WELFARE EFFECTS OF TRANSPORT INFRASTRUCTURE IMPROVEMENT ACROSS REGIONS IN A DEVELOPING COUNTRY: A SPATIAL COMPUTABLE GENERAL EQUILIBRIUM APPROACH

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ABSTRACT

This paper looks into the impact on welfare of alternative improvements in water, air and land transport infrastructure in a low-income region in the Philippines like Mindanao, using a general equilibrium model. The welfare index used will be equivalent variation. It utilizes a five-region social accounting matrix as database for a spatial general equilibrium (SCGE) model of the Philippine economy subdivided among five regions with Mindanao as focal point The four other regions are Northern Luzon, National Capital Region, Southern Luzon, Visayas and Mindanao. Each regional economy contains seven production sectors and three household income groups. The paper examines the impact of a 10% increase in capital inputs in Mindanao land transport services sector on welfare, income distribution and transport-intensity of production sectors. These are then compared with an alternative 10% increase in capital inputs in Mindanao water transport services sector and air transport services sector. After which, the Mindanao results are compared with other regions in the rest of the Philippines. In the end, the empirical results will serve as benchmarks in the optimal allocation of resources for transport infrastructure investment within Mindanao and also between Mindanao and the rest of the Philippines

Keywords: transport infrastructure, welfare, regional social accounting matrix, general equilibrium, equivalent variation

INTRODUCTION

Transport infrastructure improvements have continually been undertaken in Mindanao for the economic development of the region and upliftment of the welfare level of its people. However, the optimal allocation of funds to the specific type of transport infrastructure improvement remains a major policy concern.

To address this issue, this paper aims to do the following: (1) present a spatial general equilibrium model of the Philippine economy , using a five-region social accounting matrix as database (2) delineate the impact of a 10% increase in capital in Mindanao land transport services sector on welfare, income distribution and transport intensity, (3) show parallel results for the other two transport modes – water transport and air transport in Mindanao (4) compare such results with the regions in the rest-of-the- Philippines and (5) suggest policy directions in terms of optimal allocation of transport infrastructure investment within Mindanao and between Mindanao and the rest of the Philippines.

MODEL SPECIFICATION

The model accounts for the interregional linkages of the Philippine economy. The model was originally developed to address the issue of the spatial impact of transportation; thus the transport component of the production sector of the model is relatively well-developed. (Dakila & Mizokami, 2006). Table 1 summarizes the sectoral structure of the model. The model distinguishes between seven main production sectors which are further differentiated according to the five regions of origin. These five regions are an agglomeration of the 17 administrative regions in the Philippines. Since the National Capital Region does not have an agricultural sector, there are therefore 34 production sectors. For each region, households are differentiated into three income classes. There are, therefore, a total of 15 household categories. Low income households are all those who earn below the regional poverty threshold as determined by the National Statistical Coordination Board. The high income households are those who earn ₱250,000 and above annually. All the households with incomes between the regional poverty threshold and the highest income bracket in the Family Income and Expenditure Survey are classified as middle income households. According to Mizokami and Dakila (2005) contains a detailed description of the database utilized in the model.

Table 1. Sectoral & Areal Disaggregation of the Model

PRODUCTION SECTORS	REGIONS	HOUSEHOLDS
Agriculture Industry Water transport Land transport Air transport Other services Government	National Capital Region Northern Luzon Southern Luzon Visayas Mindanao	Low income Middle income High income

The assumptions adopted are as follows (1) All product and factor markets operate under perfectly competitive conditions. (2) Economic agents like households and firms maximize an objective function subject to constraints. Households maximize utility whereas firms maximize profit. (3) Equilibrium is defined as a state where the actions of all agents are mutually consistent and can be executed simultaneously. Quantities adjust in the model and prices follow to equate the notional and effective demand for labor. (Ginsburgh & Keyser, 2002) (4) In this model, adjustment to equilibrium is implemented by specifying that markets adjust to minimize the sum of excess supplies. (5) Among the seven-production sectors; three belong to the transport sector, namely, water transport services sector, air transport services sector, land transport services sector. The demand for services of each type of transport mode is a derived demand associated with the demand of intermediate production goods. (5) Between the two factors of production , capital is immobile and labor is mobile among the five regions. (6) The economy has 37 markets. This is composed of thirty-five product markets of each the aforementioned five regions with seven production sectors each, one capital market and one labor market.

The framework takes off from Mizokami model of two region economy in the Philippines with four production sectors including transport (Mizokami et al, 2005). However, there are variations in specification of the production function. A three- nested production function is estimated. The transport sector intermediate input is isolated in the second level of production function. A more detailed disaggregation of transport sector is delineated – namely water transport services sector, air transport services sector and land transport services sector. Furthermore, another point of difference is that households in each region are decomposed into three income levels - low, middle and high. Finally, the rest-of-the-Philippines region is divided into four regions namely Northern Luzon, Southern Luzon, Visayas and Mindanao vis-à-vis National Capital Region.

This is the first spatial equilibrium model with a disaggregated transport sector in the Philippines. All Philippine CGE models devised in the past have been national in scope. This is also a first attempt in constructing a five-region social accounting matrix as database for a spatial computable general equilibrium (SCGE) model in the Philippines.

Household Sector

The model distinguishes between 15 representative households, with 3 household types (representing the low, middle, and high income classes) for each of the six regional groupings distinguished in this paper. The preferences of each household type are summarized by a corresponding Cobb-Douglas utility function:

$$U_h = \prod_i C_{ih}{}^{\delta_{ih}} \tag{1}$$

Each representative household maximizes its utility subject to its income constraint, which we describe below.

For each region, household labor income is assumed to be the equal to the sum of the labor incomes that each household income group earns from supplying labor within the region. The endowments of labor of different income classes within a region are taken to be a constant; this then determines how labor income is distributed within each region.

