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RESEARCH REPORT

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The Impacts Of Coal Mining on the Economy and Environment of South Kalimantan Province, Indonesia

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This study investigates the impact of coal mining on the economy and environment of South Kalimantan Province, one of the most important coal producing regions in Indonesia. It uses a Social Accounting matrix to assess how the industry affects the province's economy and the livelihoods of its people. It also investigates what policy options will best reduce its negative environmental impacts at least cost to the province's economy.

The study, by Luthfi Fatah of Lambung Mangkurat University, finds that mining is one of the most significant parts of the province's economy and that it is steadily growing in importance. However, it also shows that the industry disproportionately benefits the better-off sectors of society and is having an unacceptable impact on the environment. Fatah recommends that policy makers slow the growth in coal mining through regulation of small-scale mining. This should help the environment. He also suggests that the government boost investment in agricultural –based activities to improve the employment prospects of the poorer sectors of society.

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THE IMPACTS OF COAL MINING ON THE ECONOMY AND ENVIRONMENT OF SOUTH KALIMANTAN PROVINCE, INDONESIA

Luthfi Fatah

October, 2007

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EXECUTIVE SUMMARY

The purpose of this research is to analyze the impact of the coal mining industry on the economy as well as the environment of South Kalimantan Province, Indonesia. The South Kalimantan Province is an area with abundant deposits of coal and contributes 16.36% to the national coal stock. Coal mining is a profitable business. It creates employment, generates value, and improves the foreign investment of a country or region. However, coal mining has its disadvantages including negative externalities. It seems that in this business the public gets the dust and dirt, while the workers and managers get the benefits and advantages.

This research uses a Social Accounting Matrix (SAM) to analyze the impact of the coal mining industry on the economy and to do simulations to find alternative policies on the coal industry that are suitable for economic improvement and environmental sustainability.

The results show that the coal mining industry in South Kalimantan Province is growing. Large-scale coal mining is more profitable economically than small-scale operations, but in terms of environmental impact, the latter is a better choice as it exploits less resources. The policy-maker needs to consider measures to reduce the level of coal exploitation to save the environment and investment policies that support agricultural-based activities where the employment rate is the highest. The first easy step is to impose taxes on coal mining to slow down mining activites and then use this tax revenue as transfer payments such as subsidies and direct transfers "in kind" (e.g. rice, farming equipment, etc.) to support the needs of lower income households in the province.

1.0 INTRODUCTION

One of the world's most plentiful energy resources is coal. The use of this resource is increasing and likely to quadruple by 2020. This is matched by the increasing demand for it, which in turn has spurred coal mining to grow rapidly in many parts of the world. The world coal trade grew steadily from 386.90 million tons in 1990 to 468.20 million tons in 1995, and to an estimated 1,920.90 million tons in 2005 (Mimuroto 2002).

Coal occurs in many forms and qualities. Mainly there are two general categories: (a) hard coal, which includes coking coal used to produce steel, and other bituminous and anthracite coals used for steam and power generation, and (b) brown coal (sub-bituminous and lignite), which is used mostly as onsite fuel. Coal has a wide range of content characteristics including moisture content (2–40%), sulfur content (0.2–8%), and ash content (5–40%). These can affect the value of the coal as fuel. Many environmental problems also originate from these content characteristics.

In Indonesia the coal resources are aplenty, particularly in Kalimantan and the Sumatera Islands. Coal deposits also available in some other areas, such as in West Java, Central Java, Papua and Sulawesi, in lesser amounts. National data shows that in 2004, coal deposits were estimated to reach 57 trillion tons (PSE-UI Jakarta 2002). From the amount as much as 19.3 trillion tons are possible and proven stocks. (Possible stock refers to coal deposits surveyed to be available in an area, which may be mined but does not belong to any particular mining company. Proven stock is the amount of stock proven to be available in a particular locality and it belongs to a particular company.) Production rate at the moment stands at 130 million tons per year (National Energy Coordination Agency 2005). The provincial distribution of coal stock shows that East Kalimantan stands as the highest. Its stock reached 35.38% of total national stock of coal in 2005. South Sumatera stands at second place with 33.16%. South Kalimantan is at third place with 16.36% (PSE-UI Jakarta 2002).

Coal mining is a profitable business. It creates employment, generates value-added, and improves the foreign investment of a country or region. However, coal mining has its disadvantages including negative externalities. Coal is a dirty business for locals, with problems commonly including contamination of water, coal-dust permeating the air and coating everything inside and outside houses, and health problems. Coal mining also causes floods. Many mining areas are left without rehabilitation. As a consequence, land and ecosystems are damaged. In Figure 1, we can see a coal mining field. It shows how the land can become just a large empty open space with a deep and long mining hole.

Figure 1. A Coal Mining Field

Moreover, coal transportation vehicles contribute to an increase in the incidence of road accidents and road damage. These heavy vehicles are also nuisance to the communities living along the roads they use in terms of the dust and noise they create.

The South Kalimantan Province is one of the areas in Indonesia with abundant deposits of coal. Contributing 16.36% to the national coal stock, South Kalimantan stands at third place. With the government's policy in 1980 inviting direct foreign investment in the coal industry in East Kalimantan and South Kalimantan and allowing coal transportation vehicles to utilize public roads, the mining activity started to grow. The coal business has boomed since 2000 in South Kalimantan.

In the South Kalimantan Province, there are three authorized coal mining contractors (called "legal miners"): Arutmin Indonesia Ltd., Adaro Indonesia Ltd., and Chung Hua Ltd. with licenses to operate. Legal miners are generally large-scale firms. Besides these legal miners, there are many other small-scale coal miners without licenses. These are called illegal miners. The number of illegal miners is growing. Almost every district of South Kalimantan Province contains several illegal coal miners. In 1997, 157 individuals or businesses of this type were recorded. In early 2000, this number rose sharply to 445. In 2004, the number arrived at 842 units of business. Illegal miners are unique and cannot be treated the same as legal miners, particularly in the application of rules and regulations.

Although the coal business seems to be profitable for both individuals and businesses, the benefits of this activity to the region are unclear. The coal industry is an industry of booms and busts, and hence the welfare of the community in the region is usually closely tied to the health of the coal industry (Roenker 2002). In South Kalimantan, this does not seem to apply. There is a marked difference in the welfare and incomes of the communities living nearby the mines and along the coal transportation roads and those of the coal miners who earn much more. The public get the dust and dirt of the coal industry, while the workers and managers get the benefits and advantages (*Adaro's community development fund provided to the community*, 2002).

Actually, most of the coal mined in South Kalimantan is for export. Only less than 10% is for domestic use including power for electricity generators, cement manufacture and other industries (JATAM 2002). The mining method and the activities to deliver the commodity to consumers have negative impacts on the environment. In South Kalimantan, the strip mining method is commonly used. This method contributes to land degradation and forest cover destruction. The transportation of coal from mining areas to stockpiles also creates problems such as water contamination, air pollution and deterioration of road transport services in terms of increased road damage, road accidents, and road density leading to traffic jams. All these environmental distortions reduce community welfare.

However, there is lack of research on the extent of such negative impacts. There is no information on the effects of coal mining on economic development in the region. There is also a lack of information on how and to what extent coal mining influences income distribution among the various communities in the South Kalimantan Province and whether or not the benefits are enjoyed by the communities in the region or if it also benefits other regions. These are some of the concerns that have arisen with the growing of coal mining activities, but there is not enough information on these concerns.

2.0 LITERATURE REVIEW

Coal is an organic sediment consisting of a complex mixture of substances, including humic and sapropelic (Gammidge 2004). Humic is more common and originates from peat deposits consisting mostly of organic debris deposited in situ (autochthonous). Sapropelic is derived from re-deposited (allochthonous) resistant plant fragments such as spores or aquatic plants. The sapropelic coals can be further subdivided into: cannel coal and boghead coal. Cannel coal is made up principally of uniformly-sized plant fragments e.g., spores, while boghead coal consists mainly of alginite (a coal maceral derived from algae).

Coal mining is very expensive due to the fact that most coal deposits are embedded deep in the crust of the Earth. It requires expensive mine construction and involves human miners who must go deep into the mines risking their lives. Liability insurance and the maintaining of safety standards within the mine environment add to the cost of extracting the coal from the ground.

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2.1 Methods of Coal Mining

Some of the most common methods of mining are: continuous mining, long wall mining, room and pillar mining, and strip mining. In continuous mining, a large cutting machine just moves around the perimeter of the mine shafts, shaving pieces of coal away from the existing wall. The coal is then collected and taken to the surface. Long wall mining is similar, but as the cuts into the wall of the mine grow deeper, systems of jacks are implemented to keep the roof up structurally. In comparison to these two methods, “room and pillar” is the safest. “Rooms” are dug underground, creating space to maneuver in the mine. The coal removed from these rooms is sent up to the surface where it is distributed. In order to keep the mine in a safe state, only 60% of the coal is dug out as rooms. The remaining 40% is left in place to form structural “pillars” that support the mining rooms. While this is a much less efficient method than the others, its safety value is higher in that it has decreased coal mining accidents (EBLNF 2004).

For coal deposits located at ground level, strip mining is usually used as it is relatively inexpensive and safe for the miners. However, strip mining upsets the ecology of the region. The mining companies should restore the landscape to maintain the environment. If this is not done, environmental problems such as floods and erosion will take place (Jeantheau 2003). Coal used to be extracted by digging tunnels into the ground. A new approach is to remove the "overburden" (the layer of dirt and rock on top of the coal) take the coal out, and then put the overburden back. Of course there are trees and animals — entire ecosystems — on top of that overburden. In spite of laws to ensure the reclamation of strip-mined land, the ecosystem on a reclaimed piece of land is usually not as rich as the original. Mountain-top removal is a variant of strip mining in which a mountain peak is removed to get to the coal underneath. The common practice is to fill a nearby valley with the removed dirt, burying any streams and habitat that is in the valley. In South Kalimantan coal mining, this is the commonly used method for coal extracting.

