QUANTITATIVE ANALYSIS TECHNIQUES

(NOT INCLUDING COHORT-COMPONENT POPULATION PROJECTIONS OR ECONOMIC BASE ANALYSES)

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INPUT-OUTPUT ECONOMIC ANALYSIS

1. Input-output analysis focuses on intermediate sales between an economy's sectors. It is based on more of an accounting methodology than a theory (unlike economic base analysis).

2. Input-output analysis is similar to economic base analysis in that…

- It is used both to study an economy's structure and to project that structure into the future.
- It divides the involved economy's activity into groups. However, while the economic base technique divides economic activity into basic and non-basic groups, the input-output technique classifies economic actors as either (1) *primary suppliers* (they purchase no inputs for producing outputs – they are usually households, their output is usually labor, and they usually purchase only final goods), (2) *intermediate suppliers* (they sell their outputs to either intermediate or final purchasers), (3*) intermediate purchasers* (they buy outputs from others and use them as inputs to produce outputs – intermediate purchasers and intermediate suppliers are actually the same), and (4) *final purchasers* (they use their inputs as a final goods – i.e., they consume them). Note that primary suppliers are not necessarily also final purchasers.

3. Input-output analysis makes the following assumptions, some of which are dubious…

- Economies of scale do not exist.
- The available technology and the quality of labor do not change.
- The inputs of each industry's production cannot be substituted.
- Each industry produces only one bundle of goods (i.e., output).
- Each industry's consumption of inputs stays constant.
- There are no national imports or exports.
- An economy's total output (i.e., the value of all sales in a limited time period) equals its total product (i.e., its final sales) plus its intermediate sales.
- Final demand is outside of the economy being analyzed.

4. An input-output analysis is composed of three tables…

- **The transactions table:** This table shows cash flows between intermediate economic sectors. Intermediate suppliers are listed on the y-axis (i.e., rows), and intermediate purchasers are listed on the x-axis (i.e., columns). Each row is summed to show the involved sector's total production (i.e., total outputs), and each column is summed to show the involved sector's total purchases (i.e., total inputs).
- **The direct requirements table** (also called the "industry coefficients table" or the "technical coefficients table": This table is produced by dividing each cell in the transactions table by the sum of that cell's column. Thus, the sum of each column in the direct requirements table is one. If 0.05 was a number in a cell that belonged to manufacturing's row and agriculture's column, it would be interpreted as "0.05 of the money spent by the agricultural sector to produce one "unit" of output was used to buy intermediate goods (i.e., inputs) from the manufacturing sector."

- **The total requirements table:** This table is produced by re-iterating the direct requirements table and summing the per dollar requirements of each economic sector (don't worry about this for the exam). Each sector is listed as a row on the y-axis (e.g., agriculture, manufacturing, households). On the x-axis, the following items are usually column headings: "sales to final purchasers," "sales as direct inputs" (one sub-column is provided for each economic sector, and one sub-column totals sales as direct inputs), "sales as indirect inputs" (one sub-column is provided for each economic sector, and one sub-column totals sales as indirect inputs), and "total sales."

5. Using input-output analysis…

- An input-output analysis is typically a far worse "data hog" than a corresponding economic base analysis. Performing an input-output analysis is very difficult, costly, and time consuming.
- Even though most economists prefer input-output analysis to economic base analysis, input-output analyses sometimes don't produce significantly better results.
- Input-output analysis is most often used to project scenarios. After the three above tables have been completed for a particular economy, the thus created "model" is "shocked" with a hypothetical economic event – for instance, the opening of a new shopping center. As the involved economic sector changes (it grows, in this example), the resulting changes in its inputs and outputs ripple across the model – estimating the long-term effects of the hypothetical event on all of the particular economy's sectors.
- An input-output analysis can be similarly used to project a local economy's overall size and structure into the future. In this case, sector-specific growth rates that have been projected into the future for a larger "reference region" are used to "shock" the "model."

ECONOMETRIC APPROACHES TO ECONOMIC ANALYSIS

These approaches use regression to estimate the impacts of hypothetical economic events or to project economies into the future. The economic attribute being studied serves as the dependent (i.e., "y") variable. Calibrating the involved regression can be difficult.

FISCAL IMPACT ANALYSIS[1]

1. Some of the study materials refer to fiscal impact analysis as "cost-revenue analysis."
2. In general, fiscal impact analysis is used to estimate the costs and revenues that a proposed development will bring to an area's governments and schools.
3. *The Practice of Local Government Planning* lists six types of fiscal impact analyses (on page 468), each of which is differentiated by (1) the method that it uses to estimate costs, (2) the particular type of development that it studies, and (3) whether it focuses on average costs or marginal costs.
4. All six types of fiscal impact analysis estimate the revenues that will be earned by a proposed development in a similar manner. Note that revenues for utility services and building permits are typically ignored, since they are usually user charges and just cover the costs of operation.

