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GENERAL EQUILIBRIUM EFFECTS OF INCREASING PRODUCTIVITY IN PHILIPPINE MANUFACTURING, WITH SPECIAL REFERENCE TO FOOD PROCESSING

Romeo M. Bautista

Introduction

Empirical studies on total (or multi-) factor productivity, especially those about developing countries, focus heavily on the measurement and sources of productivity growth at the aggregate and sectoral levels.[1] It is generally recognized that increases in total factor productivity (TFP) are critical to sustain growth of national output. However, beyond the contribution to per capita output, other economic effects of productivity change have received scant attention. There has also been little systematic analysis of the comparative distribution of benefits from sectoral productivity improvements and of their direct *and* indirect effects on total output. This is despite observed differences in the productivity performance among different sectors. The partial equilibrium, sector-by-sector approach typically adopted in those studies largely accounts for this one-sided focus.

In this paper, we investigate quantitatively the economy-wide effects of increasing productivity in the following Philippine industrial sectors: food manufactures; light manufactures, producing mainly consumer goods; and other manufactures, consisting of intermediate and capital goods production.[2] A computable general equilibrium framework is used,

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Research Fellow, International Food Policy Research Institute, Washington D.C. The author benefited from the comments of Richard Hooley in the earlier draft of this study. Assistance in data collection and computer work was ably provided by James Gilmartin.

[1] For useful review, see Nelson (1981). Among several studies on the Philippines are Lampman (1967), Williamson (1969), David et al. (1984), and Hooley (1985). Hooley's work goes beyond sources-of-growth accounting; it also examines the behavioral determinants of intra-manufacturing productivity change and the effects on output price, production, and employment.

[2] This sectoral classification of manufacturing industries is found appropriate for many developing countries like the Philippines because (a) a large food processing industry is strongly linked to the agricultural sector; (b) a growing consumer goods industry is being protected to encourage import substitution, or subsidized to promote exports; and (c) the domestic producer goods industry is largely non-import competing.

emphasizing intersectoral linkages in production, the role of foreign trade, and the distinction between rural and urban households in their income generation and consumption patterns. While the parameter values and initialization of the model are based on Philippine conditions, the results of the analysis could be of policy interest to other developing countries with similar structural characteristics.

As one of the most significant findings of the investigation, productivity improvement in food processing registered the highest overall income effect. The other two manufacturing branches show much lower induced increases in national income. Although the incomes of rural households, urban households, "companies," and government are each still favorably affected by sectoral productivity growth, the income effects from food manufactures are the highest. Also striking is that the estimated positive effects on urban income always exceed those on rural income, but the disparity of income gains is lowest in the case of the food processing sector.

The second section describes the structure of the general equilibrium model. The quantitative effects of an exogenous increase in total factor productivity in each of the three manufacturing sectors are discussed in the third section, comparing also their relative merits. The last section presents the conclusions.

The Model

Because of the importance of agriculture in the Philippine economy as evident in the number of people dependent on it, the multisectoral, general equilibrium model used in the present study gives emphasis to agricultural activities and their linkage to other production sectors. The food and export crop sectors are differentiated on account of their differing trade orientation. Livestock and fishery, forestry and mining constitute the other primary-producing sectors. Food manufactures (including milled products from the food and export crop sectors) and fertilizer are also given special attention owing to their strong linkage to agricultural production. The remaining production sectors cover light manufactures, other manufactures, and "services" (a residual category which *also* includes utilities, transportation, and commerce). The input-output structure of the ten production sectors for 1978, the base period for the study, is given in Tables 1 and 2. Food processing (sector 4) is seen to contribute ₱55 billion to the total output of ₱310 billion in that year; light manufactures (sector 8) and the other manufactures (sector 9) accounted for ₱35 and ₱41 billion, respectively.

In addition to differentiating rural and urban households, the model distinguishes the sectoral consumption and income generation of companies (private corporations and "unincorporated businesses") and the gov-

Table 1
INTERSECTORAL TRANSACTIONS AND INCOME GENERATION
(1978 ₱ billion)

SECTOR	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10	Total
1. Food crops	0.61	0.33	0.15	12.82	—	—	—	0.78	0.05	0.13	14.77
2. Export crops	0.39	1.28	0.13	6.42	—	—	—	1.30	0.05	0.21	9.78
3. Livestock and fishing	—	—	0.44	4.89	—	—	—	—	—	0.41	5.74
4. Food manufactures	—	—	1.76	8.46	—	—	—	0.36	0.95	1.65	13.18
5. Fertilizer	0.81	0.62	0.07	—	—	—	—	—	—	—	1.50
6. Forestry	—	—		0.02	—	0.49	0.05	2.65	0.02	0.12	3.35
7. Mining	—	—	0.02	0.06	0.38	—	0.10	—	7.49	0.57	8.62
8. Light manufactures	0.02	0.02	0.33	0.24	—	0.03	0.06	11.86	0.47	4.46	17.49
9. Other manufactures	0.11	0.12	0.24	1.24	0.42	0.43	0.93	2.71	11.58	9.70	27.48
10. Services	0.22	0.16	0.68	5.60	0.17	0.34	0.48	3.48	4.65	22.19	37.97
Subtotal	2.15	2.43	3.82	39.75	0.97	1.29	1.62	23.14	25.26	39.44	139.88
Labor income	6.80	5.52	5.33	3.81	0.11	1.17	0.61	3.73	3.33	32.80	63.22
Non-labor value added	7.16	8.42	7.92	9.48	0.22	3.17	2.13	6.04	8.78	37.28	90.60
Indirect taxes	0.27	0.39	0.55	1.81	0.05	0.39	0.57	2.33	3.24	7.05	16.66
Less subsidies											
Subtotal	14.33	14.33	13.80	15.10	0.38	4.73	3.31	12.10	15.35	77.14	170.48
TOTAL	**16.38**	**16.76**	**17.62**	**54.85**	**1.35**	**6.02**	**4.93**	**35.24**	**40.62**	**116.59**	**310.36**