2.2 The Impacts of the Coal Industry

Many environmental problems originate from the way coal is mined, which is a big problem in the coal industry and coal-related activities. Generally, there always exists a trade-off between financial benefits and environmental loss (Jeantheau 2003).

The strip mining method has significant effects on the environment in general and a particularly devastating effect on people living near the operations. It adversely affects rivers, streams, lakes and people's water supplies. A 2003 government study estimated that 724 miles of streams have been buried and over 300,000 acres of forests have been wiped out in Appalachia, USA, by the mountain top mining process (Roenker 2002). The South Kalimantan coal industry uses the same method. The consequence of applying the method without strict liability for reclamation and rehabilitation is degradation of environment. The loss of forest cover not only results in land degradation, but can also lead to floods, unbalanced ecosystems and rising temperatures.

Figure 2. An Ex-Mining Hole with a Stockpile in the Background

Once the coal has been brought up from the mine, it has to be transported to the facility that will use it to generate electrical energy, primarily coal burning electrical power plants or to the area of transit, which is commonly called a stockpile. In the stockpile area, the coal is collected to reach a specific quantity.

It could also be handled to acquire a certain form or quality. The problems that arise here are air pollution caused by coal dust and land-use problems where the people are not given proper and adequate compensation (EIA 2001). In Figure 2, we can see that the amount of coal collected in a stockpile can reach as high as a hill. The figure also shows a huge coal mining hole which is no longer used.

From the stockpile, the coal will be sent for export or inter-island trading. During the transportation process, many problems can occur. These include road accidents, road damage, traffic distortion, and air and water pollution particularly for the communities living along the coal transportation routes.

Once the coal has arrived at the electricity-generation facility, the burning of the coal produces substances that pollute the atmosphere. The chemistry of burning or combustion involves the chemical reaction of the carbon of coal with oxygen gas. This produces two oxides of carbon, carbon dioxide and carbon monoxide (CO). If the combustion is complete with an excess of oxygen, then carbon dioxide is the product. On the other hand, if there is a deficiency of oxygen in the combustion process, large quantities of carbon monoxide will result. Carbon monoxide is a very toxic gas which will tenaciously attach itself to hemoglobin molecules in red blood cells, thereby preventing the hemoglobin from carrying the needed oxygen to cells in the body. Respiration is carried out by most cells in the body. If oxygen does not reach the cells, respiration is blocked and the cells die. Carbon monoxide toxicity can have mild symptoms of irritability, headache, or nausea, but if the concentration is high, comatose and death will result. Even though carbon dioxide, the major product in the combustion of coal, can also be toxic depending on its buildup concentration, it is not as toxic as carbon monoxide (Logan 1996).

Coal is the biggest source of mercury contamination in the air, and it is the worst offender when it comes to the greenhouse gases that cause global warming. Emissions-scrubbing technology is available to clean up 90-95% of the mercury, sulfur and nitrogen emissions, but the current law in Indonesia only requires these scrubbers for new plants or for major upgrades in mining capacity.

The existence of many coal miners, legal and illegal, large and small-scale, has brought about many problems. Generally, nearby communities have been the major victims of the local coal industry and its related activities. Hundreds and even thousands of people have had to give up their land with unfair compensation. They did not want to release their farming lands to coal mining. However, they were forced to do so by the authorities, who in many cases, used various forms of intimidation, including accusing farmers and other small landowners of opposing national development if they chose not to give up their land (JATAM 2002).

Although coal operations supply many locals with jobs, the number and quality of the jobs has decreased due to increased mechanization (Jeantheau 2003). In terms of income distribution, the coal industry is more profitable for the people from outer regions (other regions in Indonesia and other countries) since many industries belong to people from Surabaya, Jakarta and even overseas. The nearby communities normally get only the low income jobs such as drivers, security officers, and the likes, but not the executive and managerial jobs because they lack the qualifications.

2.3 The Coal Industry in South Kalimantan Province

Since 1980, the General Directorate of Mining together with the Provincial Mining Office of South Kalimantan has developed small-scale mines managed by three village cooperative organizations. The purpose of this was to better distribute the income among various households in South Kalimantan. So not only do large foreign and local corporations operate in the coal business, but also the community through these three organizations.

In 1989, the demand for coal rose very sharply, especially foreign demand. The three village cooperative organizations and the big industries were unable to meet the demand. The excess demand triggered the emerging of many unlicensed miners of various scales, with various intensities of activities, owned by commercial firms, public establishments or non-governmental organizations (NGOs). Sadly, many NGO workers use their organizations to make a profit for themselves from this illegal business (JATAM 2002).

The coal mined in South Kalimantan mainly is for export. In general, there are only two plants here that use coal as their power supply. These are the electricity generator in the district of Tanah Laut and the cement factory in the district of Banjarmasin. They use up only about 5.6% of total coal production in South Kalimantan. The rest is exported to other regions in Indonesia, namely various provinces in Java (mainly East Java and Jakarta) and to other countries such as Japan, Korea, India and Russia (*Adaro's community development fund provided to the community*, 2002).

The production process together with the distribution and marketing methods used shape the type and intensity of the coal industry's impacts on the economy or environment. The common method used in South Kalimantan Province is the strip mining method, its variant being the mountain-top removal method. Both seem to completely ignore environment preservation. In the mountain top removal method, the mountain top and all its contents are removed to reach the coal underneath, and the miners do not pay adequate attention to placing back the removed contents (overburden) appropriately after extracting the coal. In many cases the practice is destructive in two ways. First, it destroys the mountain and the forest covering the mountain. Second, it destroys the valley (rivers, forest, wildlife, etc.) nearby when the overburden is just dumped in it.

The coal mining industry chooses to apply the mountain top removal method for several reasons, mainly because it is relatively cheaper than other methods, the land reclamation law is not strictly enforced, and the negative effects of the method do not affect the miners. The negative externalities, such as floods, increased temperature, and erosion which affect the nearby community.

Economic gain by the province (as a multiplier effect) is not caused by industry usage of coal, rather it is caused by the value-added factor due to export. This raises the concern about who benefits the most from the coal industry. The value-added flows are also unclear. Whether or not the benefit is utilized in and for the economy is ambiguous. It appears that the benefit flows to other regions while the negative impacts and externalities are experienced by the community in the region, where the coal mining industries operate. More specifically, information on whether the coal industry contributes to income generation in the province, other regions or other countries is not available.

The dominant impacts of the coal industry originate from various activities that relate to exporting the coal. This means many economic and environment problems are caused by a series of activities, starting from coal mining in the field up to transporting coal to ports for export. Many economic impacts have been traced here, including whether or not coal for export can improve the economy in terms of value-added[1], output, employment, and production structure.

Normally, coal mining companies make their own roads and public roads are only used for short distances. In South Kalimantan, the situation is different. The government here lets the industry use public roads for a fee. The transporting of coal involves very long distances over public roads in South Kalimantan. As the result, public transportation services are seriously compromised. The coal trucks occupy almost half the road. Generally, they are overloaded and damage the roads. In turn, the damaged roads become a source of dust that pollutes the area.

The situation where many of the businesses are illegal and small-scale miners has deep policy implications. Any strategy or policy to re-develop and re-manage the coal mining industry becomes very difficult. The illegal miners cannot be forced to follow the rules because they are not licensed or registered. Many regulations like land reclamation and community development for people living around the mining area do not apply to them.

3.0 RESEARCH QUESTIONS, OBJECTIVES AND SIGNIFICANCE

3.1 Research Questions

The research questions that are addressed in this research project are:

- What is the extent of the impact of the coal mining industry on the economy of South Kalimantan Province, especially on value-added, output, employment, and sectoral interdependency in the economy?
- What is the extent of the impact of the coal mining industry on income distribution in South Kalimantan Province?
- How much is the leakage of the coal mining industry in South Kalimantan?
- What is the most favorable policy for the coal industry in South Kalimantan in order to improve its economy and maintain its environment?

[1] Economics term which refers to additional or added value in terms of increased utility we can get from a product by doing something to/with it.

3.2 Research Objectives

The general objective of the research is to analyze the impact of the coal mining industry on the economy and environment of South Kalimantan Province, Indonesia.

The specific objectives are:

- To analyze the impact of the coal mining industry on the development of the economy of South Kalimantan Province according to the following indicators:
  - Value-added generated by the coal mining industry compared to other industries in the economy.
  - Output generated by the coal mining industry compared to other industries in the economy.
  - Employment provided by the coal mining industry compared to other industries in the economy.
  - Production structure and interdependency of the coal mining industry in the economy.
- To analyze the impact of the coal mining industry on income distribution in South Kalimantan Province.
- To analyze the extent of the "leakage"[2] the coal mining industry, in particular to compare benefits received by the region and the "outer regions" (other regions in Indonesia and other countries) from the coal mining industry.
- To simulate several policies for the coal industry of South Kalimantan Province in order to find the best strategy in terms of economic improvement and environmental maintenance.

3.3 Significance of the Research

Without enough information, it is difficult for the authorities to design the right policies for the coal mining industry and related activities. Meanwhile, rising foreign demand and the abundant resources of coal in South Kalimantan keep the industry growing. Indeed, the region receives additional income through royalties and administrative fees for licenses. However, it is questionable whether or not the royalties and fees are fair, compared to the benefits enjoyed by the coal mining companies. Even if the royalties and fees were fair in terms of the amount, the surrounding communities do not receive adequate compensation for all the negative impacts and externalities.