Since capital is fixed, then each household income group is assumed to own a fixed share of total capital, and this ratio is maintained through the policy experiments. Household income is assumed to be the sum of labor income ($w_i L_i$) plus that portion of capital income that accrues to the households ($\lambda_h \Sigma_i r_i K_i$), plus transfers from government and from the rest of the world. The latter two are exogenously determined. Thus, if we partition the indices h and i so that the r[th] partition belongs to the rth region, then total income per household type is therefore given by

$$\mathrm{Y_{h,r}} = \omega_{\mathrm{h,r}} \sum\nolimits_{\mathrm{i}\in \mathrm{r}} \mathrm{w_i L_i} + \lambda_{\mathrm{h,r}} \sum\nolimits_{\mathrm{i}} \mathrm{r_i K_i} + \mathrm{Tr_{GOV,h,r}} + \mathrm{Tr_{ROW,h,r}} \tag{2}$$

where the ω's are the labor income distribution parameters, and, as indicated, the summation is for industries belonging to the rth region. Total disposable income is found by subtracting direct taxes imposed on the household from the foregoing quantity:

$$\mathrm{Yd_h} = \mathrm{Y_h}\left(1 - \tau_{\mathrm{h}}\right) \tag{3}$$

where Y_d is disposable income and τ_h is the direct tax rate imposed on household h. Note that the summation is now application for each household type, so that we have dropped the subscript r referring to the partitioning across regions.

Each household type is assumed to consume a constant proportion of its disposable income. Thus, households maximize utility subject to the budget constraint

$$\sum\nolimits_{\mathrm{i}} \mathrm{pd_i C_{ih}} = \mathrm{c_h Yd_h} \tag{4}$$

where pd_i is the domestic price of the good and c_h is the average propensity to consume of household h. Given the Cobb-Douglas utility function, the first order conditions require that:

$$C_{i,h,r} = \delta_i c_{h,r}\left[\omega_{h,r}\sum_{i\in r} w_i L_i + \lambda_{h,r}\sum_i r_i K_i + Tr_{GOV,h,r} + Tr_{ROW,h,r}\right]\left(1-\tau_{h,r}\right)/p_i \tag{5}$$

Production Sector

Production is modeled assuming a three-stage production function. At the first stage, capital and labor are combined to produce value-added, using a Cobb-Douglas production technology.

$$V_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i} \tag{6}$$

where for sector i and region r, V = value added, K = capital, L = labor, α = share of capital in value-added, and 1-α = share of labor in value-added. Thus, the specification of the Cobb-Douglas function assumes constant returns to scale. Capital is assumed to be immobile across sectors while labor is mobile.

In stage 2, value-added is combined with non-transport intermediate inputs under a Leontief technology, to produce a composite good, which is output net of transport.

$$X_i^{NT} = \min\left[X_{1i}/a_{1i}, X_{2i}/a_{2i}, \ldots, X_{NT,i}/a_{NT,i}, V_i/a_{V,i}\right] \tag{7}$$

Finally, stage 3 combines output net of transport with transport intermediate inputs under a Cobb-Douglas production function to yield total output gross of transport of commodity i ($X_{T,i}$).

$$X_{T,i} = B_i\left(X_i^{NT}\right)^{\beta_{1i}} W_i^{\beta_{2i}} A_i^{\beta_{3i}} La_i^{\beta_{4i}} \tag{8}$$

where W, A and La represent the different transport intermediate inputs that go into sector i. Thus, this specification allows substitutability between the various transport modes – water transport, air transport and land transport. Total output of sector i (X_i) is found by summing together total output gross of transport of commodity i ($X_{T,i}$), indirect taxes on i ($T_{indirect,i}$), direct taxes imposed on firms in sector i ($T_{direct,i}$),, imports of i (M_i), tariffs imposed on i (Tar_i), and net dividends from the foreign sector into sector i ($Div_{For,i}$).

$$X_i = X_{T,i} + T_{Indirect,i} + T_{Direct,i} + M_i + Tar_i + Div_{For,i} \tag{9}$$

The firm is assumed to maximize profits. Because of the nature of the production function, profit maximization can be described in three stages. The bottom stage entails choosing the optimum levels of capital and labor so as to maximize the contribution of value added to profits. Let Π_{VA} represent this contribution of value added. Then the optimization problem is

$$\begin{aligned} &\max\text{imize } \Pi_i^{VA} = pva_i V_i - w_i L_i - r_i K_i \\ &\text{subject to} \\ &V_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i} \end{aligned} \tag{10}$$

where V represents value added, and pva is its corresponding price. Since capital is immobile, of particular interest is the first-order condition for labor, which is

$$pva_i * \frac{\partial V_i}{\partial L_i} = w_i$$

$$pva_i\left(1-\alpha_i\right)\frac{V_i}{L_i} = w_i \tag{11}$$

It is convenient to move next to the top stage of the production process, since this is likewise of Cobb-Douglas structure. There the optimization problem is

$$\begin{aligned}&\max\text{imize } \Pi_i = pd_i Q_i - w_i L_i - r_i K_i \\ &\text{subject to} \qquad (12) \\ &Q_i = B_i Q_i^{NT^{\beta_{1i}}} W_i^{\beta_{2i}} A_i^{\beta_{3i}} La_i^{\beta_{4i}}\end{aligned}$$

and the corresponding first order conditions are

$$pd_i * \frac{\partial Q_i}{\partial Q^{NT}{}_i} = p_{NT} \text{ or } pd_i \beta_{1i} \frac{Q_i}{Q^{NT}{}_i} = p_{NT} \qquad (13)$$

$$pd_i * \frac{\partial Q_i}{\partial W_i} = p_w \text{ or } pd_i \beta_{2i} \frac{Q_i}{W_i} = p_W$$

$$pd_i * \frac{\partial Q_i}{\partial A_i} = p_A \text{ or } pd_i \beta_{3i} \frac{Q_i}{A_i} = p_A$$

$$pd_i * \frac{\partial Q_i}{\partial La_i} = p_L \text{ or } pd_i \beta_{4i} \frac{Q_i}{La_i} = p_{La}$$

Finally, once output net of transport is determined, the different non-transport inputs as well as total value added can be derived using the fixed coefficients technology (7). While this may seem to over-determine value-added in the system, we take (11) as actually determining pva. We turn to this in greater detail in the section on prices.

