ECONOMIC DETERMINANTS OF OUTPUT MULTIPLIER: INTERREGIONAL INPUT-OUTPUT FRAMEWORK

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Abstract:

This study aims at identifying economic determinants of output multiplier obtained from the 1995 Indonesian interregional input-output table. In the identification, this study takes the spatial effects seriously. The spatial dependence model are fitted to accommodate these effects, whose existence is a direct consequence of using regional data. Three important findings stand out of this study. First is the importance of taking into account spatial effects in the identification of output multipliers. Secondly, this study finds primary input structure as the important determinants of output multiplier. Thirdly, this study also confirms that the propensity to spend locally is a significant variable that may affect the output multiplier.

Keywords: multiplier determinants, interregional input-output, spatial dependence, Indonesia.

Note

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1 Introduction

An impact analysis within the input-output framework owes a great deal to the existence of input-output multiplier. In such analysis, the multiplier holds a central position as it indicates the rate at which any changes in the exogenous variables, for instance the final demand, are translated into changes in the production. Generally the input-output multiplier is considered fixed at least in the short run. Analogue to that, in the Keynesian tradition, an inquiry to increase the national income is usually followed by a prescription to expand exogenous expenditures such as the government spending. The Keynesian multiplier, which is the rate at which changes in the exogenous expenditures are translated into changes in the national income, is also considered as fixed. Further inspection into the Keynesian framework will reveal that the magnitude of the multiplier is determined by various marginal propensities that characterize the economy. The question at this point is whether these propensities are also the determinants of multiplier in the input-output framework. In general, the question, which will be addressed by this study, is what constitutes the economic determinants of the input-output multiplier. In particular, the study examines economic determinants of the output multiplier within the interregional input-output framework.

The importance of this study is twofold. First, policy makers in many cases would like also to increase the economic output or income through manipulating the multiplier rather than, for instance, simply increasing the government expenditures. In the case where the policy makers would also like to change the magnitude of this multiplier, the task would be then to identify the economic variables that may affect the magnitude of multiplier, and possibly point out the magnitude of relationship. Secondly, economic variables interact in a much more complicated fashion than suggested by the input-output relationship. Changes in final demand affects not only output but also the production structure which leads to changes in the multiplier. This is the particular route that this study tries to examine. Employing an interregional input-output framework, the examination takes into account the fact that regions are interrelated one with another. This is where the spatial econometric techniques play essential role.

Out of three types of multipliers in the input-output framework (Miller and Blair, 1985), this study will concentrate on the determinants of the output multiplier. Clearly, of course, the methodology used here can also be adopted for the other type of multipliers: income and employment. Basic to this study is an assumption that the regional variations of the output multiplier are capable to hint the overall tendency of the determinants. This study will use 1995 Indonesian interregional input-output which divides the country into 27 provinces, each with nine sectors.[1] Since this study deals with regional data set that has a built-in locational identifier, then it is necessary to examine the existence of spatial effects that may affect the tendencies. To that end, spatial econometric techniques, in particular the spatial dependence model, will be employed in obtaining parameter estimates.

The attempt to find the economic determinants can be seen as an attempt for an explanation. This is to contrast with three other related notions in the input-output literatures:

[1] This is the number of provinces existing in Indonesia in 1995. East Timor province, which later on becomes the Republic of Timor Leste, is still included in our dataset, as it has not become independent until 1999.

the decomposition, the short cut, and the sensitivity analysis of multiplier. These notions will be discussed in section two following this introduction. Section three will discuss the determinants of multipliers in a theoretical context. Two models will be considered as the starting point: the standard Keynesian model and the export-base growth theory, leading to identifying possible candidates of determinants. Section four aims at elaborating Indonesian regional economy. The regional output multipliers derived from the 1995 Indonesian interregional input-output table will be discussed here. Section five presents the model and analyses estimation results. The specification search of the spatial dependence model will be conducted followed by estimating the coefficients using the maximum likelihood technique. Section seven, the closing remarks, will complete the paper.

2 Explanation: its place in the literature

There are several themes in the input-output literatures that resemble what is aimed by this paper. The first is the decomposition of input-output multiplier, the second is the attempt to find a short cut to multiplier, and the third is the sensitivity analysis of the input-output multiplier. We discuss how each one of these differs from the explanation of the output multiplier.

The decomposition of multipliers has received a vast amount of attention in the input-output literatures.[2] The basic idea is to chop the multiplier off into small pieces and analyze their economic meaning and significance. To illustrate some example, recall that in the interregional input-output model, increases in output because of shocks in final demand in a

[2] The decomposition is not only possible for multipliers, but is also done for the direct input coefficient. Along this line of research, one should note the Structural Decomposition Analyses (see Rose and Casler, 1996 for an overview).

region R can be decomposed into two different types: intraregional effect and the feedback effect (Miller and Blair, 1985). The summation of these two constitutes the total multiplier for region R. There are many other decomposition techniques offered in the literature. Some has extended the analysis beyond the input-output framework, and are suitable to handle the Social Accounting Matrix (e.g., Round, 1985). To name several of them, we note here the Structural Path Analysis or SPA(Defourny and Thorbecke, 1984; Khan and Thorbecke, 1988), Feedback Loop Effects (Sonis *et al*., 1993; Sonis et al., 1997a; Sonis *et al*., 1997b; Sonis and Hewings, 2001).

