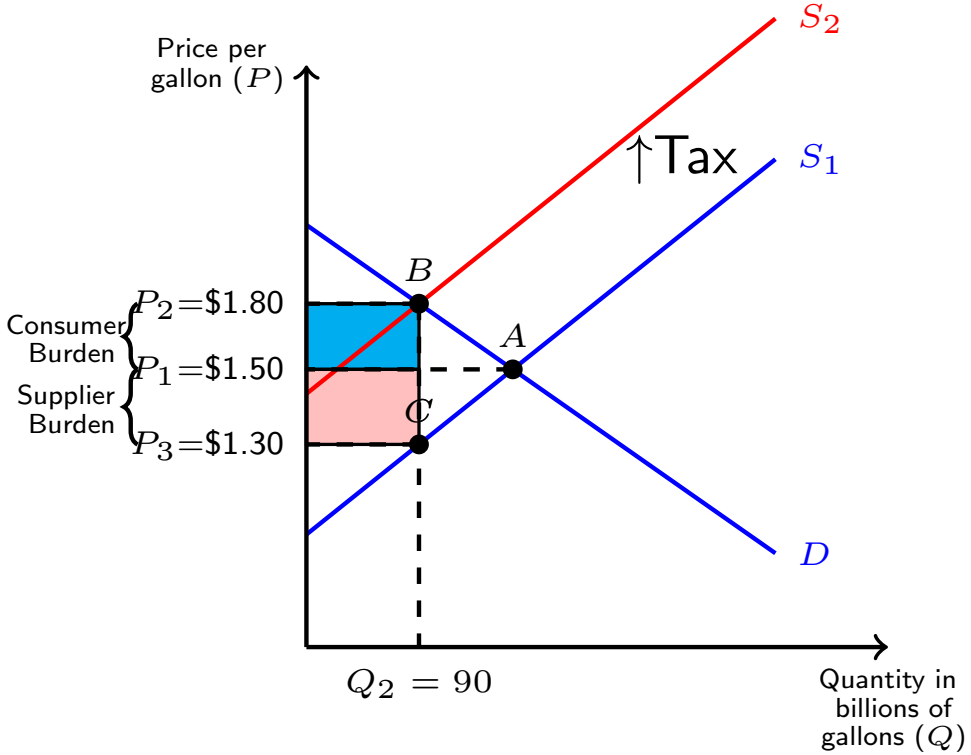
- Measuring how progressive a tax system is presents additional difficulties. Consider two simple definitions:
  1. $v_1 = \frac{\frac{T_1}{I_1} - \frac{T_0}{I_0}}{I_1 - I_0}$
  2. $v_2 = \frac{\%\Delta T}{\%\Delta I} = \frac{\frac{(T_1 - T_0)}{T_0}}{\frac{(I_0 - I_1)}{I_0}}$
- The first one says that the greater the increase in average tax rates as income rises, the more progressive is the system.
- The second one says a tax system is more progressive if its elasticity of tax revenues with respect to income is higher.
- You can get conflicting answers - try it!

Partial equilibrium tax incidence

- When a tax is imposed on producers, they will raise prices to some extent to offset this tax burden.
  - Producer tax burden = (pretax price - posttax price) + tax payments of producers
- When a tax is imposed on consumers, they are not willing to pay as much for a good, so prices fall. The tax burden for consumers is:
  - Consumer tax burden = (posttax price - pretax price) + tax payments of consumers

Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on suppliers of gasoline (1)





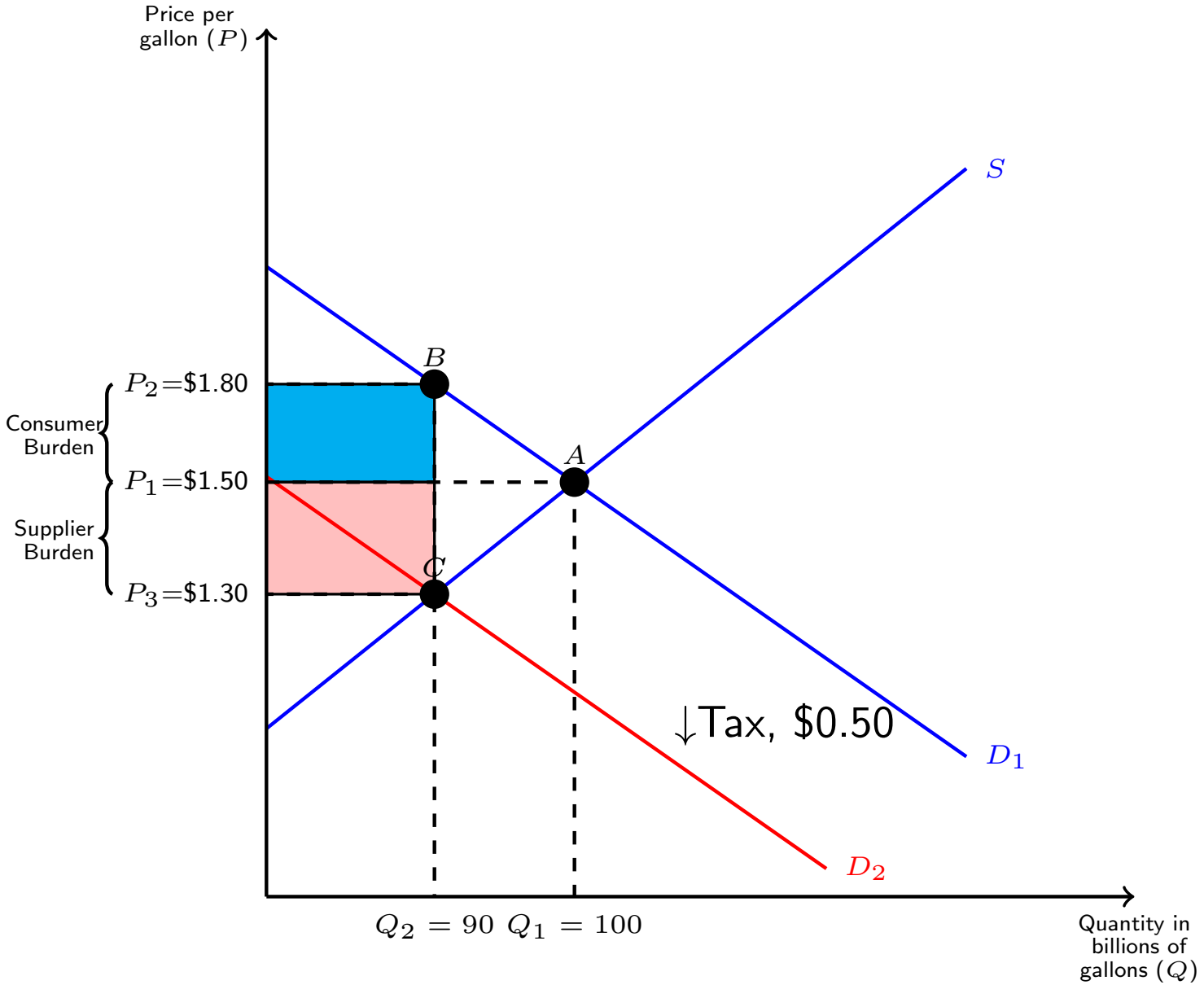
Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on suppliers of gasoline (2)

- The initial market equilibrium is 100 billion gallons sold at $1.50 per gallon.
- The $0.50 tax raises the marginal costs of production for the firm, shifting the supply curve up to S2.
- At the original market price, there is now excess demand of 20 billion gallons; the price is bid up to $1.80, where there is neither a shortage nor a surplus.
- The gasoline tax has two effects:
  1. It changes the market price
  2. Producers must now pay a tax to the government

Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on suppliers of gasoline (3)

- Recall that:
  - Consumer tax burden = (posttax price - pretax price) + tax payments of consumers = ($1.80 - $1.50) + 0 = $0.30
  - Producer tax burden = (pretax price - posttax price) + tax payments of producers = ($1.50 - $1.80) + $0.50 = $0.20
- This analysis reveals that the true burden on producers is not $0.50, but some smaller number, because part of the burden is borne by consumers in the form of a higher price.
- The **tax wedge** is the difference between what consumers pay and what producers receive from a transaction.
  - The wedge in this case is the difference between the $1.80 consumers pay and the $1.30 producers receive.

Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on demanders of gasoline (1)



Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on demanders of gasoline (2)

- The initial market equilibrium is 100 billion gallons sold at $1.50 per gallon.
- Although the *overall* willingness to pay for a unit of gasoline is unchanged, the $0.50 tax lowers the consumers' willingness to pay *producers* by $0.50 (since consumers must pay the government). Thus, the demand curve shifts to D2.
- At the original market price, there is now excess supply of gasoline; producers lower their price until $1.30, where there is neither a shortage nor a surplus.

Partial equilibrium tax incidence: Impact of a $0.50 per gallon tax on demanders of gasoline (3)

- As before, the new gasoline tax has two effects:
  1. It changes the market price
  2. Consumers must now pay a tax to the government
- Consumer tax burden = (posttax price - pretax price) + tax payments of consumers = ($1.30 - $1.50) + $0.50 = $0.30
- Producer tax burden = (pretax price - posttax price) + tax payments of producers = ($1.50 - $1.30) + 0 = $0.20
- Note that these tax burdens are identical to the burdens when the tax was levied on producers.
- This illustrates an important lesson the side on which the tax is imposed is irrelevant for the distribution of tax burdens.