This research project contributes to the existing pool of information on the impact of the coal mining industry on the economy of South Kalimantan Province, in terms of value-added, output and employment generated by the industry, and production influence of the coal industry on other industries in the economy. This research project also provides useful information on the impact of the coal mining industry on income distribution among the various households in South Kalimantan Province. Moreover this

[2] Leakage is a situation where benefit from an activity in a region is received by other regions.

project will generate accurate information about the negative impacts and externalities of the coal mining industry on the environment, in particular on water quality, air quality, road damage, road accidents, and road density. Based on this information, this research will simulate five alternative policies for the coal industry in South Kalimantan Province to find the best one in terms of its contribution to economic improvement as well as to maintaining the environment of the province.

4.0 RESEARCH METHODS

4.1 Variables Measured

As the indicators of South Kalimantan Province's economy, variables that are analyzed are:

- Value-added, output and employment generated by the coal mining industry, as compared with the same measures generated by other sectors in the economy of South Kalimantan Province.
- Backward and forward linkages between the coal mining industry of South Kalimantan Province and other industries in the economy.
- Income distribution among the various households in South Kalimantan Province.
- The amount of output and value-added of the coal mining industry that "leaks" to other regions in Indonesia as well as to overseas countries.

4.2 Population and Samples

The research population was that of South Kalimantan Province. The analysis focused on the impact of the coal industry on economic improvement, income distribution, and leakage.

This research utilized a Social Accounting Matrix (SAM) to analyze five policy simulation of policies to locate a leading policy in terms of economy and environment.

The sampling method was proportionate random sampling. The samples were chosen proportionally based on the populations of 12 districts in South Kalimantan Province with an average of 100 samples each district. At the district level, samples were chosen randomly. The total number of samples collected was 1,200.

Industry data was collected from industry samples, which were purposively chosen from the coal-related firms as the population. Forty samples were collected:

- Large-scale mining firms (3 samples)
- Small-scale mining firms (28 samples)
- Other coal-related firms (9 samples)

4.3 Method of Information Collection

This research used primary and secondary data. Primary data included household and industry data. These were collected through personal interviews. Two types of questionnaires were prepared, one for the industry and one for households. For personal interview purposes, 40 enumerators were recruited and trained. On average, every enumerator had to interview about 30 household samples and one coal-related industry sample. Both the industry and household questionnaires were made in two stages. First, drafts of the questionnaires were tested on a small sample of 60 household respondents and four coal-related industries. Then they were evaluated. Based on the evaluation results, the questionnaires were revised. The revised versions were used for the actual interviews of all the samples. The data collected through this survey included household income and expenditure, and data on the coal industry's input-output structure for the coal-related industry samples. The data was utilized to develop a SAM for South Kalimantan Province, together with the 2000 Input-Output Table of South Kalimantan Province, and the most recent data on the economic aspects of the province.

Secondary data was collected from various relevant institutions, including private and public institutions. The secondary data was generally obtained from publications or annual reports of the relevant institutions and included the recent data of South Kalimantan Province in Numbers (2005), Input-Output Table 2000 (2003), and Gross Domestic Regional Product of South Kalimantan Province (2005), industry input and output structures, and employment provided by economic sectors in South Kalimantan Province.

To complement the above, secondary data on several environmental aspects were also collected from other sources. The main source was environmental engineers or experts who were asked to provide their professional advice and opinions, and facts, through a specially-designed workshop.

4.4 Economic Valuation Methods and Biases

The Social Accounting Matrix (SAM) model that used in this research assumed that the production structure is fixed. Generally, for impact analysis using the standard accounting multiplier, there are two more assumptions imposed. Firstly, income elasticity is assumed to be unity (1), and therefore the income effects on expenditures are eliminated. Secondly, supply of all sectors in the economy is unlimited (Bautista 2000). In reality, as in South Kalimantan Province's economy, income elasticity is not unity, and the supply of all sectors is not unlimited, so the use of the accounting multiplier will be biased.

To overcome this problem, the Mixed Multiplier analysis was used in this study instead. Income elasticity information was incorporated into the model and therefore the income assumption was released. The limited supply assumption was also released to accommodate the fact that not every sector in an economy has unlimited supplies of resources. Usually primary sectors, including the coal industry, are considered to have limited supplies (Pyatt and Round 1985, Stone 1985, Lewis and Thorbecke 1992, Rich, et al. 1997, and Townsend and McDonal 1997).

There was difficulty in choosing an appropriate tool or method to connect the various environmental aspects to the coal industry. In this research, a linear simple regression model was applied separately to each environmental variable as the dependent variable and the coal mining industry as the independent variable. In this way, the environmental outcome as an impact of the coal mining industry was assumed to stand alone for each environment variable. In fact, road damage could, for example, have contributed to the number of road accidents. This fact was ignored in the modeling.

4.5 Procedures and Techniques for Data Processing and Analysis

As the base table, the Input-Output Table of South Kalimantan 2000 was used. This was updated with recent economic and industry data to form the updated tables with 2004 as the base year. The 2004 Input-output Table of South Kalimantan Province was then combined with the household income and expenditure data collected from the survey. The result was a 2004 Social Accounting Matrix of South Kalimantan Province.

SAM as a model of analysis has some advantages. This model can be constructed wide enough to represent the whole economic system of an observed region, while at the same time providing detailed information for the investigation of a particular sector of the economy. This model possesses the capacity of combining a wide range of data and organizing it in a complete, consistent and compact framework. The model also has the ability to analyze transaction flows between various sectors in the economy while also being able to examine the flow of income and its distribution within various household categories. SAM can be used for issues related to income distribution among households, as well as for issues related to inter-sectoral linkages among various industries within an economy (Thorbecke 2000).

The use of SAM as an economy-wide planning model can provide a base to compose conclusions. SAMs comprise inter-sectoral flow analyses of production as well as of government, financial and household sectors. It represents the structure of production and also explains the distribution of value-added among production factors and the distribution of income among households (Zarate-Hoyos 2000). The SAM technique can capture the distributional effects of a planned change in exogenous accounts such as government, capital, and the rest of the world on various socio-economic household groups (Nokkala and Kola 2000). This capacity is important to help understand the income disparity in a region.

SAMs have been applied in various research fields in different countries. In the US, Adelman and Robinson (1986) used SAM for investigating the impacts of various exogenous factors on agriculture, with the focus on the link between agricultural and non-agricultural sectors. Roberts (1992) used SAM to investigate the roles of agriculture in the economic development of the UK's economy. Reininga (2000) constructed a SAM for the Netherlands to examine its consistency and suitability as a database for economic policy analysis. Sanz and Perdiz (2000) used SAM multipliers to measure the inequality among different groups of Spanish households. Nokkala and Kola (2000) analyzed the effects of the EU structural and agricultural policies on rural areas of different economic structures in Finland, using SAM.

SAMs have also been broadly utilized in developing countries to assess the distributive effects of policies on households (Midmore and Harrison-Mayfield 1996). Pyatt and Round (1985) documented several examples of SAM models that have been applied to the policy analyses of several countries. More recently, Zarate-Hoyos (2000) used a SAM model to examine the aspects of labour migration from Mexico to the US. Bautista (2000) made use of SAM multipliers to assess the effects of agricultural growth on income and equity. Malan (2001) discussed the problem of income distribution in South Africa using a SAM. Indeed, SAM analysis has been useful in gathering insights for development strategy formulation particularly when addressing the issues of growth and distribution (Cohen 1986).

For this research, three types of SAM-based analyses were used. These were the mixed multiplier analysis, linkages analysis, and leakage analysis. The mixed multiplier (MM) analysis used SAM as database to calculate a formula called the multiplier. The formula of the mixed multiplier is as follows:

$$\text{MM} = \begin{bmatrix} I_1 - C_{nc} & O_1 \\ -R & -I_2 \end{bmatrix}^{-1} \begin{bmatrix} I_1 & Q \\ O_2 & -(I_2 - C_c) \end{bmatrix}$$

The complete description of this formula is given in Appendix 1.

The MM was used to investigate the impact of the coal mining industry on value-added, output, and employment generated by the industry compared to other industries in the economy, and to analyze the impact of the coal mining industry on income distribution. The multiplier was also used for simulation.

Both forward and backward linkages were used to analyze the production structure and interdependency of the economy. Leakage analysis is a SAM-based analysis that was used to investigate the structure of household income received from coal mining industries and their related activities, and to find out how much of the income leaked overseas and to other regions outside the South Kalimantan Province.

To obtain data (facts and opinions) about the environmental impacts of the coal mining industry, a specially-designed workshop was held in Banjarbaru on 28 December, 2006. For the workshop, several engineers and experts in environmental knowledge were invited to discuss and share their opinions on the above topic. The main results of the workshop reflected some of the coefficients that could indicate the link or connection between coal-related activities and the environment. Later, the information from the workshop was combined with the simulation results using the SAM-based mixed multiplier analysis. The simulations proposed were to establish the most preferred policy in terms of economic improvement and environment maintenance.

To incorporate the policies into the model, they needed to be quantified. For this purpose, four accounts in the constructed SAM were used as policy tools. These were: 1) government, 2) tax, 3) subsidy and 4) capital/investment. The policy influences were interpreted as shocks given to particular accounts in each simulation through the policy tool accounts, either in terms of percentage addition to or subtraction from their initial values (Table 1).

