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Core-Periphery Relations and Urban Transport Infrastructure Investment

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Abstract : This paper attempts to test empirically whether a five percent additional capital infusion to land transport services sector in the National Capital Region reinforces center-periphery spatial configuration in a developing economy like the Philippines. The study captures the impact of such capacity build-up in terms of changes in interregional flows, regional welfare and output. The financing of such transport capacity enhancement is through an equivalent amount of government expenditure which is funded by foreign transfer payments like official development assistance funds. A transport-oriented spatial general equilibrium model is presented based on a five region social accounting matrix. Results indicate that while absolute gains in welfare and output still go to National Capital Region, the enhanced interregional flow of goods and services creates significant spillover effects in periphery regions which are located in Southern Philippines namely, Visayas and Mindanao**.**

Key Words*: urban transport infrastructure, center, periphery, spatial general equilibrium*

1. INTRODUCTION

The concentration of urban transport infrastructure investment in the National Capital Region (NCR) during the post-war period was one of the factors that promoted huge disparities in regional economic performance between NCR and the rest of the Philippines (ROP) . At that time, a center periphery relationship existed with NCR as the center of economic activities and the rest of the other regions were peripheral areas. Key cities that comprised the NCR then became prime cities in the entire Philippine archipelago. (Pernia et al: 1983) The location of urban transport infrastructure investment played a critical role in shaping the hierarchy of cities which evolved from that time up to the present within a region and within the nation as well.

However, from the mid 70s up to the present, development efforts are geared towards regional dispersal of industries and economic centers in the Philippines. This allowed other regional centers to evolve with cities like Cebu, , Iloilo, Bacolod, Davao, Zamboanga, Cagayan de Oro, San Fernando, Laoag, Tueguegarao, rising to prominence
.
Given the above, this paper attempts to test whether infusion of additional capital inputs to land transport services sector in NCR leads to further narrowing of gap between NCR and the four other regions in rest of the Philippines namely Northern Luzon, Southern Luzon, Visayas and Mindanao. Financing of urban land transport is through official development assistance funds

given by a foreign government to the Philippines. It aims to present a spatial general equilibrium model with a transport sector .This will be used to analyze the impact of previously mentioned exogenous shock on interregional flows , regional macroeconomic variables and interregional equity. Empirical results. which show the extent of spatial interaction among the regions will then be presented.. The last part will summarize the results and conclude with a policy direction.

2 CURRENT SPATIAL DISTRIBUTION OF ECONOMIC ACTIVITIES

At present, economic activity is highly concentrated in the National Capital Region (NCR).Philippines. It has been the leading region because of its importance as the economic, social, cultural, educational and political center of the Philippines. NCR contributes around 31% of total gross domestic product, has around 10 million population base with 2.25% annual population growth rated and has an average gross regional product growth rate of 7.12% . (National Statistical Coordination Board : 2006) Given such, it is imperative that we look into the pattern of growth of the NCR and how it has affected the distribution of economic activity across the Philippines.

The growth of NCR in recent years has been uneven （NEDA: 2004） Lately , unique population movements are taking place. According to urban planner, Arturo Corpuz, there are some growth characteristics of NCR which contradict popular perception. Using centrographic measures of population movement, Corpuz asserts that rapid population increases are taking place in its peripheral cities and slow or even negative growth is taking place in west-central part (including the city of Manila) of NCR . He attributes the eastward movement of population in the prime region to lack of expansion opportunities along the western bay area, the attraction of the North Luzon Expressway (NLEX) and South Luzon Expressway (SLEX) transportation corridors and the relatively constrained eastern area. According to Corpuz, NCR and adjacent provinces of Laguna, Cavite, Bulacan and Rizal are functioning as a single integrated region. So, NCR is dispersing by itself..(Corpuz : 2006). There is no need for government economic dispersal policies. Furthermore, World Bank economists consider this kind of urban sprawl as less expensive . This is characterized by high densities, the continued dominance of mass transit, the continuous slower growth in the core metropolitan area (not just the central part of NCR) and lower infrastructure investments than targeted levels. (World Bank : 2005). On the other hand, economists at the Philippine government planning agency called National Economic Development Authority (NEDA), believe that government should disperse economic activity by building transport infrastructure projects outside the National Capital Region.. This is indicated in the Medium Term Development Plan (2004-2010) of the government as far as infrastructure plans are concerned. These include the following plans : (1) Develop roads and rail systems that will decongest Metro Manila and develop Clark-Subi**c** (Northern Luzon) as the best logistics and services hub in the region; (2) establishment of new centers for government, business and housing in non-NCR regions- (Luzon, Visayas and Mindanao). The central offices of the following government agencies shall be located outside NCR .For example, the Department of Agriculture will be placed in Mindanao; the Department of Public Works & Highways in Bicol (Luzon); the Department of Transportation & Communication in Clark (Northern Luzon); the Department of Tourism to be located in Cebu (Visayas) and the Department of Land Reform in Davao (Mindanao). Included in the medium-term development plan is the plan to make Clark in Northern Luzon as the new government center . (NEDA: 2004)

