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ANNE

FOR HER CONTINUED SUPPORT

PREFACE

The bulk of this dissertation was accomplished with the help of facilities provided by Concordia University in Montreal. Computations recorded in this study were undertaken on the University's CDC 6000 computer using the programme, Time Series Processor (TSP), Version 3.0.

In preparing the dissertation, invaluable assistance was provided by members of the Economics Department of Concordia University, especially by Professor Vittorio Corbo, my thesis supervisor, and by Professors Jaleel Ahmad and Eckhard Siggel, members of the thesis committee. Their efforts on my behalf are deeply appreciated. In addition, I would like to express my gratitude to Professor Albert Berry of the University of Toronto whose generous assistance in providing and interpreting data on Colombia contributed enormously to the final product. Finally, I would like to thank my sister, Rosalind Cook, and Merle Christie of the University of Lethbridge for their superlative typing efforts.

Any shortcomings which continue to exist in this study reflect the inadequacy of the author.

CONTENTS

LIST OF TABLES

LIST OF SYMBOLS USED*

VARIABLES

CHAPTER 3

E_i Employment of labour in the production of the i^{th} crop at domestic prices

$\bar{E}_i$ Employment of labour forthcoming when production of the i^{th} crop occurs at world prices

E_a Total agricultural employment of labour at domestic prices

$\bar{E}_a$ Total agricultural labour employment forthcoming at world prices

E_m Employment levels in factory manufacturing observed at domestic prices

$\bar{E}_m$ Employment in factory manufacturing forthcoming if production had occurred at world prices

L^* The urban manufacturing labour force excluding new migrants

M Observed internal rural-urban migration occurring in response to domestic prices

$\bar{M}$ The level of internal migration occurring in response to world prices

P_i Producer domestic price of the i^{th} crop

P_m The domestic price of aggregate factory manufacturing output

$\bar{P}_i$ The producer price of the i^{th} crop expressed in world prices

*In the following alphabetic list of variables, the subscript 't' (referring to time) is suppressed. The Greek-lettered variables appear at the end of the listing for each chapter.

$\bar{P}_m$ The price of aggregate factory manufacturing output expressed in the world price equivalent

P_i^* The internal terms of trade expressed in domestic prices faced by producers of the i^{th} crop

$\dot{P}_a$ The percentage difference between the price of aggregate agricultural output expressed in world prices and the price expressed in domestic prices

$\dot{P}_m$ The percentage difference between the price of manufacturing output expressed in world prices and the price expressed in distorted domestic prices

$\dot{P}_i^*$ The percentage difference between the internal terms of trade expressed in world relative prices and the terms of trade expressed in domestic prices

Q_{ik} Output of the i^{th} crop ($i = 1,2,\ldots,m$) produced by the k^{th} farm ($k = 1,2,\ldots,K$)

Q_m Aggregate output of the factory manufacturing sector

Q_i Total output of the i^{th} crop forthcoming at existing or domestic prices

$\bar{Q}_i$ Total output of the i^{th} crop forthcoming at world prices

Q_a Total agricultural output forthcoming at domestic prices

$\bar{Q}_a$ Total agricultural output forthcoming at world prices

$\bar{Q}_m$ Aggregate manufacturing output forthcoming at world prices

r_i Price of the i^{th} input employed in factory manufacturing

U Factory manufacturing unemployment observed at domestic prices

$\bar{U}$ Factory manufacturing unemployment forthcoming if output in both the agricultural and manufacturing sectors had occurred in response to world prices

v_j Price of the j^{th} input ($j = 1,2,\ldots,r-1,r,r+1,\ldots,n$)

W_i $(i = 1,2,\ldots,n)$. Other non-economic factors affecting the migration decision

X_{ikj} $(j = 1,2,\ldots,r-1)$. The j^{th} variable input employed by the k^{th} farm in the production of the i^{th} crop

X_{ikj} $(j = r)$. Non-crop specific land available to the k^{th} farm in the production of the i^{th} crop

X_{ikj} $(j = r+1, r+2,\ldots,n)$. Crop specific land available to the k^{th} farm in the production of the i^{th} crop

Y_i Income of producers of the i^{th} crop in terms of domestic prices

$\bar{Y}_i$ Income of producers of the i^{th} crop forthcoming if production had occurred at world prices

Y_a Total agricultural income expressed in terms of domestic prices

$\bar{Y}_a$ Total agricultural income forthcoming if production had occurred at world prices