Government Sector

The model incorporates a national government sector, i.e. the behavior of regional government units is not considered. Government enters the economy in several ways: it purchases output from each sector, imposes indirect taxes on production and tariffs on imported goods, and direct taxes on income of each household type. Government expenditures on each commodity are taken as exogenous in the model, while taxes are endogenous.

Tariff revenues per commodity equal the product of the tariff rates and import values:

$$Tar_i = tar_i \left(m_i\right) \qquad (14)$$

where Tar_i and tar_i are total tariff collections from i and the tariff rate on commodity i, respectively. Indirect tax collections are given by the product of the indirect tax rate imposed on domestic production and the rate imposed on imports of the product:

$$T_{Indirect,i} = tind_i \left(d_i + m_i \left(1 + tar_i\right)\right) \qquad (15)$$

Direct tax collections per household type in the model are computed as:

$$T_{Direct,h} = Y_h - Yd_h \qquad (16)$$

At this stage of model specification, imports and exports are taken as exogenous.

Investment-Saving Balance

Total household savings in the model are given by the aggregate difference between household disposable income and consumption expenditures:

$$S_h = \Sigma_h \left(Yd_h - C_h\right) \qquad (17)$$

Total government savings are the sum of the various revenue sources minus total government purchases of the outputs of the various sectors, total government transfers to households, and total net transfers of the government to the foreign sector:

$$S_G = \Sigma_i Tar_i + \Sigma_i T_{Indirect,i} + \Sigma_h T_{Direct,h} - \Sigma_i G_i - \Sigma_h Tr_{GOV,h} - Tr_{GOV,FOR} \quad (18)$$

Total foreign savings, S_{FOR}, are given by the current account deficit minus net dividends to foreigners. Thus, total savings are

$$S_{TOTAL} = S_h + S_{GOV} + S_{FOR} \quad (19)$$

Conceptually, total savings should equal total investment. Our framework allows for statistical discrepancy by introducing a factor ϕ which transforms savings to investments. Investment distribution per sector is then modeled as constant proportion of total investment, with the distribution coefficients γ_i calibrated according to the sectoral distribution of investment in 1994:

$$I_i = \gamma_i \phi \left(S_{TOTAL} \right) \quad (20)$$

Demand

Total intermediate demand for commodities is given by the firm arises from maximization of profits subject to the 3-level production function. At the first level, the first order condition for profit maximization entails equating the marginal product to the marginal cost of labor.

$$pva_i * \frac{\partial V_i}{\partial L_i} = w_i$$

$$pva_i \left(1 - \alpha_i\right) \frac{V_i}{L_i} = w_i \quad (11)$$

where the marginal product of labor for each production sector is evaluated assuming that capital is immobile across sectors. For any given employment, equilibrium entails that the corresponding level of production equal the demand forthcoming at the employment level. Similar equations hold for the choice between output net of transport and the various transport inputs, at the third level of the production function.

At the second level, each production sector combines value-added and every non-transport intermediate input according to a fixed proportions technology:

$$Mat_{i,j} = a_{ij} X_j^{NT} \quad (21)$$

where i runs through all the non-transport intermediate inputs and value added for each sector, j runs through all the production sectors in the economy, Mat_{ij} is the matrix of interindustry flows in the economy, a_{ij} represents the fixed coefficients technology, and, as before X_j^{NT} is output net of transport for the jth sector.

Final demand in the economy originates from households (consumption demand), firms (investment demand), government spending, and the foreign sector (export demand). Consumption demand by households originates from the maximization of the utility function, as described previously . Although, for simplicity, firms' investment demand is not described explicitly in terms of optimization, the level of investment is determined by the transformation of savings into such. Government and export expenditures are taken to be exogenously determined.

The domestic demand for commodity i consists of the total intermediate demand, plus the total final demands for consumption, investment, and government purchases, while the total composite demand, represented by Q_i, is the sum of the domestic demand and exports:

$$Q_i = \Sigma_j Mat_{i,j} + \Sigma_h C_{h,i} + G_i + Exports_i \qquad (22)$$

Prices and Equilibrium

The firm is assumed to maximize profits. The first order condition for this entails equating the marginal product to the marginal cost of labor.

$$\mathrm{pva_i} * \frac{\partial \mathrm{V_i}}{\partial \mathrm{L_i}} = \mathrm{w_i}$$

$$\mathrm{pva_i}\left(1-\alpha_i\right)\frac{\mathrm{V_i}}{\mathrm{L_i}} = \mathrm{w_i} \qquad (11)$$

For any given employment, equilibrium entails that the corresponding level of production equal the demand forthcoming at the employment level. This determines the price levels in the economy, relative to the price of labor. The labor price is assumed to be the numeraire, and is thus taken to be fixed. Since capital is a fixed factor, we take returns to capital as a residual determined by the identity:

$$r_i = \frac{\left(pva_i * V_i - w_i^0 L_i\right)}{k_i^0} \qquad (23)$$

The total product cost can then be built up from the components in a standard way. Thus, average cost per unit is

$$AC_i = \frac{\Sigma_j pd_j Mat_{j,i} + pva_i V_i}{X_i} \qquad (24)$$

where pd_i is the domestic (tax-inclusive) price of i. In equilibrium, the average cost equals the composite price pq_i of the commodity (the composite price is the peso price of both domestically produced and imported commodities).