Table 1. Summary of Simulation Policies

No.	Policy	Government Expenditure	Tax	Subsidy	Investment/ Capital
1	Stricter regulation of the small-scale miners	+5% on government and small-scale coal industry	-10% on small-scale coal industry		
2	Enforcing more stringent codes of mining management practices on all miners in the region	+15% on government and coal industry	+10 on coal industry		
3	Redistributing royalties and other revenues to lower income families in the region		+20% on coal industry	+15% on lower income households	
4	Implementing land rehabilitation programs	+5% on land rehabilitation	+15% on coal industry		+10% on forest and agriculture
5	Introducing mine rehabilitation bonds	-5% on land rehabilitation			10% from coal industry

The effects of the policy simulations were captured using several variables, which were categorized into three groups of variables. These were: 1) variables of economic impacts, 2) variables of industrial impacts, and 3) variables of environmental impacts. The variables that were used to indicate economic impacts were income distribution, value-added generation, and employment. The variables for industrial impacts were outputs of industry. Meanwhile for the environment impacts, the results of the SAM-based analysis were combined with the information collected from the workshop. As described earlier, the main results of the workshop revealed some of the coefficients that could indicate the link or connection between coal-related activities and the environment. With this information, the environmental impacts of the policy could be described.

The policy of stricter regulation of small-scale miners was incorporated into the mixed multiplier SAM, by assigning shock in the form of a 5% increase in government expenditure and a 10% decrease in tax on small-scale coal miners as a consequence of a drop in their numbers due to the stricter policy enforcement.

To simulate the policy of enforcing more stringent codes of mining management practices on all miners in the region, shock was defined as a 15% increase in government expenditure, together with a 10% increase in tax on the coal industry. Government expenditure includes expenses in supporting police enforcement activities and coal industry management.

The policy of redistributing royalties and other revenues to lower income families in the region was interpreted as a 20% increase in tax imposed on the coal industry, together with a 15% increase in subsidy to lower income households.

To simulate the policy of implementing land rehabilitation programs, shock was defined as a 5% increase in government expenditure on land rehabilitation, 15% increase in tax on the coal industry, and a 10% increase in investment on rehabilitation and development of forests and agriculture.

Lastly, the policy of introducing mine rehabilitation bonds was incorporated into the mixed multiplier matrix by assigning a 10% increase of capital acquired from the coal industry to pay for the bonds and a resulting 5% decrease in government expenditure on the coal industry as a result of miners being more careful. (A mine rehabilitation bond is the amount that has to be paid by a company when it starts to mine coal. If the company follows the rules and conducts the mining properly, the mining bond can be claimed back. But if it breaks any of the rules, then the bond cannot be claimed back. The government will use the bond money to rectify the damage caused by the mining company.)

5.0 RESULTS AND DISCUSSIONS

This section presents data and relevant discussions based on such data, field observations, and insights from the workshop that was specially designed to acquire expert input on the estimation of the coefficient of coal mining industry impacts on the environment. This section is divided into several sub-sections to meet the terms of research objectives.

The sub-sections are:

- Database Compilation and SAM Construction
- The Impact of the Coal Mining Industry on Economic Development
- The Impact of the Coal Mining Industry on Income Distribution
- Leakage of the Coal Mining Industry
- Policy Simulations

5.1 Database Compilation and SAM Construction

The database developed in this research was a Social Accounting Matrix (SAM) one. Actually SAM is not only useful as a database but is also a useful tool for analysis.

To develop a SAM, we used the Input-Output (IO) Table of South Kalimantan (BPS 2000). This was used as the basic table. The research method for updating the IO Table was the non-survey method. The basic table was updated using the RAS method (a mathematical method) using recent South Kalimantan regional income and gross domestic product (GDP) data (BPS 2005). The most recent official data that was available during the research period was for the year 2004. Therefore the Input-Output Table generated using this method was the Input-Output Table of South Kalimantan Province for 2004.

The basic IO Table of South Kalimantan Province for the year 2000 had 50 sectors. In this table, coal mining was separated from other sectors in the economy. However, it did not differentiate large-scale coal mining operations from small-scale ones. Using the data from several sources, the table was updated to 2004. Supporting data for this process included the 2005 data on the regional income and GDP, "South Kalimantan in Numbers" report (BPS 2005) and the 2005 annual report of the regional mining department (Department of Mining and Energy Province of South Kalimantan, 2005).

The next process was to construct a SAM. To do this there were two surveys carried out, an industrial survey and a household survey. The industrial survey used coal mining firms as samples. This was required in order to separate the coal mining sector into two different sectors: small-scale and large-scale. The household survey was useful for constructing details of the Institutions' (Institutions is one group of accounts in SAM, besides Sectors and Factors) income and expenditure. Combining the 2004 IO Table with data from these two surveys brought into being a 2004 SAM of South Kalimantan Province. This SAM consisted of 51 sectors similar to the IO Table except that in the SAM, coal mining consisted of small-scale and large-scale bodies, eight types of institutions, two factors, and five exogenous accounts. In total, the SAM had 66 accounts. Initially, the coal mining sector was planned to be divided into three sectors; small-scale, large-scale, and coal-related business which covered heavy vehicle rental. However, in the field, this could not be done, as heavy vehicle rental companies did not only serve coal mining activities, but also leased their equipment to plantations and for road construction, real estate development, and so on.

In this research, the SAM was utilized in two ways. Firstly, it was used as a database to develop a formula called the mixed multiplier. Based on this formula, we analyzed the income distribution. Also using the mixed multiplier formula, the simulation of several alternative policies was run. Secondly, SAM was used directly as a tool of analysis. The whole interdependency in the economy was captured in the SAM, and this made it possible to analyze the value-added generated by various sectors in the economy. The SAM also enabled us to understand the output produced in each sector of the economy as compared to others. It also helped us to see the leakage in the economy. We could see how much the proportion of output of particular sector in the economy that went into outer regions was.

For the purposes of this research, the SAM accounts were reduced in number. The reason for this was that the details of some sectors were not relevant. For instance, general information on the agricultural sector income and expenditure was adequate. There was no need to go into deep detail for rice, maize, other crops, land fishery, sea fishery, etc. The other reason was that in calculating the mixed multiplier, the spreadsheet could only process a matrix of up to 53 rows and 53 columns. Based on these reasons, the SAM was aggregated and the final form of the 2004 SAM of South Kalimantan Province had 38 accounts. These consisted of two factor accounts, 23 accounts of sectors, eight accounts of institutions, and five exogenous accounts.

5.2 The Impact of Coal Mining on Economic Development

Survey results showed that in South Kalimantan Province, there were 12 large-scale coal industries, 54 small-scale coal industries and 16 coal-related industries (including heavy equipment rentals, transportation, human resources management and finance). The coal industries operated in almost all areas of South Kalimantan Province, except for three *kabupatens* (districts); Banjarmasin, Barito Kuala, and Banjarbaru. Majority of the large-scale coal industries operated with a permit called the Coal Mining Exploration Project Agreement (CMEPA), which is in Indonesian is called a PKP2B (*Perjanjian Karya Pengusahaan Pertambangan Batubara*) permit. The small-scale coal industries included small firms as well as individuals and cooperatives. These operated with Mining Authorization (MA) permits, which in Indonesia are called KP (*Kuasa Pertambangan*) permits. Besides these legal miners, there are many other small-scale coal miners without licenses – these are called illegal miners. The number of illegal miners is growing. Almost every district of South Kalimantan Province contains several illegal coal miners. In 1997, 157 individual or group businesses of this type were recorded. In early 2000, this number rose sharply to 445. In 2004, the number increased to 842. Illegal miners are unique and cannot be treated the same as legal miners, particularly in applying rules and regulations.

In a SAM database, value-added is factorial income. This income is received by factors of production (labour and capital) in all economic sectors in South Kalimantan Province. The total value-added generated in South Kalimantan Province was IDR 25,949,476 million in 2004. This consisted of IDR 8,595,542 million generated by labour and IDR 17,353,933 million as a return to capital. This means that in South Kalimantan Province, capital is a more dominant contributor to value-added generation. This has some influence on income distribution. As the capital is mostly owned by “the have’s”, this means that “the have’s” can create more value-added in the economy.

Value-added generated from the coal industry reached IDR 2,966,456 million in the same year. This is the third largest contribution among sectors in the South Kalimantan Province economy contributing 11.4% to total value-added in the province. The highest contribution of 19.1% was from agriculture, followed by industry (15.4%). Complete details of sectoral value-added of the South Kalimantan Province economy is provided in Table 2.

Not surprisingly, large-scale coal mining had higher value-added than the small-scale one; almost twice as high. This figure implies that the intensity of small-scale mining is quite high. Considering that all potential areas in South Kalimantan Province have been allocated through CMEPA permits for all large-scale companies, the fact that the value-added generated from small-scale mining is almost half that from large-scale operations is something that the authorities need to pay attention to. What can be inferred is that if some areas can legally allocated for the small-scale companies, the value-added generated from coal mining could be improved.

