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Public Investment Regional Allocation: Evaluation of Applicability of Existent Methodologies.

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Outline

- Regional investment allocation - introduction
- Simple-criterion model
- Multi-criterion model
- The case of Greece
- Evaluation of Applicability

Introduction

- Regional policy
  - Uses investment is a basic developmental tool
  - Seeks for an effective allocation among regions
- Aim to:
  - economic development of less developed regions
  - maximization of national product
- Increase of investment
  - is among the basic tools of regional politics

Simple-criterion model

- The problem can be defined as follows (Rahman, 1963)

$$Y = \sum_{i=1}^{n} Y_i = Y_1 + Y_2 \qquad (1)$$

$$\left.\begin{aligned} C_i &= c_i Y_i \\ I^t{}_i &= k_i (Y_i^{t+1} - Y_i^t) \\ s_i &= 1 - c_i \\ Y_i &= C_i + I_i \end{aligned}\right\} \qquad (2)$$

$$(1) \overset{(2)}{\Rightarrow} \quad k_1(x_{t+1} - x_t) + k_2(y_{t+1} - y_t) = s_1 x_t + s_2 y_t \qquad (3)$$

Simple-criterion model

- Y_i national income of this country is equal to the sum of the income of the two regions
- C_i consumption of each region
- c_i the rates of consumption of each region
- I_{it} investment is assumed to have a “gestation lag” of one year for each region
- k_i the familiar incremental capital/output ratios for each region
- s_i the rates of saving in regions A and B respectively

Simple-criterion model

- ‘non-disinvestment constraint’ (Rahman, 1963)

$$Y_i^{t+1} \geq Y_i^t \qquad (4)$$

- ‘political constraint’ (Rahman, 1963)

$$\frac{Y_1^{t+1}}{Y_2^{t+1}} \geq r_1 \qquad \frac{Y_2^{t+1}}{Y_1^{t+1}} \geq r_2 \qquad (5)$$

- The problem is to maximize the equation (1) subject to conditions (3), (4) and (5).
- For solving this optimal investment problem:
  - application of Belman’s Principle of Optimality (dymanic programming).

Multi-criterion model

The model can be described as follows (Tian et al.,2007) :

- The total welfare objective [1]

$$MaxW = \eta \cdot \sum_{i=1}^{n}\sum_{j=1}^{m} \omega_i \xi_{ij} Y_{ij}(T) + (1-\eta)\int_{To}^{T} e^{-\mu(t-To)} \left(\sum_{i=1}^{n}\sum_{j=1}^{m} \omega_i \xi_{ij} Y_{ij}(t)\right) dt \quad (6)$$

- Maximization of employment rate [2]

$$MaxP = \frac{\sum_{i=1}^{n} L_i(t)}{\sum_{i=1}^{n} N_i(t)} \quad (7)$$

  - subject to $\frac{L_i(t)}{N_i(t)} \geq B$ and $0 < B < 1$ (8)

Multi-criterion model

- ω_i the weight of region i
- ξ_{ij} the weight of sector j of region i
- Y_{ij} the income of region i of sector j
- μ the exponential discounting factor
- L_i the labor in region i
- N_i the population of region i
- B a lower limit of regional employment rate in order to achieve moderate employment rate and equity between regions

Multi-criterion model

- the cross-region income per capita gap minimization [3]

$$MaxE = (-1)\sum_{k,v=1}^{n}\int_{To}^{T}\left|Y_k(t)/N_k(t) - Y_v(t)/N_v(t)\right|dt \qquad (9)$$