Y_m Factor income in factory manufacturing expressed in domestic prices

$\bar{Y}_m$ Factor income in factory manufacturing forthcoming if production had occurred at world prices

Y_k Observed income accruing to the k^{th} income class in response to domestic prices

$\bar{Y}_k$ Income accruing to the k^{th} income class if production had occurred at world prices

Y_{ik} Observed income accruing to producers of the i^{th} crop who are in the k^{th} income class

$\bar{Y}_{ik}$ Income accruing to producers of the i^{th} crop who are in the k^{th} income class in response to production occurring at world prices

Y_{mk} Observed income accruing to factors in the k^{th} income class employed in factory manufacturing

	$\bar{Y}_{mk}$	Income accruing to factors in the k^{th} income class employed in factory manufacturing in response to production occurring at world prices
	Y_{0k}	Observed income accruing to the kth income class not employed in either agriculture or factory manufacturing
	$\tilde{Y}_m$	Average factory manufacturing labour income existing at domestic prices
	$\tilde{Y}_a$	Average agricultural labour income existing at domestic prices
	$\bar{\tilde{Y}}_m$	Average factory manufacturing labour income occurring in response to world prices
	$\bar{\tilde{Y}}_a$	Average agricultural labour income forthcoming as a result of production occurring at world prices
	Z_i	The i^{th} input employed in factory manufacturing (i = 1,2,3,4)
	λ_{ik}	The Lagrangian multiplier applicable to the production of the i^{th} crop by the k^{th} farm
	λ_m	The Lagrangian multiplier applicable to the factory manufacturing sector
	π_k	Profits of the k^{th} farm
	π_k^*	The constrained profit maximization Lagrangian of the k^{th} farm
	π_m	Profits of factory manufacturing
	π_m^*	The constrained profit maximization Lagrangian of the factory manufacturing sector
CHAPTER 4	H	Observed area planted with a given crop
	H^D	"Desired" area planted with a given crop
	HC	Observed area devoted to coffee cultivation
	HN^B	Observed area devoted to the cultivation of non-coffee crops in Colombia

HCOR	Observed area devoted to the cultivation of corn
HCOT	Observed area devoted to the cultivation of cotton
HPAN	Observed area devoted to the cultivation of panela
HPLA	Observed area devoted to the cultivation of platano
HPOT	Observed area devoted to the cultivation of potatoes
HRIC	Observed area devoted to the cultivation of rice
HYUC	Observed area devoted to the cultivation of yucca
P_i	As defined in Chapter 3
P_i^E	"Expected" producer price of the i^{th} crop deflated by the price of aggregate manufacturing output
PC	Observed producer price of coffee
PM	Observed price of aggregate factory manufacturing output
PN	Observed price of non-coffee crops
PNI	Observed price of intermediate inputs employed in the cultivation of non-coffee crops
PS	Observed producer price of cane to make centrifugal sugar
PCOR	Observed producer price of corn
PCOT	Observed producer price of cotton
PPAN	Observed producer price of panela
PPLA	Observed producer price of platano
PPOT	Observed producer price of potatoes
PRIC	Observed producer price of rice
PYUC	Observed producer price of yucca
Q_i^D	"Desired" output of the i^{th} crop
T	A trend variable
u	Regression residual

	v'	Regression residual
	v_j	As defined in Chapter 3
	VN	Observed user cost of capital employed in the cultivation of non-coffee crops
	WA	Observed average agricultural daily money wage rate
	Y_i	Observed yield of the i^{th} crop
	YN	Observed yields of non-coffee crops (total non-coffee crop output over HN^B)
	YCOR	Observed yield of corn
	YCOT	Observed yield of cotton
	YPOT	Observed yield of potatoes
	YPLA	Observed yield of platano
	Z_i	As defined in Chapter 3
CHAPTER 5	HS	Observed value of the Colombian cattle herd expressed in constant Colombian pesos.
	PL	Observed producer price of livestock-derived products
	PLI	Observed price of intermediate inputs employed in raising cattle
	PM	As defined in Chapter 4
	QL	Observed output of livestock-derived products
	YL	Observed yield of livestock-derived products (output per cow).
CHAPTER 6	H	Area devoted to the cultivation of a perennial crop
	H^D	"Desired" area devoted to the cultivation of a perennial crop
	HC	Observed area devoted to the cultivation of coffee
	P	Producer price of a perennial crop