The decomposition technique is capable to point out various types of sources in the multiplier effect. It is an appropriate method to use if all one cares about is, given a magnitude of impact or multiplier, the share of various elements of economic phenomena in generating such an impact. Given a path of interest, for an example, the SPA can show the importance, in terms of the contribution, of that particular path in the total impact. Moreover, that particular path of interest can further be sliced off to get several sub-paths, and a similar analysis can hint the relative importance of these sub-paths. What the decomposition technique is mute about is what brings about such magnitude of impact, i.e., what variables to stimulate if one wants to increase the size of the multiplier.

Another closely related subject to this paper is an attempt to find a short-cut to multiplier. The attempts have been around for since 1970s, and contributions are made, among others, by Drake (1976) and a series of papers by Burford and Katz (primarily 1977a, 1977b, 1981a, 1981b, 1985). Fundamental to the attempt is a postulate that a short cut is available to estimate input-output multipliers without necessarily having to have an input-output table. More specifically Burford and Katz argue that a good proxy of sector j 's output multiplier can be calculated using two information, namely the column sum of input-output matrix $W_j = \Sigma_i a_{ij}$ and the average column sum of direct input coefficient matrix $\bar{W} = \Sigma_j W_j / n$, where a_{ij} is the usual direct input coefficient and n is the number of sectors. Toward this technique, Jensen and Hewings (1985a, 1985b) differently argue that there is no such thing as a short cut to input-output multipliers. Further, they view that the method proposed by Burford and Katz is disconnected from the economic structure. Depicted in the input coefficient matrix, this structure is unique to an economy and is irreplaceable by any short-cut methods.

The attempt to find a short cut is different from one aiming at explanation of multipliers. Primarily employing regression techniques to find the best-fitted model replicating magnitudes of multipliers, it is true that statistically significant variables can be seen to constitute the explanation of multipliers. Still, however, the attempt to find a short cut and an explanation differ in two respects. First, a method to find the short cut requires a sufficiently high goodness of fit to the existing data. Short cut implies forecasting that requires the best-possible model of replicating variations in the magnitude of multipliers. Secondly, the attempt to find the short cut to multiplier needs to conform to the parsimonious, Occam's razor, principle: the attempt has to rely on the least possible set of exogenously determined variables. On the other hand, explanation does not necessarily have to rely on model with the highest goodness of fit. More important in finding the explanation is the significance, and insignificance, of variables perceived to be the alternative determinants. In addition, the attempt to find an explanation is not necessarily governed by the Occam's razor principle. Given a set of variables as possible determinants, this study can always benefit from the statistically insignificant as well as significant ones.

Finally, the sensitivity analysis of elements in the Leontief inverse is first conducted by Sherman and Robinson (1949, 1950). The question is what happens to the magnitude of Leontief inverse elements if the corresponding input requirement coefficient changes. In a series of papers, Sonis and Hewings (1989, 1992) and Van der Linden et al. (2000) extend the idea to include the whole range of changes using the concept of field of influence. Obviously, since the output –as well as other type of– multipliers is derived from the Leontief inverse, then the above line of research can also be seen as attempts to explain the nature of the output multipliers. This present paper will be different from the above line of research for it tries to answer the effect to the exogenous variables, rather than merely the endogenous coefficient, to the magnitude of output multipliers. In the input-output framework, the exogenous variables are the final demand as well as the primary input structures. This paper tries to address whether those two classes exogenous variables, naturally together with the intermediate input structure, can be regarded as the economic determinants of the output multiplier.

3 Theoretical background of determinants

This paper aims at the explanation of the output multiplier. By explanation, we mean economic factors that affecting –as well as those not affecting– the magnitude of the sectoral and regional variables. To come up with the candidates of explaining factors, we have to consider the theory underlying the general notion of economic multipliers. This section aims at this theoretical exploration.

The starting point is the Keynesian determination of national income. Let's consider a typical formula

$$Y = k^{*}\left(C_0 + I_0 + G_0 + X_0 - M_0\right) \tag{1}$$

where Y is the national income, and C_0, I_0, G_0, X_0, M_0 are respectively autonomous consumption, investment, government expenditures, export and import. The national income multiplier, is given by $k^{*} = 1/\left[1-(c-m)(1-t)\right]$, where c is the marginal propensity to consume, m is the marginal propensity to import, and t is tax rate.[3] These variables can be considered as three factors determining the magnitude of national income multiplier in a simple Keynesian framework. Changes in the marginal propensities will bring about changes in the magnitude of Keynesian multiplier.

A different strand of literature addressing the role of multiplier in regional economy can be traced in the export-base theory of growth (Tiebout, 1962). Two different activities in a regional economy are identified: one serving local market, and another serving export market. The former is commonly called local, service, or non-basic activity[4]; while the latter is commonly referred to as basic activity. The basic sector, through export activity, produces monetary inflow to the region and creates local service employment and income. It is the prime mover of the regional economy. Further, when basic sector expands, the non-basic is presumed to move in the same direction (Tiebout, 1962:10). The size of the multiplier depends

[3] This result is obtained by usual assumptions that consumption and import, which each is a function of the disposable income, comprise autonomous and induced parts. The induced part is determined by the marginal propensity to consume and import, respectively. Also, tax is proportional to income. On the other hand, investment, government expenditures and export are all considered as autonomous expenditures.

[4] It is important to note that the notion service here differs from the term 'service sector.' The usual term 'service sector' is not necessarily categorized as 'service' according to the export base theory. When a service sector, for instance tourism or banking services, is consumed by people from outside the region then it can be classified as a base sector in the export base theory.

upon the propensity of individuals to spend money in the local economy rather than spending it outside of the local area (Blair, 1991:151).