The excess supply for each commodity is given by:

$$ES_i = X_i - Q_i \qquad (25)$$

The model treats all the foregoing relationships as constraints in a nonlinear programming problem. Markets are assumed to operate so as to minimize the value of sum of squared excess supplies for all commodities; i.e., the objective of the programming problem is to minimize the quantity

$$\Omega = \Sigma_i\left(pq_i * ES_i\right) \qquad (25)$$

In equilibrium, therefore, the unit cost is divisible into three parts: (1) $\frac{\sum_j \mathrm{pd_j q_{ji}}}{\mathrm{X_i}}$, where the j's are the non-transport inputs give the cost of non transport intermediate inputs per unit of X; (2) the same formula with the j's taken to be the transport inputs yields the transport margin; and $\frac{\mathrm{w_i L_i + r_i K_i}}{\mathrm{X_i}}$ is the cost of value added per unit of X.

WELFARE EFFECTS – NOTION OF EQUIVALENT VARIATION

To understand the welfare effects of an exogenous shock introduced within the spatial general equilibrium model, this next section will discuss the concept of equivalent variation. (Reed, 2004)

The diagrammatic analysis of equivalent variation, as indicated below, shows the measurement of the consumer welfare change associated with a change in prices.

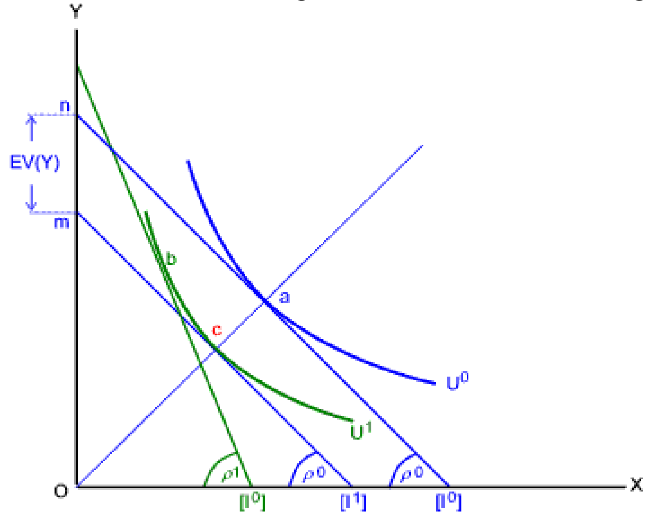

Figure 1. Diagram of Equivalent Variation

The initial equilibrium with money income I^0 and relative prices $r^0 = p_X{}^0/p_Y{}^0$ is at point a on indifference curve U^0. When relative prices change to $r^1 = p_X{}^1/p_Y{}^1$, but money income remains at I^0, the new equilibrium is at point b on indifference curve U^1. (In the case shown in the diagram, the price of X has risen – money income I^0 would, if spent entirely on X, purchase less of that good, and the price of Y has fallen – money income I^0 would, if spent entirely on Y, purchase more.)

The equivalent variation (EV) is that change in money income that would put the consumer on the new indifference curve at the old prices. That is, we must find the additional income that, at prices $p_X{}^0$, $p_Y{}^0$, would put the consumer at point c on indifference curve U^1. We may measure this in terms of the change in the amount that could be purchased of either *X* or *Y* from that additional income at the original price of the good concerned. On the diagram the EV in terms of *Y* is shown as EV(Y), or by distance mn. That is, if I^N is the money income needed to put the consumer at point *c* then $I^N = I^0 + EV(Y)^* p_Y{}^0$

If the utility function is linearly homogenous, then calculation of the money value of mn, or of the proportionate change in money income, mn/On, is fairly straightforward.

The properties of similar triangles give mn/On = ca/Oa, and the properties of linearly homogeneous functions give U^1/U^0 = Oc/Oa. Hence mn/On = $(U^0 - U^1)/ U^0$. But we can obtain the numerical values of U^0 and U^1 from the output of the CGE model, and we know the original money income, I^0. If I^N is the money income needed to put the consumer at point *c* then we have

$$EV = I^N - I^O = \left(\frac{I^N - I^O}{I^O}\right) I^O = \frac{mn}{On} I^O = \left(\frac{U^N - U^O}{U^O}\right) I^O \tag{30}$$

ANALYSIS OF RESULTS

WELFARE ANALYSIS

The next figure indicates that it is the middle income group across all five regions which had the highest increment in welfare .This was followed by the low-income group in all regions except NCR. The middle income is composed of households whose annual gross income fall between the highest income bracket of FIES and the Mindanao poverty threshold. In Mindanao, the middle income groups experienced relatively high gains, but were next only to all the income groups in National Capital Region. It is noted that low income households in Mindanao had the seventh highest welfare gain.