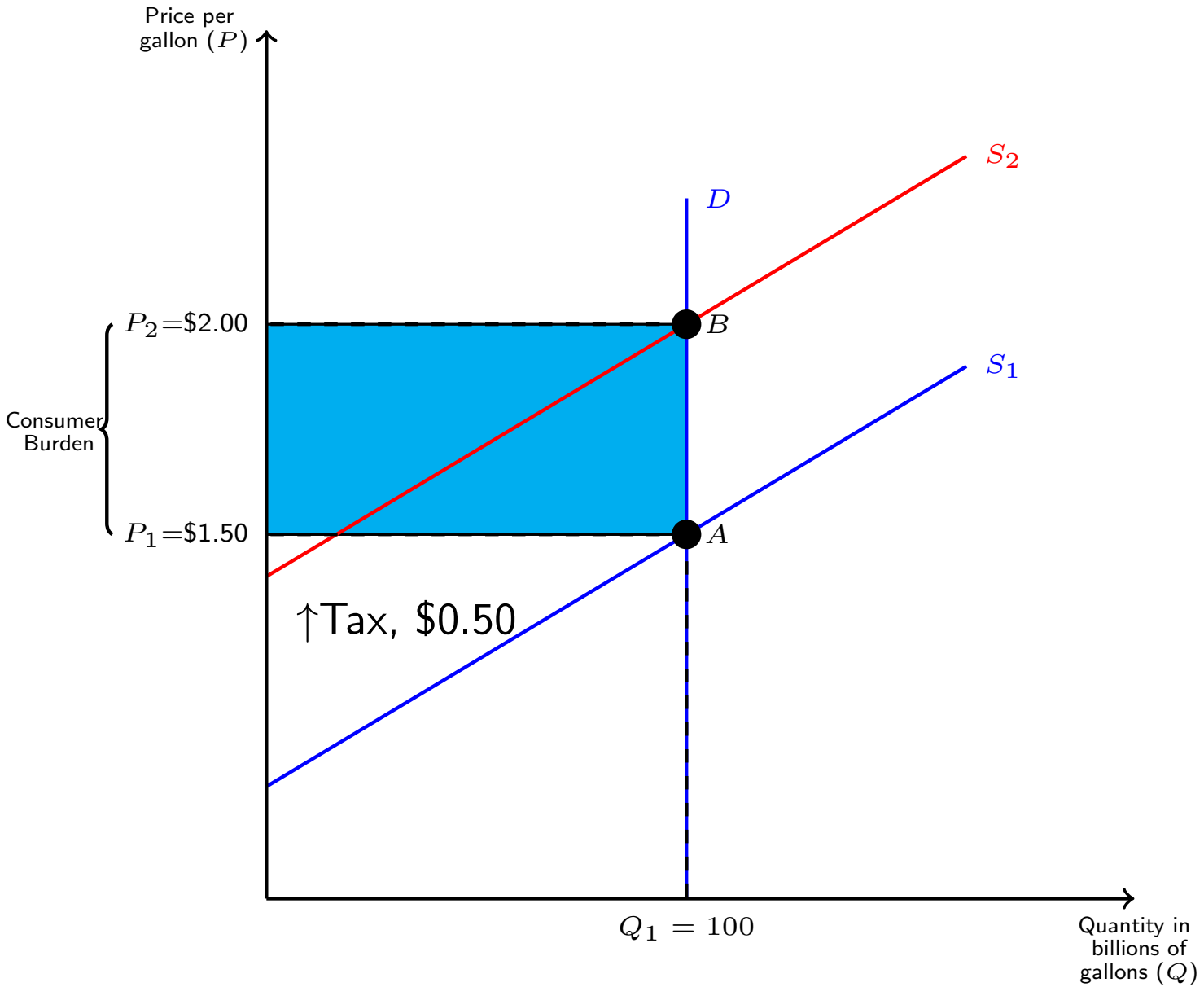
Partial equilibrium tax incidence: Who the tax is imposed on is irrelevant

- While there is only one market price when a tax is imposed, there are two different prices that economists track.
  - The **gross price** is the transaction price in the market.
  - The **after-tax price** is the gross price minus the amount of the tax (if producers pay the tax) or plus the amount of the tax (if consumers pay the tax).

Partial equilibrium tax incidence: Inelastic versus elastic supply and demand

- The third question to examine is how the tax burden varies with the elasticities of supply and demand.
- In all cases, elastic parties avoid taxes and inelastic parties bear them.
- Consider the case of perfectly inelastic demand for gasoline.

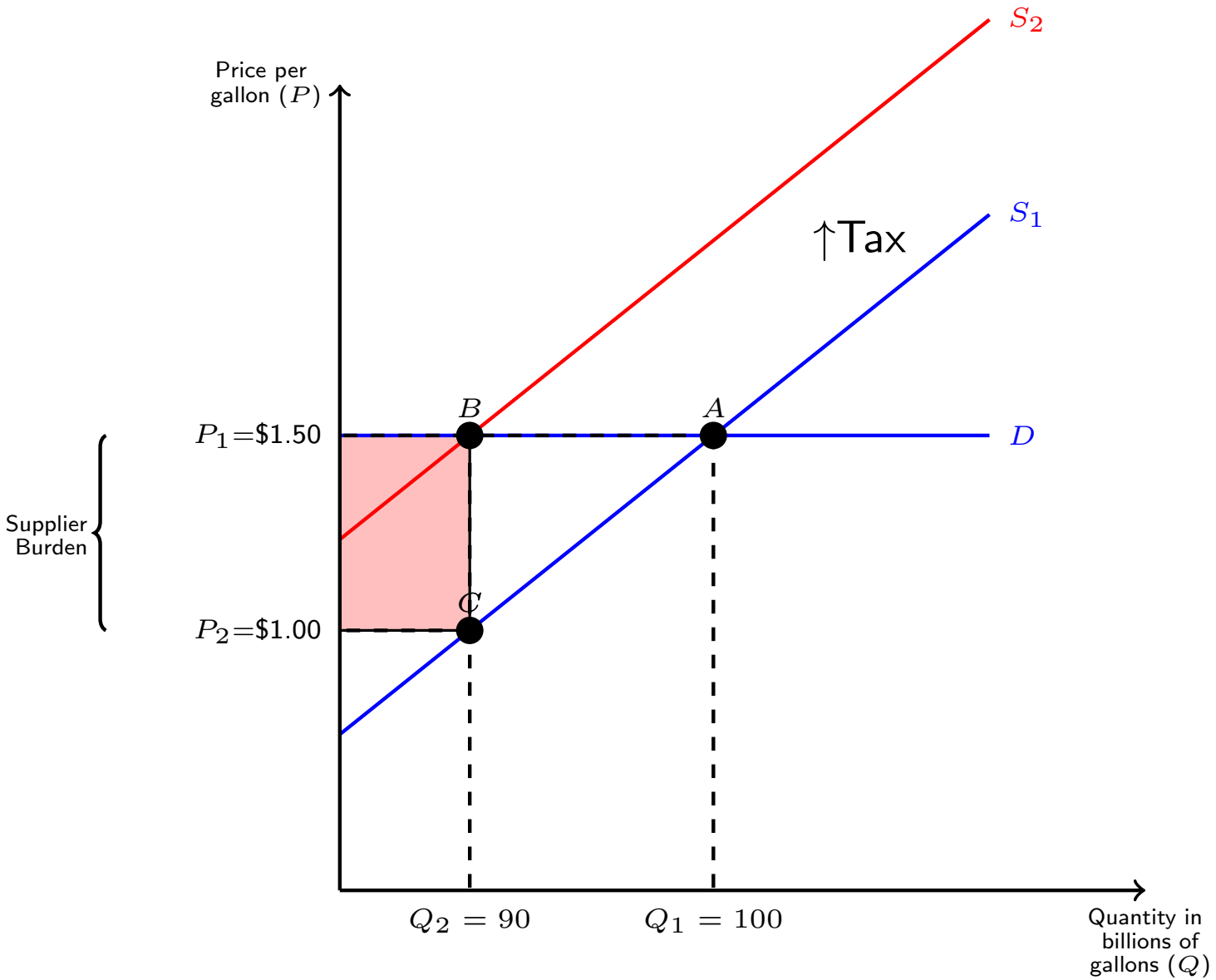
Partial equilibrium tax incidence: Perfectly inelastic demand (1)



Partial equilibrium tax incidence: Perfectly inelastic demand (2)

- The new equilibrium market price is \$2.00, a full \$0.50 higher than the original price.
- Consumer tax burden = (posttax price - pretax price) + tax payments of consumers = (\$2.00 - \$1.50) + 0 = \$0.50
- Producer tax burden = (pretax price - posttax price) + tax payments of producers = (\$1.50 - \$2.00) + \$0.50 = 0
- Note that even though the tax was legally imposed on the producer, the full burden of the tax is borne by the consumer.
- **Full shifting** is when one party in a transaction bears all of the tax burden.
    - With perfectly inelastic demand, consumers bear all of the tax burden.

Partial equilibrium tax incidence: Perfectly elastic demand (1)



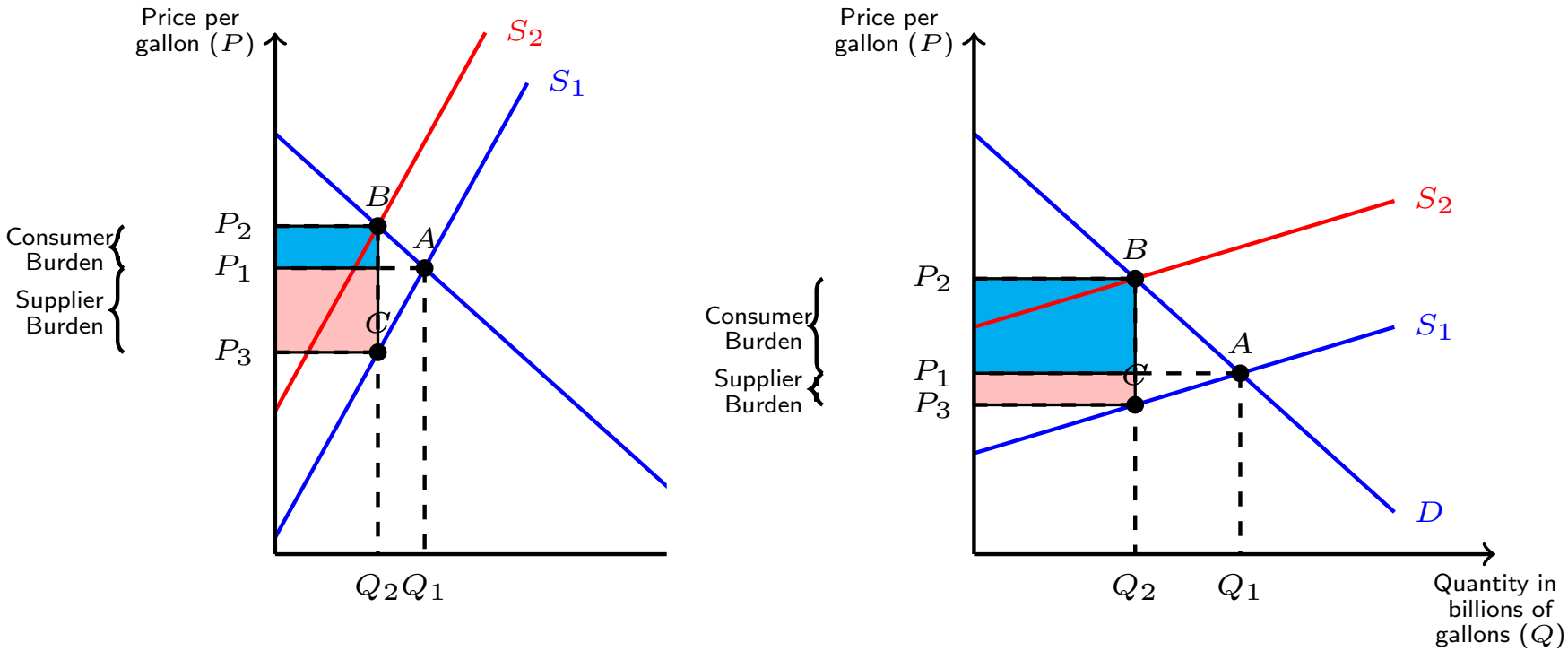
Partial equilibrium tax incidence: Perfectly elastic demand (2)

- The new equilibrium market price is \$1.50, the same as the original price.
- Consumer tax burden = (posttax price - pretax price) + tax payments of consumers = (\$1.50 - \$1.50) + 0 = 0
- Producer tax burden = (pretax price - posttax price) + tax payments of producers = (\$1.50 - \$1.50) + \$0.50 = \$0.50
- In this case, the producer bears the full burden of the tax, because consumers will simply stop purchasing the product if prices are raised.