Three variables are of importance in influencing the propensity to spend locally (Armstrong and Taylor 2000): the size of the economy, the regional industry mix, and the geographical proximity to local labor markets. On the size of the economy, smaller regions may have larger propensity to imports, and thus smaller propensity to consume locally. On the regional industry mix, they argue that higher degree of specialization on certain producing certain products in the region results in greater dependence of imports, thus reducing the propensity to consume locally. On the geographical proximity to local labor markets, they argue that if labor serving the region live outside the region, then the propensity to consume locally may be smaller for simple reason that people spend more at where they live and not a where they work. On the other account specific to the marginal propensity to import, Blair (1991) argues that this marginal propensity is sensitive to three variables: the size of economy, per capita income, and the degree of spatial isolation. As before, smaller regions may have larger propensity to imports, and thus smaller propensity to consume locally. Higher per capita income may boost up imports. So, increasing per capita income may be accompanied by soaring propensity to import. Finally, the less isolated a region, the greater the likelihood of its resident to spend money outside the community.

The above discussion gives lights to relevant variables to pose as alternative explanations to the output multiplier. Of course, data on marginal propensity for each sector in each province is not easy to compute. However, the whole input-output table provides possibility to compute various average propensities using the final demand component of the table. These average propensities will be used here in this study as proxies to the marginal propensities. More specifically, we are going to take the ratio of each component of the final demand to GDP. Given the structure of the 1995 Indonesian IRIO, we then can compute the following ratios:

1. Ratio of household consumption to GDP
2. Ratio of private investment to GDP
3. Ratio of government consumption to GDP
4. Ratio of government investment to GDP
5. Ratio of change in stock to GDP
6. Ratio of export to GDP

As we deal with a system involving inter-industry structure, there is another class of relevant variables, namely the primary input structure. Therefore, a set of variables representing the importance of several primary inputs will be included in the possible determinants of the output multiplier. They are as follows:

1. Ratio of wage and salary to total primary input
2. Ratio of operating surplus to total primary input
3. Ratio of indirect tax to total primary input
4. Ratio of primary input to total input

Another class of variables to consider in this study reflects the importance of the intermediate input in the production process. Two variables can be derived from the intermediate input structure:

1. Ratio of total provincial input to total primary input
2. Ratio of total intermediate input to total primary input

The first variable reflects the above discussed ‘marginal propensity to spend locally,’ where local is defined as province. On the other hand, the second variable should reflect the relative importance of intermediate input with respect to the primary input.

4 Regional development: 1995 Indonesian IRIO multipliers

The regional development in Indonesia is significantly marked by domination of Java, and by the western part of Indonesia in general. In 1995 the five Java provinces contribute slightly less than 60 per cent of the country’s total GDP. Together with eight other provinces in Sumatra the share is 81 per cent of total GDP. The rest of the cake is divided among other regions: Kalimantan, Sulawesi, Bali and Nusa Tenggara, and Maluku & Papua. Such an uneven distribution may be traced back to a peculiar production flow between the western and eastern parts of Indonesia. A study by Sonis *et al.* (1997) confirms a widely accepted belief that most of money flows to and through Java. In other words, money invested in the eastern part of Indonesia will eventually flow back to the western part of Indonesia. Such a belief devises a differentiation of the meaning of a ‘regional development’ (*pembangunan daerah*) from a ‘development in the region’ (*pembangunan di daerah*). The former refers to a development process that empowers all local resource and capabilities to achieve a sustainable regional progress. The latter, on the other hand, refers to a development process involving limited local capabilities. A typical example is the extraction of oil and gas that in general involves a high-tech production process. On one hand, due to low quality of human resources, it is hard for local labor to take part in the process. Most of human resources for the activity is imported from outside the region. On the other hand, a large portion of profit from this process will flow out of the region. As a result, the region will appear as rich, but not the people.

The regional diversity is also reflected in sectoral economic structures and specialization among provinces in Indonesia. A high share of agricultural sector marks most of Indonesian provinces. However, the agricultural shares in Java and Sumatra are below the national average. Also, another reflection of the strength of manufacturing and service sectors, the labor share working in agriculture for provinces outside Java (an exception is East Kalimantan) is still higher than 40 per cent. The share in East Timor, East Nusa Tenggara, and Papua is close to 75 per cent. Looking further in detail, there is also some regional specialization in agricultural product (Hill 1996). Java and Bali are mainly the producers of rice and food agriculture in general, and Sumatra, on the other hand, is the major producer of cash crops. Crops are also significant in some other provinces such as most of Sulawesi (coconuts, cocoa, cloves), West Kalimantan (rubber), and East Timor (coffee). The eastern province such as East Nusa Tenggara specialize more on livestock farm.

Manufacturing sector, in a sense of a diversified base industrial firm, is also concentrated in Java and Sumatra. In terms of GDP, the two regions account for about 87 per cent of all Indonesian manufacturing value added in 1995. That percentage is not very far from the share in its labor absorption. Manufacturing in provinces outside Java is usually marked by the existence of a small number of large manufacturing companies. Further as noted by Hill (1996) manufacturing industry in Java is typically a footloose industry, while those in the outer-island are typically resource-based.

The attractiveness of western part of Indonesia comes on quite several fronts. First is the infrastructure. Compared to the eastern part of Indonesia, the western provinces are better equipped with various basic infrastructures such as ports, roads, as well as energy sources and communication lines. Indeed, infrastructure is considered as one main obstacle for private sectors to invest in the eastern region. Second is location, especially in relation with the international trade. Despite the fact that the eastern region is closer to trading partners in the Pacific rims, but western part of Indonesia is much closer to international major trading port such as Singapore. Third is cultural. The closeness to the center of power, i.e., the capital city of Jakarta, physically and mentally, is still highly valued by many. In general, big cities are considered more attractive than small ones. The relationship between eastern and western part of Indonesia suggests some sort of competition, rather than complementarities, between the two (Nazara *et al*., 2001a, 2001b). In retrospect, this resembles the competitive growth proposed by Richardson (1973) where regional growth occurs in a zero-sum fashion. The economic growth of one region takes place at the expense of the other.