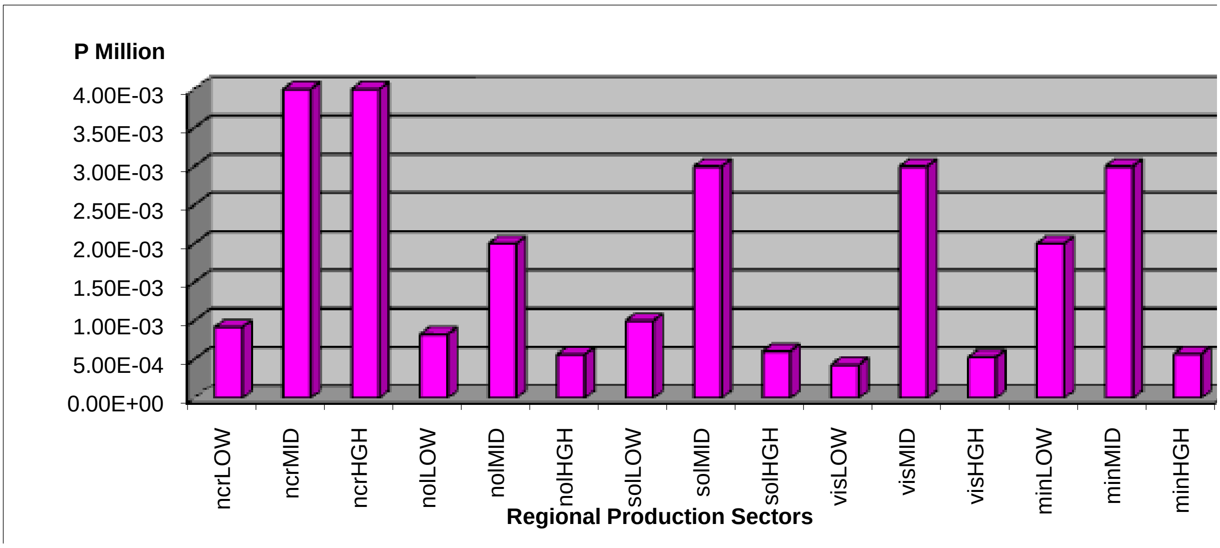

Figure 2 - Change in Welfare Levels Across Regional Income Groups

Comparative Analysis of Welfare Impact Across Transport Mode

Based on the graph below, it is obvious that land transport mode has the highest impact on welfare across all income groups in the Philippines. The water transport mode is second; but the disparity between welfare effects of investing in land transport services and water transport services in terms of absolute level is large.

It is interesting to note that in the case of Mindanao; the lowest income group had higher welfare gains than the middle income group when water transport mode experienced a 10% increase in capital

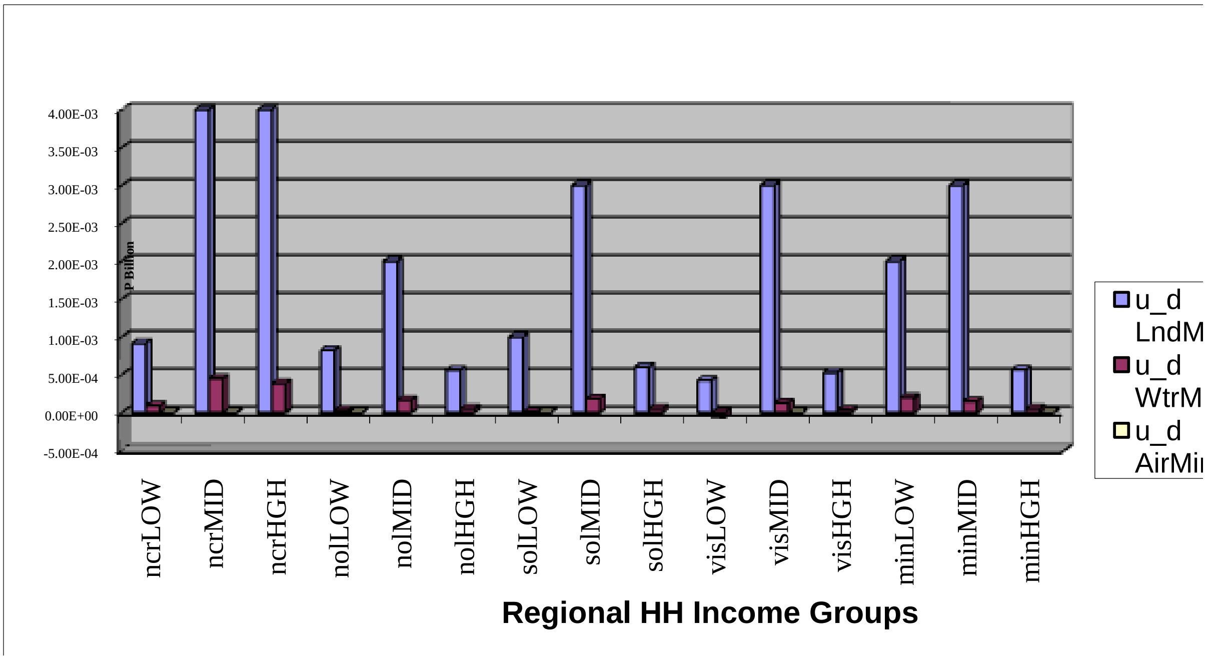

Figure 3 - Comparative Analysis of Welfare Impact of Different Transport Modes

Impact on Gross Output

Change in Gross Output Due to 10% Increase in Capital in Mindanao Land Transport Services Sector

While additional capital was infused in Mindanao land transport services sector, the highest gain in output was in the NCR – industry and other services sector Southern Luzon (SOL) industry followed. The Mindanao sectors namely – Mindanao industry, other services and agriculture were next in rank. This may be due to the strong interlinkage between NCR industrial sector which is a major end- user of agricultural output of Mindanao. Stimulating the Mindanao economy has strong spillover effects in Luzon regions which have initially high output levels.