	P^E	"Expected" producer price of a perennial crop
	$\bar{P}$	Sum of discounted future expected prices of a perennial crop
	P^*	Observed producer price of coffee over the price of aggregate manufacturing output
	Q	Output of a perennial crop
	Q^*	"Potential" output of a perennial crop
	QC	Observed output of coffee
	T^D	"Desired" stock of trees producing a perennial crop
	T	Stock of trees yielding a perennial crop
	u	Regression residuals
	v	Regression residuals
	$\tilde{v}$	Regression residuals
	w	Regression residuals
	Y_i	Yield or output of a perennial crop per tree
	Z_i	Variables other than price influencing the supply of a perennial crop
CHAPTER 7	KM	Observed value of factory manufacturing capital stock expressed in constant Colombian pesos
	P_m	As defined in Chapter 3
	P_{VA}	Price of factory manufacturing value added
	PM	As defined in Chapter 4
	PMI	Observed price of all intermediate inputs employed in factory manufacturing
	PMAI	Observed price of intermediate inputs originating in the agricultural sector and employed in factory manufacturing
	PMOI	Observed price of non-agricultural intermediate inputs employed in factory manufacturing

	PVAM	Observed price of factory manufacturing value added
	$\bar{Q}_m$	As defined in Chapter 3
	r_i	As defined in Chapter 3
	VA_m	Value added of the factory manufacturing sector
	VM	Observed user cost of factory manufacturing capital stock
	WM	Observed hourly money wage rate (incl. fringe benefits) in factory manufacturing
	Z_i	As defined in Chapter 3
	λ_{VA}	The Lagrangian multiplier applicable to value added in the factor manufacturing sector
	π^*_{VA}	The constrained profit maximization Lagrangian from which the value added manufacturing supply function is derived
	π_{VA}	Factory manufacturing profits
CHAPTER 8	E_i	As defined in Chapter 3
	$\bar{E}_i$	As defined in Chapter 3
	E_m	As defined in Chapter 3
	$\bar{E}_m$	As defined in Chapter 3
	n	Labour employment in factory manufacturing per unit of output
	P_i	As defined in Chapter 3
	$\dot{P}_i$	As defined in Chapter 3
	$\dot{P}_a$	As defined in Chapter 3
	$\dot{P}_m$	As defined in Chapter 3
	$\dot{PC}$	Percentage gap between the observed domestic price and the world price of coffee
	$\dot{PL}$	Percentage gap between the observed domestic price and the world price of livestock-derived products

	PCOT	Percentage gap between the observed domestic price and the world price of cotton
	Q_i	As defined in Chapter 3
	$\bar{Q}_i$	As defined in Chapter 3
	Q_m	As defined in Chapter 3
	$\bar{Q}^*_m$	As defined in Chapter 3
	Y_i	As defined in Chapter 3
	$\bar{Y}_i$	As defined in Chapter 3
CHAPTER 10	DUM	Dummy variable reflecting years in which violence pervaded rural Colombia
	DW	Factory manufacturing-agricultural wage rate differential
	E	As defined in Chapter 3
	L	As defined in Chapter 3
	M	As defined in Chapter 3
	m	Rate of rural-urban migration of economically active males
	PROB	Observed probability of obtaining employment in factory manufacturing
	U	As defined in Chapter 3
	W_i	As defined in Chapter 3
	WA	As defined in Chapter 4
	WM	As defined in Chapter 7
	$\overline{WA}$	Observed daily agricultural real wage rate
	$\overline{WM}$	Observed daily factory manufacturing real wage rate including fringe benefits
	WA^E	Expected future daily agricultural money wage rate
	WM^E	Expected future daily factory manufacturing money wage rate including fringe benefits

$\bar{\bar{WA}}^E$ Expected future daily agricultural real wage rate

$\bar{\bar{WM}}^E$ Expected future daily factory manufacturing real wage rate including fringe benefits

Y_m As defined in Chapter 3

Y_a As defined in Chapter 3

δ Net percentage increase in factory manufacturing employment

ρ Probability of obtaining employment in the factory manufacturing sector

μ Regression residual

<u>PARAMETERS</u>

CHAPTER 3

a_i The elasticity of the price of the i^{th} input employed in factory manufacturing with respect to the price of factory manufacturing output

a_{ij} Leontief input-output coefficients for the agricultural sector

α_{ij} The elasticity of supply of the i^{th} crop with respect to the price of the j^{th} input

b_i Leontief input-output coefficients for the manufacturing sector

b_{am} The ratio of the percentage change in the price of agricultural inputs employed in factor manufacturing to that of the price of aggregate manufacturing output