Partial equilibrium tax incidence: Perfectly elastic vs inelastic demand

- These two extreme cases illustrate a general point:
  - Parties with inelastic supply or demand bear taxes; parties with elastic supply or demand avoid them.
  - Demand is more elastic when there are many good substitutes (for example, fast food at restaurants).
  - Demand is less elastic when there are few substitutes (for example, insulin medication).
  - Supply is more elastic when suppliers have more alternative uses to which their resources can be put.

Partial equilibrium tax incidence: Inelastic versus elastic supply and demand (1)



Partial equilibrium tax incidence: Inelastic versus elastic supply and demand (2)

- When a tax is levied on an inelastic supplier - for example a steel firm that is committed to a level of production by its fixed capital investment - the consumer pays very little of the tax, and the producer almost all of it.
- In the second panel, with elastic supply, the consumer bears almost all of the tax.

Partial equilibrium tax incidence: Tax incidence is about prices, not quantities

- Finally, it is important to note that even though quantities change dramatically with perfectly elastic demand, the focus of tax incidence is on prices, not quantities.
- We ignore quantities because, at both the old and new equilibria, consumers are indifferent between buying the taxed good and spending the money elsewhere.

Partial equilibrium tax incidence: Formal derivation (1)

- This is a simple model that utilizes the technique of log linearization that we will utilize when we move to general equilibrium
- Note that this derivation can be found in Fullerton & Metcalf (NBER WP#8829)
- Assume:
  - Untaxed wage w
  - Taxed wage $w(1+\tau)$
  - Price of consumption p
  - Real gross wage cost to firm $W = \frac{w(1+\tau)}{p}$

Partial equilibrium tax incidence: Formal derivation (2)

- Log linearize

$$ln(W) = ln(w) + ln(1+\tau) - ln(p) \tag{1}$$

- Differentiate

$$\frac{dW}{W} = \frac{dw}{w} + \frac{d\tau}{(1+\tau)} - \frac{dp}{p} \tag{2}$$

- Using "hat calculus" (rate of change) Define:

$$\frac{dW}{W} = \hat{W} \tag{3}$$

- Note that the τ case will be different ($\hat{\tau} \equiv \frac{d\tau}{(1+\tau)}$)

Partial equilibrium tax incidence: Formal derivation (3)

- Thus,

$$\hat{W} = \hat{w} + \hat{\tau} - \hat{p} \tag{4}$$

- We'll be interested in changes in equilibrium prices and equilibrium labor (later also capital and output) in response to tax change.
- Start by fixing the price change: $\hat{p} = 0$ (this is the partial equilibrium part)

Partial equilibrium tax incidence: Formal derivation (4)

- Labor supply elasticity (set exogenously) is:

$$\eta^S \equiv \frac{dL^S/L^S}{dw/w} \Rightarrow \hat{L}^S = \eta^S \hat{w} \tag{5}$$

- Defining labor demand elasticity (η^D) similarly, we find that:

$$\hat{L}^D = \eta^D(\hat{w} + \hat{\tau}) \tag{6}$$

- Note that: $\eta^D \leq 0,\ \eta^S \geq 0$

Partial equilibrium tax incidence: Formal derivation (5)

- In equilibrium the condition must hold that:

$$\hat{L}^D = \hat{L}^S \tag{7}$$

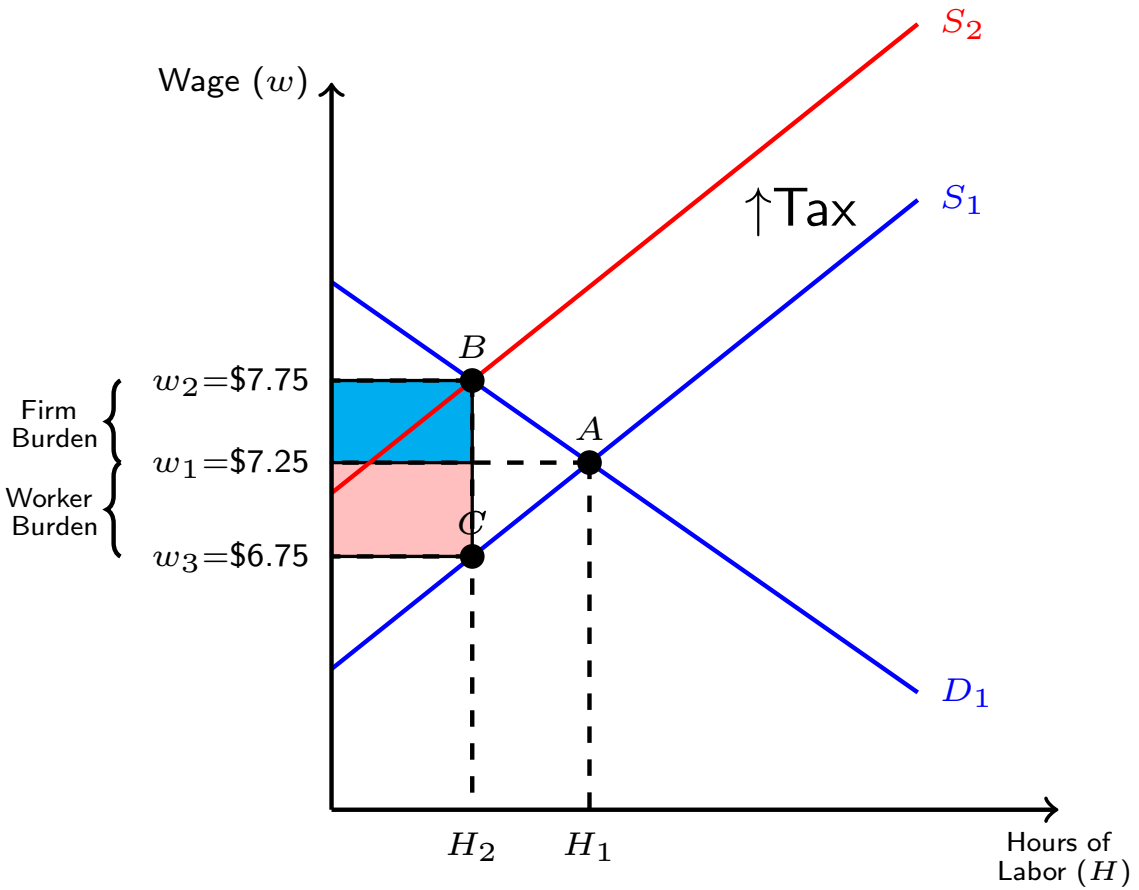
- Solving the 3 equations in our unknown labor supply, demand, and tax change we find:

$$\frac{\hat{w}}{\hat{\tau}} = \frac{\eta^D}{\eta^S - \eta^D} \tag{8}$$

- This expression lies between 0 and -1 and gives the cost of the tax change to workers as a portion of the total change.

Tax incidence extensions: Tax incidence in factor markets (1)

- Many taxes are levied on the factors of production, such as labor.
- Consider the labor market, before and after a tax on workers (the suppliers of labor) is imposed.

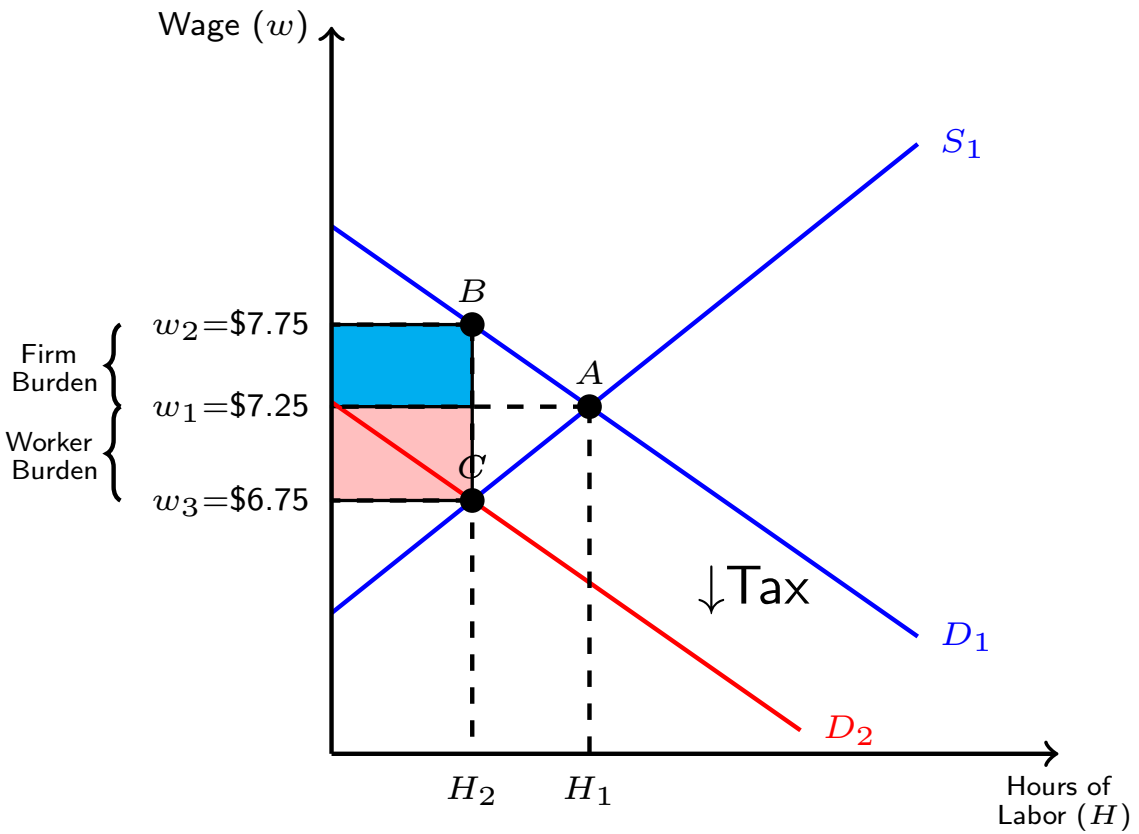


Tax incidence extensions: Tax incidence in factor markets (2)

- The \$1 per hour tax lowers the return to work at every amount of labor.
- Thus, individuals require a \$1 rise in their wages to supply any amount of labor, and the supply curve shifts upward.
- With labor demand unchanged, the new equilibrium wage is \$7.75. In this case, the tax is borne equally by workers and firms.

Tax incidence extensions: Tax incidence in factor markets (3)

- Now consider the labor market where a tax on firms (the demanders of labor) is imposed.
- A tax on firms (the "demanders" of labor), also lowers wages.