Table 2. Sectoral Value-added in South Kalimantan Province (2004) (IDR million)

Sector	Code	Labor	Capital	Factor	Share (%)
Agriculture	3	1,236,979	3,717,640	4,954,619	19.1
Oil Mining	4	23,070	1,330,775	1,353,845	5.2
Large-scale Coal Mining	5	660,261	1,230,779	1,891,040	7.3
Small-scale Coal Mining	6	231,984	843,432	1,075,416	4.1
Other Mining	7	24,899	142,088	166,987	0.6
Digging	8	19,941	300,838	320,779	1.2
Agro-industry	9	94,521	1,170,781	1,265,302	4.9
Industry	10	1,789,931	2,215,489	4,005,420	15.4
Metal, machines, transportation appliances, and other processing industries	11	12,187	193,259	205,446	0.8
Electricity	12	62,699	12,991	75,690	0.3
Drinking Water	13	11,348	648,548	659,896	2.5
Construction	14	687,533	1,102,449	1,789,982	6.9
Trading	15	590,238	20,392	610,630	2.4
Accommodation	16	6,876	315,845	322,721	1.2
Restaurant	17	104,512	886,858	991,370	3.8
Road Transportation	18	273,426	123,266	396,692	1.5
River Transportation	19	6,373	586,838	593,212	2.3
Ocean Transportation	20	153,735	169,101	322,836	1.2
Air Transportation	21	88,733	63,899	152,632	0.6
Transportation passenger services and warehousing	22	20,679	154,591	175,270	0.7
Communication	23	32,682	760,878	793,560	3.1
Services	24	2,306,767	187,285	2,494,052	9.6
Undefined activities	25	1,554	0	1,554	0.0
Outer regions	38	154,614	1,175,911	1,330,526	5.1
Total		8,595,542	17,353,933	25,949,476	100.0

Source: SAM of South Kalimantan 2004

Note: Undefined activities = all activities that do not fit under the other classifications

If we compare the small-scale and the large-scale operations in terms of their intensity, we find out that the small-scale ones are more capital intensive. This is quite surprisingly as usually the reverse is true. The measure used is the capital:labour ratio.

For the small-scale company, this value is 3.6, while for the large-scale one, it is 1.9. The reason for this is because most small-scale miners operate in relatively new areas and this requires the use of heavy machinery (high capital outlay); thus they cannot reach optimal capacity like their large-scale counterparts.

The total output of all the economic sectors of South Kalimantan Province is IDR 69,125,971 million (Table 3). The highest contribution comes from the manufacturing (industry) sector which produces output valued at IDR 11,024,693 million. This is about 15.9% of the total output. The agricultural sector with IDR 9,706,105 million rupiahs stands at second place, contributing 14%. Large-scale coal mining stands third with 12.5% valued at IDR 8,640,060 million. Actually, if the large-scale and small-scale industry of coal mining is combined, their share of the total output will be the highest at 18% valued at IDR 12,419,188 million (Table 3). This fact indicates that coal mining is dominant in the South Kalimantan economy. Mining activities can be seen almost everywhere in the province. One can see long convoys of trucks on many main roads, coal mining exploration activities in many areas, stockpiles near the sea port, and even read about coal mining activities almost every day in the local newspapers. These pertain to on-going activities. Evidence of coal mining is also apparent in what is left behind after operations are abandoned – large open lakes, cut down forests, large open spaces of neglected land, big holes on the roads, floods and climate change (higher temperatures).

If we have a look at investment in the region, we see how dominant coal mining really is in the South Kalimantan economy. From the total investment in South Kalimantan Province valued at IDR 5,493,183 million, 30.3% was invested in the coal industry. Large-scale coal mining absorbed 24.2% (IDR 1,331,010 million) and small-scale mining absorbed 6.1% or IDR 332,752 million. Although this value is less than investment in industry which has a value of IDR 2,253,617 million, the coal mining sector is still leading considering the fact that the industry sector is grouped together with several sub-sectors, including textiles, clothing and husks, plywood and wood sawmills, wooden goods, bamboo and rattan furniture, paper, printing and publications, chemicals, rubber and plastic, and non-metal digging.

As can be seen from Table 3, in terms of investment the three most dominant sectors in the South Kalimantan economy respectively are, industry, coal mining and agriculture. Each of the other sectors in the economy has less than 1% investment share in the total investment in South Kalimantan Province.

Total employment in South Kalimantan reached 1,468,590 in 2004 out of a total population of 3,250,100. This implies that about 45% of the population works. Among all sectors in the economy, agriculture has the highest employment with 741,298 people. This is about 51% of the working population, implying that the agriculture sector is still dominant in the province. The other sectors with large employment shares are trading (15%), and services (11%). Although coal mining sector is quite dominant in terms of value-added and output, this sector together with other mining activities absorb only about 2% of the working population. There are only 33,738 people working in this mining sector. The sectoral employment of South Kalimantan Province can be seen in detail in Table 3.

Table 3. Sectoral Output and Employment in South Kalimantan Province (2004)

Sector	Code	Output		Employment		Ratio of	Investment	
		IDR million	Share (%)	People	Share (%)	Emp/Out	IDR million	Share (%)
Agriculture	3	9,706,105	14	741,298	50.5	0.076	819,916	14.9
Oil mining	4	1,513,169	2.2	872	0.1	0.001	256,262	4.7
Large-scale coal mining	5	8,640,060	12.5	24,966	1.7	0.003	1,331,010	24.2
Small-scale coal mining	6	3,779,128	5.5	8,772	0.6	0.002	332,752	6.1
Other mining	7	192,711	0.3	941	0.1	0.005	49,433	0.9
Digging	8	394,529	0.6	754	0.1	0.002	73,141	1.3
Agro-industry	9	4,801,572	6.9	7,000	0.5	0.001	6,719	0.1
Industry	10	11,024,693	15.9	132,558	9	0.012	2,253,617	41
Metal, machines, transportation appliances, and other processing industries	11	2,513,448	3.6	903	0.1	0	39,189	0.7
Electricity	12	243,416	0.4	3,555	0.2	0.015	7,631	0.1
Drinking water	13	676,433	1	643	0	0.001	726	0
Construction	14	3,395,520	4.9	45,810	3.1	0.013	42,819	0.8
Trading	15	6,891,976	10	219,943	15	0.032	90,543	1.6
Accommodation	16	6,126,139	8.9	2,562	0.2	0	873	0
Restaurant	17	1,326,910	1.9	38,945	2.7	0.029	13,237	0.2
Road transportation	18	1,372,918	2	35,256	2.4	0.026	35,346	0.6
River transportation	19	614,443	0.9	822	0.1	0.001	3,897	0.1
Ocean transportation	20	1,166,827	1.7	19,823	1.3	0.017	22,474	0.4
Air transportation	21	259,377	0.4	11,441	0.8	0.044	7,664	0.1
Transportation passenger services and warehousing	22	212,687	0.3	2,666	0.2	0.013	2,549	0
Communication	23	841,065	1.2	4,214	0.3	0.005	5,636	0.1

Sector	Code	Output		Employment		Ratio of	Investment	
		IDR million	Share (%)	People	Share (%)	Emp/Out	IDR million	Share (%)
Services	24	3,430,114	5	164,237	11.2	0.048	97,659	1.8
Undefined Activities	25	2,729	0	607	0	0.222	89	0
		69,125,971	100	1,468,590	100		5,493,181	100

Source: SAM of South Kalimantan 2004

The production structure of South Kalimantan's economy indicates the dominance of the agricultural sector. This is implied by the fact that agriculture has a higher share for value-added, output and employment compared with other sectors in the economy, except for industry. Using two indicators available, value-added and output, the production structure can be described as the ratio of value-added over output (VA/O). This ratio indicates the value-added generated given a certain value of output produced. This ratio is useful for policy-makers when they want to choose a sector to produce more value-added in the economy.

Table 4 shows that the highest VA/O is drinking water with 0.976. Communication stands at second place with 0.944 and oil mining is third with 0.895. The VA/O ratio for large-scale coal mining is only 0.219. This is actually worse than small-scale mining which has a ratio of 0.285. This implies that if a decision-maker wants to choose a sector that produces the highest value-added, coal mining would not be a good choice. The value-added generated per unit output of coal mining is much lower than the value-added generated from drinking water, communication or oil mining activities. If we observe the production structure through backward and forward linkages using a SAM-based formula, the result is as given in Table 5. Backward linkage is a linkage between a particular sector and other sectors in the economy in that input for the former generates demand for output from the latter. If a sector has a high backward linkage, this means that the sector has a strong influence on the development of other sectors.

Large-scale coal mining backward linkage is very strong (0.2125) with sector No.11, which incorporates the following industries: metal, machines, transportation appliances, other processing industries and the leasing of heavy equipment. Coal mining is very much dependent on this sector as heavy equipment is a necessity in the business for every exploration procedure, opening new mining fields and handling of the coal either in the fields, stockpiles or at the sea-ports. The other sectors that large-scale coal mining has high backward linkage with are ocean transportation and road transportation. The backward linkage coefficients for these sectors are 0.0462 and 0.0406, respectively. It is easy to understand the linkage of large-scale coal mining with these sectors. As coal is mostly sent to other regions, both for export and for inter-province trading, road transportation and sea transportation is certainly needed. A similar structure of backward linkages applies to small-scale coal mining. The highest linkage is with metal, machine, transportation appliances and other processing industries. It has a backward linkage coefficient of 0.1088. The next highest linkages are with transportation sectors, both ocean and road (Table 5).

