

EE 442
Economics of Public Revenue

Topic 7
Optimal Income Taxation

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- Should the government impose progressive taxes?
 - How can we manage the trade-off between equity and efficiency?
 - What is optimal income tax?
 - Choosing the tax rates across income groups to maximize social welfare subject to a government revenue requirement.

Edworth's Model

- Explain about the optimal personal income tax.
- Assumptions

1. Given the amount of tax revenue that the government would like to collect.

The objective: Under a particular tax system, we will reach a maximum welfare level.

$$W = U_1 + U_2 + \dots + U_n$$

n = number of people in the society.

2. Each individual has the same utility function and depends on income. They have diminishing MU of income.

3. Total income is fixed.

- Max W: $MU_{IA} = MU_{IB} = \dots = MU_{IN}$

Each individual has the same utility function $\rightarrow MU_i$ of each individual is equal when they have equal income.

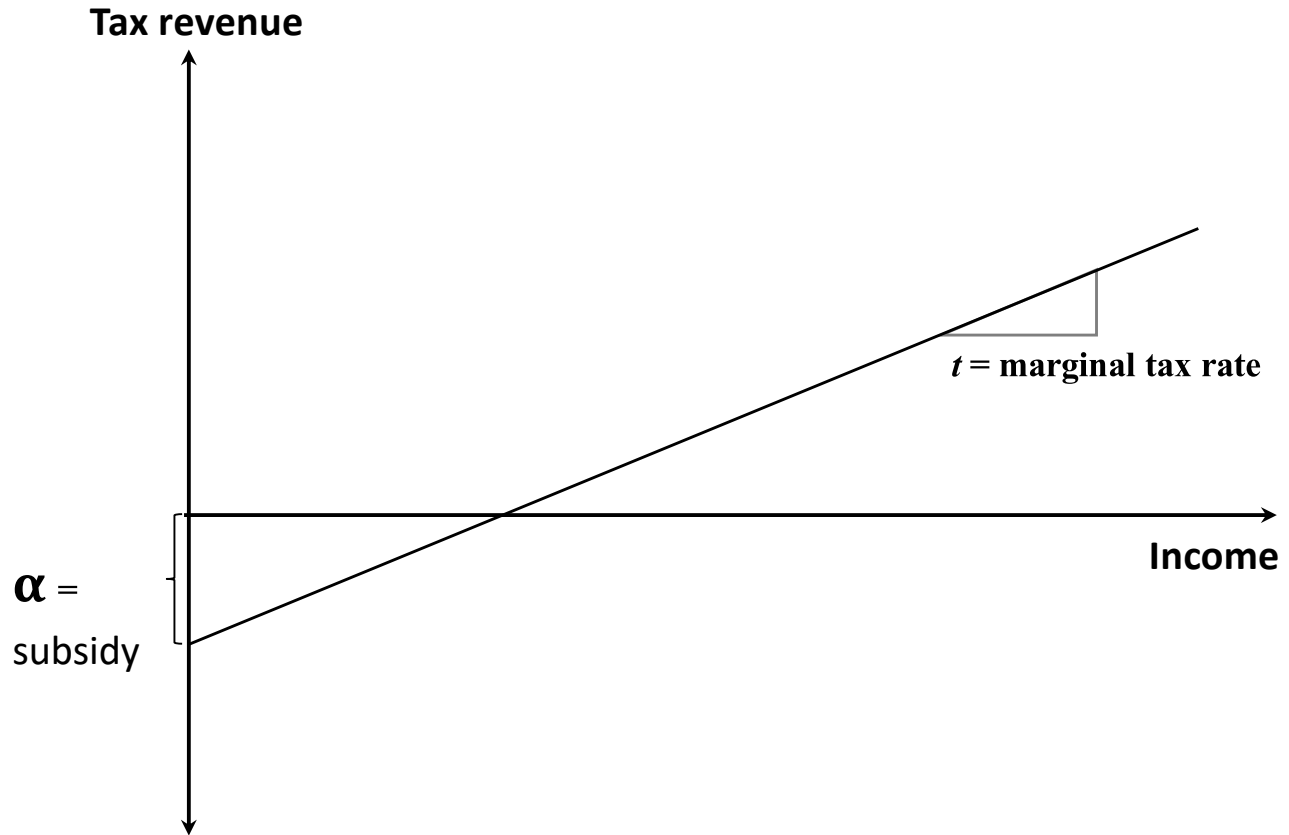
$\rightarrow$ We should design taxation in such a way that every one will have the same amount of income after tax (to the extent possible). $\rightarrow$ take away income from the rich first because the decreasing in MU of the rich $<$ MU of the poor. If the government would like to get more tax revenue after we reach equity, further taxes should be distributed equally.

- The implication of Edworth's model is the progressive tax structure. → take away income from the rich until we reach equity → marginal tax rate of the rich = 100%.

What are the results of Edworth model when the assumptions are changed?

- It assumes “fixed income in the society” so tax rate will not affect production quantity.
- In the real situation, the utility function depends on both income and leisure.
 - → imposing income taxes → distort work decisions and create the excess burden
- Under the additive social welfare function, it will be more complex.
 - On one hand, we have to distribute tax burden in order to achieve the equal income distribution after tax. But in the process, total real income will be decreased.

