

Problem Set 5 - Question 2

Younggeun Yoo

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Question 2

What is the incidence of a successful auto workers strike? Here we model that as a wage increase imposed on auto manufacturers for the benefit of the persons who were autoworkers at the time of the successful strike. Specifically, the economic equivalent of a tax is imposed on the use of labor by auto manufacturers with the “revenue” given lump sum to the striking members. We ignore lost output during the strike (it was successfully brief) and assume that the success of the strike was unanticipated (the pre-strike competition to become an auto workers was not affected by the windfall that was to come).

Question 2 - Continued

Workers and capital owners consume automobiles and the composite of all other goods. Those preferences are homothetic. Both sectors exhibit constant returns to scale in production, which uses capital and labor as production inputs. For the moment, the aggregate supply of capital is fixed, with the market determining how it is allocated between the two sectors.

The aggregate supply of labor is fixed. To simplify the analysis of income effects, we assume representative worker families that do not necessarily own capital but allocate their labor endowment between the two sectors.

Model Set-Up

- Typical example of Harberger model of tax incidence. The setting is very similar to the one you saw in the last week's problem set, so I will briefly review the main ideas.
- Production (2 by 2 model):
 - Two factors, L and K , with fixed aggregate supply (relaxed later).
 - Two sectors, auto and other goods, with CRS technology.
- Two representative consumers each in auto and other goods economy, but we can assume a representative consumer due to homotheticity.
- Firms are owned by consumers, who also have some endowments.
- Assume free mobility of production factors. Then, w and r should be equal between auto and other goods sectors in equilibrium.
- Standard functional form assumptions for u , F , and G : (i) convex preferences, (ii) Inada conditions, (iii) diminishing returns.

General Equilibrium

- Given CRS and homotheticity, focus on relative quantities:
 - Relative prices: $p_x = 1$ (auto price normalized to one), p_y, w, r
 - Relative quantities: $x/y, L_x/K_x, L_y/K_y$.
- Equilibrium conditions:
 - Consumer utility maximization ($u(x, y) = f(v(x, y))$):

$$\frac{v_x(x_1/y_1, 1)}{v_y(x_1/y_1, 1)} = \frac{v_x(x_2/y_2, 1)}{v_y(x_2/y_2, 1)} = \frac{v_x(x/y, 1)}{v_y(x/y, 1)} = \frac{p_x}{p_y} = \frac{1}{p_y}.$$

- Firm profit maximization:

$$\frac{F_L(L_x/K_x, 1)}{F_K(L_x/K_x, 1)} = \frac{G_L(L_y/K_y, 1)}{G_K(L_y/K_y, 1)} = \frac{w}{r}, \quad \frac{F_L(L_x/K_x, 1)}{G_L(L_y/K_y, 1)} = \frac{F_K(L_x/K_x, 1)}{G_K(L_y/K_y, 1)} = \frac{1}{p_y}.$$

- Firm zero profit (competitive):

$$p_x x = wL_x + rK_x, \quad p_y y = wL_y + rK_y, \quad \therefore \frac{x}{y} = \frac{wL_x + rK_x}{wL_y + rK_y} p_y.$$

Part (a)

- (a)** Use an Edgeworth box to compare the competitive equilibrium with a successful strike to the equilibrium without one.

Part (a) - Suggested Solution

- Competitive equilibrium without a successful strike:

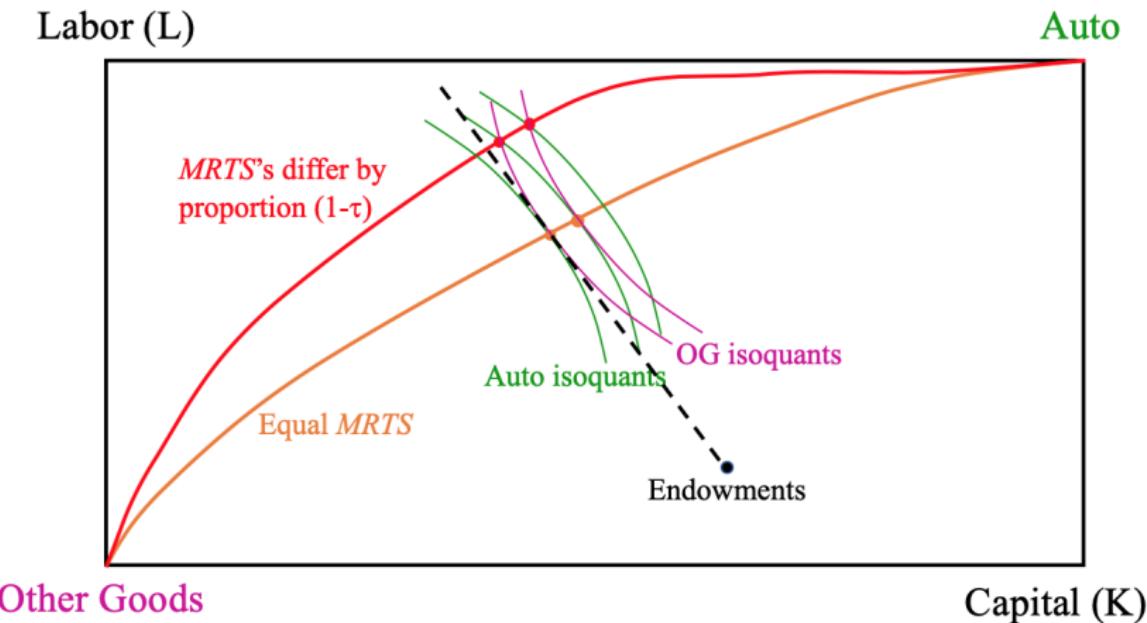
$$\frac{F_L(L_x/K_x, 1)}{F_K(L_x/K_x, 1)} = \frac{w}{r} = \frac{G_L(L_y/K_y, 1)}{G_K(L_y/K_y, 1)}.$$

- With a successful strike, now there is a tax τ imposed on the use of labor by auto (x) manufacturers. Therefore, competition equilibrium with a successful strike should satisfy

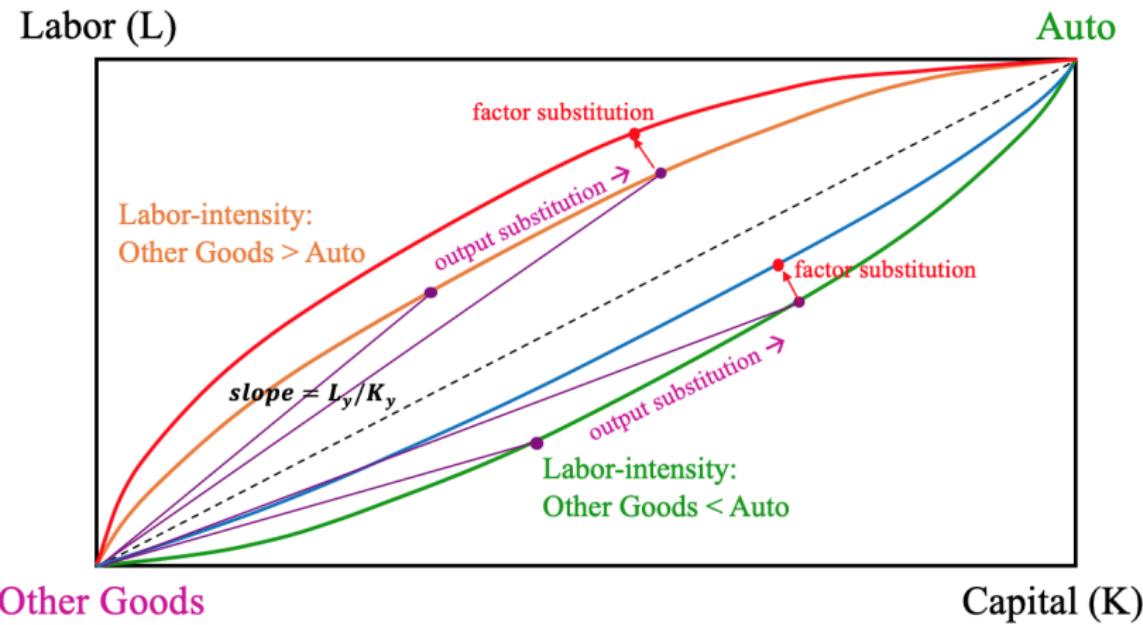
$$(1 - \tau) \frac{F_L(L_x/K_x, 1)}{F_K(L_x/K_x, 1)} = \frac{w}{r} = \frac{G_L(L_y/K_y, 1)}{G_K(L_y/K_y, 1)}.$$