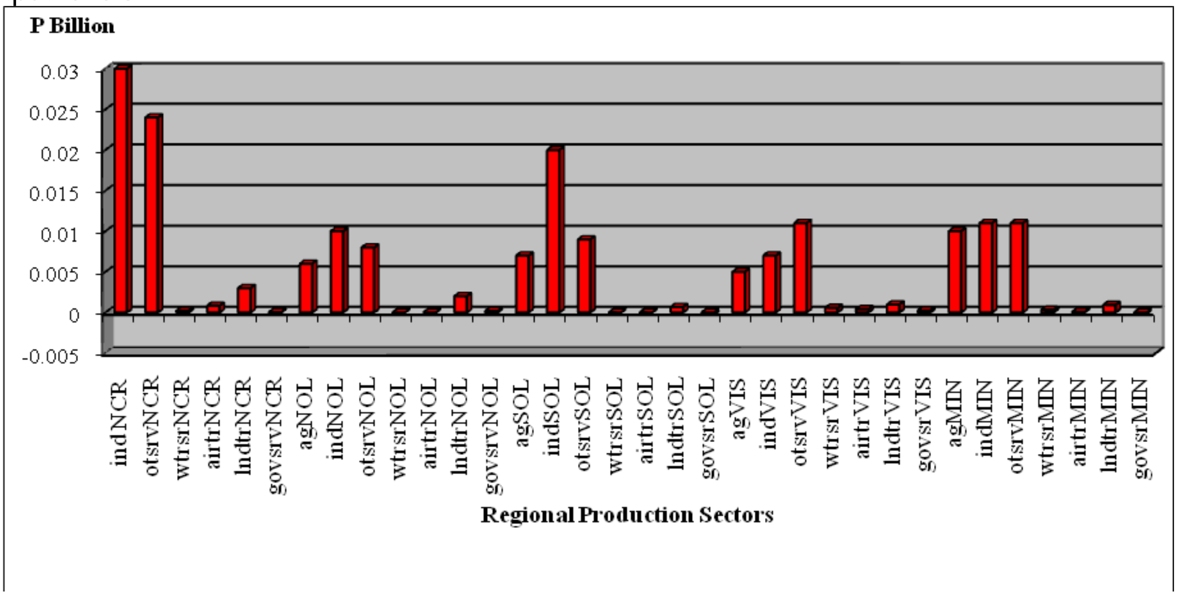

Figure 4 - Change in Gross Output

Comparative Change in Gross Output Due to 10% Increase in Capital in Three Modes of Transport in Mindanao

In terms of relative output change, it is the land transport sector in Mindanao which can trigger positive change in output in interconnected regions namely NCR , Southern Luzon and the Visayas. The infusion of capital into water transport mode in Mindanao showed relative increments in productivity across regions; whereas doing the same in air transport sector in Mindanao had comparatively negligible impact on output.

While the substantial gains in gross output were registered in the Mindanao agriculture, industry and other services sector; the magnitude of increase was second only to the National Capital Region. This holds for both ten percent capital increase in the Mindanao land transport and water transport infrastructure improvement.

Another outstanding result is that the industrial sector in Southern Luzon is a major beneficiary of the occurrence of the exogenous shock. This means that there is a great deal of intermodal movement of goods from Southern Luzon to Mindanao and vice-versa which could account for this result.

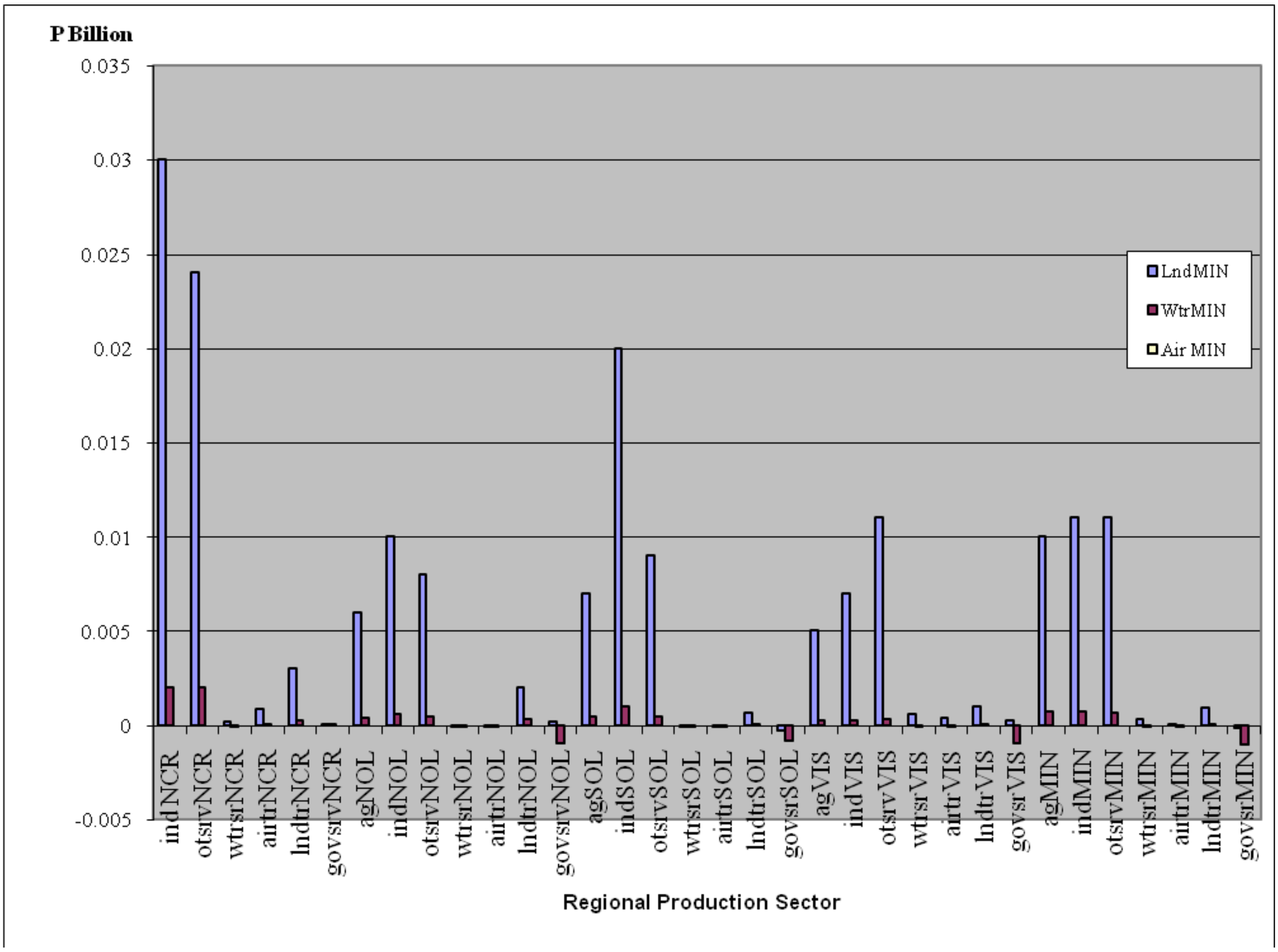

Figure 5 - Comparative Change in Output in Different Transport Modes

Impact on Transport Intensity

The exogenous shock generated the usage of more transport inputs in the services sector across all five regions. This proves the high dependence of the service sector on the transport sector. The Mindanao other services sector had the highest increment in transport intensity, next to the industrial sector in NCR. The strength of industrial linkage between the National Capital Region, Southern Luzon and Mindanao is proven by the first ranking of NCR industry and fourth ranking of SOL industry in terms of change in transport intensity. Another significant finding is that the industrial sector in NOL and MIN plus the MIN agricultural sector were among the top ten sectors which used more transport inputs relative to non-transport inputs.