β_{ji} The ratio of the percentage change in the price of the j^{th} input employed over that of the i^{th} crop

β_{ik} The proportion of producers of the i^{th} crop found in the k^{th} income class

β_{mk} The proportion of factors employed in factory manufacturing found in the k^{th} income class

δ_i The ratio of the output of the i^{th} crop to total

E_{ii}	The total price elasticity of supply of the i^{th} crop
ε_{ii}	The own price elasticity of supply of the i^{th} crop
ε_{ih}	The cross price elasticity of supply of the i^{th} crop with respect to the price of the h^{th} crop
E_m	The total price elasticity of supply of aggregate factory manufacturing output
e_m	The own price elasticity of supply of aggregate factory manufacturing output
e_a	The elasticity of supply of aggregate manufacturing output with respect to the price of agricultural inputs employed
$\bar{e}_i$	The elasticity of supply of aggregate manufacturing output with respect to the price of the i^{th} input employed
η_{hi}	$(h \neq i)$. The ratio of the percentage change in the price of the h^{th} crop over that of the i^{th} crop
η_k	The accumulated percentage of income earners in the k^{th} income class
r	Discount rate
T,t	A parameter reflecting technological change
ψ	The elasticity of rural-urban migration with respect to average manufacturing-agricultural labour income differentials

CHAPTER 4

A	Nerlove area adjustment coefficient
$\hat{A}$	Estimated value of A
α_i	Regression coefficients
β_i	Regression coefficients
γ_i	Regression coefficients
E	Nerlove price expectations coefficient

	$\hat{E}$	Estimated value of E
	$\hat{RHO}$	Estimated value of the coefficient of autocorrelation
CHAPTER 5	$\hat{A}$	As defined in Chapter 4
	$\hat{E}$	As defined in Chapter 4
	$\hat{RHO}$	As defined in Chapter 4
CHAPTER 6	$\hat{A}$	As defined in Chapter 4
	α_i	Regression coefficients
	β_i	Regression coefficients
	γ_i	Regression coefficients
	$\hat{E}$	As defined in Chapter 4
	h	rate of discount
	k	Output of coffee per tree of a given vintage
	ϕ_i	Regression coefficients
CHAPTER 7	$\hat{A}$	As defined in Chapter 4
CHAPTER 8	a_{ij}	As defined in Chapter 3
	α_i	Ratio of agricultural sector originating inputs to total intermediate inputs employed in manufacturing
	b_i	Employment of labour per unit of output of the i^{th} crop or livestock-derived products
	e_m	As defined in Chapter 3
	e_I	Elasticity of manufacturing output with respect to the price of all intermediate inputs
	E_{ii}	As defined in Chapter 3
CHAPTER 10	β_i	Regression coefficients
	$\xi_\rho, \bar{\xi}_\rho$	Elasticities of migration with respect to ρ, the

$\xi_\rho^*, \bar{\xi}_\rho^*$	Threshold values of ξ_ρ and $\bar{\xi}_\rho$
$\hat{\xi}_\rho, \hat{\bar{\xi}}_\rho$	Estimated values of ξ_ρ and $\bar{\xi}_\rho$
r	Rate of discount

INTRODUCTION TO AND OBJECTIVES OF THE STUDY

The origins of the development strategy which has come to be called "import substitution" can be traced back to two major events; the great depression and the second world war.[1] For many of the developing countries at the time,[2] the depression had a devastating impact on their exports and capital inflows and ultimately on their foreign exchange earnings.[3] The result was a substantial decline in the quantity of imported goods which could be financed with the available foreign exchange earnings. The advent of the second world war had a similar effect on their imports but for an entirely different set of reasons. Throughout the war, export demand for their primary products was bouyant and foreign exchange earnings were sufficient to afford virtually any level of imports desired. However, goods which would have been imported were just not available and the foreign exchange was left to accumulate for lack of

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[1]Discussion at this point is principally drawn from Little, Scitovsky, and Scott (1970) and Helleiner (1972). Other less fundamental backgrounds for import substitution, of course, exist. It has been argued that import substitution is in part a result of the "natural" growth process; that it is partly a product of continued balance of payments pressure; and that it is also in response to tariffs imposed at an early period on luxury goods which provided the incentive for local manufacture (Helleiner 1972, pp. 98-101).