Table 2
SECTORAL DEMAND
(1978 ₱ billion)

SECTOR	Inter-mediate Demand	Household Consump-tion	Government Consump-tion	Capital Formation	Exports	Imports	Total Final Demand	Total Value of Output
1	14.77	2.95	0.03	0.43	—	-1.80	1.61	16.38
2	9.78	4.45	0.04	0.41	2.08	—	1.98	16.76
3	5.74	11.63	0.10	0.12	0.04	—0.02	11.87	17.62
4	13.18	34.54	0.26	1.72	7.00	—1.85	41.67	54.85
5	1.50	—	—	0.08	—	—0.23	—0.15	1.35
6	3.35	0.98	—	0.79	0.96	—0.06	2.67	6.02
7	8.62	—	—	1.07	3.09	—7.85	—3.69	4.93
8	17.49	13.51	1.94	1.83	3.99	—3.52	17.75	35.24
9	27.48	11.06	2.60	19.83	2.54	—22.89	13.14	40.62
10	37.97	32.88	12.35	24.89	11.61	—3.11	78.62	116.59
TOTAL	**139.88**	**112.00**	**17.32**	**51.17**	**31.31**	**—41.33**	**170.48**	**310.36**

ernment (local and national governments, as well as public corporations). Base year values of receipts and expenditures for these four classes of consumers are shown in Appendix Tables A1 through A3, while the external sector and saving-investment accounts are shown in Appendix Tables A4 and A5. They constitute, together with the input-output table for 1978, a consistent accounting framework around which the analytical model is built.[3]

The model equations are contained in Table 3, while the variables and parameters are defined in Table 4. The number of endogenous variables in the model is 178, which is one less than the number of equations. Only relative prices and other variables in the real sphere of the economy are determined which the model abstracts from monetary phenomena. A price normalization rule, represented in equation (145), fixes the absolute price level and hence reduces the number of independent equations to 178. Sectoral prices as well as the wage and foreign exchange rates are thus defined in relation to an aggregate price level.

Except for the two agricultural crop sectors, the other sectors have their production technology represented by Cobb-Douglas functions for capital and labor, and fixed coefficients for intermediate inputs. Food and export crops are jointly produced , and both variable and fixed inputs can be reallocated between them. A system of output supply and input demand functions, represented in equations I through IV, describes producer behavior in crop agriculture. These functions find their basis in the producer prices of food and export crops, prices of the variable inputs represented by fertilizer and agricultural labor, and a vector of shift variables including quantities of fixed inputs, technology, weather, etc.[4]

[3] The principal sources of data (and values of share parameters)are the following: the Input-Output Tables for 1978 and 1979 as compiled by the National Census and Statistics Office; the unpublished 1978 Social Accounting Matrix (SAM) prepared by the Statistical Coordination Office; the 1974 and 1972 SAM tables presented, respectively, in Samson and Buenaventura (1980), and Bull (1977); and the *1982 Philippine Statistical Yearbook* (Published by the National Economic and Development Authority) which contains the national income accounts for 1978, among other data. Although input-output tables for 1983 are available, it would be unreasonable to use 1983 as base period for this study (assuming that a social accounting matrix for that year can be constructed) in view of the external disequilibrium and debt-service problems that reached crisis proportions in October 1983.

[4] Under conditions of regular technology, competitive behavior, and short-run equilibrium, equations (I) through (IV) can be derived from the variable profit function via Shephard's (1953) lemma; that is, $Q^* = \partial \pi^*/\partial P = Q^*(P,X)$, when π^* is maximized variable profits, Q^* is the vector of optimal output supplies and variable input demands (in negative units), P is the vector of output and variable input prices, and Z is a vector of quantities of fixed inputs and other supply shifters such as technology, infrastructure, and weather variables. For an analytical discussion of the profit function approach to the derivation of output supply and input demand functions, see, for example, Lau (1972); an empirical application to Philippine crop agriculture is given in Bautista (1986).