- subject to

$$\left.\begin{aligned}
&I(t) = K'(t) + \gamma \cdot K(t) \\
&L_{ij}(t) = \lambda_{ij} \cdot I_{ij} + C_{ij} \qquad \lambda_{ij}, C_{ij} > 0 \\
&K'(t) = r(t)\sum_{i=1}^{n}[(1-\sum_{k=1}^{n} b_{ij})z_i \sum_{j=1}^{m} \varphi_{ij} Y_{ij}(t)] + (1-r(t)) \cdot \sum_{i=1}^{n}[(1-\sum_{k=1}^{n} a_{ij})s_i \sum_{j=1}^{m} \phi_{ij} Y_{ij}(t)] - \gamma \sum_{i=1}^{n}\sum_{j=1}^{m} K_{ij}(t) \\
&Y(t) = \sum_{i=1}^{n}\sum_{j=1}^{m} A_{ij} K_{ij}(t)^{\alpha_{ij}} L_{ij}(t)^{\beta_{ij}}
\end{aligned}\right\} \qquad (10)$$

Multi-criterion model

- Y_{ij} the income of region i of sector j
- N_i the population of region i
- γ the current capital stock depreciating constant rate
- λ_{ij} the labor investment ratio of sector j of region i
- I_{ij}: the investment on sector j of region i
- C_{ij} the necessary simple labor of sector j of region i
- $K(t)$ the capital stock
- r the income tax rate
- a_{ij} , b_{ij} the proportions of capital transfer loss between regions
- z_i , s_i the rates of savings of public and private sectors respectively of region i
- φ_{ij} the weight of public sector investment to sector j of region i
- Φ_{ij} the weight of private sector investment to sector j of region i
- A_{ij} the contribution of technological innovation to output of sector j of region i
- α_{ij} ,β_{ij} the increase of output that will happen when the capital and simple labor respectively will increase 1%

Multi-criterion model

- The problem is to maximize all three equations *(6), (7)* & *(9)* subject to the constraints *(8) and (10)*

- For solving this optimal investment problem:
  - Genetic algorithm (powerful stochastic technique).

Multi-criterion model

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The Case of Greece

- Main industries
  - tourism, shipping, industrial products, food and tobacco processing, chemicals, metal products and mining.
- High Human Development Index in 2007 and quality-of-life index in 2005
- Main problems of Greek economy
  - high rate of unemployment, bureaucracy, corruption and tax evasion
  - Low global competitiveness and economic growth diminishing since 2009

Can these models be applied on the case of Greece?

Evaluation of Applicability

- ***Simple-criterion model***
  - Objective function: maximizing the total regional income. The income of each region is the sum of consumption and investment.
  - The constraints : total investment, total savings and the political tolerance limit.
  - A high saving rate does not indicate that the productivity of the region will be high as well
  - The optimization depends on the planner’s choice of the objective

Evaluation of Applicability

- ***Simple-criterion model***
  - Possible to apply on the case of Greece
  - Not efficient results
  - Not applicable results
  - Political tolerance limit :must be carefully considered because of the political & economical corruption
  - Labor is not taken into consideration
  - Private sector's investment is not taken into consideration
  - Regional inequality and disparity strongly exists

The application is of low significance and for a first estimation

Evaluation of Applicability

- ***<u>Multi-criterion model</u>***
  - Objective functions include the following variables:
    - the income of each sector of each region,
    - the population of each region,
    - the time-flow total income and the labor
  - The constraints include the following variables:
    - the rates of savings of public sector & of private sector,
    - the contribution of technological innovation,
    - the capital stock & the investment of public sector & of private sector.
  - Solution with genetic algorithm:
    - possibility of premature convergence,
    - The planner must introduce methods to avoid premature convergence

Evaluation of Applicability

- ***Multi-criterion model***
  - Transform into a single objective programming model & a solution effortless.
  - Possible to apply on the case of Greece.
  - Doesn't have the deficiencies of the simple-criterion model.
  - Technological innovation is also taken into account.
  - Labor, population and the contribution of public and private sector participate in this model.

More relevant results for the case of Greece.

Conclusions

- The simple structure model described can be easy applied to a double region economy and can be extended to an economy with more regions.
- The multi-criterion model is more complicated but more practical.
- For the case of Greece more suitable is to use a multi-criterion model to solve an investment regional allocation problem

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Thank you for your attention!

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