- When considering the optimal taxation system and maximizing social welfare, we need to include the costs of reaching equity (excess burden) in our consideration.
- In Edworth model, cost of reaching equity = 0 which will make absolute equity feasible.
- How will the results of Edworth model change when we consider work incentive?
- Stern (1987) used the same model as Edworth's but the individual can choose between income and leisure.



- Given that: tax revenue = $-\alpha + t \times \text{income}$
- where $\alpha \text{ and } t > 0$
- EX: $\alpha = 3,000$, $t = 0.25$ and $Y = 20,000$
 tax burden = $-3,000 + (0.25)(20,000) = 6,000$ baht
- If $Y = 6,000 \rightarrow$ tax burden = $-1,500 \rightarrow (-3,000 + (0.25)(6,000))$
 - $\rightarrow$ This person should get government subsidy = 1,500 baht
- If $Y = 0 \rightarrow$ tax burden is negative $\rightarrow$ receive government subsidy = α baht
- Every one baht of income, each person has to pay t baht to government $\rightarrow t =$ marginal tax rate
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- If t is high $\rightarrow$ more progressive $\rightarrow$ more excess burden
- Optimal income tax: find the best combination of α and t .
- Max W under condition that the government will get a certain amount of tax revenue.

- From Stern's study, there is substitution between income and leisure and the government needs tax revenue = 20% of income.
- This study finds out that
 - ❖ The tax rate which will max W is $t = 19\%$ (not Edworth's 100%).
 - ❖ If the supply of labour is highly elastic $\rightarrow$ the optimal value of t will be small with high excess burden $\rightarrow$ the cost of income redistribution is high $\rightarrow$ we should take away less income.
 - ❖ If we weigh more to the poor $\rightarrow t$ is high.

In the case of Maximin criteria $\rightarrow$ marginal tax rate will be high (80%)

If we pay more attention to equity, tax rate will be very high or approaching 100%.

- Edworth's model has one marginal tax rate.
- Gruber and Saez (2002) have 4 marginal tax rates.
 - They found that the high income group should have lower marginal tax rate than the low income group because if we reduce the marginal tax rate of the high income group → they will work more → the government can collect more tax and can use this amount of tax to compensate for tax burden of the lower income group.

Even though the marginal tax rate ↓ but the average tax rate still ↑ (relative to income) → tax structure is still progressive.

EX: Some states in Switzerland imposes low marginal tax rate with the high income group.

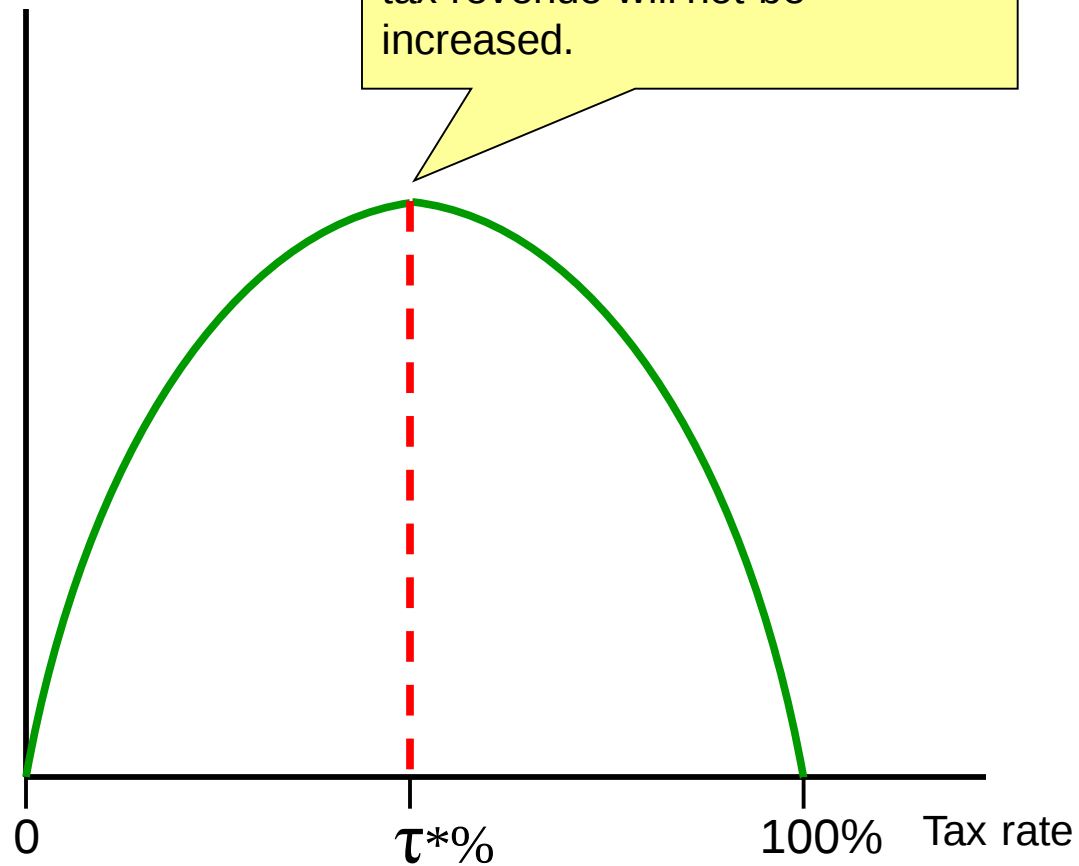
Optimal income tax and people's behavior

- By principle, there are tradeoffs between efficiency and equity in taxation.
- Government imposes more taxes → affect the tax base. People will try to avoid taxes → change their economic behavior.
- EX: When the government imposes greater taxes on labor income, it will cause 2 effects:
 - Tax revenue increases at every income level.
 - Labor reduces the amount of hours they work which decreases tax revenue.
- At a high tax rate, the second effect will have more influence when the tax rate increases more and more.

