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A NATIONALLY-LINKED ECONOMETRIC MODEL FOR A PHILIPPINE REGION

by

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Abstract

A top-down Regional econometric model is presented for possible linkage to Philippine national models. The model is tried on the expenditure accounts of the National Statistics Coordination Board.

1. Introduction

Users of econometric forecasts and policy simulations who are concerned with regional issues and problems have been interested in generating regional estimates of production, employment, and other economic aggregates. Estimates of these aggregates on the national level are usually produced by national econometric models and policy makers want to know their regional implications. This paper presents an econometric model for a Philippine region, Northern Mindanao, that could be linked to a national model and could serve as a prototype model for the other regions of the Philippines. It can be used to determine the regional impact of national policy.

2. General Description of the Model

The model presented in this paper is a top-down model, i.e., one that can be linked to a national model and the direction of causation is from the national model (top to the regional model (down). The national model generates values of economic variables which are fed as exogenous inputs to the regional model.

Top-down models were the first variety of regional econometric models that were constructed following Klein's (1969) suggestion for the specification of regional econometric models. (See also Klein and Glickman (1977)). They had the advantage of being easy to build and easy to attach in a consistent way to an existing national model. Their main disadvantage is the lack of feedback from the regional model to the national model. Despite this inadequacy, top-down models have been useful in forecasting and policy analysis (Milne et al. (1980); Crow (1973). Moreover, they are good starting points for building the type of regional econometric model that is becoming more widely used - the hybrid model or the top-down bottom-up model used. (For a good discussion of the various types of reginnal models, their problems and applications, see Adams and Glickman (1980).

The regional model presented here uses the expenditure accounts of the National Statistical Coordination Board. It will be linked to an existing national model - the NEDA-EPRS-Model - which also uses the same national accounts. The national model will be linked to the regional model via output, prices, interest rates, and government fixed investment. These links are shown in Figure 1 which also shows the relationships among the major regional variables.

3. List of Variables

3.1 Endogenous Variables

(The subscript j refers to the region)

CPI_j	consumer price index
$DINR_j$	disposable income in constant pesos
E_j	employment
ELG_j	local government expenditure in current pesos
$FCPR_j$	investment in private construction in constant pesos
GCE_j	national government consumption expenditure in current pesos
$GCER_j$	national government consumption expenditure in constant pesos
KCR_j	capital consumption
KR_j	capital stock
KRE_j	capital-labor ratio
LF_j	labor force
LT_j	local taxes
NT_j	national taxes in current pesos
P_j	Gross Regional Domestic Product (GRDP) deflator
$PCER_j$	personal consumption expenditures

$PGCE_j$	government consumption expenditrues (GCE) deflator
$PROC_j$	Gross Domestic Product (GDP) deflator, rest of the country outside of region j
Q_j	GRDP in current pesos
QOC_j	GDP, rest of the country outside region j, in current pesos
QR_j	GRDP in constant pesos
QRE_j	output-labor ratio
$QROC_j$	GDP, rest of the country outside region j, in constant pesos
$RESR_j$	residual variable
RLG_j	local government revenue in current pesos
$ROTH_j$	local revenues other than taxes
TT_j	total taxes in current pesos
TTR_j	total taxes in constant pesos
U_j	unemployment
UR_j	unemployment rate

3.2 Exogenous Variables

CPI^*	consumer price index, Philippines
CSR_j^*	change in stocks
DER_j	investment in durable equipment
$DUMCRI^*$	dummy for economic crisis (= 1 for 1984-1985; 0, otherwise
$FCGR_j^*$	investment in government construction in constant pesos
P^*	GDP deflator, Philippines
POP_j^*	population
Q^*	GDP in current pesos, Philippines
QR^*	GDP in constant pesos, Philippines
$TBILLR^*$	real 91-day treasury bill rate
$TREND^*$	time trend

4. Equations

4.1 The Behavioral Equations

4.1.1 Output

$$QRE_j = f(KRE_j, DUMCRI^*) \qquad (1)$$

Output is a function of capital and labor, i.e.,

$$QR_j = f(KR_j, E_j) \qquad (1a)$$

where QR_j, KR_j, and E_j are output, capital, and labor, respectively. Assuming a linear homogeneous production function f, we rewrite (1a) as

$$QR_j/E_j = f(KR_j/E_j,1) \qquad (1b)$$

or simply

$$QRE_j = f(KRE_j) \qquad (1c)$$

where $QRE_j = QR_j/E_j$
$KRE_j = KR_j/E_j$.

The dummy variables (DUMCRI*) is included to capture the effects of the economic crisis when the economy contracted successively for two years in 1984 and 1985.