Table 4. The Ratio of Output and Value-added as Production Indicators

Sector	Code	Output (Out) IDR Million	Value Added (Va) IDR Million	Va/Out
Drinking water	13	676,433	659,896	0.976
Communication	23	841,065	793,560	0.944
Oil mining	4	1,513,169	1,353,845	0.895
Other mining	7	192,711	166,987	0.867
Transportation passenger services and warehousing.	22	212,687	175,270	0.824
Digging	8	394,529	320,779	0.813
Restaurants	17	1,326,910	991,370	0.747
Services	24	3,430,114	2,494,052	0.727
Air transportation	21	259,377	152,632	0.588
Undefined activities	25	2,729	1,554	0.569
Construction	14	3,395,520	1,789,982	0.527
Agriculture	3	9,706,105	4,954,619	0.51
River transportation	19	614,443	293,211	0.477
Industry	10	11,024,693	4,005,420	0.363
Electricity	12	243,416	75,690	0.311
Road transportation	18	1,372,918	396,692	0.289
Small-scale coal mining	6	3,779,128	1,075,416	0.285
Ocean transportation	20	1,166,827	322,836	0.277
Agro-industry	9	4,801,572	1,265,302	0.264
Large-scale coal mining	5	8,640,060	1,891,040	0.219
Trading	15	6,891,976	610,630	0.089
Metal, machines, transportation appliances, and other processing industries	11	2,513,448	205,446	0.082
Accommodation	16	6,126,139	322,721	0.053
Total		69,125,971	1,330,526	0.019

Source: SAM of South Kalimantan 2004

Table 5. Backward and Forward Linkages of the Coal Mining Industry

Sector	Code	Backward		Forward	
		Large scale	Small scale	Large scale	Small scale
Agriculture	3	0.0020	0.0016	0.0000	0.0000
Oil mining	4	0.0000	0.0000	0.0000	0.0000
Large-scale coal mining	5	0.0003	0.0002	0.0003	0.0004
Small-scale coal mining	6	0.0002	0.0001	0.0001	0.0001
Other mining	7	0.0000	0.0000	0.0001	0.0001
Digging	8	0.0000	0.0000	0.0000	0.0000
Agro-industry	9	0.0096	0.0077	0.0000	0.0000
Industry	10	0.0077	0.0062	0.0005	0.0006
Metal, machines, transportation appliances, and other processing industries	11	0.2125	0.1088	0.0000	0.0000
Electricity	12	0.0028	0.0023	0.0003	0.0003
Drinking water	13	0.0000	0.0000	0.0000	0.0000
Construction	14	0.0014	0.0012	0.0000	0.0000
Trading	15	0.0067	0.0054	0.0000	0.0000
Accommodation	16	0.0001	0.0001	0.0000	0.0000
Restaurant	17	0.0000	0.0000	0.0000	0.0000
Road transportation	18	0.0406	0.0326	0.0000	0.0000
River transportation	19	0.0045	0.0036	0.0000	0.0000
Ocean transportation	20	0.0462	0.0371	0.0000	0.0000
Air transportation	21	0.0028	0.0022	0.0000	0.0000
Transportation passenger services and warehousing	22	0.0005	0.0004	0.0000	0.0000
Communication	23	0.0069	0.0055	0.0000	0.0000
Services	24	0.0112	0.0090	0.0000	0.0000
Undefined activities	25	0.0000	0.0000	0.0000	0.0000

Source: Processed from SAM of South Kalimantan 2004

5.3 The Impact of Coal Mining on Income Distribution

To see the impact of coal mining on income distribution in South Kalimantan Province, the mixed multiplier was utilized. The multiplier describes how much household incomes increase as a result of an increase in a particular sector in the economy. In this research, the focus of attention is the coal mining industry, both large-scale and small-scale. The multiplier values are depicted in Table 6.

As can be seen from Table 6, the highest multiplier effect (value of 0.321) of large-scale coal mining is on the household incomes of very high income non-farmers. Interestingly, the large-scale coal mining multiplier for large (and rich) land-owner farmer households is lower than the multiplier for the household of low income non-farmer. This implies that coal mining work generates more income for non-farmer households. This conforms to our observation in the field. We found that very few people living near the mining fields, who were mostly farmers, worked for the coal mining companies. Most of the workers came from other villages or provinces. Farmer families thus receive less benefit from coal mining activities.

Table 6. Income Distribution Effect of the Coal Mining Industry

Household Category	Code	Large-scale mining	Small-scale mining
Landless farmers	37	0.052	0.050
Small land-owner farmers	38	0.092	0.090
Large land-owner farmers	39	0.184	0.179
Low income non-farmers	40	0.251	0.243
Middle income non-farmers	41	0.227	0.220
High income non-farmers	42	0.306	0.299
Very high income non-farmers	43	0.321	0.328
Total		1.433	1.410

Source: Multiplier effect of SAM of South Kalimantan 2004
Note: The figures above indicate the multiplier values.

It is also obvious from the multiplier values that for the same household category, the higher the household income, the higher the multiplier. This means that coal mining generates more income for the higher income households. This applies for both farmer households and non-farmer households.

The multiplier values for small-scale coal mining follow the same pattern as for large-scale mining. As illustrated in Table 6, the small-scale coal mining industry shows a higher multiplier effect on the incomes of non-farmer households than for farmer households. It also has the same effect as large scale mining on higher income households as compared with lower income households.

The fact that most poor people are farmers combined with the fact that coal mining is biased towards non-farmer households infers that promoting coal mining activities in the development of South Kalimantan Province in not an appropriate policy if the purpose is to reduce income inequality. Based on the multiplier analysis described above, it is obvious that coal mining activities will generate additional income for the higher income non-farmer households.

5.4 Leakage of the Coal Mining Industry

It is inevitable that economic transactions of South Kalimantan take place with other regions. These regions are called “outer regions”. These could be other provinces in Indonesia or other countries. There are some inputs that are bought from outer regions and some outputs sold to outer regions. This process has some influence on the flow of benefits generated by these transactions. The excess of benefits flowing towards outer regions is referred to as leakage.

How much is the leakage of the coal mining industry in South Kalimantan? To be able to answer that question, we need to analyze the coal mining industry to compare the benefits received by the region and the outer regions. For this purpose, the 2004 SAM database of South Kalimantan Province was used to determine the leakage (Table 7).

Table 7. Leakage of Coal Mining in South Kalimantan Province

Aspects	Large-scale Mining	Small-scale Mining
	IDR million	IDR million
Income from outer regions	6,265,661	2,763,786
Expense to outer regions	3,339,410	2,117,771
Output or Input Total	8,640,060	3,779,128
	Percentage to Output (%)	Percentage to Output (%)
Income from outer regions	72.52	73.13
Expense to outer regions	38.65	56.04

Source: Calculated from SAM of South Kalimantan 2004

The total output of large-scale coal mining in South Kalimantan Province is IDR 8,640,060 million. From this amount, more than 70% is sold to outer regions. The income from outer regions created through this transaction stands at IDR 6,265,661 million. The total output from small-scale coal mining is lower at IDR 3,779,128. Its output sold to outer regions reaches the value of IDR 2,763,786 million or 73.13% of its total output value.

The fact above indicates very significant transactions between the coal mining industry in South Kalimantan with outer region. Both the large-scale and small-scale coal miners sell more than 70% of their products to other regions. This indicates a large income flow inwards from the outer regions.

If we observe the income that flows out to outer regions for large-scale coal mining, it is IDR 3,339,410 million (Table 7). This is almost 40% of the total input of the sector. The small-scale coal mining expenditure for outer regions is even higher in terms of percentage to total input. The percentage reaches 56% or in absolute value is IDR 2,117,771 million. These figures describe the leakage situation of the coal mining industry in South Kalimantan Province. The values of 40% for large-scale coal mining and 56% for small-scale coal mining expenditure flow to outer regions are strong and significant.

Small-scale coal mining appears to use more inputs from outer regions than large-scale coal mining. The reason for this is that the value is a proportionate rather than an absolute one. In absolute value, certainly large-scale mining is higher. Actually coal mining is not the only sector that has large leakage. There are some other sectors that have even higher levels (see Table 8).

Table 8. Leakage of Economic Sectors in South Kalimantan Province

Sectors	Code	Outer Regions (IDR Million)	Total Input (IDR Million)	% to Input
Metal, machines, transportation appliances, and other processing industries	11	2,111,679	2,513,448	84.015
Electricity	12	147,050	243,416	60.411
Small-scale coal mining	6	2,117,771	3,779,129	56.039
Road transportation	18	557,999	1,372,918	40.643
Large-scale coal mining	5	3,339,410	8,640,060	38.65
Air transportation	21	79,165	259,377	30.521
Agro-industry	9	1,366,198	4,801,572	28.453
Ocean transportation	20	323,680	1,166,827	27.74
Agriculture	3	2,444,196	9,706,104	25.182
Industry	10	1,956,986	11,024,693	17.751
Services	24	579,358	3,430,114	16.89
Other mining	7	763	192,711	0.396
Digging	8	466	394,529	0.118
Oil mining	4	-	1,513,169	0
Drinking water	13	-	676,433	0
Construction	14	-	3,395,520	0
Trading	15	-	6,891,976	0
Accommodation	16	-	6,126,139	0
Restaurant	17	-	1,326,910	0
River transportation	19	-	614,443	0
Transportation passenger services and warehousing	22	-	212,687	0
Communication	23	-	841,065	0
Undefined activities	25	-	2,729	0

Source: Calculated from SAM of South Kalimantan 2004

The highest leakage is for sector no. 11, which is the metal, machine, transportation appliances and other processing industries. This sector has to spend almost 85% of its input on outer regions. This means that the sector imports almost 85% of its total input. It has to be noted here that the term “import” means not only buying things from overseas, but also from other provinces in Indonesia.

The sector with the second largest leakage is electricity. This sector pays IDR 147,050 to outer regions for its input. Although this amount is small in terms of absolute value, the percentage based on its total input is very significant; about 60%.

The coal mining sectors stands at the third and the fifth positions, with road transportation at fourth place. The main reason for road transport having high leakage is because many of the vehicles used are bought from or owned by people in outer regions. Road transportation and coal mining have a close relationship in terms of transactions with outer regions. Both these sectors have an obvious dependency on outer regions for capital, human resources and equipment.