Optimal income tax and people's behavior

- *The Laffer curve* represents the relationship between the tax rate and tax revenue and has been used to manage supply side in some periods of time.
- The Laffer Curve shows that the government will not be able to keep increasing the tax rate forever. If the tax rate is too high, people will try to avoid tax and tax revenue may not increase as expected.

Tax revenue



Optimal income tax and people's behavior

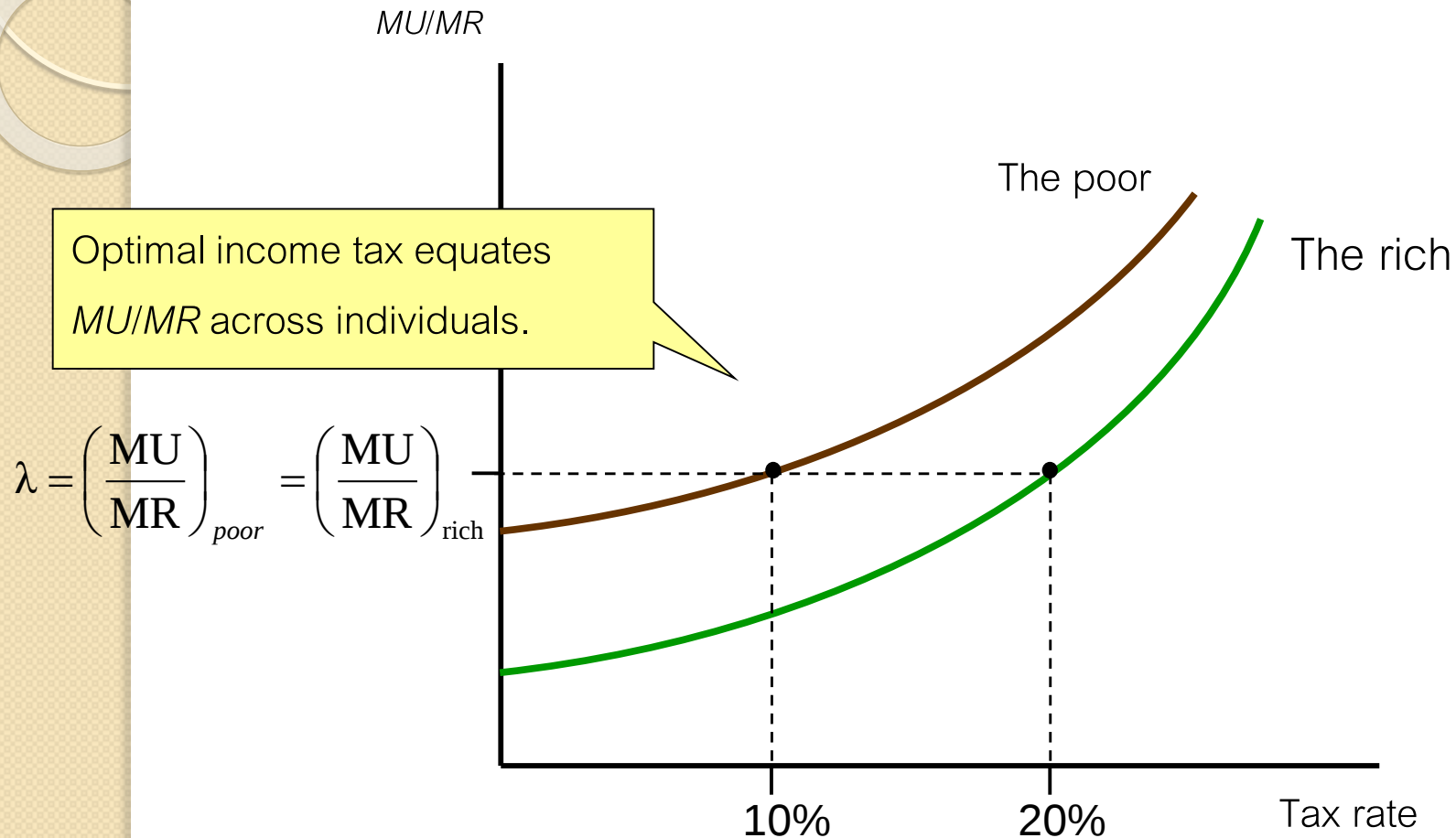
- The objectives of the optimal income tax: Max social welfare and max tax revenue.
- Condition:

$$\frac{MU_i}{MR_i} = \lambda$$

- where MU_i is the marginal utility of individual i and MR is the marginal revenue of individual i .

Optimal income tax

- Optimal income tax concerns about
 - Vertical equity
 - Behavior responses
- Optimal income tax equates $\frac{MU_i}{MR_i} = \lambda$ across individuals.
- This will lead to a high tax rate for the rich and low tax rate for the poor.



Tax collection cost

- Collecting taxes can be costly.
- Costs on both tax collectors and tax payers:
 - Costs on the officers
 - Costs on tax payers
 - Accounting costs
 - Other costs such as time cost.