Table 3: Model Equations

I.	**Production, Employment, and Wage Rates**		
Q_{x1}	=	$Q_{x1}\,(P_{x1}, P_{x2}, P_{c5}, W_a; Z)$	(1)
Q_{x2}	=	$Q_{x2}\,(P_{x1}, P_{x2}, P_{c5}, W_a; Z)$	(2)
$-Q_{a5}$	=	$Q_{a5}\,(P_{x1}, P_{x2}, P_{c5}, W_a; Z)$	(3)
$-L_a$	=	$L_a\,(P_{x1}, P_{x2}, P_{c5}, W_a; Z)$	(4)
Q_{xi}	=	$A_i\ (K_i^{1-\alpha i}\, L_i^{\alpha i},\quad i=3, \ldots, 10$	(5)-(12)
L_i	=	$B_i\, L_{ni}^{1-\beta i}\, L_{si}^{\beta i},\quad 1=3 \ldots, 10$	(13)-(20)
$h_{ni}\, W_a$	=	$\alpha i\,(1-\beta i)\, L_{ni}^{-1}\, P_{vi}\ Q_{xi},\quad 1=3 \ldots, 10$	(21)-(28)
$h_{si}\, W_s$	=	$\alpha i\, \beta_i\, L_{si}^{-1}\, P_{vi}\, Q_{xi},\ 1=3 \ldots, 10$	(29)-(36)
$L_a + \sum_{i=3}^{10} L_{ni}$	=	L_n	(37)
$\sum_{i=3}^{10} L_{si}$	=	Ls	(38)
Q_{di}	=	$x_i\ (P_{di}/P_{xi})\varepsilon i\ Q_{xi},\quad i \neq 1,5$	(39)-(46)
Q_{xi}	=	$Q_{di},\quad Q_{x5} = Q_{d5}$	(47)-(48)
II.	**Sectoral Demand and Final Consumption**		
Q_{ci}	=	$\sum_{j=1}^{10} a_{ij}\, Q_{xj} + C_i + I_i,\quad 1 \neq 5$	(49)-(57)
Q_{c5}	=	$Q_{a5} + I_5$	(58)
C_i	=	$C_{ri} + C_{ui} + C_{gi},\quad 1 \neq 5,7$	(59)-(66)
$P_{ci}\, C_{ri}$	=	$P_{ci}\, C_{ri} + \mu_{ri}\,(Yr\ Yr - \sum_j P_{cj}\, C_{rj}),\quad i \neq 5, 7$	(67)-(74)
$P_{ci}\, C_{ui}$	=	$P_{ci}\, C_{ui} + \mu_{ui}\,(Y_u\, Y_u - \sum_j P_{cj}\, C_{uj}),\quad 1 \neq 5,7$	(75)-(82)
$P_{ci}\, C_{gi}$	=	$e_{gi}\, Y_g\, Y_g,\quad 1 \neq 5,6,7$	(83)-(89)
Q_{di}	=	$d_i\,(P_{ci}/P_{di})^{\sigma i}\, Q_{ci},\quad 1 \neq 2,5$	(90)-(97)
Q_{d2}	=	$Q_{c2},\ Q_{c5} = Q_{c5} - Q_{m5}$	(98)-(99)

III. Prices

$$P_{mi} = P^*_{mi}(1 + t_{mi}) R, \quad 1 \neq 2 \qquad (100)\text{-}(108)$$

$$P_{ei} = P^*_{ei}(1 - t_{ei}) R, \quad 1 \neq 1,5 \qquad (109)\text{-}(116)$$

$$P_{ci} = (P_{di}\, Qd_i + P_{mi}\, Q_{mi})/Q_{ci}, \quad 1 \neq 2 \qquad (117)\text{-}(125)$$

$$P_{c2} = P_{d2} \qquad (126)$$

$$P_{xi} = (P_{di}\, Q_{di} + P_{ei}\, Q_{ei})/Q_{xi}, \quad 1 \neq 1,5 \qquad (127)\text{-}(134)$$

$$P_{x1} = P_{d1}, \qquad P_{x5} = P_{d5} \qquad (135)\text{-}(136)$$

$$P_{vi} = (1 - t_{xi}) P_{xi} - \sum_j a_{ji} P_{cj}, \quad 1 = 3, \ldots, 10 \qquad (137)\text{-}(144)$$

$$P = \sum_j \phi_{xi} P_{xi} \qquad (145)$$

IV. Income, Savings, and Investment

$$V_a = \sum_{i=1,2} (1 - t_{xi}) P_{xi} Q_{xi} - \sum_{j \neq 5} (a_{j1} Q_{d1} + a_{j2} Q_{d2}) P_{cj} - P_{c5} Q_{a5} \qquad (146)$$

$$V_{NL} = (V_a - W_a L_a) + \sum_{1=3}^{10} (1 - \alpha_i) P_{vi} Q_{xi} \qquad (147)$$

$$Y_r = (1 - t_r)(\alpha L_{ra} W_a L_a + \alpha NL_{ra} (V_a - W_a L_a) + \sum_{1=3}^{10} [\alpha L_{ri}^{\alpha} i + \alpha NL_{ri} (1 - \alpha_i)]\ P_{vi} Q_{xi} + C_r \alpha NL_c V_{NL} + G_{tr} + Y_{fr}) \qquad (18)$$

$$Y_u = (1 - t_u)(\alpha L_{ua} W_a L_a + \alpha NL_{ua} (V_a - W_a L_a) + \sum_{'=3}^{10} (L_{ui} \alpha_i + \alpha NL_{ui} (1 - \alpha i) P_{vi} Q_{xi} + C_u \alpha N_{LC} V_{NL} + G_{tu} + \bar{Y}_{fu}) \qquad (149)$$

