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)

\[ Y = \sum_{i=1}^{n} Y_i = Y_1 + Y_2 \]  

(1)

\[ C_i = c_i Y_i \]

(2)

\[ I_i = k_i (Y_i^{t+1} - Y_i^t) \]

\[ s_i = 1 - c_i \]

\[ Y_i = C_i + I_i \]

\[ (1) \Rightarrow k_1 (x_{t+1} - x_t) + k_2 (y_{t+1} - y_t) = s_1 x_t + s_2 y_t \]  

(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)
  \[ Y_{i}^{t+1} \geq Y_{i}^{t} \] (4)

- ‘political constraint’ (Rahman, 1963)
  \[ \frac{Y_{1}^{t+1}}{Y_{2}^{t+1}} \geq r_{1} \quad \frac{Y_{2}^{t+1}}{Y_{1}^{t+1}} \geq r_{2} \] (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 (dynamic programming).
Multi-criterion model

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

- The total welfare objective [1]
  \[ \text{Max}W = \eta \cdot \sum_{i=1}^{n} \sum_{j=1}^{m} \omega_i \xi_j Y_{ij}(T) + \left(1 - \eta\right) \int_{T_0}^{T} e^{-\mu(t-T_0)} \left(\sum_{i=1}^{n} \sum_{j=1}^{m} \omega_i \xi_j Y_{ij}(t)\right) dt \]  

- Maximization of employment rate [2]
  \[ \text{Max}P = \frac{\sum_{i=1}^{n} L_i(t)}{\sum_{i=1}^{n} N_i(t)} \]  

- subject to \[ \frac{L_i(t)}{N_i(t)} \geq B \quad \text{and} \quad 0 < B < 1 \]
Multi-criterion model

- $\omega_i$: the weight of region $i$
- $\xi_{ij}$: the weight of sector $j$ of region $i$
- $Y_{ij}$: the income of region $i$ of sector $j$
- $\mu$: 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]

\[
MaxE = (-1) \sum_{k,v=1}^{n} \int_{To}^{T} |Y_k(t)/N_k(t) - Y_v(t)/N_v(t)| dt
\]  

(9)

- subject to

\[
I(t) = K'(t) + \gamma \cdot K(t)
\]

\[
L_{ij}(t) = \lambda_{ij} \cdot I_{ij} + C_{ij} \quad \lambda_{ij}, C_{ij} > 0
\]

(10)

\[
K'(t) = r(t) \sum_{i=1}^{n} [(1 - \sum_{k=1}^{n} b_{ij}) z_i \sum_{j=1}^{m} \phi_{ij} Y_j(t)] + (1 - r(t)) \cdot \sum_{i=1}^{n} [(1 - \sum_{k=1}^{n} a_{ij}) s_i \sum_{j=1}^{m} \phi_{ij} Y_j(t)] - \gamma \sum_{i=1}^{n} \sum_{j=1}^{m} K_{ij}(t)
\]

\[
Y(t) = \sum_{i=1}^{n} \sum_{j=1}^{m} A_{ij} K_{ij}(t)^{\alpha_{ij}} L_{ij}(t)^{\beta_{ij}}
\]
Multi-criterion model

- $Y_{ij}$: the income of region $i$ of sector $j$
- $N_i$: the population of region $i$
- $\gamma$: the current capital stock depreciating constant rate
- $\lambda_{ij}$: 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 $i$
- $\varphi_{ij}$: the weight of public sector investment to sector $j$ of region $i$
- $\Phi_{ij}$: 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 $i$
- $\alpha_{ij}, \beta_{ij}$: 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

- $\omega_i$ the weight of region $i$
- $\xi_{ij}$ the weight of sector $j$ of region $i$
- $Y_{ij}$ the income of region $i$ of sector $j$
- $\mu$ 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
- $\gamma$ the current capital stock depreciating constant rate
- $\lambda_{ij}$ 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 $i$
- $\phi_{ij}$ the weight of public sector investment to sector $j$ of region $i$
- $\Phi_{ij}$ the weight of private sector investment to sector $j$ of region $i$
- $\Lambda_{ij}$ the contribution of technological innovation to output of sector $j$ of region $i$
- $\alpha_{ij}, \beta_{ij}$ the increase of output that will happen when the capital and simple labor respectively will increase 1%
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

- **Multi-criterion model**
  - 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 easily 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.
References

- **Bellman Richard** (1959), Dynamic Programming, Princenton, Princenton University Press.
Thank you for your attention!

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