5.5 Policy Simulations

Policy simulations were done to investigate the impacts of five different alternative policies in coal mining management on the economy and environment of South Kalimantan Province. The aim was to find the most favorable strategy in terms of economic improvement and environment maintenance.

The simulations were run in a SAM-based mixed multiplier model. Four accounts were used as policy tools based on the policies being investigated. These were: Government, Tax, Subsidy and Capital/investment.

The indicators which were used to help identifying the most favorable strategy were: Income distribution, Value-added Generation, Employment, Output, and Environmental Impacts.

The five alternative policies investigated were:

- Stricter regulation of small-scale miners.
- Enforcing more stringent codes of mining management practices on all miners in the region.
- Redistributing royalties and other revenues to lower income families in the region.
- Implementing land rehabilitation programs.
- Introducing mine rehabilitation bonds.

Descriptions and purposes of these policies have been discussed in the sub-section 4.5 on ‘Procedures and Techniques for Data Processing and Analysis’.

Based on the mixed multiplier values derived from the 2004 SAM of South Kalimantan Province, the simulations were run. The simulation results were based on the five indicators mentioned above. The changes in income distribution, value-added generation, and output could be seen directly from the mixed multiplier model.

For employment, the employment:output ratio was used as the coefficient. Every increase in output would be reflected by the coefficient and changes in employment could be predicted. For the environmental impacts, the coefficients were calculated based on data collected from the specially-designed workshop on “The Impacts of Coal Mining on the Economy and Environment of South Kalimantan Province Indonesia”. Data from the workshop provided ratios for several environmental impacts as follows:

- Dust concentration (μg/m3)
- Noise (dBA, which is decibel adjusted)
- Erosion (ton/ha/year)
- Land degradation (ha/year)
- Mining holes and disposal (ha/year) (Disposal is amount of earth that is removed from an area used for coal mining)
- Vehicle density (unit/day)

5.5.1 Income Distribution

The impacts of the policies on income distribution are summarized in Table 9 below. Generally policies that directly focus on the poor are the best way to improve income equality in South Kalimantan Province. To reduce the gap in incomes among households in South Kalimantan Province, we need to improve incomes of the poor at a speed that is faster than the improvement in incomes of the rich. Among the seven different households specified in the 2004 SAM of South Kalimantan Province, the poorest households are landless farmers and low income non-farmer households. Therefore, to reduce inequality in South Kalimantan Province, incomes for these two household categories need to be increased more than the other five household categories.

In Table 9, we can see that the highest multiplier (0.093) for landless farmer households is given by Scenario 3. This scenario is applying the policy of redistributing royalties and other revenues to lower income families in the region. The second biggest multiplier for landless farmers is Scenario 4, which is implementing land rehabilitation programs. Scenario 1 (stricter regulation of small-scale miners) even results in a negative multiplier value. This means that this scenario, if applied, will reduce landless farmers’ incomes. If we observe the multipliers for low income non-farmer households, the result is similar. The largest multiplier for this household category is produced by Scenario 3, followed by Scenario 2. Therefore, for the purpose of improving income distribution among households in South Kalimantan Province, the best alternative policy to apply is the third alternative policy (Scenario 3).

This policy will improve the income of the poor households the most. Distributing revenue from coal mining activities to the poor in the area will help to reduce the income gap. Additional tax applied to coal mining followed by a subsidy for poor households is very effective way to distribute income. This will give the poor some latitude to improve their lives.

Table 9. Impacts of Policies on Income Distribution

Household Category	Code	S1	S2	S3	S4	S5
Landless farmers	26	-0.013	0.093	0.015	0.008	0.002
Small land-owner farmers	27	-0.004	0.023	0.032	0.027	0.014
Large land-owner farmers	28	-0.009	0.045	0.054	0.064	0.027
Low income non-farmers	29	-0.076	0.162	0.065	0.036	0.012
Middle income non-farmers	30	-0.011	0.056	0.078	0.067	0.033
High income non-farmers	31	-0.015	0.076	0.106	0.090	0.046
Very high income non-farmers	32	-0.081	0.013	0.099	0.048	0.016
Total Household Income		-0.069	0.370	0.538	0.427	0.212

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004

Note: S = Scenario

If we take a look at total multiplier effects for all household categories, Scenario 3 is still the best alternative because it gives the highest value compared to the other scenarios. It has a total multiplier value of 0.538 for all households. This means that it is good not only for improving the income of poor households, but also good for all households in the economy.

5.5.2 Value-added Generation

To study the impacts of policies on value-added generation, the five scenarios were run using the SAM-based mixed multiplier model and the results are as in Table 10. In general, Scenario 3 is the best alternative policy for the purpose of acquiring the highest value-added from economic activities in South Kalimantan Province.

Table 10. Impacts of Policies on Value-added Generation

Sector	Code	S1	S2	S3	S4	S5
Labour	1	-0.027	0.139	0.193	0.168	0.082
Captial	2	-0.070	0.346	0.482	0.421	0.202
Factor (Total Value Added)		-0.097	0.485	0.675	0.589	0.284

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004

Scenario 3 gives the highest value-added multiplier both for labour and capital. The values are 0.193 and 0.482 respectively. To explain why the value-added multiplier for labour in this scenario is high, we refer back to the policy tools represented in the scenario. The policy tool in this scenario is to provide a 15% subsidy to lower income households. As many of the lower income households are the suppliers of labour, the subsidy will benefit labour more. Meanwhile, the high multiplier effect for capital in this scenario can be explained as follows: imposing tax on coal mining will make coal supply shrink due to the impact of price increase. This will push inefficient firms out of production. The firms with a strong capital structure will survive and in turn, receive higher returns on their capital.

5.5.3 Employment

The policy simulations show that Scenario 3 gives the best multiplier effect for total employment in South Kalimantan Province. The detailed multiplier values for each scenario can be seen in Table 11.

The multiplier for Scenario 3 is 0.036. This means that this scenario will increase employment by 3.6%. The highest contribution to this increase will be from agriculture. This does not seem to be related to the policy, because the policy involves a tax on coal mining together with a subsidy the low income households. The agriculture sector is not a direct focus of the policy. However, if we recall that agriculture is a sector which most of the poor people rely on and have the required skills for, then it will be understandable if employment in agriculture increases.

5.5.4 Output

The scenarios of the five alternative policies of managing coal mining in South Kalimantan Province also have some effects on the output of different categories in the economy, including Factors, Sectors, Institutions, Corporations and Outer Regions. The change in total output represents the effect of change in exogenous accounts (as an implementation of a particular policy).

Table 12 shows that the highest output multiplier of 4.260 is given by Scenario 3. In second and third place stand Scenario 4 and Scenario 2 respectively. The highest total output multiplier of Scenario 3 is mainly due to the high multiplier effect of sectoral output and output from outer regions. This means that imposing the scenario (that is, imposing a 20% tax on coal mining and providing a 15% subsidy for low income households) will increase output for all account categories in South Kalimantan Province; Factors, Sectors, Institutions, Corporations and Outer Regions. Factors will increase output by 0.675, sectors by 1.934, institutions by 0.648, corporations by 0.150 and outer regions by 0.853.

Table 11. Impacts of Policies on Employment

Sectors	Code	EmpS1	EmpS2	EmpS3	EmpS4	EmpS5
Agriculture	3	-0.002	0.011	0.019	0.017	0.002
Oil mining	4	0.000	0.000	0.000	0.000	0.000
Large-scale coal mining	5	0.000	0.001	0.001	0.001	0.001
Small-scale coal mining	6	0.000	0.000	0.000	0.000	0.000
Other mining	7	0.000	0.000	0.000	0.000	0.000
Digging	8	0.000	0.000	0.000	0.000	0.000
Agro-industry	9	0.000	0.000	0.000	0.000	0.000
Industry	10	0.000	0.002	0.003	0.002	0.001
Metal, machines, transportation appliances, and other processing industries	11	0.000	0.000	0.000	0.000	0.000
Electricity	12	0.000	0.000	0.000	0.000	0.000
Drinking water	13	0.000	0.000	0.000	0.000	0.000
Construction	14	0.000	0.001	0.001	0.001	0.001
Trading	15	-0.001	0.004	0.006	0.005	0.003
Accommodation	16	0.000	0.000	0.000	0.000	0.000
Restaurant	17	0.000	0.001	0.001	0.001	0.001
Road transportation	18	0.000	0.001	0.001	0.001	0.001
River transportation	19	0.000	0.000	0.000	0.000	0.000
Ocean transportation	20	0.000	0.001	0.001	0.001	0.000
Air transportation	21	0.000	0.000	0.000	0.000	0.000
Transportation passenger services and warehousing	22	0.000	0.000	0.000	0.000	0.000
Communication	23	0.000	0.000	0.000	0.000	0.000
Services	24	0.000	0.001	0.001	0.001	0.001
Undefined activities	25	0.000	0.000	0.000	0.000	0.000
Total Employment		-0.005	0.023	0.036	0.031	0.010

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004
Note: EmpS = Employment Scenario

Table 12. Impacts of Policies on Output

Scenario	Output	Factors	Sectors	Institutions	Corps	Outer
S1	-0.593	-0.097	-0.280	-0.070	-0.022	-0.123
S2	3.009	0.485	1.443	0.355	0.108	0.618
S3	4.260	0.675	1.934	0.648	0.150	0.853
S4	3.582	0.589	1.710	0.428	0.130	0.726
S5	1.834	0.284	0.887	0.212	0.064	0.387

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004

5.5.5 Environmental Impacts

The environmental impacts of the alternative policies for coal mining management in South Kalimantan Province is divided into two categories: environmental impacts caused by large-scale coal mining and environmental impacts caused by small-scale coal mining. The rationale is that the impacts on environment measured by particular ratios are associated with the level of output of the coal mining industry (either small-scale or large-scale). The ratios show how bad the environment impacts are for a given level of output. The simulation scenarios take into account the output levels of all sectors in South Kalimantan's economy, including the coal mining industry which in turn will reflect the environmental impacts.