The above is a brief regional economic background characterizing the 1995 Indonesian interregional input-output table. As has been mentioned earlier, the table consists of 27 provinces, each with nine sectors. The output multiplier shown in Table 1 is computed using the Leontief inverse matrix in the input-output framework. Note that the multiplier for mining and quarrying sector (sector no. 2) for DKI Jakarta is exactly one, due to the fact that this region is actually has no output of the sector whatsoever. In essence this region only has eight, rather than nine, sectors.

<<< Table 1 around here >>>

The magnitude of sectoral multipliers for provinces in Indonesia ranges from one to 2.206 (construction sector in Maluku province). The overall average of these multipliers is 1.583 with a standard deviation of 0.266. Looking at the total output multiplier, one may immediately note that some economically more advance provinces such as DKI Jakarta and East Java have the lowest total output multiplier. The total provincial output multiplier should be interpreted as an amount of output produced if every single sector in a particular province is each given an additional rupiah of final demand.

In each province, the construction sector (no.5) is typically a sector with the highest or the second highest output multiplier. In provinces where it is the second highest, i.e., in North Sumatra, Jambi, Bengkulu, Lampung, DKI Jakarta, and Papua, the highest output multiplier is taken by manufacturing sector (no.3). The exception is DKI Jakarta where the highest is the electricity, gas and water supply sector (no.4). Another proof of the importance of the two sectors in Indonesian as a whole is the fact that construction is also the sector with the highest provincial average (average: 1.942), followed by manufacturing (1.809).

On the other hand, mining and quarrying is the sector with the lowest provincial average of multipliers (1.245). In provinces that are rich with oil and gas, most notably Aceh, Riau and East Kalimantan, the output multiplier of this sector is notably small below the average. They are 1.149, 1.163 and 1.161, respectively, for the three mentioned provinces. This must be related to the fact that mining, although provides a substantial amount of returns, is a highly capital intensive activity.

As a final note, if one concludes that the magnitude of output multiplier is inversely related to this economic aggregate, it is not necessarily true. In fact, the output multiplier has a fairly low correlation with variables like total output (correlation: 0.028), total final demand (0.064), and total primary input (-0.128). At this point it can be concluded that each of these variables does not singly determine the magnitude of output multipliers. Values of the correlations that are very close to zero suggest that the obtained positive or negative correlation can be changing if there are other variables perceived to simultaneously affect the output multiplier. We move on to this issue in the next section by estimating the determinants of the output multiplier.

5 Model and estimation results

For the estimation purposes, we will define two types of output multipliers, each originating from the usual Leontief inverse matrix $\mathbf{B} = [b_{ij}] = (\mathbf{I} - \mathbf{A})^{-1}$. The first type of multiplier is the standard output multiplier, which will be further referred to as total output multiplier. For sector *j* in region *r*, it is defined as $O_j^r = \Sigma_{s=1}^{R} \Sigma_{i=1}^{n} b_{ij}^{sr}$ for all $i, j = 1, ..., n$ and $r, s = \{1, ..., R\}$. The value of total output multiplier denotes the increase of output of sector *j* in region *r* for every dollar increase in the final demand of this particular sector. The second type of output multiplier that will be examined is called the own-province output multiplier. The own-province for sector *j* in region *r* is defined as $\tilde{O}_j^r = \Sigma_{i=1}^{n} b_{ij}^{rr}$ for all $i, j = 1, ..., n$ and $r, s = \{1, ..., R\}$, i.e., summing up the Leontief inverse only for the corresponding province. It excludes the output multiplier that coming from outside the region.

The output multiplier for a specific region is obtained by recognizing two postulates: a particular region is different from others, and this region is in relationship with other regions in the nation. The fact that regions are in interaction one with another suggests that there are spatial effects that need to be taken into consideration in an attempt to come up with the economic determinants of the output multipliers. The implication of this issue will be discussed again further below.

Two alternative models of spatial dependence are possible (Anselin, 1988): the spatial lag model and spatial error model. Spatial lag model assumes the following structure $\mathbf{y} = \rho\mathbf{W}\mathbf{y} + \mathbf{X}\beta + \varepsilon$ where parameter ρ denotes the spatial lag coefficient relating the value of y in one region with those of its neighbors, which are represented by $\mathbf{W}\mathbf{y}$. On the other hand, the spatial error model assumes the standard model $\mathbf{y} = \mathbf{X}\beta + \varepsilon$ with an autocorrelated error structure in the form of $\varepsilon = \lambda\mathbf{W}\varepsilon + \xi$, where $\xi \sim N(0, \sigma^2\mathbf{I})$. Here parameter λ signifies how error in one region is affected by error in the neighboring areas.

To arrive at the appropriate model, the procedure outlined in Anselin (1988) and Anselin and Bera (1998) will be adopted. This is a data-driven approach since the appropriate model is formulated based on a set of statistical tests of the data in study. At the center of the specification search is the OLS residuals of a model perceived to depict the appropriate behavior of dependent variables. These residuals are subjected to various Lagrange Multiplier (LM) specification tests (Anselin 1988, 2001a, 2001b; Anselin and Bera 1998), with random specification as the null hypothesis. A confirmation of a randomly distributed error suggests that there is no spatial dependence structure in the model. On the contrary if the tests cannot statistically confirm a random pattern, then a spatial dependence structure will have to be taken into account.