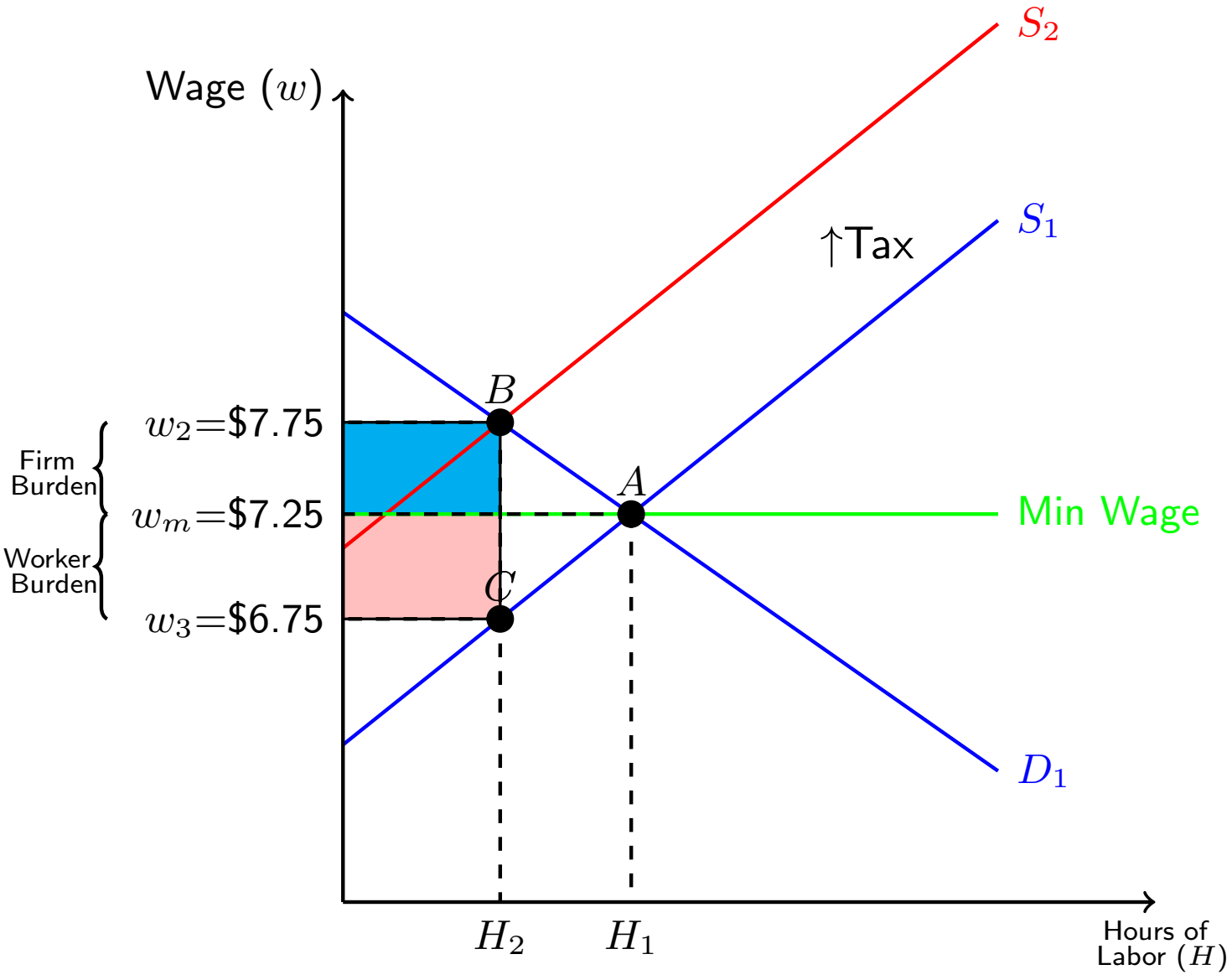
Tax incidence extensions: Tax incidence in factor markets (4)

- With the tax on firms, the demand curve shifts downward to D_2, and market wages fall to \$6.75.
- The firm pays workers \$0.50 less than the original \$7.25, but must send \$1 to the government. In effect, they are paying a wage of \$7.75.
- As in output markets, the tax incidence of a payroll tax shows that it makes no difference on which side of the market it is levied, and the economic burden can differ from the statutory burden.

Tax incidence extensions: Tax incidence in factor markets (5)

- This analysis will not be correct if there are impediments to wage adjustments, however.
- The **minimum wage** is a legally mandated minimum amount that workers must be paid for each hour of work.
    - The current federal minimum wage is $7.25 per hour.

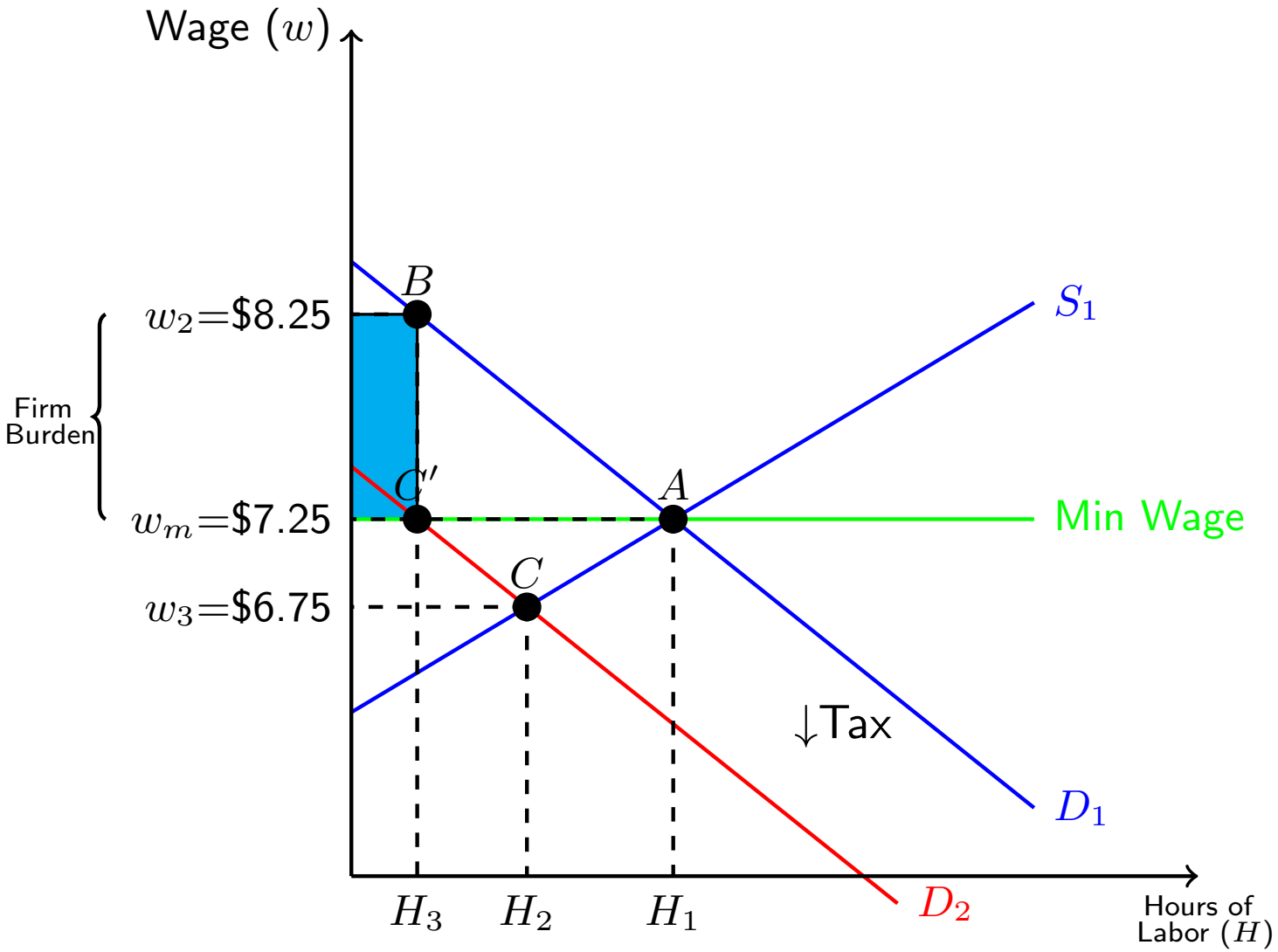
Tax incidence with imperfect markets: minimum wage, tax on workers (1)



Tax incidence with imperfect markets: minimum wage, tax on workers (2)

- With a tax on workers, the labor supply curve shifts upward as before. Workers are paid \$7.75 per hour, but are forced to pay \$1 of that to the government for taxes.
- The incidence is borne in the same manner as when there was no minimum wage.

Tax incidence with imperfect markets: minimum wage, tax on firm (1)



Tax incidence with imperfect markets: minimum wage, tax on firm (2)

- With a tax on firms, the labor demand curve shifts downward. Without wage impediments, the market wage would fall from \$7.25 to \$6.75, and the firm would also pay \$1 to the government. Hours of work would be H_2.
- With the minimum wage, wages cannot adjust downward, so the firm instead demands $H_3 < H_2$ hours of labor, pays \$7.25 per hour, and also pays \$1 to the government. **The economic burden of the tax falls on the firm.**

Tax incidence with imperfect markets

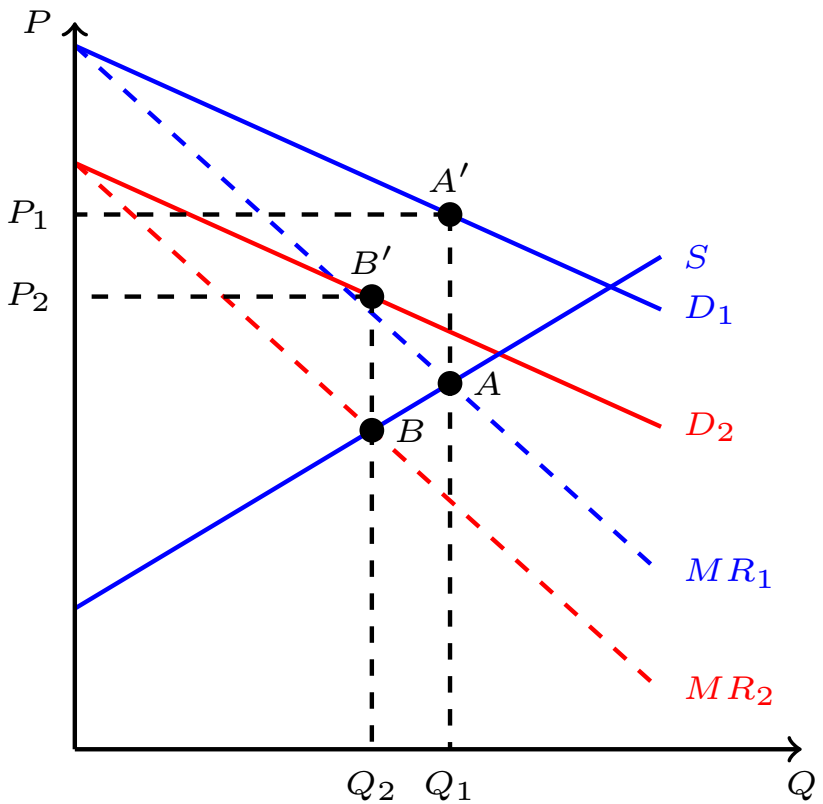
- When there are barriers to reaching the competitive market equilibrium, the side of the market on which the tax is levied can matter.
  - Minimum wages
  - Workplace norms
  - Union rules
- There are more frequent in input markets than output markets.