Tax collection cost

- The government has to consider:
 - management cost and
 - the compliance cost of tax payers
- Even though the income tax is optimal (efficiency and equity), if the operation cost is high, it may not be appropriate to impose that kind of taxes.



Optimal commodity tax

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- An important question to design economic policy:
Should one commodity be taxed at a higher rate than the other commodities?
 - What tax rates should each commodity be taxed?
 - Answer by *the optimal commodity tax theory*.

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- In order to design tax collection → What are the government's objectives?
 - Assume that the only objective of the government is to have enough tax revenue to finance government expenditure with the least excess burden (EB) and avoid lump sum tax. → consider the efficiency and equity issues.

- Assume that Mr. A consumes 2 products: X Y and I (leisure)
- P_x = price of X
- P_y = price of Y
- w = price of leisure
- The maximum numbers of Mr.A's work hours are fixed (time endowment) = T' $\rightarrow$ work hours = $T' - I$
- income = $w(T' - I)$

- Assume that Mr.A spends his money on X and Y (no saving)

- Mr.A's budget constraint is

$$w(T' - I) = P_x X + P_y Y$$

- Rearrange the equation:

$$wT' = P_x X + P_y Y + wI$$

- Assume that the government imposes an ad valorem tax on X, Y and L at rate t .
- The effective price of X is $(1 + t)P_x$,
the effective price of Y is $(1 + t)P_y$,
the effective price of L is $(1 + t)w$.
- The budget constraint of Mr. A after tax is

$$wT' = (1 + t)P_x X + (1 + t)P_y Y + (1 + t)wL$$

divided by $(1 + t)$, we will get

$$1/(1 + t)wT' = P_x X + P_y Y + wL$$

Note: Imposing tax on every commodities including leisure at the same rate $(t) \rightarrow$ reduce the value of time from wT' to $[1/(1 + t)] wT'$

EX. Imposing 25% tax on X Y and L is equivalent to reducing the value of time by 20%.

w and T' are fixed. $\rightarrow wT'$ is also fixed.

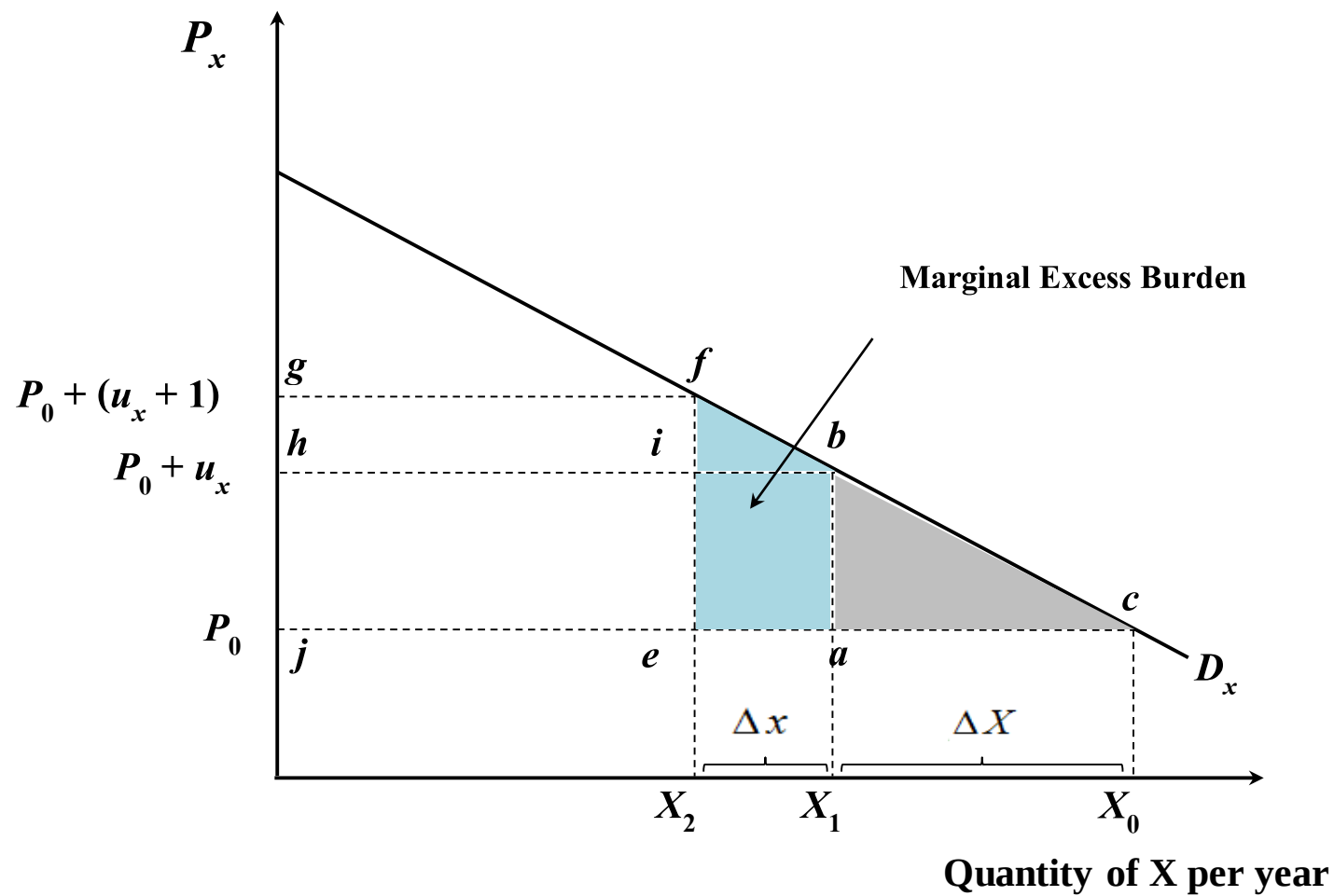
At each wage rate, each individual cannot change the value of their time. $\rightarrow$ Taxation is proportional to time.
 $\rightarrow$ lump sum tax $\rightarrow$ no EB

Conclusion: Imposing tax on every commodity including leisure at the same rate is equivalent to lump sum tax with no EB.