$$Y_c = (1 - t_c)(1 - C_r - C_u)\, \alpha_{NLC} V_{NL} \qquad (150)$$

$$Y_g = \alpha_{NLg} V_{NL} + t_r Y_r/(1 - t_r) + t_u Y_u/(1 - t_u) + t_c Y_c/(1 - t_c) + R\,(\sum_i t_{mi} P^*_{mi} Q_{mi} + \sum_i t_{ei} P^*_{ei} Q_{ei}) + \sum_i t_{xi} P_{xi} Q_{xi} - (G_{tr} + G_{tu}) \qquad (151)$$

$$I = \sum_k (I - Y_k) Y_k + S^*_f R, \quad k = r, u, c, g \qquad (152)$$

$$P_{ci} I_i = \phi_{Ii} I \qquad (153)\text{-}(162)$$

V. Foreign Trade

$Q_{ei} = e_i (P_{ei}/P_{xi})\varepsilon_i Q_{xi},\ 1 \neq 1, 5, 6$		(163)-(169)
$Q_{mi} = m_i (P_{mi}/P_{ci})^{-\sigma 1} Q_{ci},\ 1 \neq 2.5$		(170)-(177)
$Q_{m5} = s_{m5} Q_{c5}$		(178)
$\sum_i P^*_{mi} Q_{mi} - \sum_i P^*_{ei} Q_{ei} = S^*_f + (Y_{fr} + Y_{fu})/R$		(179)

Table 4
DEFINITION OF VARIABLES AND PARAMETERS

Endogenous Variables			Number of Variables
Q_{x1}	=	Sectoral Production	10
Q_{ci}	=	Sectoral consumption	10
Q_{a5}	=	Fertilizer demand in agricultural crop production	1
Q_{di}	=	Consumption of sectoral domestic products	10
Q_{mi}	=	Sectoral imports, $i \neq 2$	9
Q_{ei}	=	Sectoral exports, $i \neq 1, 5, 6$	7
L_a	=	Employment in agricultural crop production	1
L_i	=	Sectoral employment , $i = 3, \ldots, 10$	8
L_{ni}	=	Sectoral employment of unskilled labor, $i = 3, \ldots, 10$	8
L_{si}	=	Sectoral employment of skilled labor, $i = 3, \ldots, 10$	8
W_a	=	Agricultural wage rate	1
W_s	=	Average wage rate for skilled labor	1
C_1	=	Final consumption demand, $i \neq 5, 7$	8
C_{ri}	=	Consumption of rural households, $i \neq 5, 7$	8
C_{ui}	=	Consumption of urban households, $i \neq 5,7$	8
C_{gi}	=	Consumption of government, $i \neq 5, 6, 7$	7
Y_r	=	Disposable (after tax) income of rural households	1
Y_u	=	Disposable (after tax) income of urban households	1
Y_c	=	Disposable income of companies (after transfers to households)	1
Y_g	=	Disposable income of government (after transfers to households)	1
P_{ci}	=	Price of composite consumption goods	10
P_{xi}	=	Price of composite production goods	10
P_{di}	=	Price of domestic products	10
P_{mi}	=	Price of imported products, $i \neq 1, 2, 5$	7

Endogenous Variables			Number of Variables
t_{m1}	=	Tax rate on food crop imports	1
t_{m5}	=	Tax rate on fertilizer imports	1
P_{ei}	=	Domestic price of sectoral exports, i ≠ 1, 5	8
P_{vi}	=	Sectoral value added per unit output, i = 3, . . . , 10	8
V_a	=	Value added in agricultural crop production	1
V_{NL}	=	Total non-labor value added	1
I	=	Total investment	1
I_i	=	Sectoral investment demand	10
R	=	Exchange rate	1
TOTAL			178

Exogenous Variables

P	=	General price level
P_{mi}	=	Government-determined price of imported food crops
P_{m5}	=	Government-determined price of imported fertilizer
P^*_{mi}	=	Foreign price of imports, 1 ≠ 2
P^*_{ei}	=	Foreign price of exports, 1 ≠ 1, 5
Q_{e6}	=	Government-determined quantity of forestry exports
G_{tr}, G_{tu}	=	Government income transfer to rural (urban) households
K_i	=	Sectoral capital stock, i = 3, ..., 10
L_n	=	Total supply of agricultural and unskilled labor
L_s	=	Total supply of skilled labor
S^*_f	=	Foreign capital inflow
s_{m5}	=	Share of imports in total fertilizer supply
Y_{fr}, Y_{fu}	=	Income from abroad received by rural (urban) households
Z	=	Vector of quantities of fixed inputs and other shifters in crop supply
a_{ij}	=	Sectoral input-output coefficients
A_i	=	Productivity parameter in sectoral Cobb-Douglas production function, 1 = 3,..., 10
B_i	=	Scale parameter in sectoral Cobb-Douglas labor aggregation function, 1 = 3, ..., 10
α_i	=	Output elasticity with respect to composite labor, 1 = 3, ..., 10
β_i	=	Composite labor elasticity with respect to skilled labor, 1 = 3, ..., 10
${}^{\alpha}L_{ra}$, ${}^{\alpha}L_{ua}$	=	Labor income share of rural (urban) households in agricultural crop production
${}^{\alpha}NL_{ra}$, ${}^{\alpha}NL_{ua}$	=	Nonlabor income share of rural (urban) households in agricultural crop production
${}^{\alpha}L_{ri}$, ${}^{\alpha}L_{ui}$	=	Sectoral labor income share of rural (urban) households, 1=3, ..., 10