Tax incidence with imperfect markets: Markets with market power (1)

- The analysis has so far focused on competitive markets.
- **Monopoly markets** are markets in which there is only one supplier of a good.
    - Monopolists are price makers, not price takers.
- Unlike a perfect competitor, the monopolist faces a downward sloping marginal revenue curve, because it must lower its price on all units to sell another unit.
- The marginal revenue curve, MR_1, is therefore everywhere below the demand curve. Setting $MR_1 = MC$, the quantity Q_1 initially maximizes profits.

Tax incidence with imperfect markets: Markets with market power (2)

- The tax on consumers shifts the demand curve downward to D_2, and the associated marginal revenue curve to MR_2.
- Setting $MR_2 = MC$, the quantity Q_2 now maximizes profits.
- The monopolist's price falls from P_1 to P_2, so it bears some of the tax, just as a competitive firm does.



- The three rules of tax incidence continue to apply for a monopolist.

Tax incidence with imperfect markets: Markets with market power (3)

- Step 1: Define the linear (inverse) demand curve
  - $P = a - bY$
- Step 2: Assume marginal costs are constant
  - $MC = C$
- Step 3: Profit is equal to total revenue minus total cost
  - $\Pi = TR - TC$
- Step 4: Rewrite the profit equation as
  - $\Pi = PY - CY$

Tax incidence with imperfect markets: Markets with market power (4)

- Step 5: Replace price with $P = a - bY$
  - $\Pi = (a - bY)Y - CY$
- Step 6: Maximize profits by differentiating profit with respect to output and setting equal to zero
  - $\frac{\partial \Pi}{\partial Y} = a - 2bY - C = 0$
- Step 7: Solve for the profit maximizing level of output (Y_{bt})
  - $Y_{bt} = \frac{a-C}{2b}$

Tax incidence with imperfect markets: Markets with market power (5)

- Step 8: Solve for the price (P_{bt}) by substituting Y_{bt} into the (inverse) demand function
  - $Y_{bt} = \frac{a-C}{2b}$
- Recall that $P = a - bY$, therefore
  - $P_{bt} = a - b\left(\frac{a-C}{2b}\right)$
  - $P_{bt} = \frac{a+C}{2}$

Tax incidence with imperfect markets: Markets with market power (6)

- Step 9: Replace $C = MC$ with $C = MC + t$ (one could repeat all of the above algebra if unconvinced)
  - $P_{bt} = \frac{a+C}{2}$, Price before tax
  - $P_{at} = \frac{a+C+t}{2}$, So price after tax, P_{at}, increases by $\frac{t}{2}$

Tax incidence with imperfect markets: Markets with market power (7)

- Most markets fall somewhere between perfect competition and monopoly.
- **Oligopoly** markets are markets in which firms have some market power in setting prices, but not as much as a monopolist.
    - There is less consensus on how to model these markets.
    - Economists tend to assume the tax incidence results apply in these markets as well.

Tax incidence with imperfect markets: Markets with market power (8)

Some general differences from models with perfect competition:

- Overshifting: It is possible to get an increase in the after tax price $>$ level of the tax (depends on demand and MC curves)
- Ad valorem (percent of price) and excise (per unit) taxes are no longer equivalent (see Salanié text)

General Equilibrium Tax Incidence

- Our models so far have focused on partial equilibrium.
  - **Partial equilibrium tax incidence** is analysis that considers the impact of a tax on a market in isolation.
- To study the effects on related markets, we use general equilibrium analysis.
  - **General equilibrium tax incidence** is analysis that considers the effects on related markets of a tax imposed on one market.

General Equilibrium Tax Incidence: Harberger Model (1)

- First we have to introduce some concepts and notation:
- Producing good X with inputs L and K:
  - $X = F(K, L)$
- We want a nice linear form. Differentiate and divide through by X to get

$$\frac{dX}{X} = \frac{F_K K}{X} * \frac{dK}{K} + \frac{F_L L}{X} * \frac{dL}{L} \tag{9}$$

General Equilibrium Tax Incidence: Harberger Model (2)

- Some definitions:
  - r is the price of capital
  - p_x is the price of X
  - θ_K factor share for capital ($\frac{rK}{p_X X}$)
    - From Cobb-Douglas production function: $X = F(K, L) = K^{\theta_K} L^{\theta_L}$
- Perfect competition implies: $\theta_K = \frac{F_K K}{X}$
- and similarly the labor share: $\theta_L = \frac{F_L L}{X}$

General Equilibrium Tax Incidence: Harberger Model (3)

- Constant returns to scale implies factor shares sum to 1.
- Redefining $\theta = \theta_K$ and $\theta_L = 1 - \theta$

$$\hat{X} = \theta \hat{K} + (1 - \theta)\hat{L} \tag{10}$$

- Pre-tax elasticity of substitution between K and L in production (briefly ignoring tax):

$$\sigma = \frac{d(K/L)/(K/L)}{d(w/r)/(w/r)} \tag{11}$$

General Equilibrium Tax Incidence: Harberger Model (4)

- We find that: $d(K/L)/(K/L) = \hat{K} - \hat{L}$
- So: $\sigma = \frac{\hat{K}-\hat{L}}{\hat{w}-\hat{r}}$
- Can rearrange, so statement about behavior: $\hat{K} - \hat{L} = \sigma(\hat{w} - \hat{r})$
- With a tax on wages (so that firms pay gross wage rate $w(1+\tau)$):

$$\hat{K} - \hat{L} = \sigma(\hat{w} + \hat{\tau} - \hat{r}) \tag{12}$$

- Note that our log linearization technique means that our solution is a good approximation only for small changes in the tax.
- Note also that the log linearization approach does not require fixed θ (as Cobb-Douglas production) or fixed σ (as CES production), only that we know initial θ & σ. We trade off using an approximation that is valid only locally to gain generality in the assumed form of production.

General Equilibrium Tax Incidence: Harberger Model (5)

Finally to the Harberger Model which assumes:

1. Technology:
    - Firms in each sector use only capital and labor.
    - Constant returns to scale
    - Production technologies themselves, however, may differ across sectors with respect to the ease with which capital can be substituted for labor (elasticity of substitution) and the ratios with which capital and labor are used (intensity of use - capital intensive or labor intensive.)
2. Behavior of factor suppliers
    - Suppliers of K and L maximize total returns.
    - K and L are perfectly mobile across sectors
    - This means the net marginal return to K and L must be the same in each sector (otherwise a reallocation that increases total net returns is possible.)

General Equilibrium Tax Incidence: Harberger Model (6)

3. Market Structure
   - Competitive; profit maximizers $\rightarrow$ prices are perfectly flexible.
   - This means full employment, and the return paid to each factor of production is the value of its marginal product. (the value to the firm of the output produced by the last unit of the output)
4. Total factor supplies: Total amount of K and L are fixed.
5. Consumer Preferences:
   - All consumers have identical preferences.
   - This means a tax cannot generate distributional effects by affecting people's use of income. This assumption allows us to concentrate on the effect of taxes on the sources of income.
6. Tax incidence framework
   - The framework for the analysis is differential tax incidence: We consider the substitution of one factor for another.
   - This means that approximately the same amount of income is available before and after the tax, so it is unnecessary to consider how changes in aggregate income may change demand and factor prices.

General Equilibrium Tax Incidence: Harberger Model (7)

- $X = F(K, L)$, $\bar{L} = L + Y$, Y is leisure.
- $\bar{L}$ is the fixed total supply of worker hours. Clearly the price of leisure to the worker is the foregone wY . We assume K fixed.
- Totally differentiating the labor equation:

$$\lambda_{LX}\hat{L} + \lambda_{LY}\hat{Y} = 0 \tag{13}$$

- where λ_{LX} is the labor share that goes into the production of X $\left(\frac{L}{\bar{L}}\right)$ and λ_{LY} goes into the production of Y $\left(\frac{Y}{\bar{L}}\right)$.

General Equilibrium Tax Incidence: Harberger Model (8)

- From Equation 12 we know

$$\hat{L} = \sigma_X(\hat{r} + \hat{\tau_K} - \hat{w} - \hat{\tau}_L), \tag{14}$$

  where τ_i is the tax on factor income i.
- Under our perfect competition assumption, the value of output = factor payments, or

$$p_X X = w(1 + \tau_L)L + r(1 + \tau_K)K \tag{15}$$

- Totally differentiating and evaluating at $\tau_i = 0$ for $i = L, K$, yields

$$\hat{p}_X + \hat{X} = \theta_L(\hat{w} + \hat{\tau}_L + \hat{L}) + \theta_K(\hat{r} + \hat{\tau}_K + \underbrace{\hat{K}}_{=0}) \tag{16}$$

General Equilibrium Tax Incidence: Harberger Model (9)

- Additionally, we totally differentiate F to find:

$$\hat{X} = \theta_L \hat{L} \tag{17}$$

  (since K change is 0, and referring to Equation 10).
- Finally, the elasticity of substitution in demand between X and Y for the worker (σ_D) is such that

$$\hat{X} - \hat{Y} = \sigma_D(\hat{w} - \hat{p}_X - \hat{\tau}_X) \tag{18}$$

  where τ_X is an *ad valorem* tax on X.

General Equilibrium Tax Incidence: Harberger Model (10)

- We have 5 equations (Equations 13-18) and 5 unknowns $(\hat{X}, \hat{L}, \hat{p}_X, \hat{w}, \hat{r})$ ($\hat{Y}$ is defined once we know $\hat{L}$)
- The solution to this system describes the responses of production and goods and factor prices to a vector of exogenous tax changes.
- Substituting Equation 13 into Equation 18:

$$\hat{X} + \phi\hat{L} = \sigma_D(\hat{w} - \hat{p}_X - \hat{\tau}_X) \tag{19}$$

where $\phi \equiv \frac{\lambda_{LX}}{\lambda_{LY}}$

General Equilibrium Tax Incidence: Harberger Model (11)

Analysis of a tax on capital

- Capital is supplied inelastically in this model. Since supplied capital cannot react to a change in its rate of return here the burden of a tax on capital will fall entirely on the owners of capital.
- Note that the capital return and tax always appear together as $\hat{r} + \hat{\tau}_K$
- If we tax only capital, so $\hat{\tau}_L = \hat{\tau}_X = 0$, then the solution to the system is

$$\hat{r} = -\hat{\tau}_K, \hat{L} = \hat{p}_X = \hat{X} = \hat{w} = 0 \tag{20}$$

General Equilibrium Tax Incidence: Harberger Model (12)

Analysis of a tax on labor

- Tax labor only, set $\hat{\tau}_K = \hat{\tau}_X = 0$
- Use Equation 14 and Equation 17 to get expressions for $\hat{L}$ and $\hat{X}$, and substitute these into Equation 16 and Equation 19 to get a system of 2 equations and unknowns, $\hat{r}$ and $\hat{w}$.

$$\left(\frac{\sigma_D}{\phi + \theta_L}\right)\hat{w} = \sigma_X(\hat{r} - \hat{w} - \hat{\tau}_L) \tag{21}$$

$$\theta_L(\hat{w} + \hat{\tau}_L) + \theta_K\hat{r} = 0 \tag{22}$$

General Equilibrium Tax Incidence: Harberger Model (13)

- From the second equation:

$$\hat{r} = -(\theta_L + \theta_K)(\hat{w} + \hat{\tau}_L) \tag{23}$$

- Substituting the above into Equation 14:

$$\hat{L} = -\left(\frac{\sigma_X}{\theta_K}\right)(\hat{w} + \hat{\tau}_L) \equiv \eta^D(\hat{w} + \hat{\tau}_L), \tag{24}$$

- where η_D is the elasticity of demand for labor with respect to its cost, and we've derived the labor demand response to the tax change as before in the simple partial equilibrium (exogenous elasticities) model.