[2]The most important of which were Argentina, Brazil, Mexico and British India.

[3]The effect on these countries was of course compounded by the fact that a large part of their consumer and intermediate goods and virtually all of their capital goods were imported.

goods on which to spend it.[4]

Following the war, there existed, therefore, two pre-conditions which eventually led to the import substitution strategy. The first was the pent-up demand for consumer goods, coupled with the accumulated funds to pay for the imported raw materials and capital goods needed for their production. Secondly and more significantly, there was "the desire for self-sufficiency and economic independence born out of the experience of depression and war" (Little, Scitovsky and Scott 1970, p. 34). Since the war, import substitution has become to some extent the premier development strategy of much of the developing world.

In those countries which have pursued import substitution, the initially observed increases in the rate of growth of national output were, to say the least, impressive. However, the successful implementation as well as the continued survival of the import substitution process required the deliberate and simultaneous introduction of a set of policies designed to protect the newly formed industrial enterprises. The policies were mainly centered around the restriction of imports of manufactured goods through the use of tariffs, quotas, import licensing

[4] To help compensate for the sharp decline in the supply of imported manufactured goods, existing industrial capacity was more intensely and efficiently utilized, leading to substantial increases in wartime industrial output in such countries as Mexico (47 percent), Brazil (36 percent), Argentina (24 percent) and British India (20 percent) (Little, Scitovsky and Scott 1970, p. 32).

and foreign exchange controls.[5] Supplementary measures such as low interest rates, multiple exchange rates and wage subsidies were also utilized to promote the success of import substitution.

The economic justification for these protective policies was based in part on the extension of the "infant industry argument" to the economy as a whole. Such measures, it was argued, would provide the protection needed while the country acquired the skills needed to manage an industrialized economy. Presumably when the economy "matures", the need for such measures would cease to exist and would be withdrawn. The date of maturity would no doubt coincide with the economy's ability to withstand international competition.

Up until about the mid-1960's, it would be safe to say that most traditional economists tended to think that the growth strategy of import substitution was sufficiently compatible with other policy objectives that emphasis on measures to increase per capita GNP would more or less move the typical developing country up the ladder of economic and social development. For almost all developing countries, events have proved otherwise. Since then, it has become increasingly clear that while most countries have achieved what appear to be satisfactory rates of growth at least in the initial stages of import substitution (the growth rates declined substantially as the "easy" stage of import substitution was completed),

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[5]The extent of both nominal and effective average tariff protection on manufactures have been estimated for a number of countries in a set of studies carried out by the OECD summarized in Little, Scott, and Scitovsky (1970), the NBER under the direction of Bhagwati and Krueger, and by B. Balassa and Associates (in "The Structure of Protection in Developing Countries", 1971). For example, Little, Scitovsky and Scott (Table 5.1 and Table 5.2) found that the average nominal rate ranged between 22 percent (Mexico) and 41 percent (Argentina) while the average effective rate ranged between 27 percent (Mexico) and 31 percent (India). These average effective rates hid a number of unbelievably high rates for some industries.

the costs in terms of inefficient production, foregone exports, rising unemployment and continuing poverty have been significant in many.[6]

It has now been generally recognized that the development effort in terms of the pursuit of a general growth strategy has failed in four principal areas:

1) the long-term dynamics of the growth process
2) balanced sectoral growth
3) income redistribution
4) the creation of sufficient employment opportunities.

These development failures did not entirely emerge by themselves but were partly a result of the set of policy measures required to ensure the successful introduction and survival of import substitution industrialization. One of the more serious consequences of these measures is that they often so severely distorted the system of economic incentives that existing product and factor prices bore little semblance to existing scarcities. Specifically, such measures have led to three principal sets of price distortions: the price of capital and labour services relative to their equilibrium values, the price of foreign currency per unit of domestic currency in relation to its "equilibrium" value, and the ratio of the domestic price of agricultural goods to the domestic price of manufactured goods relative to the same ratio but expressed in world prices. It is the

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[6] A number of developing countries (Korea, Taiwan, Pakistan, for example) are already aware of the costs entailed in the import substitution regime and entered some time ago what is called the "export promotion" phase of development, pursuing a more "liberal" trade policy, including the readjustment of distorted relative price to correspond more with their respective shadow values. These readjustments have had a beneficial effect on labour absorption, inter-sectoral income distribution, agricultural output and on exports (Ranis 1971). Moreover, many other countries particularly in Latin America are becoming increasingly aware of these costs and have reconsidered or are now reconsidering past policies with view to "opening up" their respective economies.