To put into perspective the center-periphery relationship which has evolved between the National Capital Region and the rest-of-the-Philippine regions, a discussion of the ideal type of spatial planning will now commence.

3. IDEAL FORM OF SPATIAL PLANNING FOR TRANSPORT INFRASTRUCTURE

The spatial distribution of economic activity within a country, or within a region is determined by spatial competition. This initially favors areas with locational advantage which includes rich natural resource base, strategic geography within the economic network and highly skilled population base.

The ideal form of spatial planning for transport infrastructure should be based on comparative advantage of each region. Efficiency considerations can play an important role in determining the location of transport infrastructure investment. This can be complemented by social infrastructure which is meant to address the equity concern by providing safety nets and is meant to equalize opportunities across regions. Social infrastructure includes schools, hospitals, housing which can be set up in disadvantaged regions.

Another point in the discussion of ideal spatial planning is reconciling the conflict between attainment of national and regional efficiency. Proper spatial planning can minimize the " seeming " conflict between between national and regional efficiency goals as far as location of transport infrastructure investment in the Philippines is concerned. National government efficiency goals can complement regional efficiency goals since it is national government which facilitates transfer of resources from the affluent regions to the poor regions through public finance measures (taxation, subsidies, transfers). This improves macroeconomic performance of both the high-income region like NCR and also low-income region like Mindanao. However, political reality in the Philippines seems to suggest that national efficiency concerns sometimes are overlooked in favor of regional efficiency considerations by members of Congress who approve the infrastructure budget. There is a tendency to lobby for bigger share of transport infrastructure budget for respective regional turf of each lawmaker**.**

4. PRESENTATION OF MODEL

4.1 DATABASE

The benchmark data are taken from a five-region social accounting matrix constructed by the authors for the Philippines, using 1994 Philippine interregional input-output data. (Dakila and Mizokami :2006). The delineation of regions is based on the archipelagic geography of the Philippines. The disaggregation into seven sectors (with three transport sectors – water, air, and land mode is done to enable the researcher to look into the impact of a change in transport capacity on alternative modes of transport and non-transport sectors. Households are divided into three income groups; namely low-income households, middle-income households and high-income households. 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 pesos and above annually. All the households earning income between the regional poverty threshold and the highest income bracket in the Family Income and Expenditure Survey (250,000 pesos and above) are classified as middle income households. The derived interregional flows from this secondary database, match the direction and relative magnitude of flows estimated JICA and Department of Transportation team using survey results.(JICA& DOTC: 2004)

4 .2 ASSUMPTIONS OF MODEL

The discussion now presents the model used to estimate the impact of capital infusion within the NCR land transport services sector .

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. (4) In this model, adjustment to equilibrium is implemented by specifiying 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 36 markets . This is composed of thirty-six product markets of each the aforementioned five regions with seven production sectors each (except NCR which has six sectors due to negligible agricultural sector), one capital market and one labor market.

When a national SAM is split into regional SAMs (RSAM), the flow of income from production units to consuming units is given a spatial dimension. In line with this objective, a five-region SAM was constructed in order to analyze ripple effects of particular exogenous shocks. This RSAM is presented in detail in Dakila, C. and Mizokami, S. (2006). The main data source for the study is the 1994 five-region Philippine inter-regional input-output (PIRIO) table, which regrouped the 15 administrative regions of the country in 1994 (now 17) into five greater regions according to geographic proximity (Secretario: 2002). This regional classification is carried over to the present paper.