General Equilibrium Tax Incidence: Harberger Model (14)

- To get the elasticity of supply for labor, we use the workers budget constraint: $pX = wL + M$
- Totally differentiate, assuming non-labor income fixed

$$\hat{p} + \hat{X} = \theta_L(\hat{w} + \hat{L}) + \theta_K \hat{M} \tag{25}$$

and substitute into 16 to get

$$(\theta_L + \phi)\hat{L} = (\sigma_D - \theta_L)(\hat{w} - \hat{p}) + \theta_K(\hat{M} - \hat{p}) \tag{26}$$

- Note that labor supply responds only to changes in the real wage and real income.

General Equilibrium Tax Incidence: Harberger Model (15)

- If all prices, wages and non-labor income change by the same percentage, then $\hat{p} = \hat{w} = \hat{L} = \hat{M} = 0$
- Holding real non-labor income constant,

$$\hat{L} = \left(\frac{\sigma_D - \theta_L}{\theta_L + \phi} \right) (\hat{w} - \hat{p}) \equiv \eta^S (\hat{w} - \hat{p}) \tag{27}$$

- Numerator of η^S : θ_L is the income effect and σ_D is the substitution.
- The η^S is an uncompensated labor elasticity (i.e. it includes the income effect).

General Equilibrium Tax Incidence: Harberger Model (16)

- Since in our incidence analysis we assume no initial tax AND we return the tax revenue to households lump-sum, we need a compensated elasticity (η_C^S)

$$\eta_C^S = \frac{\sigma_D}{\theta_L + \phi} \tag{28}$$

- We can see that the compensated elasticity removes the income effect, and solving our new system

$$\hat{L} = \eta_C^S \hat{w} \tag{29}$$

$$\hat{L} = \eta^D (\hat{w} - \hat{\tau}_L) \tag{30}$$

General Equilibrium Tax Incidence: Harberger Model (17)

- We find the general equilibrium effects of the labor tax on the factor prices

$$\frac{\hat{w}}{\hat{\tau}_L} = \frac{\eta^D}{\eta_C^S - \eta^D} \tag{31}$$

$$\frac{\hat{r}}{\hat{\tau}_L} = \left(\frac{\theta_L}{\theta_K}\right) \frac{-\eta_C^S}{\eta_C^S - \eta^D} \tag{32}$$

- Compare Equation 31 to Equation 8. The difference between the incidence on labor here and in the simple partial equilibrium model is that here we account for the use of the revenue and employ the compensated elasticity of labor supply.
- Further, the general equilibrium incidence analysis includes analysis of the incidence on capital. Note that the burden on capital responds to both the relative elasticities of labor supply and demand and the output shares of labor and capital.

General Equilibrium Tax Incidence: Harberger Model (18)

Tax Equivalencies in the Harberger 2 Sector General Equilibrium Model

- Different taxes can have the same economic incidence
  - t_{LX} is a "partial factor" tax on labor used to produce X

$$
\begin{array}{lllll}
t_{LX} & \text{and} & t_{KX} & \rightarrow & t_X \\
\text{and} & & \text{and} & & \text{and} \\
t_{LY} & \text{and} & t_{KY} & \rightarrow & t_Y \\
\downarrow & & \downarrow & & \downarrow \\
t_L & \text{and} & t_K & \rightarrow & t
\end{array}
$$

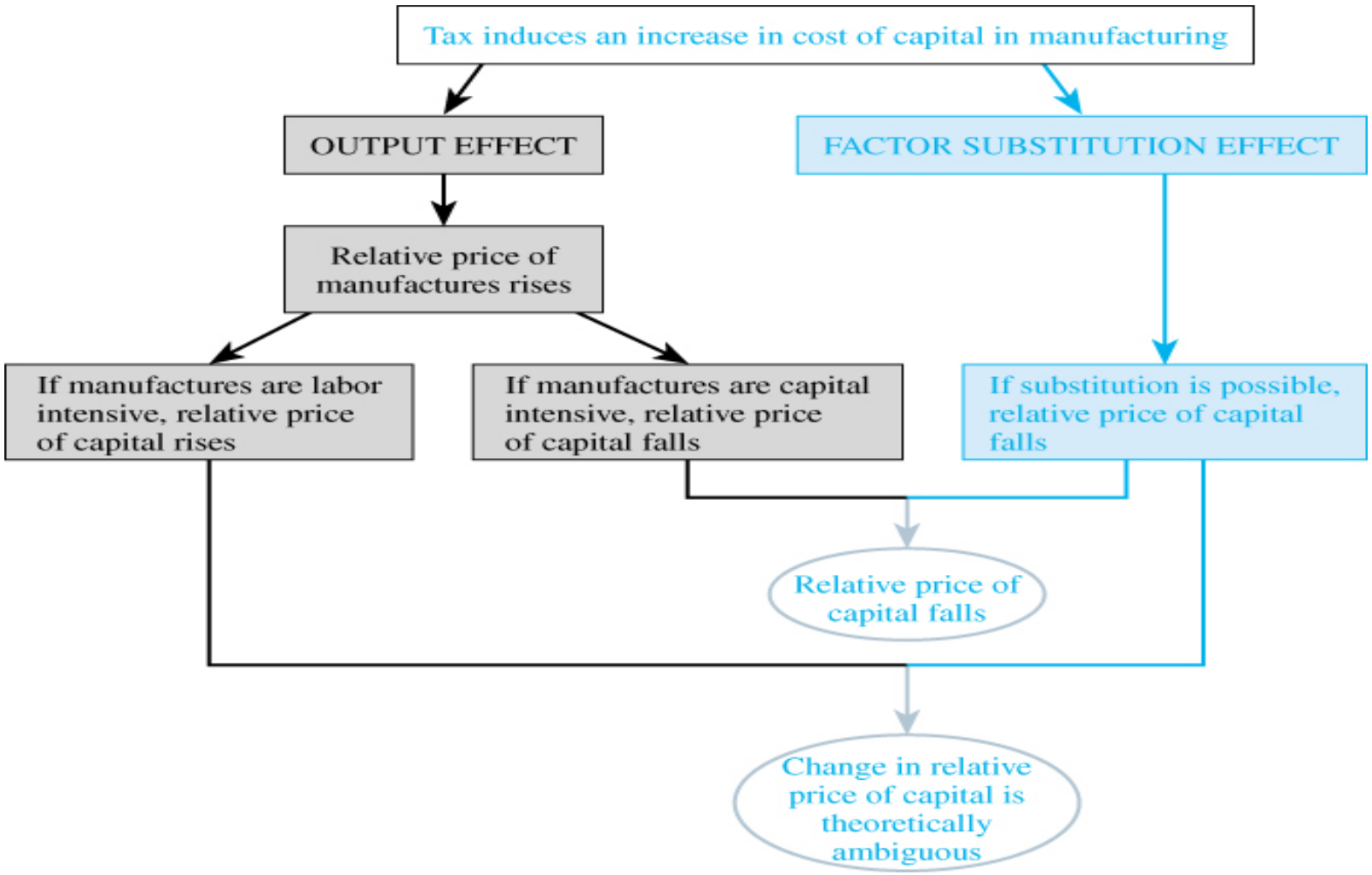
General Equilibrium Tax Incidence: Harberger Model (19)

Conclusions

- Income tax: Since it is equivalent to set of taxes on labor and capital at same rate, and factors are fixed, income tax cannot be shifted.
- Labor tax: No incentive to switch use between sectors, labor bears full burden if capital fixed.
- Partial factor tax (like the corporate tax): Two initial effects
  - *Output effect*
  - *Factor substitution effect*

General Equilibrium Tax Incidence: Harberger Model (20)

Impact of a Partial Factor Tax According to the Harberger Model



General Equilibrium Tax Incidence: Harberger Model (21)

- This version of the model is a "closed-economy" model in the is consistent with an economy (country) cut off from the rest of the world
- Results differ if we consider an "open-economy" version
  - In this model we typically consider that capital is mobile and labor is not.
  - As a result we can get the result that the burden of a tax on capital is born by labor rather than capital and further, under particular assumptions, it may bear more than the full burden of the tax- the tax is "over shifted" from capital to labor
- This leaves us with the question of what is the right model and the answer is it depends on the specifics of the market and tax in question

Lessons from Harberger

- Modeling this question is difficult and requires lots of simplifying assumptions
- Outcome is highly dependent on those assumptions.
  - Closed vs open economy
  - Specific parameter assumptions matter
- Owners of corporate capital certainly do not bear the sole burden
- Labor could bear more than 100% of the burden of the tax
- Short-run burden is likely very different from that in the long run.

Computable General Equilibrium (CGE) Models

- Harberger Model is very simple but it is about all we can find formal solutions for.
- For greater complexity need to move to CGE models
  - Use computer to numerically solve the general equilibrium model
  - Start with an initial equilibrium and use an algorithm to search for the final after-tax equilibrium.

Computable General Equilibrium (CGE) Models: Steps in a CGE Model

- Choose a model – number of sectors, consumer groups
- Select functional forms for the utility and production functions
- Assign parameter values
- Solve for the counter-factual equilibrium

Computable General Equilibrium (CGE) Models: Weaknesses with CGE models

- Difficulties of choosing appropriate elasticities and other parameter values
- Intractability
- Convergence is not guaranteed.
- Uniqueness is not guaranteed

Lifetime Tax Incidence

- Area of recent research has been to recognize that annual income may not be the best measure of well-being
  - Some low income individuals will always be low income while others are only there temporarily (e.g. students)
  - Economists typically assume that consumption (and hence welfare) is smoothed to some degree over ones lifetime
- Two major types of research
  - Empirical research looking at income mobility
    - Recent estimates show that 60% of Americans change income quintiles within a decade.
  - CGE models with life cycle behavior

Analysis of Tax Incidence in Practice: CBO incidence assumptions (1)

- The Congressional Budget Office (CBO) has examined the incidence of taxation in the U.S.
- The CBO assumes:
  - Income taxes are fully borne by the households that pay them.
  - Payroll taxes are fully borne by workers, regardless of the statutory incidence.
  - Excise taxes are fully shifted forward to prices.
  - Corporate taxes are fully shifted forward to the owners of capital.