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The Ramsey Rule

- How can we determine the tax rate on X and Y in order to have the least EB?
- In order to have the least EB $\rightarrow$ the marginal EB of each commodity should be equal.



- Assume that product X and Y are not related. $\rightarrow$ Price changed will affect just the demand for that particular product, it will not affect the demand of the other products.
- The compensated demand for X of Mr. A $\rightarrow D_x$
- Assume that Mr. A can buy all X at P_0 .
- Assume that the government imposes per unit tax on X = $U_x \rightarrow$ demand reduced from X_0 to $X_1 \rightarrow \Delta X \rightarrow$ EB is the area abc.
- Assume that increasing tax by 1 baht $\rightarrow U_x + 1$. The price will be $P_0 + (U_x + 1)$. Demand decreased = Δx to X_2 . $\rightarrow$ EB = area fec.

- Marginal EB = the difference in the area of 2 triangles = area fbae = $\frac{1}{2} \Delta x [U_x + (U_x + 1)]$
- Marginal EB is approximately equal to ΔX .
- Find the marginal EB with respect to the increasing in tax revenue.

Computing the change in tax revenues associated with raising the rate from U_x to $(U_x + 1)$

- When $t = U_x$, tax revenues = $U_x X_1$ (the tax per unit times number of units sold) = rectangle hbaj
- When $t = (U_x + 1)$, tax revenues = rectangle gfej
- Comparing these 2 rectangles, when the tax goes up, the government gains area gfih but loses area ibae.
- The change in revenues is $gfih - ibae$, which is
$$X_2 - (X_1 - X_2)U_x$$
- $X_1 - \Delta X = \text{marginal tax revenue}$
- Marginal EB per additional baht of tax revenue = $\Delta X / X_1 - \Delta X$

- If a unit tax of U_y is levied on $Y \rightarrow$ marginal EB per last baht of revenue = $\Delta Y / Y_1 - \Delta Y$
- Min overall EB: the marginal EB per last baht of revenue be the same for each commodity, we must set

$$\Delta X / X_1 - \Delta X = \Delta Y / Y_1 - \Delta Y$$

or

$$\Delta X / X_1 = \Delta Y / Y_1$$

- which is the percentage change in that variable (the change in a variable divided by its total value).
- In order to minimize total EB, tax rate should be set so that the percentage reduction in the quantity demanded of each commodity is the same. $\rightarrow$ Ramsey rule
- This rule still holds even for cases when X , Y and I are related goods (substitutes and complements).



Why should efficient taxation induce equiproportional changes in quantities demanded rather than equiproportional changes in prices?

- EB is a consequence of distortion in quantities.
- To total minimize EB $\rightarrow$ all these changes in quantity of each product be in the same proportion.

The relationship between Ramsey rule and demand elasticities

- η_x is compensated elasticity of demand for X.
- t_x is tax rate on X (ad valorem tax) $\rightarrow t_x$ is the percentage increase in the price induced by the tax.
- $t_x \eta_x$ is percentage change in the price times the percentage change in quantity demanded when the price increases by 1%. $\rightarrow$ the percentage reduction in the demand for X induced by the tax.
- $t_y \eta_y$ is the proportional reduction in Y.

- Ramsey rule: To minimize EB $\rightarrow$ these percentage reductions in quantity demanded must be equal.

$$t_x \eta_x = t_y \eta_y$$

- divided by $t_y \eta_x$

$$t_x/t_y = \eta_y/\eta_x \rightarrow \text{inverse elasticity rule (IER)}$$

- As long as goods are unrelated in consumption. $\rightarrow$ tax rates should be inversely proportional to elasticities. $\rightarrow$ The higher is η_y relative to $\eta_x \rightarrow$ the lower should be t_y relative to t_x .
- Efficiency does not require that all rates be set uniformly.

IER $\rightarrow$ Efficient taxes distort decisions as little as possible.

➤ *More elastic the demand for a commodity $\rightarrow$ the distortion is greater.*

$\rightarrow$ Efficient taxation requires that relatively high rates of taxation be levied on relatively inelastic goods.

The Corlett-Hague Rule

- Prove an interesting implication of the Ramsey rule.
- When there are 2 commodities: efficient taxation requires taxing the commodity that is complementary to leisure at a relatively high rate.
- If it were possible to tax leisure, → a “first-best” result (tax with no excess burden).
- But the government cannot tax leisure → tax goods that tend to be consumed jointly with leisure → indirectly lower demand for leisure.
- EX. If computer games are taxed at a very high rate → people buy fewer of computer games and spend less time at leisure. → indirect way to get at leisure → more closer to the perfectly efficient outcome (equivalent to imposing tax on leisure).

