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A Top-Down Multiregional Econometric  
Model of the Philippines

by

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A TOP-DOWN MULTIREGIONAL ECONOMETRIC MODEL  
OF THE PHILIPPINES

*Rolando A. Danao*

**Abstract**

This paper presents the results of the estimation and historical simulation of a system of top-down regional econometric models for the regions of the Philippines. The structure of the model ensures that the regional forecasts will be consistent with the national forecasts. The dynamic historical simulations show that the predicted values of the national variables track their actual values quite well.

## A TOP-DOWN MULTIREGIONAL ECONOMETRIC MODEL OF THE PHILIPPINES

### 1. Introduction

This paper presents the results of the estimation and simulation of a system of regional econometric models for the regions of the Philippines. The specification of each regional model follows essentially the prototype model for a single region described in an earlier paper (Danao [1990]). The new features of the model include the introduction of a wage equation and the updating of data to 1987.

The model is of the top-down variety, (Klein [1979]; Milne et al. [1980]) i.e., each regional model is linked to a national model in which the direction of causality is from the national model (top) to the regional model (down). The main feature of the model is that its structure ensures that the regional forecasts will be consistent with the national forecasts. Each regional model is linked to a national model via output, employment, price, government consumption, private investment, and public investment. These links are shown in Figure 1 which also shows the relationships among the regional variables. The national model generates values of economic variables which are fed as exogenous inputs to the regional models. Each regional model determines gross regional product, regional personal consumption, regional private construction, regional employment, regional price and wage rate, regional taxes, and local government revenues and expenditures.

The simulation shows that the predicted values of national variables, taken as sums or averages of the values of corresponding regional variables