An important element of this spatial dependence model is the $N \times N$ weight matrix. In a strictly spatial data set, this matrix would depict the structure of interaction, shown by the neighborhoodness, among the spatial units. In this simple structure, the element typical element of this matrix w_{ij} takes a value of one if spatial units i and j are neighbors, and zero otherwise. In this setting, the row i will depict neighbors of a particular spatial unit i. In a more general account the magnitude of element w_{ij} would illustrate how close is the relationship between two spatial units i and j. It is therefore possible for this element to take values between zero and one. A closer the values to 1 signifies a more intense the relationship between i and j. For more discussion about the weight matrix, see Cliff and Ord (1973, 1981).

An added complication introduced here is the existence of sectoral classifications within each region in study. Unlike regions, sectors do not have locational identifiers but they are in interaction with others both in same as well as different regions. It is just possible that provinces in Sumatra have direct interrelationship with provinces in Java, while the two regions are separated by sea. This relationship should characterize the weight matrix for this analysis. Every sector in a province is unique in its relationship with sectors in the same or other regions. The main question that arises at this point is how such a weight matrix can be built. Clearly the 'other regions' concept here does not necessarily means contiguous, adjacent regions. Instead, the term should be economically interpreted. In other words, the neighborhoodness here is represented by the existing export-import relationship within the country.

The appropriate weight matrix that will be used in this study is thus a modification of the interregional input coefficient matrix. Recall that each row of this matrix can be read as the allocation of output produced by a particular sector in a certain region. It shows how that sector relates to other sectors in the same region as well as in the other regions, thus denoting interregional and intersectoral interaction. A higher entry on the row elements signifies higher interaction of this particular sector with the corresponding other sector, with zero entry means that sector i in region r has no interaction with sector j in region s. A modification that is needed from the interregional input coefficient, to make it appropriate for a weight matrix, is to set the main diagonal elements to zero. There are two reasons for this. Firstly, this practice is standard in the spatial econometrics literature. It simplifies a substantial amount of computations because spatial models involves a lot of trace operations (Anselin, 1988). Second is substantive matter. Aside from showing the structure of interaction, a weight matrix can also be seen as depicting the structure of competition among elements. The higher the competition the higher the entry of this weight matrix would be, with zero in the case of no competition. Clearly, a sector in a particular region (in this example: sector 1 in region r) is not in competition with itself. Thus, a zero entry is appropriate for the main diagonal of this weight matrix.

Table 2 presents the specification test statistics for the two dependent variables: total output multiplier and own-province output multiplier, using OLS residuals of regression model using variables previously outlined in Section 3. The specification tests suggest that residuals from the above model conceive the spatial error dependence. This is indicated by the rejection of null for LM-error test that is more convincing than that for LM-lag test. We will subsequently re-estimate our parameters using this particular model. Before that, let us see some regression diagnostics pertaining to the residuals. The Breusch-Pagan heteroskedasticity test (Breusch and Pagan, 1979, 1980) suggests that there is a heteroskedastic structure that needs to be taken into account in the data. Using the 6-region specification, the test suggests a rejection of homoskedastic error structure for both regressions. The Jarque-Bera normality test (Jarque and Bera, 1980) suggests that the residuals are somewhat marginally normal for the total output multiplier regression. The maximum likelihood estimation will be then used to the estimation of the spatial error model.

<<< Table 2 around here >>>

Table 3 presents the estimation results of the spatial autoregressive error model. A groupwise heteroskedasticity, in terms of six regions in Indonesia, is taken into account. There are several observations that stand out of these results. We will discuss them below.

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First, the spatial autoregressive coefficient λ turns out to be statistically significant in both models, and with a value statistically close to one. This is quite high in magnitude considering that maximum value that the spatial autoregressive coefficient can take is one (Anselin 1988). This high and significant coefficient signifies a notion that there is a spatial error structure in the 1995 Indonesian regional output multipliers. How to interpret this result? What is captured in the error term is the unmodelled effects, which typically indicating the existence of some omitted variables. The perceived regression model formulated earlier is not totally free from the possibility of those variables. The above results suggest that these effects are statistically and spatially correlated. Despite that possibility, a significant spatial autoregressive term guarantees spatially correct β coefficients. One can think that the spatial autoregressive term plays a role as a nuisance parameter, i.e., a parameter that has to be statistically significant in a model, in order to obtain a statistically correct coefficient estimates.

Secondly, the intercept in each of the two specifications is statistically not different from one, which fact agrees to the input-output theoretical framework. The minimum value of output multiplier in one, which is the case when a sector produces or demands nothing. This, for instance, will be the case for mining and quarrying sector for DKI Jakarta. Basically this sector does not exist, which means zero entries to all explanatory variables, and a unity output multiplier.

When the spatial effects are taken into account, the results show that the statistically significant economic determinants of the output multiplier are related to the primary input rather than to the final demand variables. For wage, profit and indirect tax –each as a ratio to the total input– the inclusion of spatial effects increases their negative effects to the magnitude of output multiplier. These negative impacts should be understood in the context of primary-intermediate input substitutability. Greater proportion of primary input in the production function implies a reduced share of intermediate input, which leads to lower entries in the intermediate input matrix and hence lower output multiplier. Comparing total and own-province multipliers, it can be seen that the coefficients for the former in greater, in absolute value, than those for the latter. Such a result is not surprising since the magnitude of total multiplier is indeed greater than that of the own-province.