4.3 DESCRIPTION OF THE MODEL

The model delineates parameters which were calibrated directly from the cell entries of the constructed five-region SAM. Some examples of these are the expenditure shares of consumptions found in Cobb-Douglas utility function, the Leontief technical coefficients, and the Cobb-Douglas transport input payment share out of total output. No parameters were borrowed from econometric studies. The five-region SAM was compiled based on the Philippines interregional input-output table previously constructed. The interregional flows derived from five-region SAM were verified to be similar to those in survey of interregional freight and passenger flows conducted by JICA and DOTC team in the Philippines.(Dakila & Mizokami : 2006) It 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. To produce a transport –oriented computable general equilibrium model, a three- nested production function is estimated. Transport inputs are isolated in the middle stage of a three-level production function which is of Cobb-Douglas & Leontief type. At the first stage, capital and labor are combined to produce value-added, using a Cobb-Douglas production technology. 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. 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. A more detailed disaggregation of transport sector is delineated – namely water transport services sector, air transport services sector and land transport services sector. 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.

The model presented below has been applied in various papers of Dakila and Mizokami which address transport issues related to congestion, environmental impact, welfare effects and effect of technological change in transport sectors in the Philippines. It is a simple representation of an economic system with assumption of perfect competition in goods and factor markets and constant returns to scale in production. Also, it is recognized that recent advances in spatial computable general equilibrium (SCGE) modeling have incorporated such assumptions as increasing returns to scale, agglomeration economies , imperfect competition in the model. Given that SCGE modeling is at its infancy stage in the Philippines, these modifications will be undertaken in future studies.

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. Since the model uses macro level data, important micro considerations as in reduction in travel time are level are left out. Foreign trade sector and government sector expenditures are exogenized.

Table 1 Sectoral Structure of the Model

Production sectors	Regions	Households
Agriculture (Ag) Industry (Ind) Water transport (WtrSrv) Land transport (LndTr) Air transport (AirTr) Other services (OtSrv) Government (Gov)	National Capital Region (NCR) Northern Luzon (NOL) Southern Luzon (SOL) Visayas (VIS) Mindanao (MIN)	Low income (Low) Middle income(Mid) High income (High)

4.3.1 . 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:

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

where δ_{ih} is the elasticity of the utility of the h^{th} household with respect to consumption of the i^{th} good. 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 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 calculated as 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 we obtain total income per household type as:

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

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:

$$Yd_h = Y_h \left(1 - \tau_h\right) \tag{3}$$

where Y_d is disposable income and τ_h is the direct tax rate imposed on household h. Note that the summation now runs within 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

$$\sum_i pd_i C_{ih} = c_h Yd_h \tag{4}$$

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 yield the following consumption demands for each commodity by each household type in each region:

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

4.3.2 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. This specification of the Cobb-Douglas function assumes constant returns to scale. Capital is assumed to be immobile across sectors while labor is mobile. In this paper, the exogenous shock which is 5% capital infusion into NCR land transport services sector, is introduced at this bottom level of the production function. It takes the form of an improvement in road capacity via road widening and extension in the National Capital Region **.**

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

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

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, namely, water, air and land transport. This specification allows substitutability between the various transport modes. 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. At the second stage, as noted above, value-added is combined with other intermediate non-transport inputs in a fixed coefficients (Leontief) technology to produce output net of transport. Finally, the top stage determines the optimal combination of transport inputs to deliver output to the region of destination. Then for commodity j, the optimization problem is

Maximize

$$\Pi_j = pd_j X_j - \sum_i pd_j Mat_{i,j} - pva_j V_j \tag{10}$$

subject to

$$X_j = B_j X_j^{NT\,\beta_{1j}} W_j^{\beta_{2j}} A_j^{\beta_{3j}} La_j^{\beta_{4j}}$$

$$X_j^{NT} = \min\left[X_{1j}/a_{1j}, \ldots X_{NTj}/a_{NTj}, V_j/a_{V,j} \right] \tag{11}$$

$$V_j = A_j K_j^{\alpha_j} L_j^{1-\alpha_j}$$

where Π is total profits, Mat_{ij} is the matrix of intermediate inputs of each commodity into commodity j, V represents value added, and pva is its corresponding price.