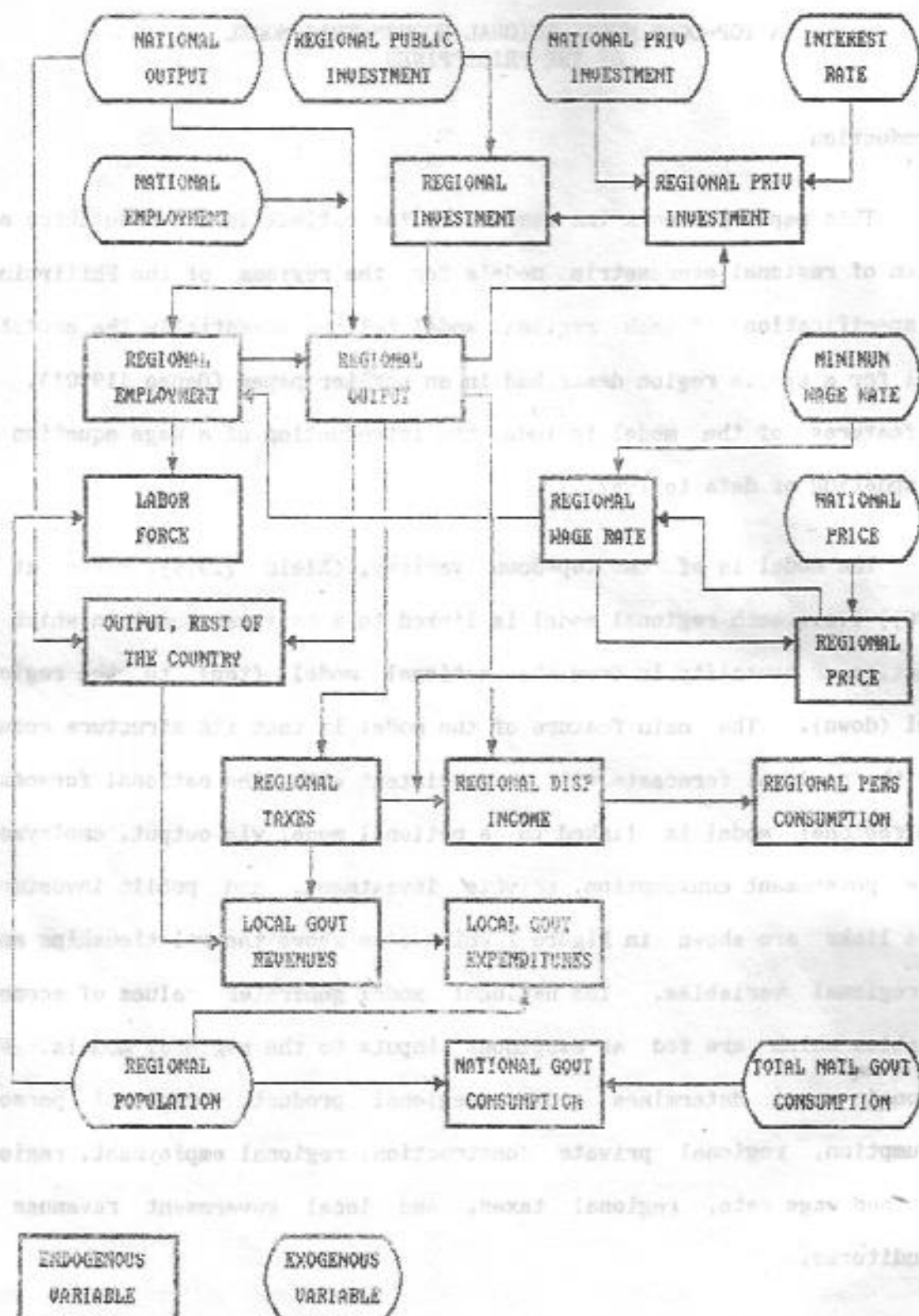


FIGURE 1. SCHEMATIC DIAGRAM OF THE MODEL FOR A SINGLE REGION

have very small errors. For example, the mean absolute percent errors for gross domestic product and employment are 1.32 and 2.49, respectively.

## 2. The Equations of the Model

### 2.1. List of Variables

#### Endogenous Variables

(Note: The subscript  $j$  refers to the region)

Variable Name	Description	Unit of Measure
1. $CPI_j$	consumer price index	
2. $DINR_j$	real disposable income	Million Pesos
3. $DR_j$	capital consumption	Million Pesos
4. $E_j$	employment	Millions
5. $ELG_j$	local government expenditures in current pesos	Million Pesos
6. $FCPR_j$	real investment in private construction	Million Pesos
7. $GCE_j$	national government consumption expenditure in current pesos	Million Pesos
8. $GCER_j$	real national government consumption	Million Pesos
9. $DR_j$	capital consumption	Million Pesos
10. $KR_j$	cumulative fixed investment	Million Pesos
11. $ER_j$	employment rate	Percent
12. $LF_j$	labor force	Millions
13. $LNE_j$	natural logarithm of $E_j$	

14.	LNQR <sub>j</sub>	natural logarithm of QR <sub>j</sub>	
15.	LT <sub>j</sub>	local taxes	Million Pesos
16.	NT <sub>j</sub>	national taxes	Million Pesos
17.	P <sub>j</sub>	gross regional product deflator	
18.	PCER <sub>j</sub>	real personal consumption expenditure	Million Pesos
19.	PGCE <sub>j</sub>	government consumption expenditure deflator	
20.	PROC <sub>j</sub>	gross domestic product deflator, rest of the country outside of region j	
21.	Q <sub>j</sub>	gross regional product in current pesos	Million Pesos
22.	QOC <sub>j</sub>	gross domestic product, rest of the country outside region j, in current pesos	Million Pesos
23.	QR <sub>j</sub>	real gross regional product	Million Pesos
24.	QROC <sub>j</sub>	real gross domestic product, rest of the country, outside region j	Million Pesos
25.	RE <sub>j</sub>	growth rate of employment	Percent
26.	RESR <sub>j</sub>	residual (net exports and statistical discrepancy)	Million Pesos
27.	RLG <sub>j</sub>	local government revenue in current pesos	Million Pesos
28.	ROTH <sub>j</sub>	local government revenues other than taxes	Million Pesos
29.	W <sub>j</sub>	money wage rate	Pesos

Exogenous Variables

1.	CPI	consumer price index, Philippines	
2.	DER <sub>j</sub>	investment in durable equipment	Million Pesos

3.	DU8387	dummy for the change in the definition of local taxes and other revenues	
4.	E	national employment	Millions
5.	FCGR <sub>j</sub>	real government construction	Million Pesos
6.	FCPR	real total private construction	Million Pesos
7.	GCE	national government consumption	Million Pesos
8.	RTBILL	real interest rate	Percent
9.	P	gross domestic product deflator, Philippines	
10.	POP <sub>j</sub>	population	Millions
11.	QR	real gross domestic product, Philippines	Million Pesos
12.	WL <sub>j</sub>	legislated minimum money wage rate	

## 2.2. Stochastic Equations

For completeness, we summarize the discussion of the equations in Danao [1990].

### (1) Gross Regional Domestic Product (Real)

$$\text{LNQR}_j = f(\text{LNKR}_j, \text{LME}_j, \text{QR}/E)$$

Gross regional product in region  $j$  ( $\text{QR}_j$ ) is determined by a Cobb-Douglas production function

$$\text{QR}_j = (\text{KR}_j)^\alpha (\text{E}_j)^{\beta_0} (\text{QR}/E)$$

where the national trend in average labor productivity ( $\text{QR}/E$ ) is a proxy for technological progress. Taking logarithms, we have

$$\ln QR_j = \alpha \ln KR_j + \beta \ln E_j + \tau (QR/E).$$

(2) Personal Consumption (Real)

$$PCER_j = f(DINR_j, PCER_j(-1))$$

Personal consumption expenditure ( $PCER_j$ ) is a linear function of disposable income. The lagged value of  $PCER_j$  is included to capture habit formation.

(3) Private Construction (Real)

$$FCPR_j = f(FCPR, RTBILL, QR_j(-1) - QR_j(-2))$$

Investment in private construction depends on the cost of capital (real interest rate ( $RTBILL$ )) and the expectation on the future of the economy represented by the change in output lagged one period,  $QR_j(-1) - QR_j(-2)$ . Since a portion of regional investments are made by industries which have national markets, national investment trends, represented by total investment in private construction ( $FCPR$ ), is included as an explanatory variable.