The importance of the propensities to spend locally is highlighted by significant coefficient on the ratio of intermediate provincial input to the total input, in both regressions. The difference in coefficient magnitudes, i.e., 3.4 for the total multiplier regression and 1.5 for the own-province regression, is indeed interesting. To interpret this result, recall that local spending may induce output increase through the feedback impact (Miller and Blair, 1985). The difference in the above coefficient magnitudes may be sparked by such an impact.

6 Concluding remarks

There are two main points of the above discussions and estimation results. First spatial effects play an important role in the determinants of output multiplier. Policy makers should recognize this. It has been shown that spatial effects statistically and significantly persist in a model depicting determinants of 1995 Indonesian regional output multipliers. Effect of policies implemented in one region, for instance a government investment decision, will not be isolated to that particular region. Effects to other regions should also be anticipated given the fact that regions are interrelated one with another, in terms of the interregional input-output framework, through exports and imports of interindustrial inputs. In retrospect, when Walter Isard (1960:183) argues that [a] far-sighted resources development analyst *should* investigate further *because* [r]egions are not isolated entities, *rather* [t]hey are interrelated *and* [t]o any given region are transmitted the ups and downs of regions which are its neighbors (italics added by the author), that call should also be directed to policy makers.

The second important point of this study is that there is a set of economic variables that can be regarded as the economic determinants of regional and sectoral output multiplier derived from 1995 Indonesian interregional input-output table. Taking into account the regional trade structure, it is shown that the economic determinants of the regional output multipliers comprise of the elements of primary inputs. The propensity to spend locally turns out to be significant in affecting the magnitude of regional output multipliers. This is also a policy path that may be adopted by regional government in order to boost up the regional output multipliers.

Another note on this policy implication is in order. What has been advocated in this paper is a possibility of stimulating the output multiplier as a way to promote the economic growth. This paper has shown a set of economic variables that can be used to accomplish such goal. What has not been shown is the efficiency of this particular policy prescription, especially in comparison to the commonly prescribed demand management policy. In one aspect, output multiplier depicts the rate of economic efficiency in transforming changes in the exogenous to the endogenous variable. In practice, changes in the economic efficiency are commonly considered as a long run, rather than a short run, process. A more thorough examination on this matter would be needed before any further conclusion can be made.

Methodologically this study has shown how to identify the economy determinants of the output multiplier. The use of interregional output multiplier requires a proper treatment of spatial effects as a result of interregional relationships. The spatial dependence, employing the spatial econometrics techniques, starts with an attempt to identify the type of dependence existing in the data set. Given the type of dependence, the proper estimation technique is then employed. This study confirms the existence of spatial error dependence in the output multiplier from the 1995 Indonesian interregional input-output. The maximum likelihood estimation is then used to find the coefficient estimates. On this front, future research agenda may involve an attempt to come up with a model specifying different behavior for different regions, where behavior is captured in the estimated parameters. A richer data set is deemed required. The existence of future interregional input-output tables may warrant this type of studies. An added complication in the modeling framework will come, among others, from the fact that there are three possible dimensions that at play: regional, sectoral, and time-series.

One important aspect that needs further examination is the sectoral differences in the impact to the output multiplier. The above analysis hinges on a homogeneity assumption on the impact of exogenous variables to the output multiplier. Related to that, future agenda should address the possibility of differences in these impacts across sectors. Naturally, a more degree of freedom is necessary and this will be possible with the availability of such an interregional input-output table over time.

References

Anselin, L. (1988) *Spatial Econometrics: Methods and Models* (Dodrecht, Kluwer Academic Publisher).

Anselin, L. and Bera, A. (1998) Spatial dependence in linear regression models with an introduction to spatial econometrics, in: A. Ullah and D.E. Giles (eds) *Handbook of Applied Economic Statistics* (Oxford: Blackwell) pp. 310-30.

Anselin (2001a) Rao's score test in spatial econometrics, *Journal of Statistical Planning and Inference*, 97, pp. 113-139.

Anselin (2001b) Spatial Econometrics, in: Badi H. Baltagi (ed) *A Companion to Theorethical Econometrics* (Blackwell Publishers).

Armstrong, H. and Taylor, J. (2000) *Regional Economics and Policy* (Blackwell Publisher).

Baltagi, B. and Li, D. (2001) Double length artificial regressions for testing spatial dependence, *Econometric Reviews*, 20, pp. 31-40.

Beck, N. and Katz, J.N. (1995) What to do (and not to do) with time-series cross-section data, *American Political Science Review*, 89, pp. 634-47.

Blair, J.P. (1991) *Urban & Regional Economics* (Irwin Publisher).

Breusch, T., and Pagan, A. (1979) A simple test for heteroskedasticity and random coefficient variation, *Econometrica*, 47, pp. 1287-94.

_____(1980) The lagrange multiplier test and its application to model specification in econometrics, *Review of Economic Studies*, 67, pp. 239-53.

Burford, R.L. and Katz, J.L. (1977a) Regional input-output multipliers without a full I-O table, *Annals of Regional Science*, 11, pp. 21-38

_____(1977b) An estimator of regional interindustry multipliers without an I-O matrix, *Business and Economics Section Proceedings of the American Statistical Association*, pp. 453-458.

_____(1981) A method for estimation of input-output-type output multipliers when no I-O model Exists, *Journal of Regional Science*, 21, pp. 151-61.

_____(1985) Shortcut 'input-output' multipliers, alive and well: response to Jensen and Hewings, *Environment and Planning A*, 17, pp. 1541-1549.