At the top production level, the corresponding first order conditions (FOCs) for profit maximization are

$$pd_i * \frac{\partial X_i}{\partial X^{NT}{}_i} = p_{NT} \text{ or } pd_i \beta_{1i} \frac{X_i}{X^{NT}{}_i} = p_{NT} \tag{12}$$

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

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

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

There are no corresponding FOCs for the second level production stage, since this is characterized by fixed coefficients technology, and marginal conditions are not defined. However, 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 in Eqn (7).

At the bottom level, profit maximization entails choosing the least cost combination of labor and capital to produce the required value-added. Since capital is immobile, of particular interest is the first-order condition for labor, which is

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

$$pva_i \left(1-\alpha_i\right) \frac{V_i}{L_i} = w_i \tag{13}$$

4.3.3 Government and the External Sector.

The model incorporates a national government sector, i.e., the behavior of local 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:

$$Tar_i = tar_i \left(m_i\right) \tag{14}$$

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:

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

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

$$T_{Direct,h} = Y_h - Yd_h \tag{16}$$

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

4.3.4 Investment-Saving Balance

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

$$S_h = \Sigma_h \left(Yd_h - C_h \right) \tag{17}$$

We introduce a balancing factor (ϕ) to account for any discrepancies between measured savings and investments.

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:

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

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

$$S_{TOTAL} = S_h + S_{GOV} + S_{FOR} \tag{19}$$

Conceptually, total savings should equal total investment. As noted previously, 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:

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

4.3.5 Demand

Total intermediate demand for commodities by the firm arises from its maximization of profits subject to the three-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.

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

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

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. This equilibrium condition together with (11) determines pva. We turn to this in greater detail in the section on prices.

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

$$\mathrm{Mat}_{i,j} = a_{ij} X_j^{NT} \tag{21}$$

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 in previous section . Although for simplicity, firms' investment demand are 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:

$$Q_i = \sum_j \mathrm{Mat}_{i,j} + \sum_h C_{h,i} + I_i + G_i + \mathrm{Exports}_i \tag{22}$$

4.3.6 Prices and Equilibrium

For any given employment level, equilibrium entails that the corresponding level of production should equal the demand forthcoming at the employment level. This requirement, together with the first order conditions for profit maximization by the firms in each region, 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:

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

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

$$AC_i = \frac{\Sigma_j pd_j \mathrm{Mat}_{j,i} + pva_i V_i}{X_i} \tag{24}$$

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

$$\Omega = \Sigma_i \left(pq_i * ES_i^{\,2}\right) \qquad (26)$$

In equilibrium, therefore, the unit cost is divisible into three parts: (1) $\frac{\sum_j pd_j q_{ji}}{X_i}$, 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 $\frac{w_i L_i + r_i K_i}{X_i}$ is the cost of value added per unit of X.

4.3.7 Equilibrium Condition

$$Y = C + I + G + X - M \qquad (27)$$

Where Y : aggregate supply
C: total consumption expenditures of the national economy
I: total investment expenditures of the national economy
G : total government expenditures of the national economy
X: total purchases of locally-made goods by foreign sector
M : total purchases of foreign-made goods by domestic residents of nation

5 .EMPIRICAL RESULTS

The following results indicate the direction and magnitude of impact of enhanced road capacity of urban transport infrastructure in the National Capital Region of the Philippines

5.1 IMPACT ON INTERREGIONAL FLOWS

Within the National Capital Region, all trade flows with origin and destination classified as water transport services sector and air transport services sector experienced a decline in magnitude. This indicates that substitution in favor of more intensive use of land transport mode relative to water and air transport mode took place. The industrial sector in adjacent regions like Southern Luzon and Northern Luzon experienced substantial gains in trade as evidenced by the increase in interregional flows emanating from and going to these two regions. Interregional flows originating from agriculture sector in Mindanao, Southern Luzon and the Visayas benefited from

NCR land transport infrastructure improvement as they registered the biggest increment in trade flows. In terms of other services sector, the regions of NCR, Visayas and Southern Luzon had positive increments in interregional flows as origin and destination sectors.

