An Input-Output Analysis of the Economic Impact for Sustainable Rural Development in Wonogiri District, Indonesia

Shintaro Kobayashi, Shigeki Yokoyama*, Satoshi Uchida, Yoshiko Iizumi

Japan International Research Center for Agricultural Scineces, Tsukuba, Japan
**Corresponding author: Social Science Division, Japan International Research Center for Agricultural Scineces, 1-1 Ohwashi, Tsukuba, 305-8686, Japan.*
Tel.: +81 29 838 6343; fax: +81 29 838 6342.
syokoyam@affrc.go.jp

Abstract

Wonogiri district located in Central Java is the water source of Solo River. There is a large multi-purpose reservoir in the region. However, the reservoir is reported to be losing its function due to rapid sedimentation caused by forest conversion and intensive farming. For sustainable resource management, assessment of development strategies incorporating alternative agro-forest systems is required. This study, as a preparation for the assessment of development strategies, was aimed to grasp regional industrial structure, using the input-output analysis. The results showed that the importance of agriculture in the region was both as an income source especially for unskilled labor and as financial base for purchasing manufactured goods. Therefore, environmentally sound agro-forest systems need to be proposed so that strict environmental restriction on agriculture can be avoided.

Keywords: sustainable rural development, input-output analysis, Wonogiri.

Introduction

Wonogiri district is located in Central Java, Indonesia and is the water source of Solo River (Figure 1). There is a large multi-purpose reservoir in the region, and it has contributed to both flood control and water utilization. However, the reservoir is reported to be losing its functions as a public reservoir due to extremely rapid sedimentation. It is said that main reasons for the rapid sedimentation is forest conversion and intensive farming induced by regional population increase (JICA, 2007). In order to achieve sustainable resource management in the region, assessment of development strategies incorporating alternative agro-forest systems is required. This study, as a preparation for the assessment of development strategies, was aimed to grasp the regional industrial structure and income multiplier effects by sector, using the input-output analysis, an economic analysis method.

Figure 1. Location of Wonogiri District.

Materials and Methods

The input-output analysis was proposed by W. Leontief (e.g. Leontief, 1986) and it was used for projections of impacts of changes in production technology, social environment, consumer preference, or economic policy on an economy. Based on economic statistics or economic survey, simulation models called “input-output model” were formulated. Simplified flow of the analysis was as follows. Firstly, an input-output table which described all transactions among economic sectors was estimated (Figure 2). Secondly, production technologies and traits of transactions were abstracted from the table as the form of parameters called "input coefficients" (Figure 3). Lastly, using the input coefficients, transactions between demand sectors and production sectors and among production sectors were formulated to produce simultaneous equation for simulation (Figure 4). Based on the statistics of Wonogiri district, we estimated an input-output table. Tables 1, 2, and 3 show sector classification of the estimated table.

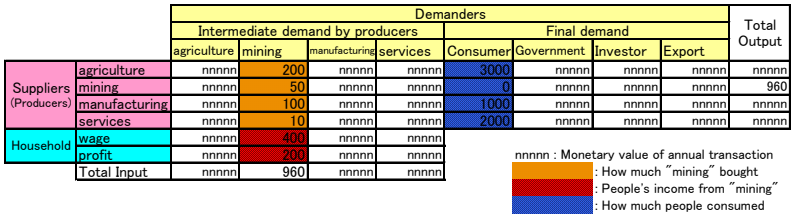

Figure 2. A sample structure of an input-output table. The table is estimated based on economic statistics or economic survey of a target region. Row vectors in the table show the amounts of supply valued at market prices. Column vectors show the purchase of goods and services.

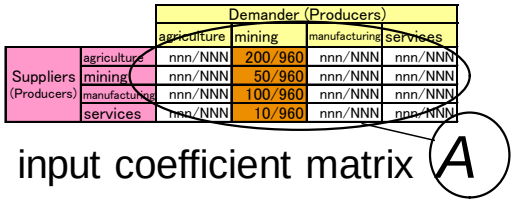

Figure 3. Abstraction of information on production technology as the form of parameters called "input coefficient" A.

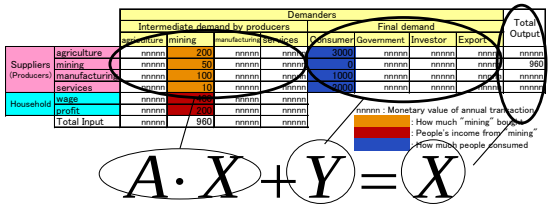

Figure 4. Formulation of technology A, production X, and demand Y in an economy.

Table 1. Production sectors

P1	Farm crops
P2	Livestock and products
P3	Forestry
P4	Fishery
P5	Mining and quarrying
P6	Oil and gas manufacture
P7	Other manufacture
P8	Electricity supply
P9	Gas supply
P10	Water supply
P11	Construction
P12	Trade, hotel, and restaurant
P13	Road transport
P14	Other transport
P15	Communication
P16	Financial services
P17	Real estate and business services
P18	Public administration and social services
P19	Personal and household services

Table 2. Demand sectors

D1	Private consumption
D2	Private investment
D3	Governmental consumption
D4	Public investment

Table 3. Value added sectors to supply primary factors to production

V1	Land
V2	Unskilled labor
V3	Skilled labor
V4	Capital
V5	Natural capital
V6	Indirect tax

In this paper, we drew skyline chart and derive income multipliers of economic activites. Skyline chart revealed trade characteristics of target economy. Drawing method was as follows. An input-output table could be expressed as follows:

$$X = A \cdot X + F + E - M \qquad \text{Eq. 1}$$

where X is a column vector of total output, A is "input coefficient matrix", F is a column vector of domestic final demand, E is an export column vector, and M is an import column vector. Solving Eq. 1, X can be decomposed into 3 inducing factors as follows:

$$X = (I - A)^{-1} \cdot F + (I - A)^{-1} \cdot E - (I - A)^{-1} \cdot M \qquad \text{Eq. 2}$$

where the first term of right-hand side indicates the production induced by domestic final demand F, the second term indicated the production induced by export E, and the last term indicated the potential domestic production to be substituted for import M. Based on Eq. 2, a skyline chart shows each factor's relative contributions to production on the vertical scale, with 100% was representing $(I - A)^{-1} \cdot F$. In addition, the horizontal scale showed the sectoral share in total production.