[1] Most of this section summarizes pages 466-470 of *The Practice of Local Government Planning* (So, Frank S., and Judith Getzels, eds. Washington DC: the International City/County Management Association, 1988).

- For proposed residential development, per capita school district revenues are calculated by dividing all school non-tax revenues and tax revenues (except for real property tax revenues and earned income tax revenues) by the current number of residents in the school district.
- For proposed residential development, per capita municipal government revenues are calculated by dividing all municipal non-tax revenues and tax revenues (except for real property tax revenues, earned income tax revenues, and state liquid fuels tax revenues) by the current number of residents in the municipality.
- The per capita school district and per capita municipal government revenues are then applied to the expected number of residents in the new development.
- The increase in real property tax revenues due to the proposed development is calculated using information provided by the developer, the school district's millage rate, and the municipality's millage rate.
- For proposed residential development, the increase in earned income tax revenues is calculated using information provided by the developer, statewide average household income per unit multipliers, the school district's earned income tax rate, and the municipality's earned income tax rate.
- For proposed commercial or industrial development, the increase in wage taxes is calculated using the developer's employment and wage estimations as well as the wage tax rates of the school district and the municipality.
- The increase in liquid fuels tax revenues is calculated using the expected increase in residents and road mileage due to the proposed development (if any).
- The increase in federal and state grant-in-aid program funding to the municipality and the school district due to the proposed development is calculated using the rules of the program at hand.
- The above items are then totaled to show the total increased revenues due to the new development.

5. **The Per Capita Multiplier Method:** Of the six types of fiscal impact analyses listed in *The Practice of Local Government Planning,* the per capita multiplier method is by far the most commonly used. It is used for estimating the *average costs* of a proposed *residential* development. Its typical steps are summarized below…

- First, the number of school-aged residents and the total number of residents expected to reside in the new development are calculated using statewide per unit multipliers.
- The per pupil school district spending rate is applied to the expected number of school-aged residents in the new development.
- The per resident municipal spending for roads, police services, fire protection, government administration, and all other services is applied to the expected total number of residents in the new development on a category by category basis.
- The above items are then totaled to show the total increased costs due to the new development.
- The simple per capita multiplier technique summarized above could be made more sophisticated by detailing the types of residences included in the new development and applying specific multipliers to each. For instance, townhouses generally house fewer school-aged children than single-family detached dwellings do. Senior apartments often require less police services than college student apartments do.

- Note that the simple per capita multiplier technique summarized above assumes that the proposed development will not necessitate major infrastructure construction projects (e.g., the school district will not have to build a new school to handle the increase in students). More sophisticated versions of this technique can deal with such complications.

6. Of the six types of fiscal impact analyses listed in *The Practice of Local Government Planning,* the following three – like the per capita multiplier method – are used for estimating the *average costs* of a proposed *residential* development…

- **The Case Study Method:** The characteristics of the proposed development are shown to various municipal and school district officials, who collectively estimate a range of possible future costs to serve the development.
- **The Service Standard Method:** This method, which is similar to the per capita multiplier approach, focuses on the manpower requirements needed to service the proposed development – using specific service categories.
- **The Comparable City Method:** This method, which is rarely used, estimates the costs of the proposed development using information from other municipalities who have experienced similar developments.

7. Of the six types of fiscal impact analyses listed by *The Practice of Local Government Planning,* the following two are used for estimating the costs of a proposed *commercial or industrial* development…

- **The Proportional Valuation Method:** This method is used to estimate the *average costs* of a proposed non-residential development. It assigns a proportion of the municipality's costs to the proposed development based on that development's real property valuation in comparison to that of the community as a whole.
- **The Employment Anticipation Method:** This method is used to estimate the *marginal costs* of a proposed non-residential development. It is based on the assumption that a municipality's costs in serving a facility are related to that facility's total number of employees.

8. There are several critiques of fiscal impact analysis…

- Fiscal impact analyses usually consider only direct, monetary impacts on the pubic sector. Indirect or non-quantifiable impacts are often ignored – as are impacts on the private sector.
- Fiscal impact analyses often focus exclusively on *current* dollar costs.
- Fiscal impact analyses usually ignore the costs and revenues imposed on county, state, or federal governments.
- For better or worse, these analyses can force developers to change their site plan. A single-family detached subdivision that would overload the local school system may be manipulated into shifting towards townhouses or senior apartments.
- The result of a fiscal impact analysis is often dependent on the community in which it is performed. The same moderate-income residential development may receive a negative result in a high-income municipality and a positive result in a low-income municipality. This may lead to ethical and legal problems with fair housing.