The simulation results for large-scale coal mining are portrayed in Table 13. From the table, we can observe that in terms of environment indicators, the most favourable scenario is Scenario No. 1, that is, stricter regulation of small-scale miners.

Scenario 1 gives negative multiplier values for three environment indicators. This means that applying the policy in the scenario will cause a shrink in output which in turn will reduce these sources of environmental disturbances or pollutants such as dust. The reduction is -0.0000060μg/m^3 for each IDR million of total output of large-scale coal mining. For noise, the multiplier value is -0.0000001 and for vehicle density, the value is -0.000003. These negative values indicate that the implementation of Scenario 1 will reduce noise and dust as well as vehicle density. These findings show that an effective way to conserve the environment is through reducing resource exploitation. Scenario 1 is also better than the other scenarios in terms of reducing erosion, land degradation, and mining holes and disposal. Although the values for these indicators are not negative, they are lower than those of the other scenarios. This means that applying Scenario 1 will still cause some erosion, land degradation, and mining holes and disposal, but the rate of destruction will be far lower compared to the other scenarios. In general, therefore, Scenario 1 is the best alternative policy for coal mining management if the purpose is to maintain environmental quality.

Scenario 3, which is economically the most favourable strategy, is no longer leading in terms of environment indicators. In fact, it gives the highest environmental impacts for all indicators. This fact implies that Scenario 3 implementation has a serious trade-off. Economically it is profitable, but environmentally it is destructive.

The simulation results for small-scale coal mining are very similar to those of large-scale mining (Table 14). The best alternative policy is Scenario 1. Like for the large-scale coal mining, this scenario gives three negative multiplier values for dust concentration, noise, and vehicle density. This means that implementation of Scenario 1 can help to reduce environmental problems in terms of these three indicators. For the remaining three indicators: erosion, land degradation, and mining holes and disposal, Scenario 1 gives the smallest multiplier effect meaning that the rate it causes these three impacts is the lowest among all the scenarios.

Table 13. Environmental Impacts of Large-scale Coal Mining for Different Simulation Scenarios

Large-scale Coal Mining	Unit of measurement	EnvS1	EnvS2	EnvS3	EnvS4	EnvS5
Dust Concentration	µg/m3/IDR million	-0.0000060	0.0000564	0.0000649	0.0000618	0.0000398
Noise	dBA/IDR million	-0.0000001	0.0000008	0.0000009	0.0000008	0.0000005
Erosion	Ton/ha/year/IDR million	0.0000002	0.0000015	0.0000017	0.0000016	0.0000010
Land Degradation	ha/year/IDR million	0.0000014	0.0000130	0.0000149	0.0000142	0.0000091
Mining Holes and Disposal	ha/year/IDR million	0.0000016	0.0000151	0.0000174	0.0000165	0.0000107
Vehicle Density	Unit/day/IDR million	-0.0000030	0.0000285	0.0000328	0.0000312	0.0000201

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004

Note: EnvS = Environmental Scenario

Table 14. Environmental Impacts of Small-scale Coal Mining for Different Simulation Scenarios

Small-scale Coal Mining	Unit of measurement	EnvS1	EnvS2	EnvS3	EnvS4	EnvS5
Dust Concentration	µg/m3/IDR million	-0.0000058	0.0000176	0.0000183	0.0000187	0.0000130
Noise	dBA/IDR million	-0.0000001	0.0000002	0.0000002	0.0000003	0.0000002
Erosion	ton/ha/year/IDR million	0.0000002	0.0000005	0.0000005	0.0000005	0.0000003
Land Degradation	ha/year/IDR million	0.0000013	0.0000040	0.0000042	0.0000043	0.0000030
Mining Hole and Disposal	ha/year/IDR million	0.0000016	0.0000047	0.0000049	0.0000050	0.0000035
Vehicle Density	unit/day/IDR million	-0.0000029	0.0000089	0.0000092	0.0000094	0.0000066

Source: Calculated from Multiplier Matrix of SAM of South Kalimantan 2004

Scenario 3, however, unlike in the case of large-scale mining, has the largest multiplier only for erosion, and even this value is the same as for Scenarios 2 and 4. The higher multiplier for small-scale coal mining is found in Scenario 4. This also means that when applying Scenario 3, which is economically the best policy, small-scale coal mining will give better results in terms of environmental impacts than large-scale operations.

6.0 CONCLUSIONS AND POLICY IMPLICATIONS

Of the five hypothetical policies whose effects we simulated, two stand out. Scenario 3 (redistributing royalties and other revenues to lower income families in the region), is economically the most favourable strategy. But it results in increased environmental destruction. Scenario 1 (regulation of small-scale miners) produces the largest favourable environmental impacts for all indicators but has some negative economic effects. Thus, an initial analysis does not reveal a "win-win" solution but rather a trade-off between an economy-friendly policy and an environmentally-friendly one.

However, the social accounting matrix allows us to look in more detail at these impacts. After all, it is not only the direction of the impacts but their magnitude that matters. On the whole, the negative impacts of Scenario 1 are relatively mild and may be an acceptable price to pay for significantly improved environmental performance.

Although coal mining dominates the economy of South Kalimantan in terms of value added and output, this sector, together with other mining activities, absorbs only 2% of the working population. The contraction of the industry that Scenario 1 would produce will affect a very small number of workers. In addition, the analysis shows that the higher the household income, the higher the multiplier from coal mining. (I.e. coal mining generates more income for the higher income households.) So the households most affected by the contraction would be the relatively rich ones.

Coal mining produces little value added per unit of output, compared to other activities in the province. Furthermore, Table 5 shows that, although Scenario 3 gives the highest value added multiplier for labor, capital and total, in a comparison between labor and capital, Scenario 1 gives better results. This Scenario's contraction of coal output affects the value added of capital more than labor. As in the case of output, the poor are less affected than the rich. The reverse is true for Scenario 3, which would increase value added, but more for capital than for labor, thus exacerbating income inequality.

An assessment of these policies' effects on income distribution yields similar results (Table 4). The total multiplier effect in terms of income decrease for the poor is 0.002 + 0.012 = 0.014. The total income decrease for the rich (large landowning farmers, high income and very high income non- farmers) is 0.009 + 0.015 + 0.016 = 0.040. The decrease in income for poor households is less than that experienced by the rich.

In the real world, win-win policies are scarce. More often we must be willing to make hard tradeoffs between desirable but incompatible outcomes. Of the policies assessed, Scenario 1 (regulation of small scale mining) seems preferable. It produces the best environmental performance of the five options investigated. It does have economic costs but these would be borne by those most able to afford them. And in the long run, the province may able to attract investment into new activities, ones that provide healthier and less dangerous jobs. Implementation of this policy could be a first step in that direction.

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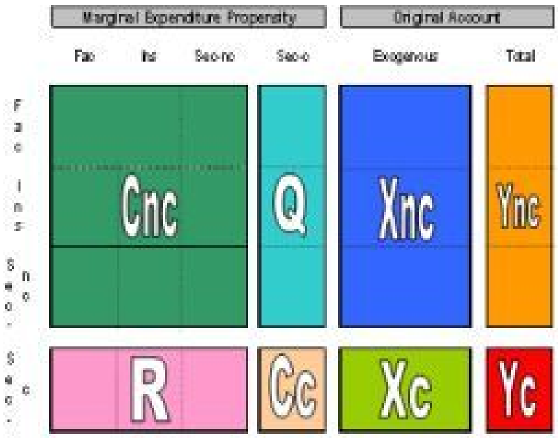
APPENDIX 1. MIXED MULTIPLIER FORMULA



$$\partial\begin{bmatrix} Y_{nc} \\ X_c \end{bmatrix} = MM * \partial\begin{bmatrix} X_{nc} \\ Y_c \end{bmatrix}$$

Mixed Multiplier = MM = a^{-1} * b

$$\underbrace{\begin{bmatrix} I_1 - C_{nc} & O_1 \\ -R & -I_2 \end{bmatrix}^{-1}}_{a}\underbrace{\begin{bmatrix} I_1 & Q \\ O_2 & -(I_2 - C_c) \end{bmatrix}}_{b}$$

Fac	Factors
Ins	Institutions
Sec-nc	Sectors with suply unconstrained
Sec-c	Sectors with suply constrained
Cnc	Marginal Expenditure Propensity among factors, institutions and sectors with suply unconstrained
Q	Marginal Expenditure Propensity of sectors with suply constrained on factors, institutions and sectors with suply unconstrained
Xnc	Exogenous expenditure on factors, institutions and sectors with suply unconstrained
Ync	Total income of factors and institutions and total output of sectors with suply unconstrained
R	Marginal Expenditure Propensity of factors, institutions and sectors with suply unconstrained on sectors with suply constrained
Cc	Marginal Expenditure Propensity among sectors with suply constrained
Xc	Exogenous expenditure on sectors with suply constrained
Yc	Total output of sectors with suply constrained
I1	Identity Matrix (same order as Cnc)
I2	Identity Matrix (same order as Cc)
O1	Zero Matrix (same order as Q)
O2	Zero Matrix (same order as R)