$^{\alpha}NL_{ri}, {}^{\alpha}NL_{ui}$	=	Sectoral nonlabor income share of rural (urban) households, 1 = 3,..., 10
$^{\alpha}NL_{c}, {}^{\alpha}NL_{g}$	=	Share of companies (government) in total nonlabor value added
ϕI_i	=	Share in total investment by sector of origin
ϕ_{xi}	=	Sectoral share in total value of domestic production
ϕ_{ki}	=	Sectoral share in total consumption expenditure of consuming class k
Y_k	=	Ratio of total consumption expenditures to disposable income of consuming class k
ε_i	=	Sectoral elasticity of substitution between domestic and export markets, $i \neq 1, 5, 6$
σ_i	=	Sectoral elasticity of substitution between domestic and imported products, $i \neq 2, 5$
c_r, c_u	=	Share of rural (urban) households in income transfer from companies
t_r, t_u, t_c	=	Tax rate on rural (urban, company) income
t_{mi}, t_{ei}	=	Sectoral import (export) tax rates, $i \neq 1, 5$
t_{xi}	=	Sectoral indirect tax rates
$h_{ni}, h_{si}, d_i, x_i, e_i, m_i$	=	Constants of proportionality

Notes: Production sector i = l (food crops), 2 (export crops), 3 (livestock and fishery), 4 (food manufactures), 5 (fertilizer), 6 (forestry), 7 (mining), 8 (light manufactures), 9 (other manufactures), 10 (services).

Consuming class k = r (rural households), u (urban households), c (corporations and other enterprises), g (government).

A sectoral Cobb-Douglas aggregation function for unskilled and skilled labor is assumed for sectors outside crop agriculture. Profit-maximizing behavior of producers determines labor demand. Total supply of skilled workers is exogenously given and their wage rate is determined through market clearing. Unskilled and agricultural labor are assumed substitutable and mobile across sectors.[5] Total demand is equated to the fixed labor supply. Unskilled labor wage in each sector is assumed to remain in constant proportion to the agricultural wage rate, and intersectoral wage differentials for skilled labor are also fixed, as observed in the base period. Capital is sectorally fixed; once installed it is not freely mobile across sectors.

[5] According to Lal (1986, p. 38): "Philippine labor markets function closer to the competitive than the structuralist view ... which emphasizes labor market segmentation ...There is considerable intrasectoral mobility of labor within the rural sector, with multiple farm and nonfarm occupations common among rural households, and within the so-called urban informal sector."

Final consumption demand corresponds to the sum of demands from rural households, urban households, and government. Sectoral consumption levels for rural and urban households are specified based on the linear expenditure system, a widely used complete set of demand equations. Sectoral consumption demand by government is assumed to be determined simply by constant expenditure shares.

The small country assumption is applied to foreign trade; hence, foreign prices of sectoral imports and exports are exogenously determined. Two sets of trade substitution parameters form part of the model. One pertains to the distinction by consumers between sectoral imports and domestic products; there is a constant elasticity of substitution between them wherein a smaller elasticity value indicates greater difficulty in substituting one for the other as their relative prices change. This product differentiation permits two-way trade and provides some autonomy to the domestic price system not found in models that assume perfect substitutability between domestic production and imports (de Melo and Robinson 1981). The other set of trade substitution parameters relates to the distinction by producers between the domestic and export markets, in recognition of risk and transactions cost in foreign trade (Bautista 1977). Given different prices in the domestic and export markets, producers will not necessarily sell the entire output to the market offering the higher price if there are uncertainties regarding the reliability of either market and if switching markets is costly.

Savings of rural and urban households, companies, and government each serve as a fixed proportion of disposable income. As a macroclosure rule, total investment adjusts directly to the supply of domestic savings plus exogenous foreign savings. Investment expenditures by sector of origin are assumed to be constant proportions of total investment.