Analysis of Tax Incidence in Practice: CBO incidence assumptions (2)

- These assumptions are generally consistent with empirical evidence.
  - For example, Poterba (1996) shows full shifting to prices from increases in the sales tax.
- The most questionable assumption relates to the corporate income tax. It is likely that consumers and workers bear some of the tax.
- Table on the next slide shows the effective tax rates over time, by income quintile.
- The effective tax rate is taxes paid relative to total income.

Effective Tax Rates (in percent)	1979	1985	1990	1995	2001
			Total effective tax rate		
All households	22.2	20.9	21.5	22.6	21.5
Bottom quintile	8.0	9.8	8.9	6.3	5.4
Top quintile	27.5	24.0	25.1	27.8	26.8
			Effective Income Tax Rate		
All households	11.0	10.2	10.1	10.2	10.4
Bottom quintile	0.0	0.5	-1.0	-4.4	-5.6
Top quintile	15.7	14.0	14.4	15.5	16.3
			Effective Payroll Tax Rate		
All households	6.9	7.9	8.4	8.5	8.4
Bottom quintile	5.3	6.6	7.3	7.6	8.3
Top quintile	5.4	6.5	6.9	7.2	7.1
			Effective Corporate Tax Rate		
All households	3.4	1.8	2.2	2.8	1.8
Bottom quintile	1.1	0.6	0.6	0.7	0.3
Top quintile	5.7	2.8	3.3	4.4	2.9
			Effective Excise Tax Rate		
All households	1.0	0.9	0.9	1.0	0.9
Bottom quintile	1.6	2.2	2.0	2.4	2.4
Top quintile	0.7	0.7	0.6	0.7	0.6

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Analysis of Tax Incidence in Practice: CBO incidence assumptions (3)

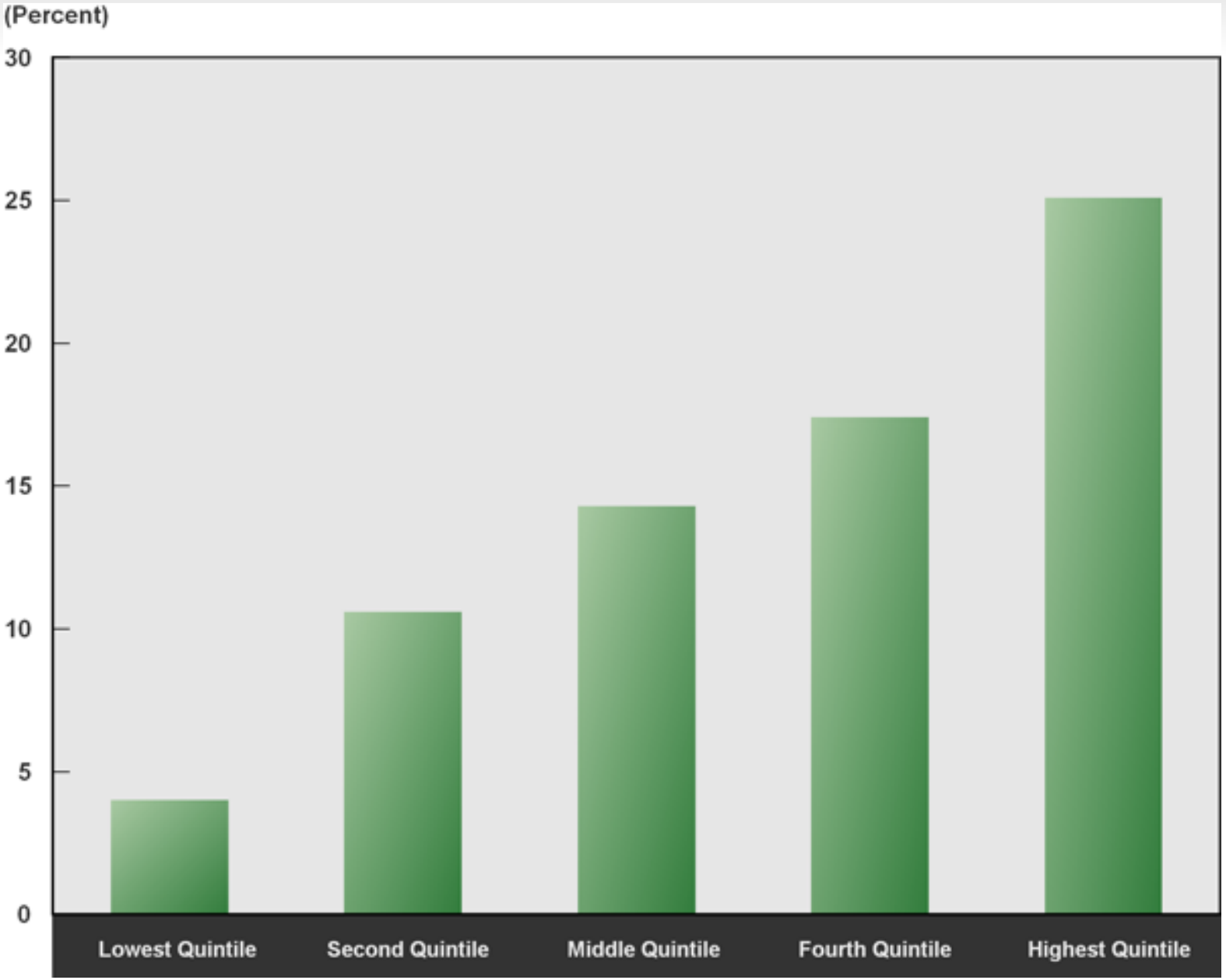
- The table shows that effective tax rates for the poor have fallen since 1985, while the effective rate for the rich have risen.
- The distribution of various components of the tax system varies, however.
  - The payroll tax, for example, is regressive.
- Effective corporate tax rates are small relative to income and payroll tax rates, and have fallen at both the top and bottom of the income distribution.
- Next table shows the top and bottom quintile's share of income and tax liabilities.

Top and Bottom Quintile's Share of Income and Tax Liabilities (in percent)	1979	1985	1990	1995	2001
	Top Quintile				
Share of income	45.5	48.6	49.5	50.2	52.4
Share of tax liabilities	56.4	55.8	57.9	61.9	65.3
	Bottom Quintile				
Share of income	5.8	4.8	4.6	4.6	4.2
Share of tax liabilities	2.1	2.3	1.9	1.3	1.1

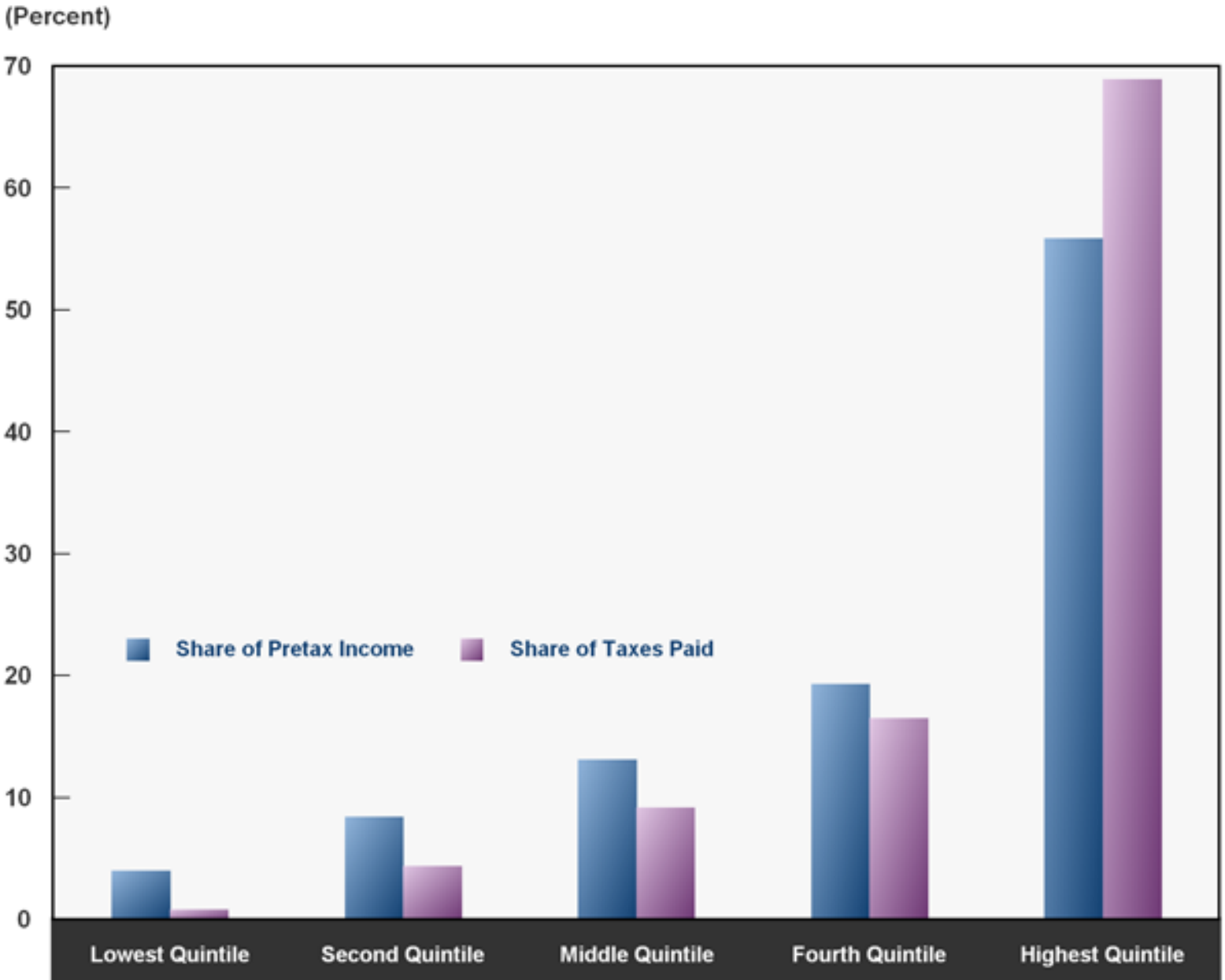
Analysis of Tax Incidence in Practice: CBO incidence assumptions (4)

- The bottom quintile of taxpayers has always paid a very small share of taxes, and that share has fallen over time.
- The top quintile has always paid the majority of taxes, and that share has risen over time.
    - The top 20% earn more than half of all income, and pay almost two-thirds of the taxes.