(4) Capital Consumption (Real)

$$DR_j = f(KR_j(-1), QR_j)$$

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

(5) National Government Consumption in the Region

$$GCE_j = f(GCE, POP_j, GCE_j(-1))$$

National government consumption expenditure in region  $j$  ( $GCE_j$ ) depends on the national trend in consumption expenditure ( $GCE$ ) (reflecting national fiscal policies) and the region's population ( $POP_j$ ) population pressure for more services. The lagged dependent variable reflects the fact that budgetary requests usually exceed the previous year's allocation.

(6) Employment

$$LNE_j = f(LNQR_j, LN(W_j/P_j))$$

Employment ( $E_j$ ) is a demand-for-labor function of the level of output ( $QR_j$ ) and the real wage rate ( $W_j/P_j$ ) which may be derived from the first-order condition for profit-maximization with a Cobb-Douglas production function (Intriligator [1978]).

(7) Labor Force

$$LF_j = f(POP_j, RE_j)$$

Labor force ( $LF_j$ ) is a function of population ( $POP_j$ ) and the growth rate of employment ( $RE_j$ ). A rising  $RE_j$  indicates an increasing number of jobs attracting more people to join the labor force.

(8) National Taxes

$$NT_j = f(Q_j, NT_j(-1))$$

(9) Local Taxes

$$LT_j = f(Q_j, LT_j(-1), DU8387)$$

National taxes ( $NT_j$ ) and local taxes ( $LT_j$ ) collected from the region are aggregations of different types of taxes. We therefore, use regional output ( $Q_j$ ) as the tax base. The lagged dependent variable reflects changes in the tax structure. In the local tax equation, a dummy (DU8387) for the change in the definition of local taxes is included.

(10) Gross Regional Product Deflator

$$P_j = f(P, W_j)$$

(11) Consumer Price Index

$$CPI_j = f(CPI, W_j)$$

Regional price ( $P_j$ ) is a function of the national price level ( $P$ ) as the factors affecting prices work their way through the national price variable. To capture the possible effect of local wages we include the money wage rate. The regional consumer price index ( $CPI_j$ ) is also a function of the national CPI and the local wage rate.

(12) Money Wage Rate

$$W_j = f(CPI_j, WL_j)$$

Regional wage rate ( $W_j$ ) is a function of the consumer price index ( $CPI_j$ ), reflecting workers' demand for cost-of-living increases, and the legislated minimum wage ( $WL_j$ ), reflecting the effects of government imposed wage adjustments.

- (13) Government Consumption Deflator

$$PGCE_j = f(P)$$

The government consumption expenditure deflator ( $PGCE_j$ ) is expressed simply as a function of the price level ( $P$ ).

- (14) Local Government Expenditure

$$ELG_j = f(RLG_j, POP_j)$$

Local government expenditures ( $ELG_j$ ) is a function of local government revenues ( $RLG_j$ ) while population ( $POP_j$ ) increases will require more services.

- (15) Local Nontax Revenue

$$ROTH_j = f(QOC_j, DU8387)$$

Local nontax revenue ( $ROTH_j$ ) is a function of the gross product of the rest of the country outside region  $j$  ( $QOC_j$ ) since a large portion of nontax revenues come from trade with other regions. The dummy variable ( $DU8387$ ) reflects the reclassification of some local taxes into other revenues.

### 2.3. Definitions and Identities

- (16) Gross Domestic Product of the Rest of the Country (Real)

$$QROC_j = QR - QR_j$$

- (17) Gross Domestic Product of the Rest of the Country (Nominal)

$$QOC_j = QROC_j * PROC_j$$

(18) Price Deflator for GDP, Rest of the Country

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

(19) Gross Regional Product (Real)

$$QR_j = EXP(LNQR_j)$$

(20) Gross Regional Product (Nominal)

$$Q_j = QR_j * P_j$$

(21) Government Consumption (Real)

$$GCER_j = GCE_j / PGCE_j$$

(22) Cumulative Fixed Investment

$$KR_j = KR_j(-1) + DER_j + FCPR_j + FCGR_j - DR_j$$

(23) Disposable Income

$$DINR_j = QR_j - (NT_j + LT_j) / P_j$$

(24) Local Government Revenues

$$RLG_j = LT_j + ROTH_j$$

(25) Residual

$$RESR_j = QR_j - PCER_j - DER_j - FCPR_j \\ - FCGR_j - GCER_j$$

(26) Employment

$$E_j = EXP(LNE_j)$$



$$(2) \quad \text{PCER7} = 557.89260 + 0.0508554 * \text{DINR7} + 0.7690141 * \text{PCER7}(-1)$$