4.1.2. Personal Consumption

$$PCER_j = f(DINR_j, POP_j^*, CPI_j) \qquad (2)$$

Real personal consumption expenditures ($PCER_j$) constitute the largest component of final demand, averaging 56.2 percent of Gross Regional Domestic Product of Region 10 during the period 1975-86. The specification follows a simple Keynesian formulation: consumption expenditures is a linear function of disposable income increases. At the same time, increases in population (POP_j) can bring about an autonomous rise in consumption the price variable (CPI ;expenditures in) is expected to lower consumption expenditure. By formulating personal consumption expenditure real terms, we have assumed that consumers do not have money illusion.

4.1.3. Investment

$$FCPR_j = f(DINR_j, TBILLR^*, DUMCRI^*(-1) \qquad (3)$$

Private construction (FCPRj) is explained by disposable income (DINRj), real interest rate ($TBILLR^*$) and the dummy for economic crisis ($DUMCRI^*$). The higher the income, the higher the level of private construction. The cost of financing construction is reflected by the real interest rate which is represented by the 91-day Treasury Bill Rate ($TBILLR^*$). Since the money market is largely a national market, it is assumed that the real interest rate is uniform for the entire country. The

lagged dummy for economic crisis (DUMCRI* (-1) captures the delayed effect of the economic crisis on private construction mainly due to existing contracts.

Investment in durable equipment (DER_j^*) is taken as exogenous since the data includes both the private and public components. The public component, which depends solely on the decisions of policy-makers, has made the data less amenable to model fitting. Government construction is also an exogenous variable since it is a policy variable. Change in stocks is taken as part of the residual defined in Equation 4.2.5.

4.1.4 Capital Consumption

$$KCR_j = f(QR_j, KR_j(-1) \quad (4)$$

Capital consumption (KCR_j) depends on the existing capital stock $KR_j(-1)$ and the intensity of economic activity represented by regional output (QR_j).

4.1.5 National Government Consumption

$$GCE_j = f(f(Q,POP_j) \quad (5)$$

National government consumption expenditure (GCE_j) is expected to rise as national income (represented by national output Q) rises. It will also increase with increasing population (POP_j^* as the government has to provide more services. Government expenditures are in current price since decisions on government budgetary allocation are made on this basis.

4.1.6 Employment and Labor Force

$$E_j = f(QR_j, TREND) \quad (6)$$

$$LF_j = f(POP_j^*) \quad (7)$$

The employment equation is a demand-for-labor model given a level of output (QRj). The trend variable captures the effects of technological changes that could affect the relationship between output and employment. Labor Force (LF_j) is given as a function of population (POP_j^*).

4.1.7. Taxes

$$NT_j = f(Q_j) \quad (8)$$

$$LT_j = f(Q_j) \quad (9)$$

The tax equations distinguish between national taxes and local taxes. National taxes (NT_j) and local taxes (LT_j) collected from the region are expressed as linear functions of the regional output (Q_j) since most taxes are based on the level of economic activity.

4.1.8 Regional Prices

$$P_j = f(P^*) \quad (10)$$

$$CPI_j = f(CPI^*) \quad (11)$$

$$PGCE = f(P_j) \quad (12)$$

Regional prices determined by national prices. Factors that affect prices on the national level (e.g., money supply, exchange rate, supply-demand) work their way through the national price variable determined by the national model. Consequently, the regional price level (P_j), represented by the Gross Regional Domestic Product (GRDP) deflator, is expressed as a function of the national price level (P^*), represented by the Gross Domestic Product (GDP) deflator. Similarly, the regional consumer price index (CPI_j) is estimated as a function of the national consumer price index (CPI^*).

A government consumption expenditure deflator ($PGCE_j$) is included in order to convert government consumption expenditure in current prices (GCE_j) to real government consumption expenditure ($GCER_j$).

4.1.9 Local Government Expenditures and Nontax Revenues

$$ELG_j = f(RLG_j, ELG_j(-1) \quad (13)$$

$$ROTH_j = f(QOC_j) \quad (14)$$

Local government expenditures have been found to be strongly related to local government revenues. Custom frowns upon local government deficits. However, financial assistance from the national government sometimes allows the local executive to circumvent this restriction. To allow for this more complex interaction,

both local government revenues and the lagged value of local government expenditures are used as explnatory variables. Local government revenues (RLG_j) are defined as the sum of tax (RT_j) and non-tax revenues ($ROTH_j$).

Local nontax revenue (ROTHj) is a function of the gross national product of the rest of the country outside region j (QOC_j) in current pesos. Because a large portion of nontax revenue flows from trade with other regions (e.g. port fees, etc.) this function performs quite well. Other formulations may, however, have to be explored for other regions with a different nontax revenue structure.