Income multipliers could be obtained by the following procedures. Assuming that import was in proportion to domestic demand, Eq. 1 could be transformed as follows:

$$X = A \cdot X + F + E - \tilde{M}(A \cdot X + F) \qquad \text{Eq. 3}$$

where $\tilde{M}$ is a diagonal matrix of import coefficients. Solving Eq. 3 for *X*, we obtain the following equation.

$$X = \left\{I - (I - \tilde{M})A\right\}^{-1} \cdot \left\{(I - \tilde{M})F + E\right\} \qquad \text{Eq. 4}$$

where $\left\{I - (I - \tilde{M})A\right\}^{-1}$ is called "Leontief inverse matrix" and includes information on the industrial structure of an economy. Supposing that $\tilde{V}$ is a diagonal matrix of value added ratio to production cost, income multiplier was column sums of a matrix $\tilde{V}\left\{I - (I - \tilde{M})A\right\}^{-1}$.

Results and Discussion

Based on an input-output table of Wonogiri district estimated for year 2005, we analyze current situation of Wonogiri district. Major findings were as follows:

(i) Farm crop sector was the largest income source and accounts for 46% of regional gross domestic products (Figure 5). This implied that environmental restriction on agricultural activities would affect the standard of living in the region. Therefore, environmentally sound agricultural systems including agro-forestry need to be proposed so that strict environmental restriction can be avoided.

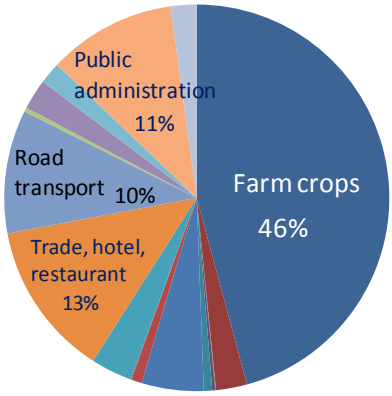

Figure 5. Share of income sources.

(ii) The district exported substantial amount of Farm crops and imports manufactured products (Figure 6). This means that the district participates in a regional division of labor and an interregional trade system. High self-sufficiency of Road transport seems to reflect the active transportation of products including Farm crops.

(iii) Agricultural sectors had tendency to strongly induce income of unskilled labor. Trade, hotel, and restaurant sector had also high value in income multiplier for unskilled labor (Table 4). These facts implied that integrated activities consisting of agriculture and services such as ecotourism was promising for pro-poor development.

This multiplier showed how much income of unskilled labor was induced by one unit of final demand for each sector.

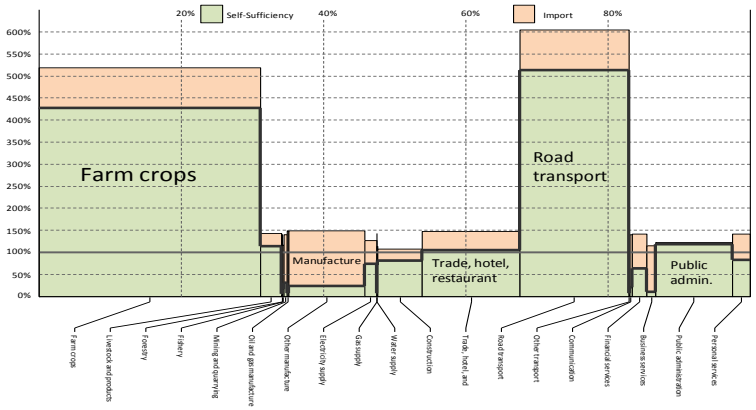

Figure 6. Skyline chart. Horizontal axis shows share of production and vertical axis shows self-sufficiency rate.

Table 4. Income multiplier for unskilled labor

Trade, hotel, and restaurant	0.389
Farm crops	0.388
Forestry	0.324
Personal and household services	0.321
Livestock and products	0.310
Public administration and social services	0.285
Road transport	0.270
Fishery	0.227
Construction	0.218
Other manufacture	0.174
Financial services	0.155
Communication	0.152
Mining and quarrying	0.148
Water supply	0.137
Electricity supply	0.077
Real estate and business services	0.054

Conclusions

Income source share and the skyline chart showed the importance of agriculture both as an income source and financial base for purchasing manufactured goods. Therefore, environmental policies to restrict agricultural activities would affect the standard of living. In order to avoid reducing income level in the region, environmentally sound agro-forest systems need to be proposed. Income multiplier implied that “Trade, hotel, and restaurant”, as well as agricultural sectors, had a strong power to induce income of unskilled labor. Therefore, integrated activities consisting of agriculture and services such as ecotourism were promising for pro-poor development. The remaining issues were crop-wise input-output analysis for decomposing Farm crop sector, backward and forward linkage among sectors, and simulation analysis on income generation effects of proposed community business models.

Acknowledgement

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