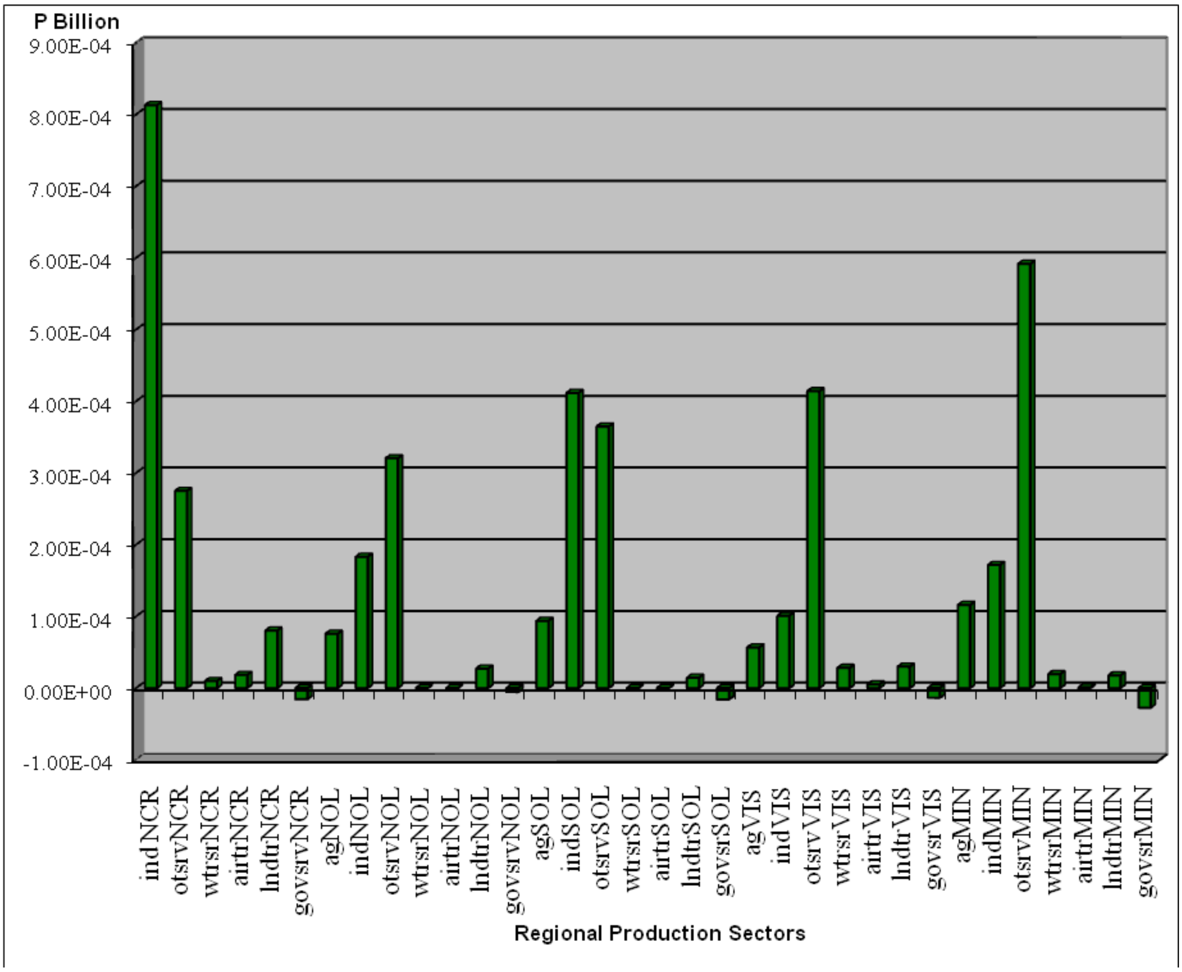

Figure 6 - Change in Transport Input

Impact on Labor Income

The table below shows the impact on income distribution of a 10% increase in capital in the Mindanao land transport services sector. The gain to the Mindanao region is reflected in the fact that the middle income group in Mindanao had the second highest increase in labor income after the NCR middle income group. The low income group in Mindanao ranked number 8. All the other middle income groups across the five regions belong to the top ten income classes with the highest increment. The income groups with their respective ranks are – SOL middle income group(rank no. 4), VIS middle income group (rank no. 5) and NOL middle income group (rank no. 6). It is interesting to note that the following low income groups benefited from the exogenous shock – SOL low income group (rank no.7), NCR low income group(rank no. 9), NOL low income group (rank no. 10) and VIS low income group (rank no. 11).