Equity considerations

- The efficient tax theory has unpleasant policy implications.
- IER says inelastically demanded goods should be taxed at relatively high rates.
- Q: Is it fair?
 - Do we really want a tax system that collects its revenues from taxes on medicine?
- A: Of course not.
- The Ramsey rule has been modified to account for the distributional consequences of taxation.

- EX. The poor spend a greater proportion of their income on commodity X than do the rich, and vice versa for commodity Y.
- X is rice. Y is pizza.
- Assume that the social welfare function puts a higher weight on the utilities of the poor than on those of the rich.
- Even if X is more inelastically demanded than Y, $\rightarrow$ optimal taxation may require a higher rate of tax on Y than X. $\rightarrow$ A high tax rate on Y creates a relatively large excess burden, but it also tends to redistribute income toward the poor. Society may be willing to pay the price of a higher excess burden in return for a more equal distribution of income.

- In general, the optimal departure from the Ramsey rule depends on 2 considerations.

1. How much society cares about equality.

If society cares only about efficiency then it may as well strictly follow the Ramsey rule.

2. Do the consumption patterns of the rich and poor differ?

If the rich and the poor consume both goods in the same proportion, taxing the goods at different rates cannot affect the distribution of income. Even if society has a distributional goal, it cannot be achieved by differential commodity taxation.

- Summary:

- ❖ If lump sum taxation were available, taxes could be raised without any excess burden at all. Optimal taxation would need to focus only on distributional issues.
- ❖ Lump sum taxes are not available.
- ❖ The problem is how to raise tax revenue with a small an excess burden as possible.

- In general minimizing EB requires that taxes be set so that the (compensated) demands for all commodities are reduced in the same proportion.
- For unrelated goods: tax rates should be set inverse proportion to the demand elasticities.
- If society has distributional goals, departures from efficient taxation rules may be appropriate.

Application: Taxation of the Family

- If the fundamental unit of income taxation is the family.
- A husband and wife are taxed on the sum of their incomes. Regardless of whether the wife or the husband earns an extra baht, it is taxed at the same rate.
- Q: Is this efficient?
 - Is the family's EB minimized by taxing each spouse's income at the same rate?

- Family is a unit whose utility depends on the quantities of 3 commodities:
 - total family consumption,
 - husband's hours of work, and
 - wife's hours of work.
- Family utility $\uparrow$ with family consumption but $\downarrow$ with each spouse's hours of work.
- Each spouse's hours of work depend on his or her wage rate, among other variables.
- A tax on earnings distorts the work decision, creating an EB.

How should tax rates be set so the family's EB is as small as possible?

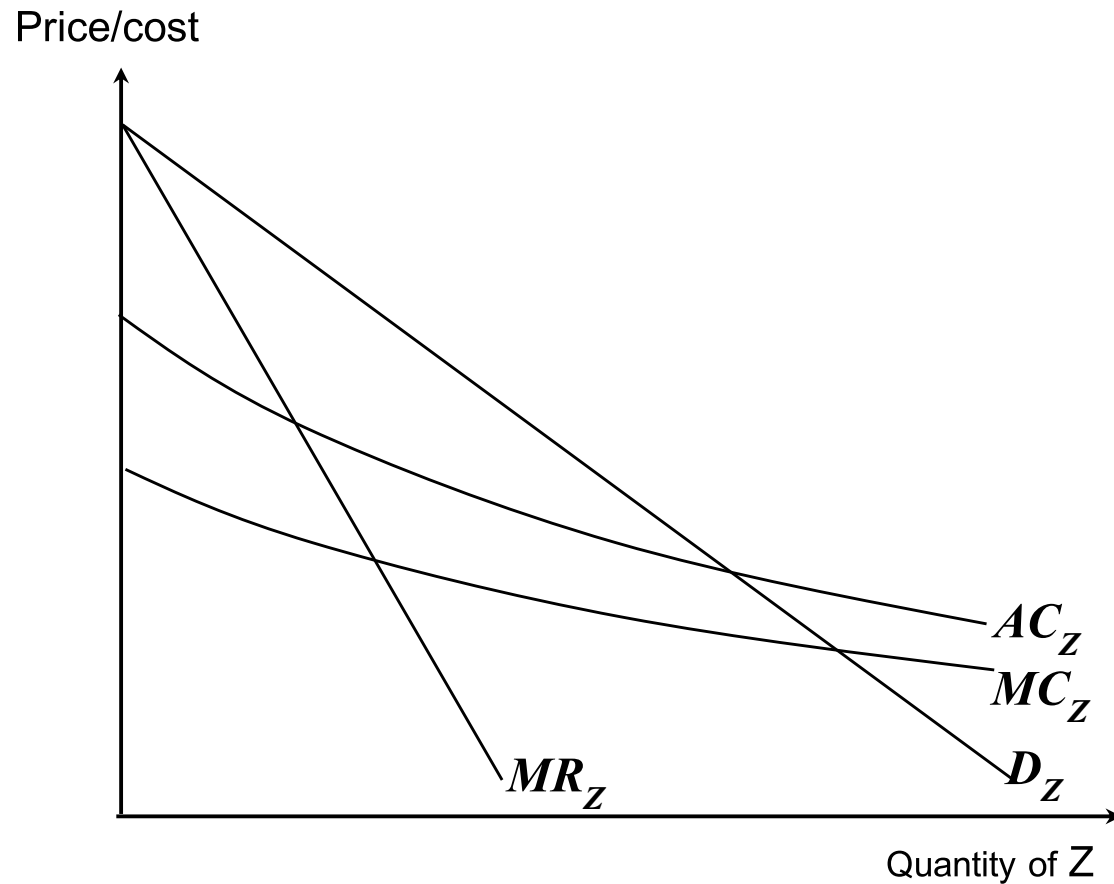
- Assume that the husband's and wife's hours of work are approximately "unrelated goods". → An $\uparrow$ in the husband's wage rate → has very little impact on the wife's work decision, and vice versa.
- IER suggests that a higher tax should be levied on the commodity that is relatively inelastically supplied.
- To enhance efficiency, whoever's labor supply is relatively inelastic should bear a relatively high tax rate.
- A lot of econometric studies suggest that the husband's labor supplies are considerably less elastic than wives'. → Efficiency could therefore be gained if the current tax law were modified to give husbands higher marginal tax rates than wives.
- In this EX, we emphasize that efficiency is only one consideration in tax design. However, it is interesting that this result is consistent with the claims of some who have argued that on equity grounds, the relative tax rate on the earnings of working wives should be lowered.