(6.78)                      (2.78)                      (18.98)

$$+ 245.11021 * \text{DU86}(-1)$$

(10.42)

$$\bar{R}^2 = 0.99 \quad \text{SER} = 21.30 \quad \text{DW} = 2.52 \quad \text{F} = 616.52$$

$$(3) \quad \text{FCPR} = -64.896613 + 0.0655941 * \text{FCPP} - 1.0307035 * (\text{RTBILL} - \text{RTBILL}(-1))$$

(2.45)                      (13.99)                      (2.06)

$$+ 0.0230953 * (\text{QR7}(-1) - \text{QR7}(-2))$$

(1.15)

$$\bar{R}^2 = 0.97 \quad \text{SER} = 18.43 \quad \text{DW} = 2.32 \quad \text{F} = 89.30$$

$$(4) \quad \text{DR7} = 175.15528 + 0.0273175 * \text{KR7}(-2) + 0.0812688 * (\text{KR7}(-1) - \text{KR7}(-2))$$

(1.14)                      (3.20)                      (2.00)

$$+ 0.0467061 * \text{QR7}$$

(2.68)

$$\bar{R}^2 = 0.82 \quad \text{SER} = 18.67 \quad \text{DW} = 1.91 \quad \text{F} = 9.39$$

$$(5) \quad \text{GCE7} = 436.86225 + 0.0239917 * \text{GCE} + 0.2720079 * \text{GCE7}(-1) + 132.73344 * \text{POP7}$$

(0.48)                      (3.77)                      (1.16)                      (0.49)

$$\bar{R}^2 = 0.99 \quad \text{SER} = 57.32 \quad \text{DW} = 1.95 \quad \text{F} = 280.48$$

$$(6) \quad \text{LNE7} = 0.3380162 * \text{LOG}(\text{QR7}) - 0.4419791 * \text{LOG}(\text{W7/P7}) - 0.1568907 * \text{DU8081}$$

(9.20)                      (7.82)                      (5.48)

$$\bar{R}^2 = 0.91 \quad \text{SER} = 0.03 \quad \text{DW} = 2.17 \quad \text{F} = 43.37$$

$$(7) \quad \text{LF7} = -1.1367019 + 0.6033845 * \text{POP7} + 0.0063340 * ((\text{E7} - \text{E7}(-1)) / \text{E7}(-1)) * 100$$

(2.87)                      (6.96)                      (1.86)

$$\bar{R}^2 = 0.87 \quad \text{SER} = 0.06 \quad \text{DW} = 1.41 \quad \text{F} = 24.25$$

$$(8) \quad NT7 = 71.575027 + 0.0083583*Q7 + 0.9037606*NT7(-1)$$

(0.48)                    (1.93)                    (2.84)

$$\bar{R}^2 = 0.90 \quad SER = 97.12 \quad DW = 1.33 \quad F = 43.93$$

$$(9) \quad LT7 = -2.2940766 + 0.0060740*Q7 + 0.5707005*LT7(-1)$$

(0.13)                    (7.98)                    (5.45)

$$- 134.58155*DU8386$$

(7.00)

$$\bar{R}^2 = 0.95 \quad SER = 15.49 \quad DW = 1.57 \quad F = 60.89$$

$$(10) \quad P7 = 0.0193220 + 0.9551929*p + 0.00003197*W7(-1)$$

(0.25)                    (35.17)                    (0.19)

$$\bar{R}^2 = 0.99 \quad SER = 0.05 \quad DW = 1.76 \quad F = 5243.00$$

$$(11) \quad CPI7 = 7.1305636 + 0.9154460*CPI(-1) + 1.1530763*(CPI-CPI(-1))$$

(0.67)                    (11.65)                    (18.23)

$$+ 0.229328*W7(-1)$$

(0.99)

$$\bar{R}^2 = 0.99 \quad SER = 5.58 \quad DW = 1.77 \quad F = 1094.65$$

$$(12) \quad W7 = 244.17650 + 3.8875021*CPI7(-3) + 12.508610*WL$$

(3.24)                    (4.25)                    (2.57)

$$\bar{R}^2 = 0.96 \quad SER = 87.20 \quad DW = 2.20 \quad F = 100.49$$

$$(13) \quad PGCE7 = 0.0301228 + 0.3451776*p + 0.6765089*PGCE7(-1)$$

(0.51)                    (8.73)                    (11.55)

$$\bar{R}^2 = 0.99 \quad SER = 0.07 \quad DW = 2.00 \quad F = 2411.40$$

$$(14) \quad \text{ELG7} = 565.75852 + 0.7034943 \cdot \text{RLG7} + 171.22545 \cdot \text{POP7} \quad (8)$$

(1.37)                      (2.97)                      (1.34)

$$\bar{R}^2 = 0.98 \quad \text{SER} = 26.29 \quad \text{DW} = 1.50 \quad \text{F} = 254.01$$

$$(15) \quad \text{ROTH7} = 21.315107 + 0.0002010 \cdot \text{QOC7} + 160.28966 \cdot \text{DU8386} \quad (9)$$

(2.75)                      (5.87)                      (12.40)

$$\bar{R}^2 = 0.99 \quad \text{SER} = 10.40 \quad \text{DW} = 1.57 \quad \text{F} = 754.46$$