4.2. Indentities and Definitions

4.2.1. Gross Domestic Product of the Rest of the Country

$$QROC_j = QR^* - Qr_j \tag{15}$$

4.2.2. Gross Regional Domestic Product in Current Pesos

$$Q_j = (QR_j)(P_j) \tag{16}$$

4.2.3. Gross Domestic Product of the Rest of the Country in Current Pesos

$$QOC_j = (QROC_j)(PROC_j) \tag{17}$$

4.2.4. Government Consumption Expenditures in Constant Pesos

$$GCER_j = GCE_j/PGCE_j \tag{18}$$

4.2.5. Residual Variables

$$RESR_j = QR_j - (PCER_j + DER_j^* + FCER_j + FCGR_j^* + GCER_j + CSR_j^*) \tag{19}$$

4.2.6. Disposable Income

$$DINR_j = QR_j - TTR_j \tag{20}$$

4.2.7. Unemployment

$$U_j = LF_j - E_j \tag{21}$$

4.2.8. Unemployment Rate

$$UR_j = (LF_j - E_j)/LF_j \tag{22}$$

4.2.9. Total Local Taxes in Current Pesos

$$TT_j = NT_j + LT_j \tag{23}$$

4.2.10. Total Local Taxes in Constant Pesos

$$TTR_j = TT_j/P_j \tag{24}$$

4.2.11. Local Government Revenues

$$RLG_j = LT_j + ROTH_j \tag{25}$$

4.2.12. Price Deflator for GDP of the Rest of the Country

$$PROC_j = \frac{QR^*}{QROC_j} P^* - \frac{QR_j}{QROC_j} P_j \tag{26}$$

The price deflator $PROC_j$ is derived from the identity

$$(QR^*)(P^*) = (QROC_j)(PROC_j) + (QR_j)(P_j) \tag{26a}$$

where QR^* = real GDP of the country

P^* = GDP deflator

$QROC_j$ = real GDP, rest of the country outside region j

$PROC_j$ = GDP deflator, rest of the country outside region j

QR_j = real GRDP, region j

P_j = GRDP deflator, region j

Equation (26a) is then solved for $PROC_j$.

4.2.13. Gross Regional Domestic Product in Constant Pesos

$$QR_j = (QRE_j)E_j \quad (27)$$

4.2.14. Gross Domestic Capital Formation

$$KR_j = KR_j(-1) + DER_j^* + FCPR_j + FCGR_j^* + CSR_j^* - KCR_j \quad (28)$$

4.2.15. Capital-Labor Ratio

$$KRE_j = KR_j/E_j \quad (29)$$

5. Data and Estimation

The model used time series data for the period 1975-1986. The data were obtained from the NEDA Regional Development Staff and the National Statistical Coordination Board (NSCB). The NSCB has constructed the regional expenditure accounts for the period 1975-1986. The regional expenditure accounts include the following: personal consumption durable equipment, private construction, change in stocks, government consumption, government construction and net exports. Regional exports and imports could not be estimated because land-transported commodity flows are unrecorded. Consequently, net exports were obtained as a residual.

The equations were estimated by ordinary least squares. In a few equations, the Cochrane-Orcutt procedure was used to minimize the effects of serial correlation.

6. Estimation Model for Region 10 (Northern Mindanao)

6.1 Behavioral Equations

Explanatory Notes:

(1) Starred variables are exogeneous.

(2) Numbers in parenthesis below the regression coefficients are t-statistics

(3) R^2 is the adjusted coefficient of determination.

(4) DW is the Durbin-Watson statistic.

(5) SER in the standard error of regression.

(6) F is the F-statistic.

(7) Period is the period of estimation

(8) RHO is the serial correltion coefficient.

6.1.1. QRE10 = -546.71089 + 0.5295144 KRE10
(-0.672689) (6.3117697)

-158.86477 DUMCRI*
(-06817950)

$\bar{R}^2$ = 0.820974 SER = 255.6819 RHO = 0.7092842
DW = 1.202611 F = 14.7573 Period: 1977-1986

6.1.2 PCER10 = -1281.3646 + 0.766591 DINR10
(-2.4292836) (0.8126034

+ 1288.8404 POP10* - 154.73297 CPI10
(3.707172) (-2.7704823)

$\bar{R}^2$ = 0.981909 SER = 41.38932
DW = 1.616816 F = 200.0149 Period: 1975-1986

6.1.3 FCPR10 = -211.52581 + 0.1195357 DINR10
(-4.7682507) (11.095938)

-277.88767 DUMCRI*(-1) - 0.7284146 TBILLR*
(-17.812114) (-1.0224145)

$\bar{R}^2$ = 0.956785 SER = 21.09077 RHO = -0.268681
DW = 2.190894 F = 50.81556 Period: 1977-1986

6.1.4 KCR10 = 1.2792815 + 0.0287451 DR10(-1)
(0.747) (15.525)

+ 0.0204986 QR10
(1.921)