The figure below shows the general direction of changes in interregional flow of goods and services after the introduction of the exogenous shock. The sectors with visible bar graphs are the origin-destination sectors which had the highest interregional trade volume after the occurence of the exogenous shock. It can be deduced from the these results that while the center-periphery configuration remains, the spillover effects of additional urban transport infrastructure in the rest-of-the Philippines are of significant importance. Adjacent regions like Southern Luzon and Northern Luzon benefited and even as regions as far down as Mindanao. The extent of interconnection reinforced by the additional provision of urban land transport infrastructure in National Capital Region will make the lagging regions catch up with the lead region.

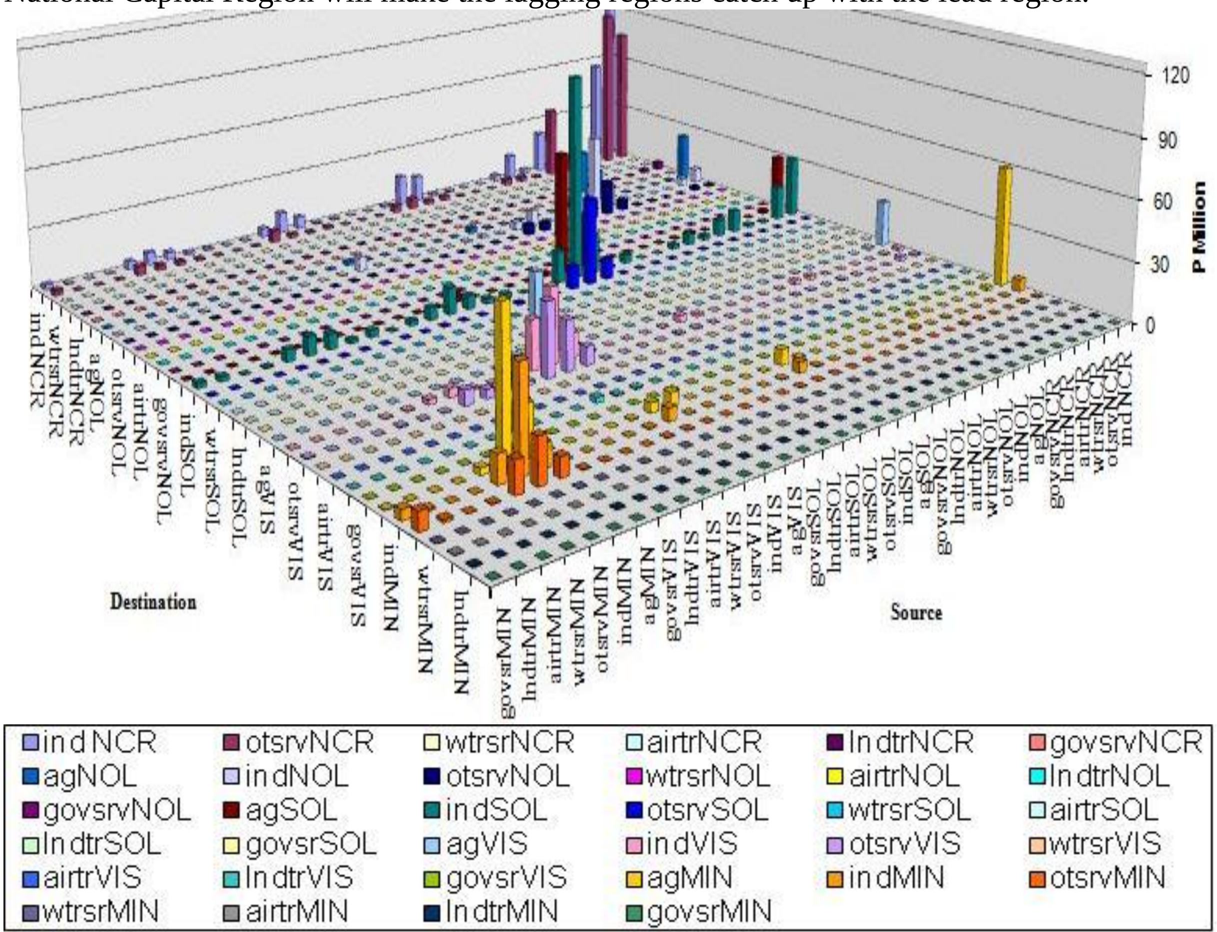

Figure 1. Change in Interregional Flows

5.2 IMPACT ON GROSS OUTPUT

The effect of additional urban land transport infrastructure in NCR resulted in productivity increases in industrial and agricultural sector of adjacent region – Southern Luzon and agricultural sector in Mindanao. This reflects the strong interregional linkage between NCR and Southern Luzon and Mindanao. However, the highest increase in output was in transport intensive sectors located in NCR namely industry and other services sector. The intermodal transport routes which transport industrial goods coming from Southern Luzon and Mindanao to