**Model Performance**

A historical dynamic simulation was performed on the regional models for the period 1978-1987. In this simulation, all regional and national exogenous variables were set equal to their actual values. As a measure of model performance, we used the mean absolute percent error (MAPE). The MAPE of an endogenous variable  $y$  is defined as

$$\text{MAPE}(y) = \frac{1}{T} \sum_{t=1}^T \left| \frac{y_t^s - y_t^a}{y_t^a} \right|$$

where  $T$  is the length of the simulation period,  $y_t^s$  is the simulated value of  $y$  in period  $t$ , and  $y_t^a$  is the actual value of  $y$  in period  $t$ . The results of the simulation for selected variables for the 13 regions are shown in Table 1.

The MAPE statistics for gross regional product are generally low except for Region 9 which exceeded 5% by 0.69 of a percentage point. The Consumer Price Index also has low MAPE statistics except for Region 6 where MAPE is 6.89%. As expected, personal consumption, because of its low variability, has the lowest MAPE, ranging from 0.70% to 2.68%. The employment MAPEs are slightly higher, although generally less than 5% with

only 4 regions that have MAPEs greater than 5%. Investment in private construction, being the more volatile economic variable, showed larger MAPEs although only one region (Region 9) exceeded 10%. Money wage rate also has larger MAPEs but in only one region (Region 9) did it exceed 10%.

Table 1. MAPE Statistics for the Dynamic Simulation by Region

Region	Gross Product	Employment	Price Level	Private Construction	Money Wage Rate	Personal Consumption	Labor Force
1	1.60	3.90	1.45	4.10	6.34	1.42	3.77
2	1.04	4.25	5.50	7.53	6.62	1.76	3.96
3	1.96	3.00	1.55	5.34	7.05	1.33	2.90
4	2.90	8.32	1.58	2.82	7.33	2.68	1.13
5	1.74	4.75	1.16	6.41	7.49	0.95	1.13
6	2.65	5.24	6.99	5.21	7.60	0.70	3.39
7	2.84	3.12	1.13	4.39	5.91	0.27	4.04
8	2.20	3.86	5.01	6.12	9.20	1.13	6.53
9	5.69	4.86	1.36	11.02	12.74	1.35	4.60
10	2.98	7.17	1.60	9.76	5.72	1.32	5.29
11	2.67	5.75	2.09	7.67	4.46	1.87	3.19
12	3.91	3.52	1.86	8.38	1.63	1.53	2.71
13	2.26	2.80	4.10	2.91	7.54	0.92	5.26
Mean	2.65	4.86	2.72	6.28	6.89	1.33	3.68
RP	1.32	2.49	1.53	1.74	5.08	.99	1.64

The bottom row in Table 1 presents the MAPEs for the entire country (RP). The simulated values for the country were obtained as totals (or

averages) of the regional simulated values. The MAPEs ranged from 0.99% to 5.08%.

The simulated and the actual values of the national variables are presented graphically in Figures 1-6.

Year	Region	Product	Actual Value	Simulated Value	MAPE (%)
1977	1	1.50	1.40	1.40	0.99
1978	1	1.60	1.55	1.55	1.25
1979	1	1.70	1.65	1.65	1.33
1980	1	1.80	1.75	1.75	1.58
1981	1	1.90	1.85	1.85	1.73
1982	1	2.00	1.95	1.95	1.92
1983	1	2.10	2.05	2.05	2.10
1984	1	2.20	2.15	2.15	2.27
1985	1	2.30	2.25	2.25	2.43
1986	1	2.40	2.35	2.35	2.60
1987	1	2.50	2.45	2.45	2.77
1988	1	2.60	2.55	2.55	2.94
1989	1	2.70	2.65	2.65	3.11
1990	1	2.80	2.75	2.75	3.28
1991	1	2.90	2.85	2.85	3.45
1992	1	3.00	2.95	2.95	3.62
1993	1	3.10	3.05	3.05	3.79
1994	1	3.20	3.15	3.15	3.96
1995	1	3.30	3.25	3.25	4.13
1996	1	3.40	3.35	3.35	4.30
1997	1	3.50	3.45	3.45	4.47
1998	1	3.60	3.55	3.55	4.64
1999	1	3.70	3.65	3.65	4.81
2000	1	3.80	3.75	3.75	4.98
2001	1	3.90	3.85	3.85	5.15
2002	1	4.00	3.95	3.95	5.32
2003	1	4.10	4.05	4.05	5.49
2004	1	4.20	4.15	4.15	5.66
2005	1	4.30	4.25	4.25	5.83
2006	1	4.40	4.35	4.35	6.00
2007	1	4.50	4.45	4.45	6.17
2008	1	4.60	4.55	4.55	6.34
2009	1	4.70	4.65	4.65	6.51
2010	1	4.80	4.75	4.75	6.68
2011	1	4.90	4.85	4.85	6.85
2012	1	5.00	4.95	4.95	7.02
2013	1	5.10	5.05	5.05	7.19
2014	1	5.20	5.15	5.15	7.36
2015	1	5.30	5.25	5.25	7.53
2016	1	5.40	5.35	5.35	7.70
2017	1	5.50	5.45	5.45	7.87
2018	1	5.60	5.55	5.55	8.04
2019	1	5.70	5.65	5.65	8.21
2020	1	5.80	5.75	5.75	8.38
2021	1	5.90	5.85	5.85	8.55
2022	1	6.00	5.95	5.95	8.72
2023	1	6.10	6.05	6.05	8.89
2024	1	6.20	6.15	6.15	9.06
2025	1	6.30	6.25	6.25	9.23
2026	1	6.40	6.35	6.35	9.40
2027	1	6.50	6.45	6.45	9.57
2028	1	6.60	6.55	6.55	9.74
2029	1	6.70	6.65	6.65	9.91
2030	1	6.80	6.75	6.75	10.08