$\bar{R}^2$ = 0.942 SER = 14.980
DW = 0.675 F = 82.261 Period: 1976-1986

6.1.5. GCE10 = -1048.7541 + 0.001094 Q + 527.07921 POP10*
(-1.251194) (1.7670391) (1.43434985)

$\bar{R}^2$ = 0.71456 SER = 0.112183
DW = 1.660165 F = 26.03364 Period: 1977-1986

6.1.6 E10 = 0.0001841 QR10 + 0.0326654 TREND*
(7.2981375) (2.2736333)

$\bar{R}^2$ = 0.71456 SER = 0.112183
DW = 1.660165 F = 26.03364 Period: 1977-1986

6.1.7 LF10 = -1.0482764 + 0.7569593 POP10*
(-5.8674887) (12.168138)

$\bar{R}^2$ = 0.892235 SER = 0.067619 RHO = -0.4154916
DW = 2.118155 F = 38.25747 Period: 1977-1986

6.1.8 NT10 = 46.422546 + 0.0212162 Q10
(0.7680034) (6.6575718)

$\bar{R}^2$ = 0.797508 SER = 106.3158
DW = 1.722823 F = 44.32326 Period: 1975-1986

6.1.9. LT10 = 90.564682 + 0.0029981 Q10
(2.0629917) (1.5429368)

$\bar{R}^2$ = 0.488734 SER = 35.70948 RHO = 0.4904488
DW = 1.921256 F = 5.779641 Period: 1976-1986

6.1.10 P10 = 0.1765891 + 0.9755151 P*
(3.6625037) (80.946854)

$\bar{R}^2$ = 0.998324 SER = 0.075489
DW = 1.707580 F = 6552.393 Period: 1975-1986

6.1.11. CPI10 = 0.1152565 + 0.9745059 CPI*
(0.7632917) (16.894977)

$\bar{R}^2$ = 0.997591 SER = 0.049385 RHO = 0.6531001
DF = 1.026625 F = 2071.286 Period: 1976-1986

6.1.12. PGCE10 = 0.3400834 + 0.7504954 P10
(1.9401444) (17.390528)

$\bar{R}^2$ = 0.964792 SER = 0.263907
DW = 1.59432 F = 302.4305 Period: 1975-1986

6.1.13. ELG10 = 1.4144641 + 0.7733356 RLG10
(0.3446229) (7.7138398)

+ 0.2468642 ELG10(-1)
(2.2187064)

$\bar{R}^2$ = 0.998127 SER = 5.585167
DW = 2.076416 F = 2665.451 Period: 1976-1986

6.1.14 ROTH10 = -45.258762 + 0.0005363 QOC10

R2 = 0.901304 SER = 30.57887
DW = 1.692927 F = 101.453 Period: 1975-1986

6.2 Identities and Definitions

6.2.1. QROC10 = QR^* - QR10

6.2.2. Q10 = (QR10) (P10)

6.2.3. QOC10 = (QROC10)(PROC10)

6.2.4. GCER10 = GCE10/PGCE10

6.2.5. RESR10 = QR10 - (PCER10 + $DER10^*$ + FCPR10
+ $FCGR10^*$ + GCER10 + $CSR10^*$)

6.2.6. DINR10 = QR10 0 TTR10

6.2.7. U10 = LF10 - E10

6.2.8. UR10 = (LF10 - E10)/FL10

6.2.9. TT10 = NT010 + LT10

6.2.10. TTR10 = TT10/P10

6.2.11. RLG10 = LT10 + ROTH10

6.2.12. $$PROC10 = \frac{QR^*}{QROC10} P^* - \frac{QR10}{QROC10} P10$$

6.2.13. QR10 = (QRE10)(E10)

6.2.14. KR10 = KR10(-1) + DER10* + FCPR10 + FCGR10*
+ CSR10* - DR10

6.2.15 KRE10 = KR10/R10

References

Adams, F. Gerard and Norman J. Glickman. eds., **Modelling the Multiregional Economic System.** Lexington Books, Mass. (1980)

Crow, R.T., A Nationally Linked Regional Econometric Model. **Journal of Regional Science** 13 (1973)

Klein, Lawrence R., The Specification of Regional Econometric Models. **Papers of the Regional Science Association** 27 (1969)

Klein, Lawrence R. and Norman J. Glickman. Econometric Model Building at the Regional Level. **Regional Science and Urban Economics**, 7 (1977)

Milne, Willian J., F. Gerard Adams and Norman J. Glickman, A Top-Down Multiregional Model of the U.S. Economy, in F. Gerard Adams and Norman J. Glickman, eds., **Modelling the Multiregional Economic System** Lexington Books, Masc. (1980)