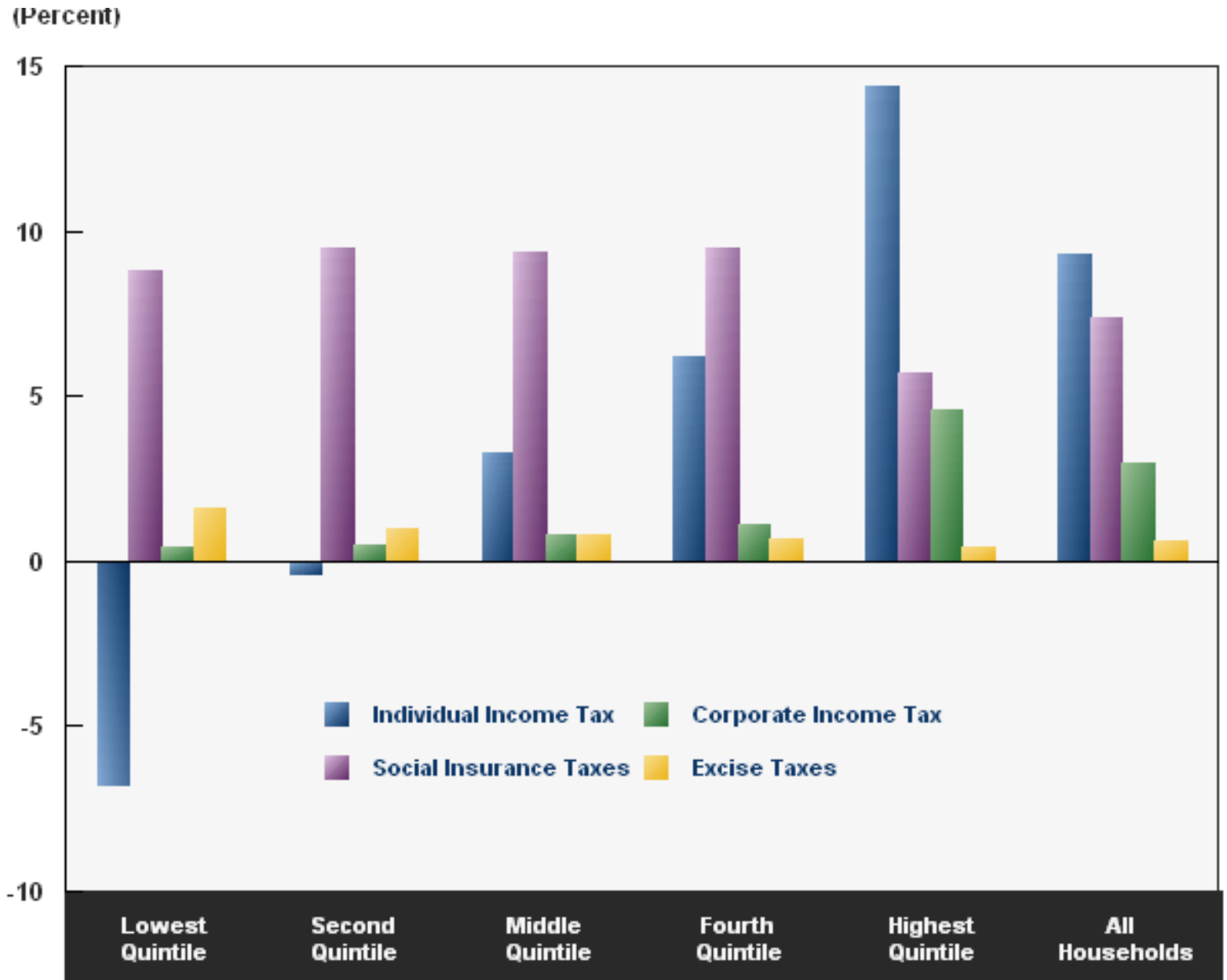
Average Federal Tax Rates in 2007 (CBO)



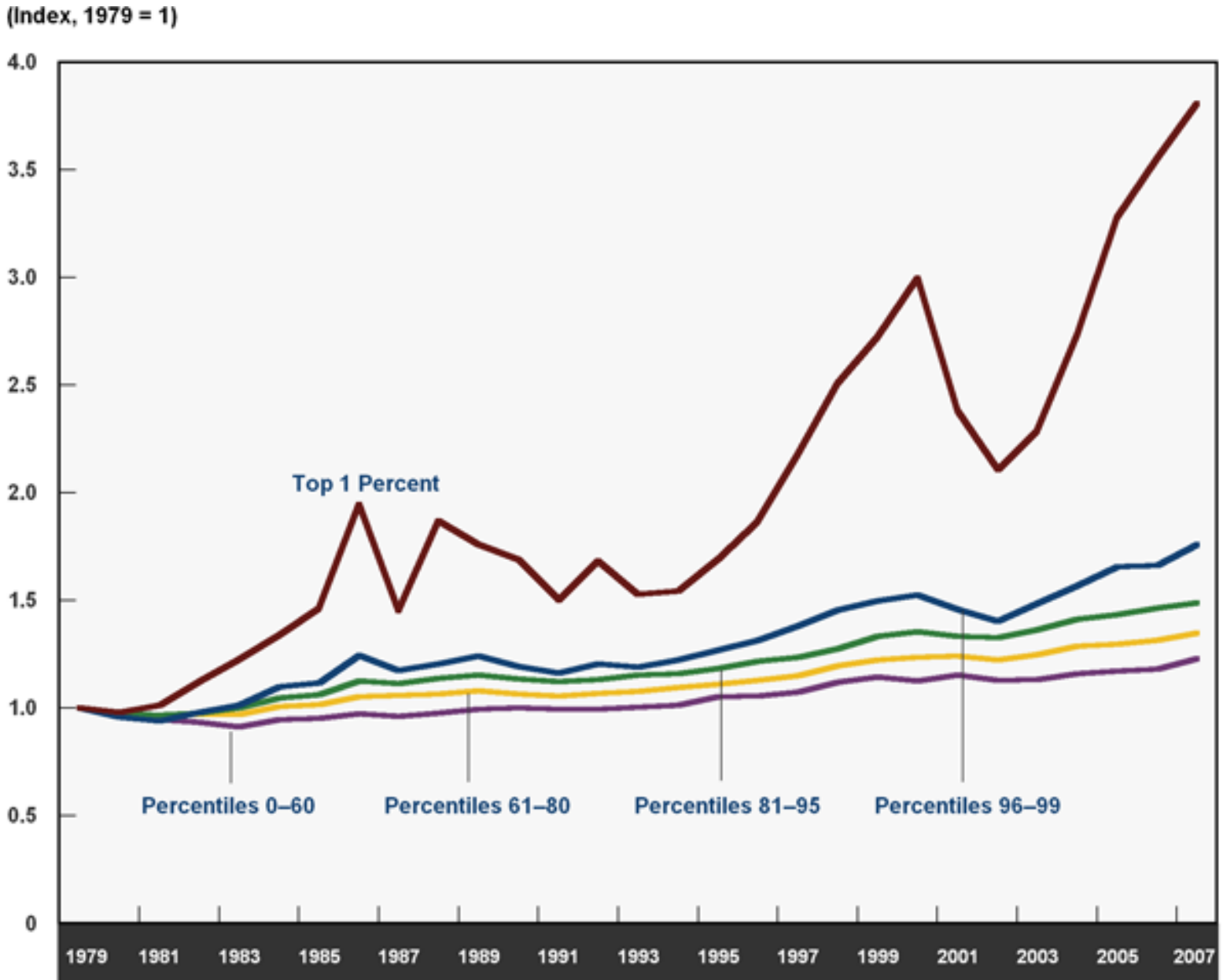
Share of Total Before-Tax Income and Total Federal Tax Liabilities in 2007 (CBO)



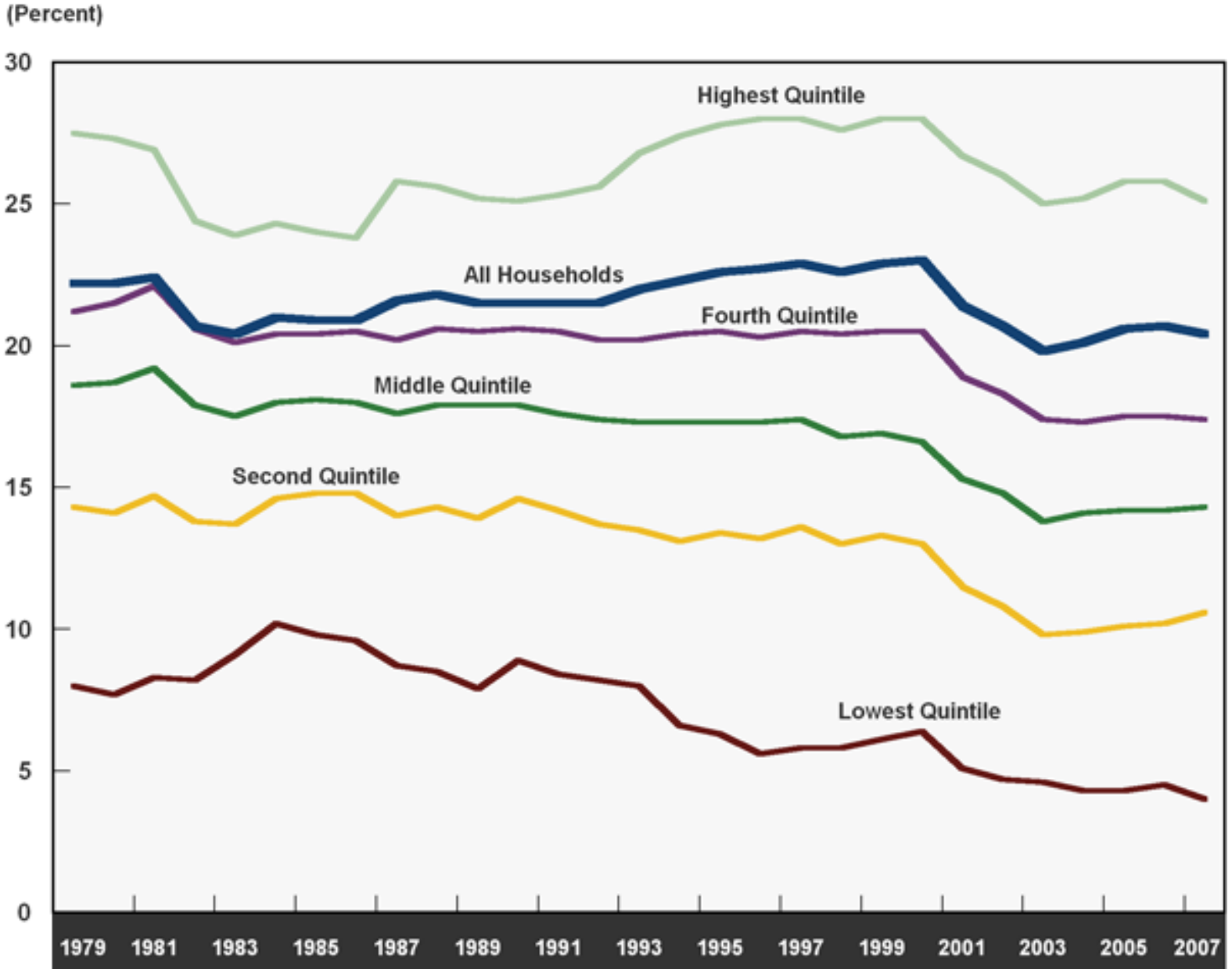
Average Federal Tax Rates by Income Quintile and Tax Source in 2007 (CBO)



Cumulative Change In Real After-Tax Average Income (CBO)



Average Federal Tax Rate by Income Quintile, 1979-2007 (CBO)



Fiscal Cliff Incidence