Cliff, A. and Ord, K. (1973) *Spatial Autocorrelation* (London: Pion)

_____ (1981) *Spatial Processes: Models and Applications* (London: Pion)

Defourny, J. and Thorbecke, E. (1984) Structural path analysis and multiplier decomposition within a social accounting framework, *Economic Journal*, 94, pp. 111-36.

Drake, R. L. (1976) A short-cut to estimates of regional input-output multipliers: methodology and evaluation, *International Regional Science Review*, 1, pp, 1-17.

Hill, H. (1996) *The Indonesian economy since 1966: Southeast Asia's emerging giant* (Cambridge University Press).

Isard, W. (1960) *Methods of Regional Analysis: An Introduction to Regional Science* (MIT Press).

Jarque, C. and Bera, A. (1980) Efficient tests for normality, homoskedasticity and serial independence of regression residuals, *Economic Letters*, 6, pp. 255-9.

Jensen, R.C. and Hewings, G.J.D. (1985a) Shortcut 'input-output' multipliers: a requiem, *Environment and Planning A*, 17, pp. 747-759.

_____(1985b) Shortcut 'input-output' multipliers: the resurrection problem (a reply), *Environment and Planning A*, 17, pp. 1551-1552.

Kelejian, H. and Robinson, D.P. (1998) A suggested test for spatial autocorrelation and/or heteroskedasticity and corresponding Monte Carlo results, *Regional Science and Urban Economics*, 28, pp. 389-417.

Khan, H.A. and Thorbecke, E. (1988) *Macroeconomic Effects and Diffusion of Alternative Technologies within a Social Accounting Matrix Framework* (Gower, Aldershot).

Miller, R. E. and Blair, P.D. (1985) *Input-Output Analysis: Foundations and Extensions*, (New Jersey, Prentice-Hall, Inc.).

Moran, P. (1948) The interpretation of statistical maps, *Journal of the Royal Statistical Society B*, 10, pp. 243-51.

Nazara, S., Sonis, M., and Hewings, G.J.D. (2001a) Interregional competition and complementarity in Indonesia, *REAL Discussion Paper* no. 01-T-02, March 2001.

Nazara, S., Hewings, G.J.D., and Sonis, M. (2001b) Hierarchical spatial interaction: an exploratory analysis, *REAL Discussion Paper* no. 01-T-12, November 2001.

Richardson, H.W. (1973) *Regional Growth Theory* (Bristol: Macmillan).

Round, J. I. (1985) Decomposing multipliers for economic systems involving regional and world trade, *Economic Journal*, 95, pp. 383-99.

Sonis, M., and Hewings, G.J.D. (1989) Error and sensitivity input-output analysis: a new approach, in: Miller, R.E., Polenske, K.R., and Rose, A.Z (eds) *Frontiers of Input-Output Analysis* (New York, Oxford University Press).

Sonis, M., and Hewings, G.J.D. (1992) Coefficient change in input-output models: theory and applications, *Economic Systems Research*, 4, pp. 143-57.

Sonis, M. and Hewings, G.J.D. (2001) Feedbacks in input-output systems: impacts, loops and hierarchies, in: Lahr, M.L. and Dietzenbacher, E. (eds) *Input-Output Analysis: Frontiers and Extensions* (Palgrave).

Sonis, M., Guilhoto, J.J.M., and Hewings, G.J.D (1997a) The Asian economy: trade structure interpreted by feedback loop analysis, *Journal of Applied Input-Output Analysis*, 2, pp. 24-40.

Sonis, M., Hewings, G.J.D., Guo, J., and Hulu, E. (1997b) Interpreting spatial economic structure: feedback loops in the Indonesian interregional economy, 1980, 1985, *Regional Science and Urban Economics*, 27, pp. 325-42.

Sonis, M., Oosterhaven, J., and Hewings, G.J.D. (1993) Spatial economic structure and structural changes in the European Common Market: feedback loop input-output analysis, *Economic Systems Research*, 5, pp. 173-84.

Rose, A. and Casler, S. (1996) Input-output structural decomposition analysis: a critical appraisal, *Economic Systems Research*, 8, pp. 33-62

Tiebout, C. (1962) *The Community Economic Base Study* (New York, The Committee for Economic Development).

Tobler, W. (1979) Cellular geography, in: Gale, S. and Olsson, G. (eds) *Philosophy in Geography* (Dodrecht, Reidel) pp. 379-386.

Van der Linden, J.A., Oosterhaven, J., Cuello, F.A., Hewings, G.J.D., and Sonis, M. (2000) Fields of influence of technological change in EC intercountry input-output tables, 1970-1980, *Environment and Planning A*, 32, pp. 1287-1302.