The bottom row in Table 1 presents the MAPEs for the entire country. The simulated values for the country are obtained as follows (1991):

Figure 1. GROSS DOMESTIC PRODUCT

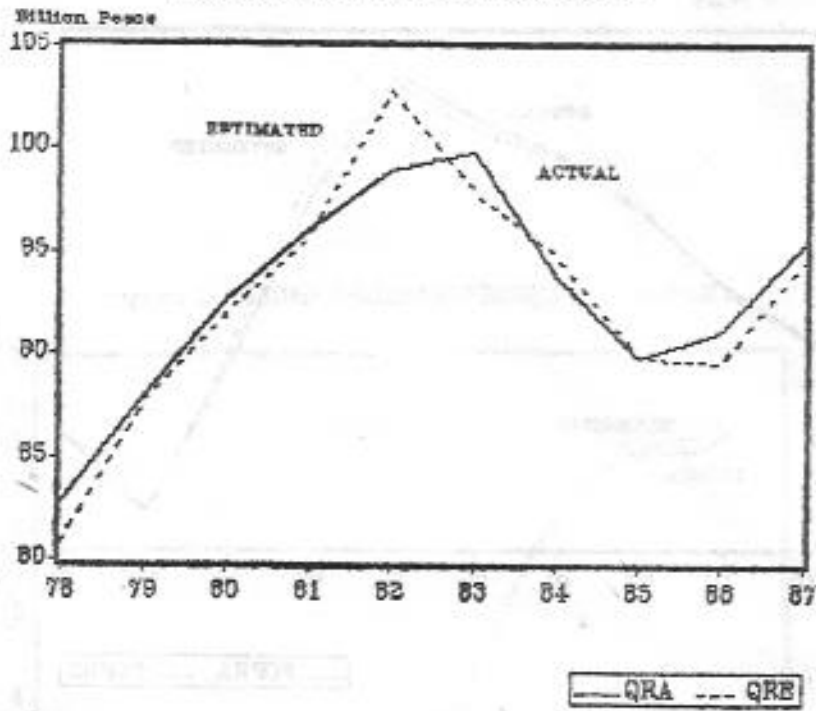


Figure 2. EMPLOYMENT

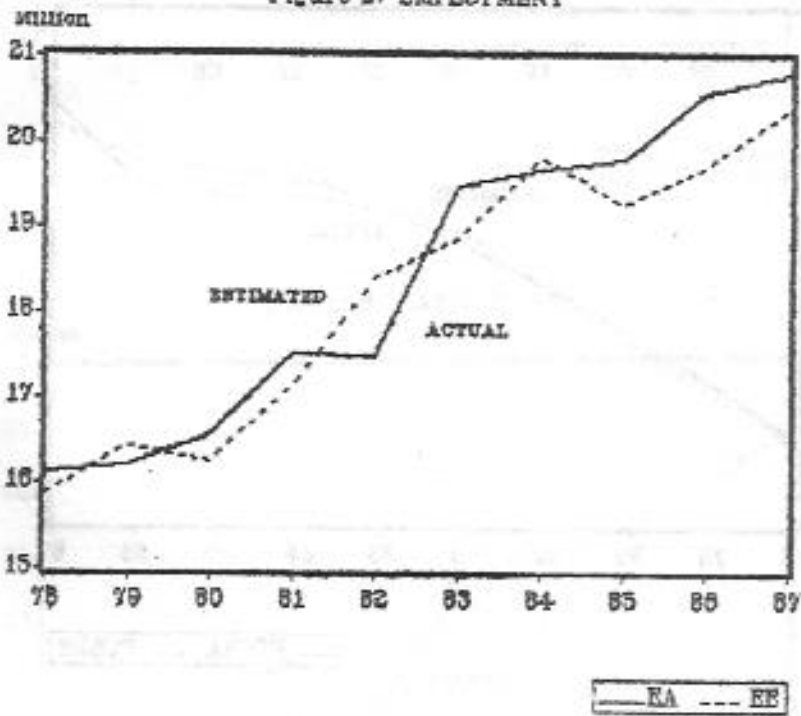


Figure 3. PRIVATE CONSTRUCTION

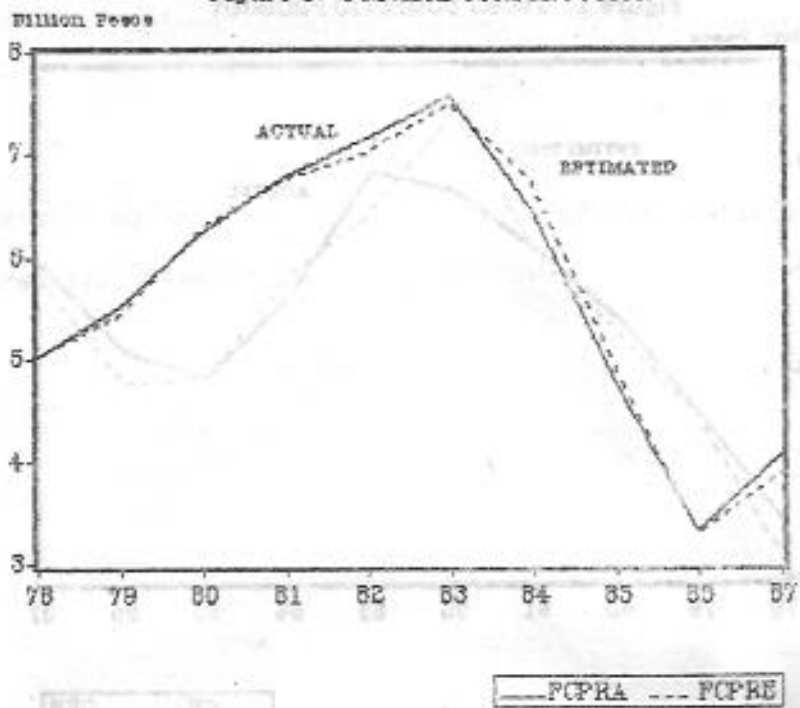


Figure 4. PERSONAL CONSUMPTION

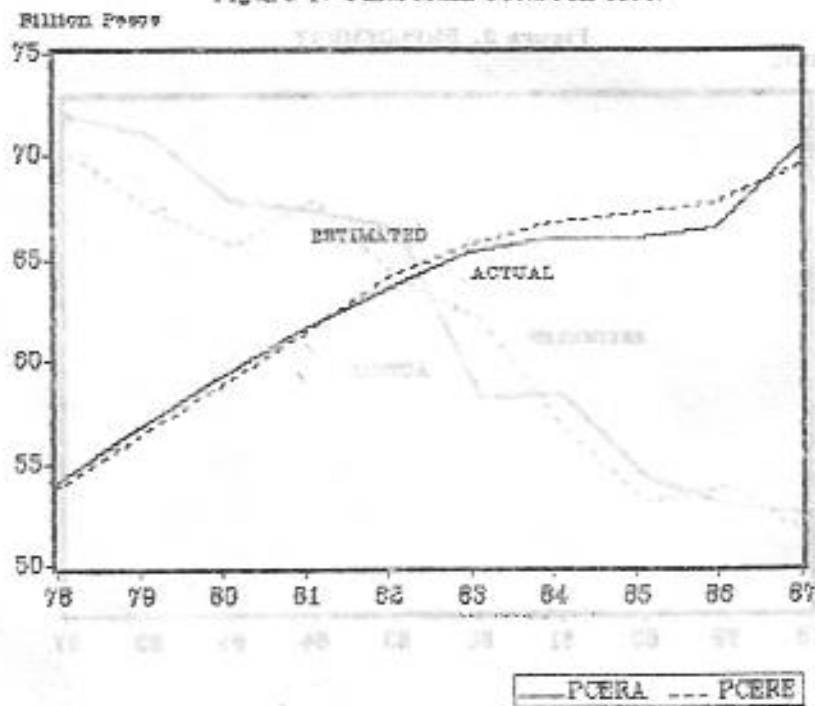


Figure 5. GROSS DOMESTIC PRODUCT DEFLATOR

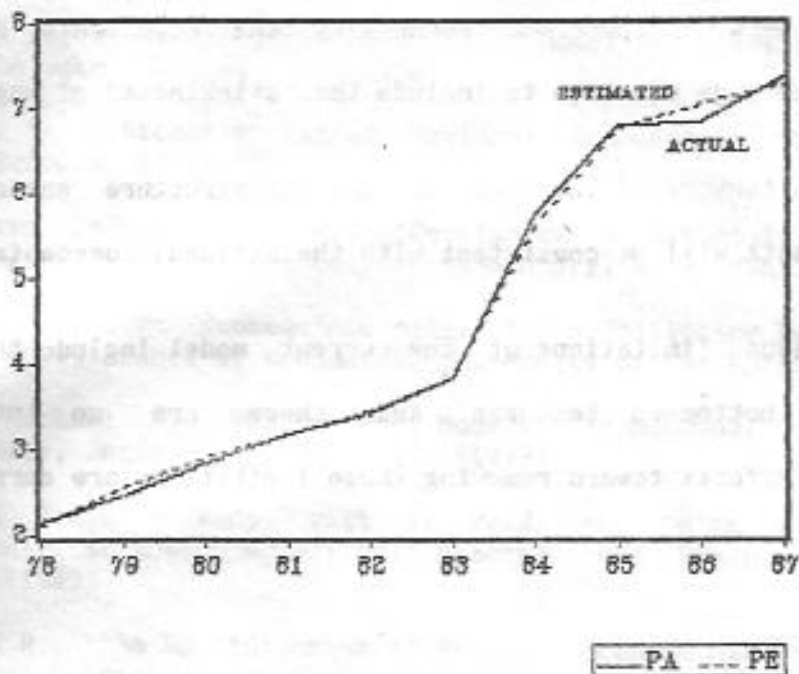