contention of this study that of the three sets of price distortions, that of the last one may have had the more serious consequences.[7]

One of the immediate consequences of the distortions in the internal or domestic terms of trade (TOT) may have been their effects on agricultural output and incomes by destroying one of the principal incentives to expanding agricultural output. The important empirical question, of course, is to what extent the slow growth and stagnation found in the agricultural sectors of much of the third world can be traced to such policy-induced TOT distortions. The burden of agricultural stagnation has, of course, largely fallen on those who earn their living in the agricultural sector but also on those who have migrated to urban centres in search of jobs which were just not available. It may also be reflected in a lack of any real long-run improvement in living standards of a large part of the population, in the continuing highly skewed, and in some countries increasingly unequal, patterns of income distribution, and in the high levels of disguised unemployment found in rural areas as well as in the unacceptable numbers of unemployed in urban centres.

Despite this there does not appear to have been any empirical investigation which attempts to quantify the impact that distortions in relative intersectoral commodity prices may have had on these important indexes of economic and social development. Such investigations would seem imperative if we are to have some indication of the importance of the role agriculture plays in the development process and more importantly if we are to have some quantitative measure of some of the costs entailed in

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[7]The last price ratio is commonly referred to as the internal or domestic terms of trade (TOT).

implementing the development strategy of import substitution. Using a country case study approach, the objective of this study will involve an attempt to measure such costs. Within the overall framework of a dualistic model, this study will try to obtain some measure of the following:[8]

1) the cost of TOT distortions in terms of lost agricultural output;
2) given the impact of the TOT distortions on agricultural output, the cost in terms of lost opportunities for rural employment;
3) given the extent of TOT distortions and their impact on agricultural output, the consequences for agricultural incomes and for the patterns of sectoral and national income distribution;
4) the cost in terms of the urban unemployment arising out of the effect increasing urban/rural income differentials have had on migration and the supply of labour to the industrial sector.

Clearly, the significance of these costs depends on the extent to which the TOT distortions exist and the responsiveness of agricultural output or supply to changes in relative prices. The most acceptable method of measuring the extent of TOT distortions is to compare existing TOT with the TOT the agricultural sector would face if it were allowed to trade directly with the outside world. Once the distortions have been measured, then their ultimate impact would largely depend on the supply responsiveness of the agricultural sector.[9]

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[8] This study will be concerned with the comparative static impact of TOT distortions on agricultural output, incomes, income distribution, and rural and urban unemployment. It is not proposed that any of the dynamic implications be tested, such as that of the much-discussed effect on growth of the redistribution of income.

[9] Of course, even if the supply elasticities turn out to be not significantly different from zero, the costs in terms of lost agricultural incomes, income distribution and urban unemployment would still exist, although such loses may be partly offset by gains elsewhere.

The country selected for study, it is felt, must exhibit three characteristics. First, it must be essentially dualistic in nature. Secondly, it must be characterized by a history of policy-induced relative price distortions. Finally, it must have a reasonably developed national statistical service. Colombia stands up reasonably well against these characteristics. Moreover, it is interesting to note that after 45 years of trade restrictions Colombia has in the last ten years or so come to recognize some of the costs such restrictions have or would have entailed and has pursued a policy of liberalization of its foreign trade sector.

If one were to look for a social "raison d'etre" for this study, all one has to do is realize that import substitution as acceptable development strategy is by no means a dead issue. There are a number of countries, especially in Africa, lower down on the development scale than Colombia, which are at present in the process of implementing or are actively engaged in developing a regime of import substitution industrialization behind a wall of highly protectionist policies. It would therefore seem valuable if some empirical substance can be given to some of the costs involved in such policies, particularly if they involve a country whose development for a long period was largely hinged on import substitution and which has since made efforts to return to export-led growth policies.

The policy implications which could potentially arise out of this study may be especially significant. If one views movements up the ladder of economic and social development as something more than just industrialization for its own sake coupled with a spurt in the growth of national output for a decade or so, then import substitution and the trade restricting policies which accompany it, as a long-run development strategy, must be regarded as having severe limitations.