Table 1
Total output multiplier of 1995 Indonesian IRIO

	Sector[a]									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
1. Sumatra										
Aceh	1.308	1.149	1.802	1.934	2.086	1.491	1.627	1.569	1.633	14.598
N. Sumatra	1.305	1.157	1.957	1.713	1.946	1.438	1.568	1.384	1.645	14.112
W. Sumatra	1.250	1.231	1.877	1.759	1.968	1.410	1.602	1.362	1.579	14.037
Riau	1.365	1.163	1.829	1.783	1.873	1.383	1.623	1.465	1.608	14.092
Jambi	1.359	1.251	1.928	1.791	1.916	1.472	1.600	1.440	1.657	14.415
Bengkulu	1.350	1.253	1.817	1.548	1.802	1.422	1.655	1.436	1.611	13.894
Lampung	1.309	1.288	1.861	1.793	1.833	1.379	1.531	1.384	1.524	13.902
S. Sumatra	1.303	1.299	1.859	1.819	1.928	1.390	1.537	1.416	1.585	14.135
2. Java										
DKI Jakarta	1.079	1.000	1.540	1.629	1.566	1.381	1.329	1.336	1.460	12.319
W. Java	1.214	1.110	1.906	1.668	1.943	1.520	1.562	1.392	1.563	13.878
C. Java	1.339	1.285	2.015	1.705	2.043	1.500	1.550	1.446	1.639	14.522
Yogyakarta	1.226	1.230	1.948	1.895	2.159	1.815	1.571	1.385	1.588	14.817
E. Java	1.156	1.144	1.708	1.611	1.587	1.388	1.388	1.309	1.447	12.738
3. Bali & Nusa Tenggara										
Bali	1.375	1.393	1.976	1.907	2.164	1.771	1.965	1.513	1.699	15.763
W. Nusa T.	1.272	1.302	1.824	1.969	1.989	1.438	1.608	1.520	1.567	14.488
E. Nusa T.	1.256	1.276	1.831	1.946	1.943	1.400	1.585	1.484	1.541	14.263
E. Timor	1.382	1.354	2.021	2.025	2.188	1.414	1.786	1.573	1.642	15.385
4. Kalimantan										
W. Kalimantan	1.240	1.210	1.944	1.823	1.909	1.361	1.560	1.289	1.516	13.853
C. Kalimantan	1.322	1.335	1.903	1.906	1.913	1.406	1.581	1.444	1.559	14.369
S. Kalimantan	1.305	1.289	1.957	1.932	2.055	1.469	1.686	1.430	1.565	14.687
E. Kalimantan	1.315	1.161	1.736	1.613	1.836	1.468	1.592	1.501	1.597	13.820
5. Sulawesi										
N. Sulawesi	1.259	1.271	1.864	1.856	1.950	1.415	1.653	1.495	1.589	14.352
C. Sulawesi	1.362	1.346	2.023	2.035	2.130	1.410	1.890	1.521	1.630	15.347
S. Sulawesi	1.186	1.195	1.765	1.777	1.792	1.335	1.564	1.389	1.423	13.427
SE. Sulawesi	1.351	1.376	1.880	1.956	2.136	1.377	1.944	1.463	1.781	15.263
6. Maluku & Papua										
Maluku	1.362	1.344	2.079	2.018	2.206	1.437	1.795	1.546	1.692	15.479
Papua	1.174	1.202	1.762	1.447	1.565	1.275	1.531	1.407	1.282	12.643

Note: a Numbering of sectors: (1) Agriculture; (2) Mining and quarrying; (3) Industry manufacturing; (4) Electricity, gas and water; (5) Construction; (6) Trade, restaurant & hotel; (7) Transportation and communication; (8) Financial services; (9) Government and other social services

Table 2
Specification test and other statistics based on OLS residuals

	Dependent variable: Total multiplier	Dependent variable: Own-province multiplier
Regression diagnostics		
Observation	242	242
No. of explanatory variables	12	12
Adjusted R-squared	0.9437	0.9460
Ln likelihood	333.341	388.921
Jarque-Bera normality test (df.=2)	5.778 (0.056)	16.693 (0.000)
Linear specification heteroskedastic test		
27-province specification (df.=1)	10.050 (0.002)	7.096 (0.008)
6-region specification (df.=1)	9.724 (0.002)	8.065 (0.002)
Spatial specification tests		
Moran's I	0.572	0.582
Moran's I normal approx.	14.258 (0.000)	14.518 (0.000)
LM test for lag (df.=1)	3.437 (0.064)	5.423 (0.020)
LM test for error (df.=1)	185.058 (0.000)	192.042 (0.000)
Robust LM test for lag (df.=1)	2.244 (0.134)	4.024 (0.045)
Robust LM test for error (df.=1)	183.865 (0.000)	190.643 (0.000)

Note: probability greater than chi-square statistics in parentheses.

Table 3
Results of spatial autoregressive error model

	Dependent variable: Total multiplier	Dependent variable: Own-province multiplier
Constant	1.0752 (0.475)*	1.0986 (0.369)**
Household consumption/GDP	-0.3958 (0.472)	-0.2856 (0.472)
Private investment/GDP	-0.2786 (0.471)	-0.2042 (0.366)
Government consumption/GDP	-0.1894 (0.281)	-0.1469 (0.216)
Government investment/GDP	-0.2228 (0.299)	-0.1756 (0.232)
Change in stock/GDP	-0.4429 (0.472)	-0.3139 (0.365)
Export/GDP	-0.4458 (0.472)	-0.3209 (0.366)
Wage/total input	-0.2570 (0.075)**	-0.1730 (0.055)**
Profit/total input	-0.2844 (0.064)**	-0.1743 (0.046)**
Indirect tax/total input	-0.3393 (0.189)*	-0.3331 (0.132)*
Primary input/total input	0.6826 (0.119)**	0.4049 (0.080)**
Total intermediate provincial input/total input	3.3546 (0.192)**	1.4739 (0.118)**
Total intermediate input/total input	1.6553 (0.118)**	-0.0688 (0.073)
Spatial autoregressive coefficient - λ	0.9197 (0.229)**	0.8785 (0.229)**
Number of observations	242	242
R-squared	0.8559	0.8482
Log likelihood	378.43	439.38
Test on groupwise heteroskedasticity		
Likelihood Ratio (prob>χ, df.=5)	26.12 (0.00)	33.78 (0.00)

Note: Standard error in parentheses, ** significant at 1%, * significant at 10%