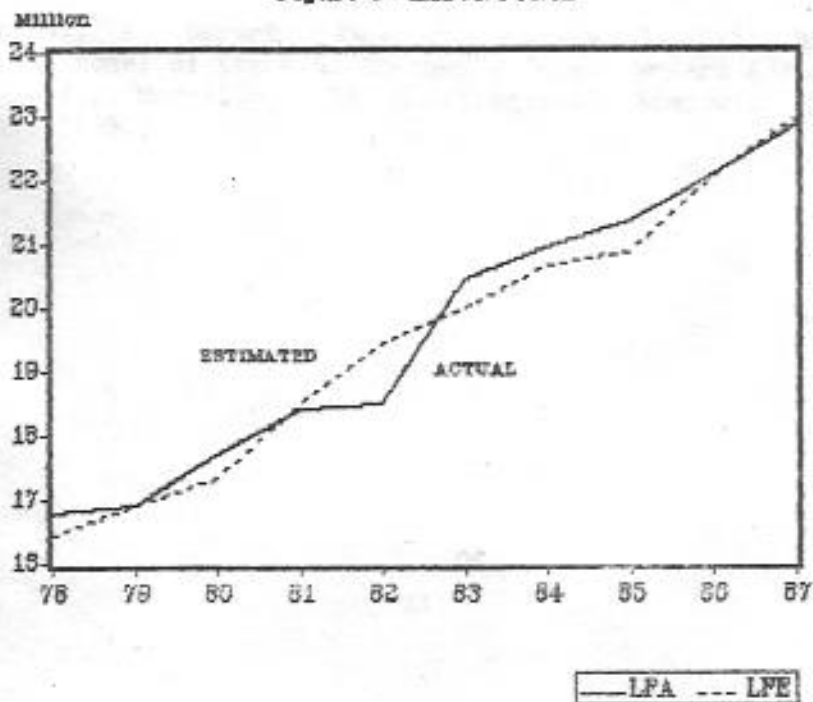


Figure 9. LABOR FORCE



## Concluding Remarks

This paper presents an initial attempt at building a multiregional econometric model for the Philippines. The multiregional model is of the top-down variety. The dynamic simulation showed errors that are within current modelling standards except the money wage variable. Two things that can be done here include (a) rechecking the wage rate data and (b) respecifying the wage equation to include the "stickiness" of wage behavior.