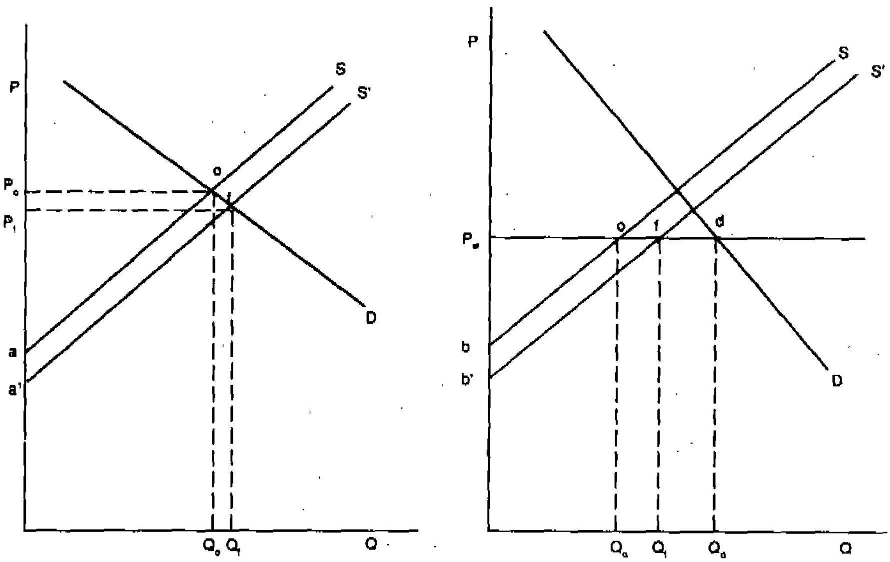
Concerning other structural features of the Philippine economy, since the government controls the prices of imported food crops and fertilizer as sold to domestic users, the implicit import taxes, instead of the domestic prices, of imports for sectors 1 and 5, are the endogenous variables in the model. Since 1976, the volume of log (forestry) exports has also been significantly restricted by the government due to environmental concerns; this variable is thus considered to be exogenously determined. Finally, exports of food crops and fertilizer, and the imports of export crops are excluded, reflecting the 1978 trade structure.

Effects of Increasing Manufacturing Productivity

Based on partial equilibrium analysis, some comparative static effects of increasing total factor productivity are illustrated in Figure 1.

Figure 1

PARTIAL EQUILIBRIUM EFFECTS OF INCREASED PRODUCTIVITY



Case A : No Foreign Trade

Case B: World Pricing

Assuming there is no foreign trade (Case A), the induced downward shift in the supply schedule from S to S' lowers the equilibrium price of the product from P_o to P_f and raises the quantity demanded and supplied from Q_o to Q_f. Producers gain in this case to the extent that the triangle $P_{fa\,f}$ is larger than the triangle $P_o$ao, as determined in part by the demand and supply elasticities.

The other extreme case (Case B) assumes that the domestic price of the product is set at the world price P_w. Total domestic demand Q_d is initially being met by domestic production Q_o and imports Q_d- Q_f, with total consumption remaining at Q_d. Producers gain unambiguously, from the productivity improvement as indicated by the area bofb'.

The above representation of the effects of a rise in total productivity can be modified and extended in several ways, depending on the purpose. If the producing sector under study is of substantial importance in the national economy, concern about economy-wide effects would warrant the examination of the further repercussions of the price and quantity adjustments in the particular product market where the productivity improvement took place. Not only is the demand schedule as represented in Figure 1 likely to shift due to the positive income effect of increased productivity; the markets for other commodities and for factors of production, will also react in interrelated ways.[6] Such linkages with the rest of the economy are taken into systematic account in a multi-sectoral general equilibrium model as specified for the Philippines in the preceding section.

An important assumption in the partial equilibrium analysis of the study is that the product is homogeneous and that it is either *non-traded* where its price does not depend on the world price (Case A) or *traded* where it is either imported or exported, but not both, at the given world price (Case B). From an empirical view, especially in the context of estimating economy-wide effects, the traded/non-traded goods dichotomy and the assumption that domestic and foreign goods are perfectly interchangeable seem too extreme. In the multi-sectoral model specified earlier, sectoral imports and domestic products are generally assumed to be neither perfect substitutes nor perfect complements. This allows two-way trade and the simultaneous influence of both domestic and foreign market forces on the domestic price system as pointed out above.

The terms-of-trade effect of increasing productivity, therefore, would not lead to zero (Case B in Figure 1) or be determined simply by the induced shift in the particular sector's supply schedule (Case A). The direct effect on sectoral domestic supply only initiates an economy-wide adjustment process sustained by the intersectoral linkages in production, consumption, and trade (as specified in the multi-sectoral model) leading to a new equilibrium position for the economy as a whole.

To examine empirically the effects of manufacturing productivity increases with no change in base period policies, an initial situation of static equilibrium is assumed for the Philippine economy, approximated by the observed conditions in 1978 so that the equations in Table 3 are satisfied. By logarithmic differentiation, this non-linear system of equations can be transformed into a set of equations that are linear in proportionate changes, expressing changes in the endogenous variables

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[6] A rightward shift of the demand curve can even lead to a price increase (i.e., a positive terms of trade effect) in Case A. But in Case B, it only leads to larger imports (or smaller exports if the world price is above the initial intersection point of the supply and demand schedules).

through corresponding changes in the exogenous variables of the model.[7] The coefficients in the transformed set of linear equations consist of the share parameters reflecting the initial situation of static equilibrium assumed for the Philippine economy in the benchmark year, 1978, and the structural parameters in the untransformed non-linear equation system. Values of the share parameters are computed directly from available data for 1978, most of which are contained in Tables 1, 2 and A1 through A5. The other parameters are assigned values based either on formal statistical estimation done in previous studies on the relevant aspects of the Philippine economy, or on estimates used by other investigators in similar applications to other developing countries.[8]

In general, the impact of given changes in any exogenous variables on the endogenous variables of the model can be calculated using simple matrix methods; that is, $y = A^{-1}x$, where y is a column vector of proportionate changes in the 178 endogenous variables, x is a column vector containing the assumed changes in exogenous variables, and A^{-1} is the inverse of the 178 x 178 coefficient matrix. The analysis is one of comparative statics which assumes an adjustment period long enough for the direct and indirect effects of the exogenous shocks to work themselves out. The repercussions of manufacturing productivity increases, as quantified in the model simulations, should be interpreted as deviations from a reference growth path of the economy with no change in base period values of the other exogenous variables and parameters of the model.