The emphasis in the literature has traditionally been on the benefits of industrialization and it has only been in the last decade that development economists have become aware of some of the costs involved in the types of policies required to ensure the survival of such industrialization programmes. The principal implication which could follow is that in the long-run a successful development strategy may require a fostering of comparative advantage rather than its disavowal.

The rest of this thesis consists of ten chapters. Chapter one surveys the literature on the various aspects of the interaction between the agricultural and manufacturing sectors in the development process, with particular emphasis on the hypothesized effects of policy-induced relative price distortions on the agricultural sectors of third world countries. In Chapter two, we telescope into a Colombian context much of the discussion contained in the previous chapter with a brief review, from a sectoral point of view, of the Colombian economy. However, the bulk of the Chapter will be concerned with the estimation of commodity price distortions in Colombia coupled with a review of the trade policies which led to their existence. Chapter three contains the model upon which the empirical work is based.

Chapters four, five, and six are concerned with the econometric estimation of supply responsiveness in Colombian agriculture. Chapter four focuses on the estimation of the supply responsiveness of the seven principal non-coffee crops cultivated in Colombia, while Chapter five involves the estimation of the supply responsiveness of livestock-derived products. Chapter six investigates the supply responsiveness of Colombian coffee growers. Chapter seven also involves the econometric estimation of supply responsiveness but in this case it is that of manufactured goods produced in the modern (or factory) manufacturing sector.

Chapters eight, nine, and ten are concerned with the impact TOT distortions have had on the Colombian economy. In Chapter eight, we estimate the effects of these distortions on agricultural and manufacturing output, incomes, and employment, while in Chapter nine, an attempt is made to measure the impact the commodity price distortions have had on sectoral as well as national income distribution patterns. Chapter ten begins with an econometric estimation of a migration response function for Colombia and concludes with an estimate of the impact commodity price distortions have had on relative sectoral incomes and hence on the level of internal migration. The study concludes with a summary of the results obtained and with an examination of their policy implications.

Before proceeding further, a caveat is perhaps warranted. The approach used in this study to estimate the supply responsiveness of the various crops is essentially a partial equilibrium one. This means we have abstracted from the possibility that the total availability of arable land may act as a constraint in the agricultural production process. If so, then the estimated elasticities would tend to be biased upward. The choice of a partial rather than a general equilibrium approach can be justified on several grounds. The first is that at the time the estimations were undertaken, there was considerable doubt as to whether the available data would allow much more than a partial equilibrium approach. Secondly, the use of a general equilibrium model in which supply functions of competing crops would be estimated simultaneously would involve certain problems. First, many of the crops which compete for land with the crops estimated in this study did not involve output values sufficiently large to justify their inclusion for purposes of this study. Secondly, the substitution possibilities among the important crops considered here were not thought to be that strong or that unique to warrant a general equilibrium approach. Moreover, test regressions in which the prices of potential competing crops were included in different specifications of the various supply functions indicated cross elasticities not significantly different from zero. A final justification for a partial equilibrium approach can be made on the basis of the Colombian Government's policy over the period studied here of encouraging agricultural area expansion both in the settled and frontier parts of the Country. The results of this policy can be seen in the fact that, with few exceptions, area and output expansion was common for all crops over the period. This observation would not be entirely consistent with a situation in which land is a binding constraint. While we might expect some upward bias in the elasticity estimates for the individual crops, it is thought that given the foregoing, the bias would tend to be rather small.

CHAPTER 1

SURVEY OF THE LITERATURE

1.1 INTRODUCTION

It is proposed in this Chapter to explore that part of the development literature which has concerned itself with the interactions between agriculture and manufacturing that occur as development progresses. Our main focus will be on the effects that the distortions in the TOT, arising from the trade policies accompanying import substitution industrialization, may have had on: 1) agricultural output and employment, 2) inter- and intra-sectoral income distribution and, 3) internal migration and urban unemployment. Each of these in some way represents a real problem to many third world countries. The Chapter will conclude with a survey of "dualistic" growth models which provide the theoretical framework within which agriculture/industry interactions are usually analyzed.

For purposes of this study, the TOT would be said to be distorted against the agricultural sector if:

$$(P_A/P_M)_D < (P_A/P_M)_W \qquad (1.1)$$

where P_A and P_M are the prices of agricultural and manufacturing goods, respectively while the 'D' and the 'W' refer to 'domestic' and 'world', respectively. Two comments are warranted as this point. First, distortions in relative commodity prices are found in most countries, although in some, particularly among EEC members, the distortion may be the other way, that is, against manufacturing. However, the distortions tend to be largest in developing countries. Secondly, a good case can be made to the effect that for developing countries some bias against agriculture is justified, if not desirable, particularly in the form of taxes on agricultural exports facing inelastic demand curves and on certain manufactures consumed by farmers (Little, Scitovsky and Scott 1970). However, "some bias" may be considerably different from existing biases.