NCR and the increased demand for output of industry and services within NCR and adjacent Southern Luzon could explain why these two sectors enjoyed highest level of output. The substitution away from production of air transport services was reflected in decline in gross output of such sector in almost all regions. Another manifestation of the substitution effect is low increase in output of water transport services sector in all five regions. The figure below indicates such outcomes**.**

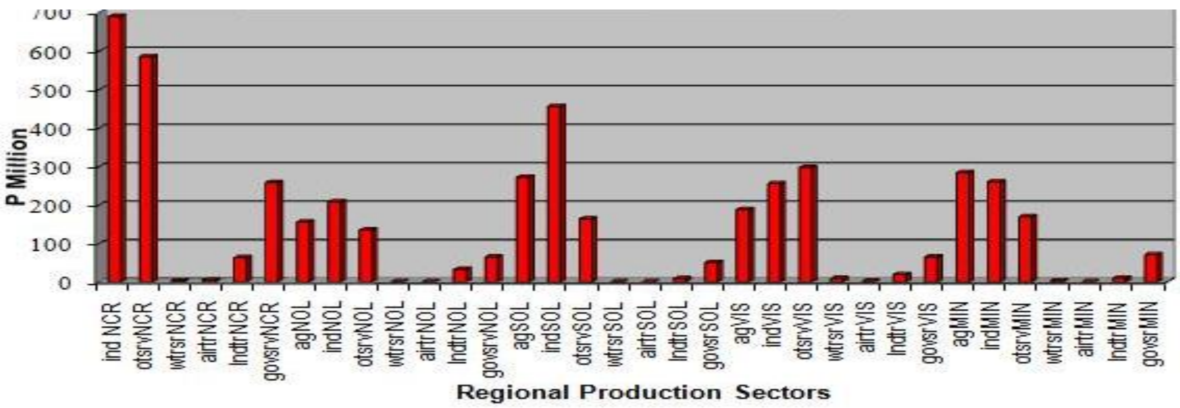

Figure 2. Absolute Change in Regional Gross Production Output

5.3 IMPACT ON WELFARE

Welfare is measured in terms of equivalent variation. (EV). EV is the change in money income that would put the household on the new indifference curve at the old prices before the exogenous shock. The change in price is brought about by the exogenous shock in the form of capital infusion into the land transport infrastructure sector.

5.3.1 CHANGE IN ABSOLUTE LEVELS OF WELFARE

The biggest increase in welfare as measured by change in equivalent variation was experienced by the middle income group in all four regions -NCR, Visayas, Mindanao and Southern Luzon. This complements earlier results since the middle income group are owners of land transport vehicles and therefore are constant users of land transport infrastructure services. Middle income groups which use intermodal combination of land and water transport services stand to gain more utility in terms of less travel time and less disutility in moving from one point to another .This is an offshoot of the increased capacity in land transport services in NCR. The low income groups in Southern Luzon, Visayas and Northern Luzon had the sixth , seventh and ninth highest increase in welfare. It is also significant to note that the group with the highest welfare gain , the middle income class in NCR was double that of the Visayas and Mindanao middle income group . The intraregional equity effect can be seen in the fact that the high income group in Southern Luzon, Northern Luzon, Mindanao and Visayas experienced the smallest increase in welfare. The figure below shows the aforementioned results.