The simulation experiments assume a 10 percent increase in total factor productivity (TFP) in each of the three manufacturing sectors resulting from say, technological change of the disembodied type, that is attained at no costs. Table 5 summarizes the results, focusing on the effects on output and product price for the three sectors, the distribution of income gains, and some macro-economic variables of significant policy interest.

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[7] After some parameter values are substituted and rendered linear, equations (V), (X) and (XI) in Table 3 would then appear as follows (the hat (^) over a variable denotes proportionate change from the base period value):

$$\hat{Q}x4 - .286\hat{L}_4 = .714\hat{K}_4 + \hat{\hat{Q}}x4$$

$$\hat{Q}x8 - .382\hat{L}_8 = .618\hat{K}_8 + \hat{\hat{Q}}x8$$

$$\hat{Q}x9 - .275\hat{L}_9 = .725\hat{K}_9 + \hat{Q}x9$$

where the $\hat{\hat{Q}}_{xi}$'s (i = 4, 8, 9) are exogenous total factor productivity changes in Sectors 4,8, and 9.

[8] The choice of parameter values and the data sources used are described in the Appendix. A write-up on it entitled "Parameterization of the Model," can be obtained from the author upon request.

Table 5
SIMULATION RESULTS

	M-1	M-2	M-3
Sectoral Prices			
Food manufactures, P_{x4}	−7.85	0.44	0.53
Light manufactures, P_{x8}	1.94	−6.63	2.72
Other manufactures, P_{x9}	3.09	1.75	−8.16
Sectoral Output			
Food manufactures, Q_{x4}	3.98	0.35	0.58
Light manufactures, Q_{x8}	1.27	6.02	2.79
Other manufactures, Q_{x9}	1.79	1.01	5.49
Wage Rates			
Agricultural, W_a	2.82	1.16	1.07
Skilled, W_s	1.33	1.78	1.96
Cost-of-living (Col) Index			
Rural, $P_r = \Sigma\phi_{cri}P_{ci}$	−1.99	−0.17	0.46
Urban, $P_u = \Sigma\phi_{cui}P_{ci}$	−1.50	−0.33	0.29
Rural Income			
Nominal, Y_r	2.93	1.59	1.67
COL-adjusted, $Yr \div P_r$	4.93	1.76	1.21
Urban Income			
Nominal, Y_u	3.61	2.27	2.40
COL-adjusted, $Y_u \div P_u$	5.11	2.61	2.11
Government Income, Y_g	2.95	1.45	2.67
Company Income, Y_c	2.19	2.03	1.80
Total Investment, I	2.44	1.58	1.94
National Income, Y $(=V_a + \sum_{i=3}^{10} P_{vi}Q_{xi})$	2.72	1.83	1.64

Note: M-1, M-2, and M-3 refer to the simulation experiments involving a ten percent increase in total factor productivity for sectors 4 (food manufactures), 8 (light manufactures), and 9 (other manufactures), respectively.

Increasing Productivity in Food Manufactures (M-1)

The excess supply of the sectoral product initially created by the 10 percent productivity gain eventually leads to a decline in the domestic price of food manufactures (relative to the general price level) by 7.85 percent and to an increase in sectoral output by 3.98 percent. The real wage rate for skilled workers rises by 1.33 percent while that for agricultural and unskilled workers rises by a much larger 2.83 percent reflecting the strong linkage between the agricultural and food processing sectors.

A bigger decline in the cost-of-living index is observed for rural households than for urban households, owing to the larger share of sector 4 products in rural expenditure. But urban income has a higher increase than rural income, with or without cost-of-living adjustment. Company and government incomes as well as total investment and national income also rise, each by more than 2 percent.

Increasing Productivity in Light Manufactures (M-2)

As shown in the second column of Table 5, there is also an induced deterioration in the sectoral terms of trade. Despite the 6.83 percent decline in the domestic price of industrial consumer goods, sectoral output increases by 6.02 percent. The agricultural wage rate goes up, but by much less than in the previous experiment. On the other hand, the real wage rate for skilled workers is observed to rise by a larger percentage.

The high degree of urban concentration of light manufacturing in the Philippines, in terms of both production and expenditure, is reflected in the much greater income gain for urban households than for rural households, especially after adjusting for changes in the cost-of-living index. The positive effects on company and government incomes, as well as on total investment are seen to be smaller than in the previous experiment. National income increases by 1.83 percent, which is much less than the estimated 2.72 percent gain resulting from the productivity increase in food manufactures.

Increasing Productivity in Other Manufactures (M-3)

There is again a negative terms-of-trade effect where the domestic price of sectoral product falls by 8.16 percent in comparison to the general price level. Sectoral output (of industrial producer goods) increases by 5.49 percent. As in the second experiment, the real wage rate for skilled workers is more than the agricultural wage rate (1.96 against

1.07 percent).