- Due to tax on the use of labor by auto manufacturers (L_x),
 - ① Output substitution: $\uparrow MC_x \rightarrow \uparrow p_x \rightarrow \downarrow q_x \rightarrow L_x$ and K_x both lower
The resulting change in relative outputs depend on relative labor-intensiveness of auto and other goods sectors.
 - ② Factor substitution: $\downarrow L_x/K_x \rightarrow \uparrow L_y/K_y$

Part (a) - Suggested Solution



Part (a) - Suggested Solution



Part (b)

(b) Is it possible that worker families are worse off from a successful strike? What values of the model parameters would make their benefit small or negative?

Part (b) - Suggested Solution

- Continuing with intuitions we built with Edgeworth boxes, let's think about this question using factor and output substitution effects.
- Factor substitution: Tax on L_x makes auto manufacturers to shift production away from labor, so aggregate demand for L goes down. Since total L supply is fixed, w falls and workers bear some burden.
- Output substitution: Tax on L_x makes autos more expensive relative to other goods. Therefore, demand shifts towards other goods.
 - Case 1:** Auto sector is more labor intensive than other goods sector. Since now there are less outputs in more labor intensive sector, aggregate demand for L decreases even further. Therefore, output substitution effect reinforces factor substitution effect, and workers bear burden of the tax.
 - Case 2:** Auto sector is less labor intensive than other goods sector. Since now there are less outputs in less labor intensive sector, aggregate demand for L increases. Therefore output and factor substitution effects now have opposite signs, and the net effect on aggregate labor demand is ambiguous.

Part (b) - Suggested Solution

- Combinations of factor and output substitution effects can make workers bear anywhere from less than 0% to more than 100% of tax.
- Relevant model parameters are (i) elasticities of factor demands in production (substitutability of L and K), (ii) relative labor-intensity between the sectors, and (iii) shapes of utility functions.
- If workers bear sufficiently high tax burden, workers may be worse off from a successful strike even after getting tax revenue as a lump-sum.
- Example: Suppose auto sector is more labor intensive than other goods sector, and the demand for cars is very elastic. Then,

tax on $L_x \rightarrow \uparrow MC_x \rightarrow \uparrow p_x \rightarrow \downarrow\downarrow q_x \rightarrow \downarrow\downarrow$ aggregate demand for L

$\rightarrow \downarrow\downarrow$ very low pre-tax $w \rightarrow$ worker families worse off.

Part (c)

(c) Is it possible that the owners of capital are better off? How do these two questions of incidence relate to the supply-demand analysis of ethanol subsidies in the Introduction of *Chicago Price Theory*?

Part (c) - Suggested Solution

- The owners of capital can be better off when there is “overshifting of tax”, due to very strong output substitution effects.
- In the extreme case of the example illustrated in the part (b), suppose

$$dw < -d\tau \text{ i.e., overshifting}$$

Since the after-tax wage is now even lower than no-tax wage, firms generally increase outputs leading to higher aggregate demand for K .

- Together with fixed aggregate supply of capital, capital rental rate r increases. Then, the owners of capital would be better off.
- Ethanol subsidy story in the book was slightly different since there were two sectors (ethanol and animal feed) but only one factor of production (corn). But the main intuition is the same: “normally, we want to charge the lower price to the people with relatively elastic demand and higher price to people with relatively inelastic demand”.