NET PRESENT VALUE[2]

1. The net present value formula is used to show the net monetary value of a project, discounted to present value. So, if the net present value of a proposed convention center will be greater than zero, then the monetary benefits of the convention center will outweigh its monetary costs.
2. NPV = $t((B_t - C_t)/(1 + r)^t)$, where t = the number of years in the project's lifespan, B_t = the monetary benefits, C_t = the monetary costs, and r = the interest rate (for discounting purposes).
3. **Internal Rate of Return:** This analysis technique uses a variation of the net present value formula. A project's net present value formula is set to zero, and the interest variable ("r") is left blank. If the resulting interest variable is greater than the available market interest rate, then the project should be considered.

COST BENEFIT ANALYSIS

1. Cost benefit analysis is used both to determine the net monetary value of a project and to weigh the net monetary values of alternative, competing projects. Like net present value, its close cousin, cost benefit analysis discounts to present value.
2. The "benefit/cost ratio" = (the net present value formula)/$t(C_t/(1 + r)^t)$. If this ratio results in a number greater than one, then the monetary benefits of the project outweigh its monetary costs.[3] If project "x" earns a higher "benefit/cost ratio" than project "y," then project "x" has a superior net monetary value. Note that this ratio can be manipulated by hiding some costs in the numerator as a "net annual benefit."
3. Cost benefit analysis can only address impacts that are quantifiable in terms of money. Furthermore, it can obviously only address known impacts. Thus, it tends to ignore secondary impacts.
4. The results of a cost benefit analysis and the net present value formula can conflict over the same project.
5. Alternatives to cost benefit analysis include…

- **The Total Cost of a Project Over its Lifetime and The Annualized Cost of a Project:** These two costs can be used to compare two or more projects that will provide identical benefits. However, if the benefits of the alternative projects are not identical, then cost benefit analysis must be used.
- **Planning Balance Sheets:** A planning balance sheet is actually an evaluation matrix, with competing projects forming the rows and evaluation criteria forming the columns. With a little creativity, a planning balance sheet can evaluate economic, social, and environmental criteria – on both a short-term and a long-term basis – that are difficult to quantify in terms of money, and thus, hard to include in cost benefit analyses.[4]
- **Goals Achievement Matrix:** A goals achievement matrix is only a simple variation of a planning balance sheet. The various socioeconomic groups that the competing

[2] The information in this section was taken from page 157 ("Fact Sheets & Readings") of *The National AICP Exam Preparation Course Guidebook* (Washington DC: the American Institute of Certified Planners, 1999).
[3] *The National AICP Exam Preparation Course Guidebook* (1999). Page 157.
[4] *The National AICP Exam Preparation Course Guidebook* (1999). Page 158.

projects could cost or benefit form the table's columns, instead of the evaluation criteria found in planning balance sheets.[5]

COST EFFECTIVENESS ANALYSIS

1. Cost effectiveness analysis (or CEA) is usually used to compare two competing projects that will provide roughly the same benefits. However, it is more complex than merely comparing the *total* or *annualized* costs of the projects over their lifetimes (see the previous page).[6]
2. Like cost benefit analysis, CEA discounts costs to present value.
3. CEA is based on a simple ratio: e/c. The "e" is a composite measure of effectiveness that can consider direct impacts, secondary impacts, and negatives – such as the traffic congestion that comes with economic growth. Note that metrics can be used to control for both the differences in measurement units and the relative importances among variables. The "c" addresses monetary costs.
4. **Equivalent Uniform Annual Cost Analysis (EUAC) and Equivalent Uniform Annual Benefit Analysis (EUAB):** These two techniques are close relatives of CEA. EUAC is a more complex form of comparing the a*nnualized costs* of two or more competing projects with roughly identical benefits (see the previous page). On the other hand, EUAB compares the benefits of two or more competing projects with roughly the same costs. EUAC and EUAB both address costs at their present values and allow alternatives with different lifespans and cost/benefit streams to be compared equally.[7]

[5] Chapter Presidents Council, the American Planning Association. *Study Manual for the Comprehensive AICP Exam of the American Institute of Certified Planners*. The American Planning Association, November 1999. Page 209.
[6] Chapter Presidents Council, the American Planning Association. Pages 209-210.
[7] Chapter Presidents Council, the American Planning Association. Pages 197-198.