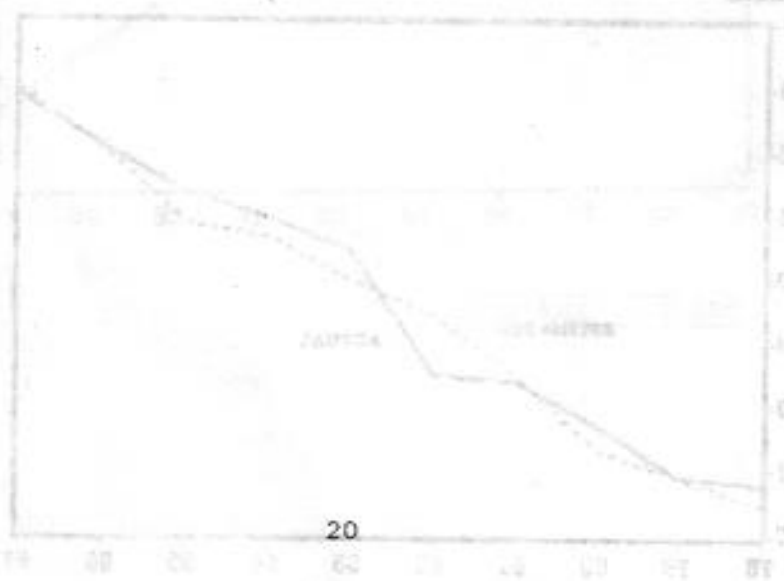
The main feature of the model is that its structure ensures that the regional forecasts will be consistent with the national forecasts.

The obvious limitations of the current model include the fact that there are no bottom-up features and there are no inter-regional interactions. Efforts toward removing these limitations are currently being pursued.

60 65 70 75 80 85 90

79 29

REGIONAL GROWTH



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