Part (c) - Suggested Solution

- Subsidy = Lower Factor Price, Tax = Higher Factor Price
- Farmers gain from higher corn prices. Therefore, when the demand for corn in ethanol sector is elastic, the subsidy is very effective in increasing corn demand in the ethanol sector. That in turn leads to higher aggregate demand for corn and subsequently higher corn prices.
- Workers lose from lower wages. Therefore, when the demand for labor in auto sector is elastic, the tax is very effective in decreasing labor demand in the auto sector. That in turn leads to lower aggregate demand for labor and subsequently lower wages.
- Labor demand in the auto sector is more elastic when the sum of factor and output substitution effects are stronger. That is why, as shown in the part (b), the workers can become worse off even from a successful strike when such effects are extremely strong (despite of receiving tax revenue as a lump-sum payment).

Part (d)

(d) The president of the auto worker union points out that labor is a small share of the costs of making an automobile. What does your answer to (b) say about the relevance of his observation for determining the worker-family benefit of a successful strike? What does Marshall's Law say about its relevance to predicting the effect on the number of workers employed in auto manufacturing?

Part (d) - Suggested Solution

- How would labor being a small share of the cost of making an automobile (i.e. small s_L) affect our answer to (b)?
- Small s_L can be caused by low L_x/K_x , low w/r , or both.
- When s_L is lower, the effect of higher cost of L_x (due to taxes) on the cost of auto production would be lower. Thus, we would have weaker output substitution effects.
- Low L_x/K_x could mean that, when w increases, we can set $MTRS$ equal to new after-tax relative factor prices even with small decrease in L_x/K_x . Thus, we may also have weaker factor substitution effects.
- If we interpret small s_L as the auto sector being less labor intensive, then output and factor substitution effects have opposite signs. Therefore, the effect of small s_L on worker benefit is ambiguous and depends on the parameters discussed in the part (b).
- In Marshall's Law, the relevance of s_L on the number of auto workers depends on very similar model parameters (elasticity matters).

Part (d) - Suggested Solution

- Marshall's Law (with two factors of production, L and K): The own-price elasticity of derived demand for labor decomposes to an output and a substitution effect as the following (page 132-133):

$$\epsilon_{LL} = \underbrace{s_L \epsilon_d}_{\text{scale effect}} + \underbrace{(1 - s_L)\sigma}_{\text{substitution effect}}, \quad \therefore \frac{\partial \epsilon_{LL}}{\partial s_L} = \epsilon_d - \sigma,$$

where s_L is a share of total production costs accruing to labor, ϵ_d is the elasticity of demand (of the final product), and σ is the elasticity of substitution between two factors of production (Hicks' correction).

- The relevance of s_L on predicting the effect of taxes on the number of auto workers depends on the relative magnitudes of ϵ_d and σ . They also play important roles in our 2 by 2 model: ϵ_d affects the magnitude of output substitution effect, and σ affects the magnitude of factor substitution effect.

Part (e)

(e) Now we let the aggregate capital stock be endogenous. Following Chapter 18 of *Chicago Price Theory*, we replace the $dK = 0$ condition with a fixed return $dr = 0$. In this model, it is possible that worker families are worse off from a successful strike?

Part (e) - Suggested Solution

- Main intuition: Tax creates deadweight losses, so the total surplus in the economy drops (unless labor demand in the auto sector is perfectly inelastic so that tax does not distort behaviors). However, since r is now fixed, capital owners cannot be worse off. Therefore, worker families (as a whole) must be worse off from a successful strike (similar intuition in the Chapter 18 of *Chicago Price Theory*).
- What would happen if the labor demand in the auto sector is perfectly inelastic?
- Even with taxes in auto labor, aggregate demand for labor does not change. Therefore, w stays the same.
- Auto manufacturers pay taxes τL_x , but it is given lump-sum to the workers. Therefore, worker families as a whole becomes indifferent.
- If workers in the other goods sector also owned some shares of auto firms pre-strike, then some of their surplus is transferred to the workers in the auto sector (sum of their surplus still unchanged).