The cost-of-living index is observed to go up for both rural and urban households; this is consistent with the observed decline in the *relative* price of industrial producer goods which implies a price increase in other domestic products including household consumer goods. Even so, COL-adjusted rural and urban incomes are seen to rise, with urban households gaining much more than rural households (2.11 versus 1.21 percent). Company income also increases but in a lesser degree than those in the two previous experiments. By contrast, government income and total investment expand in this simulation by more than in M-2 but by less than in M-1. Most strikingly, the observed rise in national income (1.64 percent) is lowest in comparison with the results obtained in the M-1 and M-2 experiments.

Hooley (1985) has examined empirically the relationship between rates of the total factor productivity (TFP) growth on the one hand and rates of change in product price and output on the other. He uses estimates of productivity growth rates for 25 manufacturing industries at the 3-digit level over the period 1956-80. The elasticity of price with respect to TFP is estimated at –.75. This is well within the range of sectoral elasticities (–.785, –.663, and –.816 for food, light, and other manufactures, respectively) indicated in the above simulation results. As for the elasticity of manufacturing output with respect to TFP, Hooley's estimate of 1.08 is remarkably close to the theoretical value of one implied by a constant returns Cobb-Douglas production function in partial equilibrium analysis. By comparison, the general equilibrium effects of TFP on sectoral output are seen in Table 5 above to indicate elasticity values of .398, .602, and .549 for food, light, and other manufactures, respectively. The negative indirect effect on sectoral output due to the lower product price induced by the productivity increase explains why the latter estimates are each less than one.

Conclusions

The benefits of manufacturing productivity improvement are reflected in the results of the general equilibrium analysis presented above: lower domestic price and higher output of the sectoral product, larger incomes for both rural and urban households, and increased national income, among others. These findings indicate that the quantitative effects can be significantly different among the three manufacturing branches considered in this study. Of particular significance is the relatively more favorable impact of increasing productivity in food manufactures (in comparison to either light manufactures or other manufactures) on the agricultural wage rate, rural income (with or without cost-of-living adjustment), and national income. This can be attributed not only to the larger share of the food processing sector in the country's gross domestic product but also to its stronger linkages to agriculture in production and to the rural population in expenditure.

Another significant finding is that the income gains for urban households are always larger than for rural households, especially when the productivity increase takes place in either of the two non-food manufacturing sectors. This is not at all surprising given the well documented urban bias of Philippine manufacturing (Bautista, Power and Associates 1979). Such unfavorable impact of increasing manufacturing productivity on income distribution warrants special attention, considering the official concern frequently expressed by Philippine policymakers about the need to reduce the existing wide gap in average income levels between rural and urban households.

APPENDIX

Table A1
RURAL AND URBAN HOUSEHOLD ACCOUNTS
(1978 ₱ billion)

	Rural	Urban		Rural	Urban
Total Receipts	61.14	72.67	Total Expenditures	61.14	72.67
Value added	39.28	49.04	Consumption expenditures	57.93	54.06
Sector 1	8.84	0.75	Sector 1	2.29	0.66
Sector 2	7.18	0.61	Sector 2	2.65	1.80
Sector 3	6.93	0.59	Sector 3	6.58	5.05
Sector 4	1.68	3.63	Sector 4	19.24	15.30
Sector 5	—	0.15	Sector 5	—	—
Sector 6	1.52	0.13	Sector 6	0.52	0.46
Sector 7	0.31	0.54	Sector 7	—	—
Sector 8	1.64	3.56	Sector 8	6.20	7.31
Sector 9	1.47	3.17	Sector 9	4.58	6.48
Sector 10	9.71	35.91	Sector 10	15.88	17.00
Transfers from:			Direct taxes	1.88	3.42
Companies	19.95	21.62	Savings	1.33	16.21
Government	1.14	1.70			
Rest-of-the-world	0.77	1.32			

Table A2
COMPANIES ACCOUNT
(1978 ₱ billion)

Total Receipts	61.03
Value added	61.03
Total Expenditures	61.03
Distributed income to:	
Rural households	19.95
Urban households	21.62
Tax payments	2.12
Savings	17.34

Table A3
GOVERNMENT ACCOUNT
(1978 ₱ billion)

Total Receipts	28.54
Value added	4.46
Income tax receipts from:	
Rural households	1.88
Urban households	3.42
Companies	2.12
Other taxes	16.66
Total Expenditures	28.54
Consumption expenditures	17.33
Transfers to:	
Rural households	1.14
Urban households	1.70
Savings	8.37

Table A4
REST-OF-THE WORLD ACCOUNT
(1978 ₱ billion)

Total Receipts	41.32
Exports	31.31
Income transfers to:	
Rural households	0.77
Urban households	1.32
Savings	7.92
Total Expenditures	41.32
Imports	41.32

Table A5
INVESTMENT AND SAVINGS
(1978 ₱ billion)

Total Investment	51.17
Total Savings	51.17
Rural households	1.33
Urban households	16.21
Companies	17.34
Government	8.37
Rest-of-the-world	7.92

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