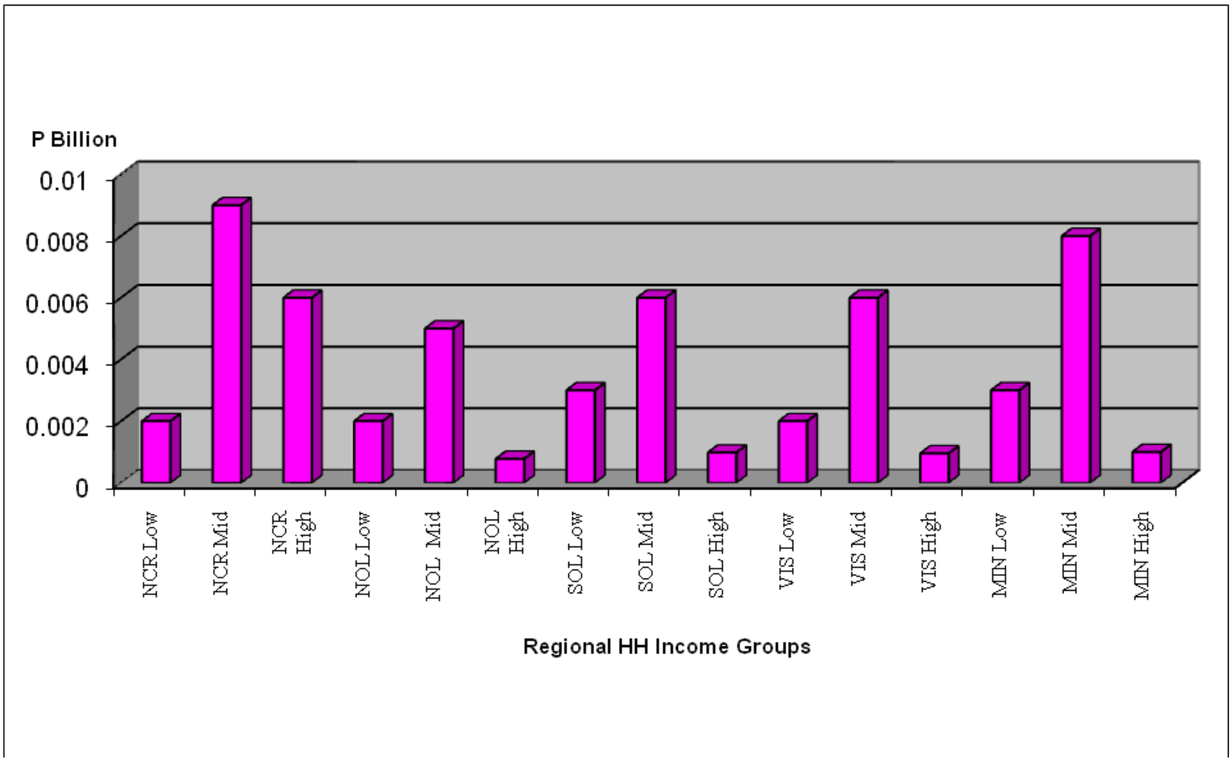

Figure 7 - Change in Labor Income

CONCLUSION

The foregoing discussion underscores the importance of having a general equilibrium framework with a transport sector, in analyzing the welfare effects of an exogenous shock in regional economy of Mindanao. The simulation scenario assumed a 10 % increase in capital input in the Mindanao land transport services sector.

In terms of welfare effect and income distribution, infusion of more capital into the land transport sector had far better impact than alternative modes of transport like water transport mode and air transport. An example of this would be investment in more technologically advanced road network and railway system within Mindanao. The middle income group in Mindanao registered big gains in terms of equivalent variation units and labor income. The Mindanao low income group was next. Across the four other regions, the middle income groups followed by the low income groups experienced significant gains in welfare and labor income. In the case of additional capital infusion into air transport mode, the effect on welfare was negligible.

The strong interregional impact of the exogenous shock is manifested in the output effect and transport intensity effect. The industrial sector in NCR, SOL and VIS registered significant gains in gross output. Within Mindanao, the sectors of agriculture, industry and other services registered significant gains.

The high transport intensity of the services sector across all five regions is documented by the shift in more transport inputs vis-à-vis non-transport inputs in such sector.Investment in Mindanao land transport services also increased usage of transport inputs in the agricultural and industrial sector in Mindanao.

In the end, the allocation of more government funds towards improvement of land transport infrastructure in Mindanao vis-à-vis other transport mode infrastructure is a viable policy direction to enhance overall social welfare in the region and in the rest of the Philippines.

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APPENDIX

Legend for Household Sector

ncrLOW	Low-income household in the National Capital Region
ncrMID	Middle-income household in the National Capital Region
ncrHIGH	High-income household in the National Capital Region
nolLOW	Low-income household in Northern Luzon
nolMID	Middle-income household in Northern Luzon
nolHIGH	High-income household in Northern Luzon
solLOW	Low-income household in Southern Luzon
solMID	Middle-income household in Southern Luzon
solHIGH	High-income household in Southern Luzon
visLOW	Low-income household in Visayas
visMID	Middle-income household in Visayas
visHIGH	High-income household in Visayas
minLOW	Low-income household in Mindanao
minMID	Middle-income household in Mindanao
minHIGH	High-income household in Mindanao

Legend for Production Sector

indNCR	industry sector in the National Capital Region
otsrvNCR	other services sector in the National Capital Region
wtrsrvNCR	water transport services in the National Capital Region
airtrNCR	air transport services in the National Capital Region
lndtrNCR	land transport services in the National Capital Region
govsrvNCR	government services in the National Capital Region
agNOL	agriculture in Northern Luzon
indNOL	industry sector in Northern Luzon
otsrvNOL	other services sector in Northern Luzon
wtrsrvNOL	water transport services in Northern Luzon
airtrNOL	air transport services in Northern Luzon
lndtrNOL	land transport services in Northern Luzon
govsrvNOL	government services in Northern Luzon
agSOL	agriculture in Southern Luzon
indSOL	industry sector in Southern Luzon
otsrvSOL	other services sector in Southern Luzon
wtrsrvSOL	water transport services in Southern Luzon
airtrSOL	air transport services in Southern Luzon
lndtrSOL	land transport services in Southern Luzon
govsrvSOL	government services in Southern Luzon
agVIS	agriculture in Visayas

indVIS	industry sector in Visayas
otsrvVIS	other services sector in Visayas
wtrsrvVIS	water transport services in Visayas
airtrVIS	air transport services in Visayas
lndtrVIS	land transport services in Visayas
govsrvVIS	government services in Visayas
agMIN	agriculture in Mindanao
indMIN	industry sector in Mindanao
otsrvMIN	other services sector in Mindanao
wtrsrvMIN	water transport services in Mindanao
airtrMIN	air transport services in Mindanao
lndtrMIN	land transport services in Mindanao
govsrvMIN	government services in Mindanao