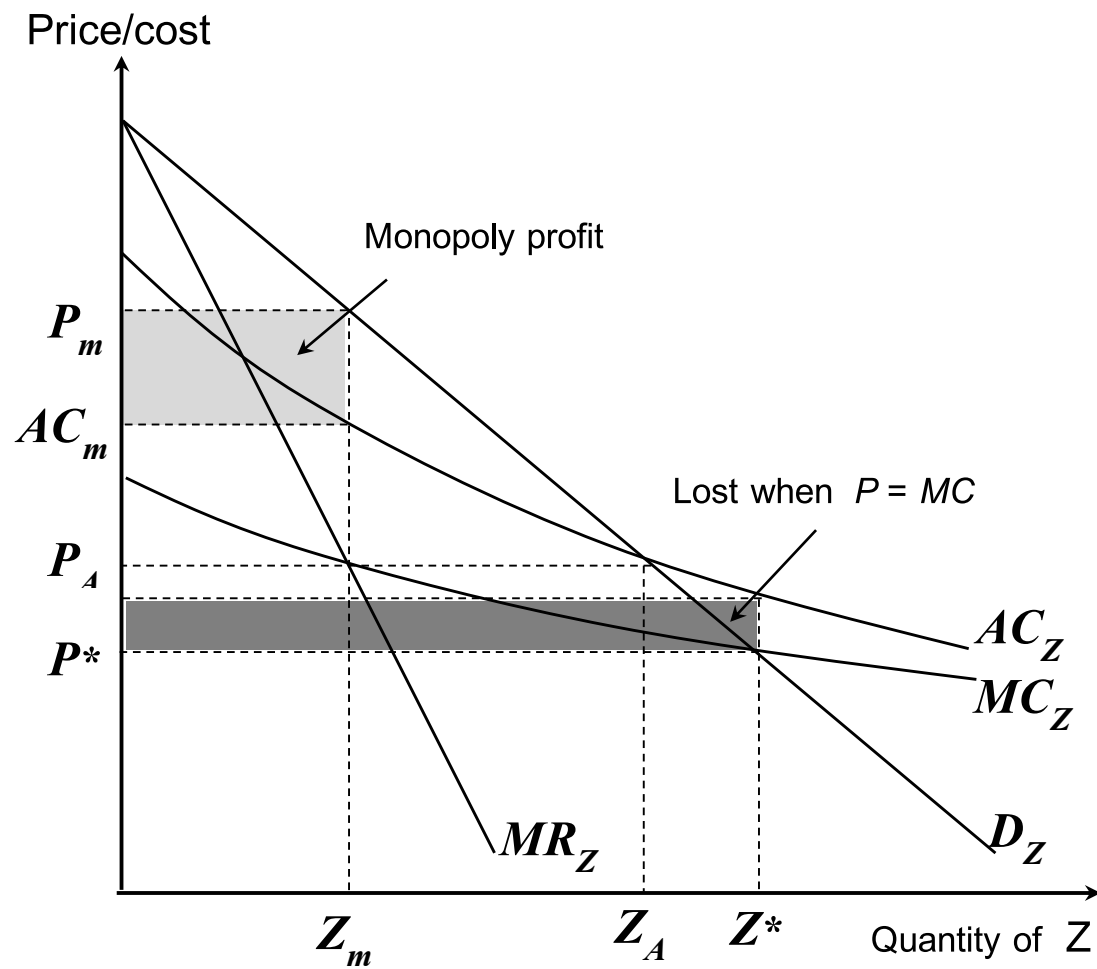
Optimal User Fees

- Sometimes, the government itself is the producer of a good or service. → The government must directly choose a user fee (*a price paid by users of good or service provided by the government*).
- We would like to determine the “best” possible user fee.

Natural monopoly



- The average cost schedule is AC_Z (decrease continuously over all relevant ranges of output).
- Because AC_Z is decreasing, MC_Z must be less than average. (MC_Z lies below AC_Z).
- The demand curve for Z is D_Z .
- The marginal revenue curve is MR_Z .
- Why decreasing average costs often lead to public sector production or regulated private sector production, consider what would happen if A was produced by an unregulated monopolist.



- A monopolist seeking to maximize profits produces up to the point that $MR = MC$.
Output level = Z_m
- Price level = P_m
- Monopoly profits are equal to the product of number of units sold times the profit per unit and are represented geometrically by the light colored rectangle.