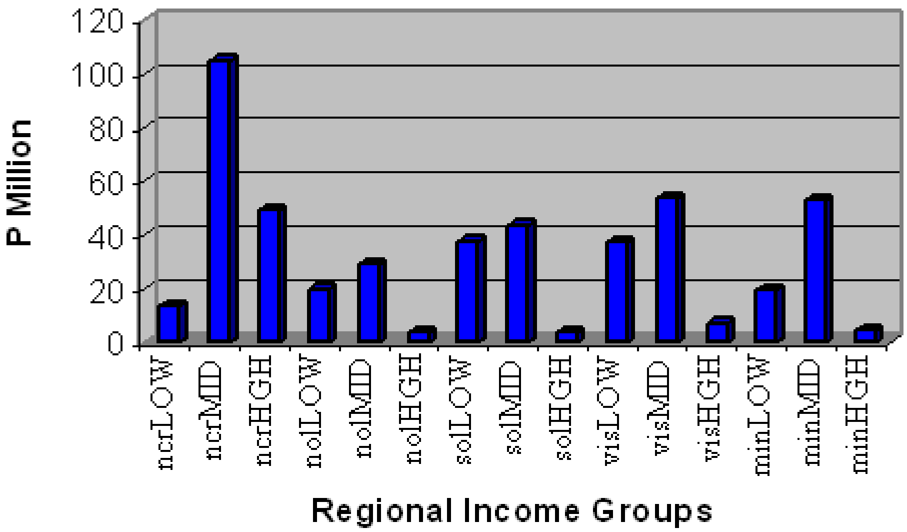

Figure 3. Absolute Change in Level of EV of Regional HH Income Groups

5.3.2 CHANGE IN RELATIVE WELFARE LEVELS

The narrowing of welfare differentials across income groups within regions and across regions can be deduced from the result indicated in the figure below. The low income groups in the Visayas and Southern Luzon had the biggest relative welfare gains despite the fact that the capital infusion took place in NCR land transport sector. The middle income groups in NCR , Visayas and Mindanao had the next highest welfare gains. The low income class in Northern Luzon followed.

These results indicate that low and middle income groups in other regions specially those in Southern Philippines, namely Visayas and Mindanao benefit from capital infusion in NCR. There is a very prominent effect in terms of relative change in welfare of low income class in the Visayas and Southern Luzon. In fact, the low income groups of aforementioned regions had the biggest increment in relative welfare after the exogenous shock occurred, The middle income classes of Mindanao, Visayas and NCR had the next highest welfare gain.

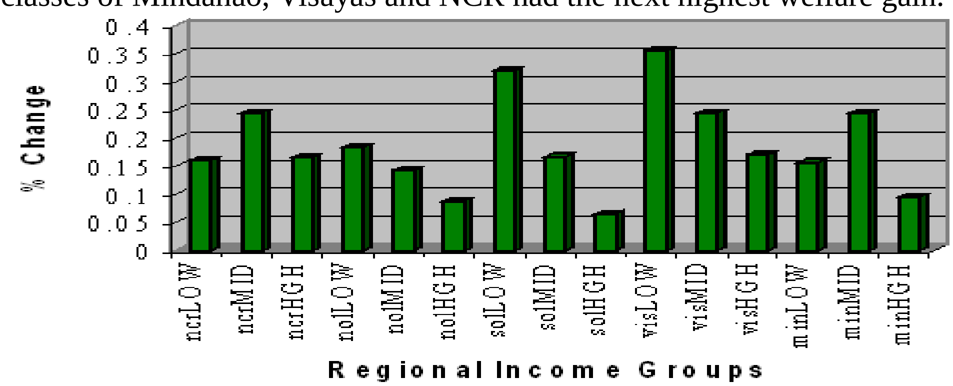

Figure 4. Relative Change in Level of EV of Regional HH Income Groups

6. CONCLUSION

The study demonstrates that there are significant spillover and equity effects of capital infusion in land transport services sector in the National Capital Region. It affects the spatial pattern of economic benefits, the value of economic benefits among industries and the distribution of benefits among income classes. The results also indicate that production sectors in adjacent region like Southern Luzon and even those in Southern Philippines composed of the Visayas and Mindanao benefited in terms of increased interregional trade flows and higher levels of output. Specific reference is made to the industrial and other services sector. Welfare gains in absolute terms went to middle income groups in almost all regions . But a significant finding is that in relative terms, the low income groups in non-NCR regions acquired the biggest welfare gain .

It also shows that allocation of resources in the prime region, NCR, can narrow the economic gap among regions in the Philippines. This is so because significant increases in output, welfare and interregional flows occured in the other four regions in the rest of the Philippines, specially Visayas, Mindanao and Southern Luzon after more capital was introduced in NCR land transport services sector.

Overall, the study indicates that the location of urban transport infrastructure investment is one factor which determines the spatial configuration of the Philippine economy and has a significant impact on narrowing interregional gaps in economic performance.

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