- Q: is output Z_m efficient?
- According to the theory of welfare economics, efficiency requires that $\rightarrow P = MC$ (the value that people place on the food must equal the incremental cost to society of producing it).
- At Z_m , price is greater than MC so Z_m is inefficient.
- This inefficiency plus the fact that society may not approve of the existence of the monopoly profits provide a possible justification for government taking over the production of Z .

- *The government policy should be* to produce up to the point where $P = MC$ and output = Z^* , price = P^* where price $< AC$. $\rightarrow$ It suffers losses.

(The total loss is equal to the product of the number of units sold, Z^* times the loss per unit, measured as the vertical distance between the demand curve and AC_Z at Z^* which is the darker colored rectangle).

- *How should the government confront this dilemma?*

- Solutions:

1. Average Cost Pricing

By definition, when price equals AC, there are neither profits nor losses (break even). The operation no longer has to worry about a deficit.

→ Output = Z_A ($Z_A < Z^*$ but $Z_A > Z_m$)

→ Price = P_A

→ This level of production is still inefficient.

2. Marginal Cost Pricing with Lump Sum Taxes

Charge $P = MC$, and make up the deficit by levying lump sum taxes. Charging $P = MC$ ensures efficiency in the market for Z; financing the deficit with lump sum taxes on the rest of society guarantees that no new inefficiencies are generated by meeting the deficit.

There are 2 problems with this solution:

- Lump sum taxes are generally unavailable. The deficit has to be financed by distorting taxes, such as income or commodity taxes. If so, the distortion due to the tax may more than outweigh the efficiency gain in the market for Z.
- Fairness requires consumers of a publicly provided service to pay for it (benefit-received principle). If this principle is taken seriously, it is unfair to make up the deficit by general taxation. If the coast guard rescues me from a stormy sea, why should you pay for it?

- Suppose that the government running several enterprises, and as a group they cannot lose money, but any individual enterprise can.
- Suppose further that the government wants the financing come from users of the services produced by the enterprises.
- Q: By how much should the user fee for each service exceed its MC?
- The difference between the MC and the user fee is the “tax” that the government levies on the commodity. The government has to raise a certain amount of revenue enough for a group of enterprises to break even.
- From Ramsey rule, set the user fees so that demands for each commodity are reduced proportionally.

Taxes on Producers

- Firms never bear the incidence of a tax, but individuals do, as
 - shareholders
 - workers
 - consumers
- ❖ Does Pareto efficient taxation imply that taxes should be imposed on production processes?
 - ✓ The taxes interfere with one of the 3 conditions for Pareto efficiency, product mix efficiency ($MRT \neq MRS$).
 - ✓ Do we want to maintain production efficiency, even if we cannot maintain product mix efficiency?

- Many of taxes also affect the production efficiency of the economy.
- Production efficiency requires that MRTS between any 2 inputs be the same in all firms, and that the MRT between any 2 outputs.
- Any tax on an input that is not uniform across all firms, or any tax on an output that is not uniform across all firms → the economy's not being productively efficient.
- EX: corporate income tax → raises the after-tax cost of capital in corporations above that in unincorporated businesses.

Gasoline that is used for most business purposes is taxed VS
gasoline used for farming is not.

Market and non-market sector

- Only activities performed in the market sector are taxed.
- EX: An individual driving himself to work (no tax) VS a taxicab driver who drives the individual to work (taxed).

A person who bakes a loaf of bread at home (not taxed) VS the bakers (taxed).

→ A distortion between the marketed and nonmarketed sectors → the economy is not productively efficient.

Intermediate goods

- Any tax on intermediate goods is distortionary.
- EX: A firm that produces and uses computers in its own production plants → the cost of the computer is simply the cost of the factors of production (including the return to capital employed in the production).
- In a competitive economy, this firm would be forced to sell the computers at its costs of production → the cost of any other firm using a computer would be the same as the cost of the manufacturing firm in using it.
- After imposing a sales tax: the cost to the firm manufacturing the computer and using it is less than the cost to another firm using the computer in its production processes. → distortion → the economy is no longer productively efficient.

Should the government impose such distortionary taxes if it wishes to minimize the DWL of the tax system?

- Naïve answer is “of course not”.
- Under some circumstances, the conclusion of the naïve argument is correct.
- If the government can tax away all profits in the private sector, and if there are no other restrictions on the ability of the government to impose taxes. → productive efficiency is desirable.
- The government should impose no distortionary taxes on businesses.
- Whatever the government could do with a distortionary tax on producers, it could do better with a direct tax on consumers that maintained the economy on the production possibilities schedule.

Difficulties in imposing taxes

- Government cannot distinguish between final consumer use of a commodity and the use of the commodity by a business.
- If the government will impose a tax on consumers → it must also impose a tax on business use.
- Whenever the government cannot identify and tax away all pure profits in the private sector, and whenever there are other restrictions on the ability of the government to impose taxes, it may be desirable to impose distortionary taxes on producers.

The dependence of optimal tax structure on the set of available taxes

- Ramsey showed that without income tax (and assuming no redistributive objectives) → different commodities should be taxed at different rates depending only on the elasticities of demand and supply.
- With an optimal chosen income tax → it may not be desirable to impose differential commodity taxes or if it is desirable to impose differential commodity taxes, they do not depend simply on the elasticities of demand.