Trade restricting import substitution industrialization is, of course, neither a necessary nor a sufficient condition for the existence of distortions which turn the TOT against the agricultural sector. For example, despite considerable import substitution during the 1950's and 1960's, there was no evidence of TOT distortions against agriculture in Turkey throughout that period (Krueger 1974). This could reflect the existence of other policies relating specifically to agriculture which prevented the TOT from turning against agriculture.

While there has been some investigation into movements in the TOT with respect to such countries as Argentina, Pakistan, India, the Philippines, Brazil, Taiwan, and Japan (Little, Scitovsky, and Scott 1970, pp. 346-351), there appear to be few studies which attempt to measure the extent of distortions in the TOT in individual countries. One exception is Lewis' study on Pakistan (Lewis 1968).

Lewis begins with the concept of an implicit exchange rate which he defines as the ratio between the domestic wholesale price of a commodity in local currency and the foreign price of the same item, at the port of entry or exit in some international currency. Thus the existence of trade restrictions would result in differences between the implicit exchange rate and the official exchange rate. The ratio of the average implicit exchange rates of agricultural and manufactured goods would, therefore, indicate the ratio of the existing TOT to the TOT agriculture would enjoy if it could trade directly in international markets, assuming infinite elasticity of world offer curves. Since exports are largely agricultural goods and imports mainly manufactures, any trade restrictions on imports would clearly indicate a turning of the internal terms of trade against agriculture.

Lewis found that in the mid-1950's agriculture received about 50 percent of the value its sales would have earned if it could have traded at international prices. The corresponding mid-1960's figure was 65 percent reflecting the trade liberalization which had occurred in the interim. Some criticisms have been levelled at Lewis' study. It has been argued that the distortions in the TOT were mainly the result of declines in the price of agricultural output rather than increases in the price of manufactures and that the effect on real agricultural income of any change in the price of manufactures is relatively small since the part of agricultural income spent on manufactures (particularly that of large scale industry) is small (Soligo 1971).

The existence and extent of TOT distortions in the Colombian economy are discussed in the next chapter.

1.2 AGRICULTURAL OUTPUT

A study of the consequences of TOT distortions for development must begin with an assessment of their impact on the growth of agricultural output. The impressive overall growth rates enjoyed by many developing countries, at least in the initial stages of import substitution, hide the fact that contributions by individual sectors within the economy vary enormously. Agriculture's contribution has lagged well behind that made by the modern industrial sector. The significance of this is re-inforced when one considers that in almost all developing countries, agriculture is the principal economic activity and in some countries the only industry of any consequence.[1] It will be argued that the slow growth of agricultural output in many developing countries may in part be the result of those trade policies which were needed to ensure the successful introduction of import substitution, and which led to the turning of the TOT against agriculture.[2]

Economists and policy-makers have traditionally viewed third world agriculture as a sort of "purgatory" in which the bulk of the population survive at the subsistence level while awaiting the "call" of the developing industrial sector. However, the fact that import substitution does seem to get bogged down (usually at the consumer durables level) may indicate the folly of a neglected agricultural sector and the existence of some "critical minimum rate of agricultural growth" (Krishna 1967, p. 500). The failure to achieve this minimum in many developing countries can and has had the following consequences (Mellor 1967, 1974, Mellor and Lele 1972, Falcon 1970, and others):

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[1]On an average approximately 40 to 50 percent of GNP is agricultural production and about 50 to 80 percent of the economically active population is engaged in agricultural activities of some kind (Johnston and Mellor 1961).

[2]In addition to tariffs, import licencing and foreign exchange controls on manufactured goods, there have been other devices which have affected the prices received by farmers relative to the prices they pay for manufactures. These include export taxes, marketing boards, overvalued exchange rates and imports of PL 480 surpluses. The first three discourage exports of agricultural goods; the first two by reducing the price received by the farmer below the international trade price and the third by reducing the return to farmers in terms of domestic currency for a unit of exported agricultural goods. There is, of course, historical precedent for neglecting the agricultural sector in the structural transformation of economies. The best discussion of the factors which have traditionally been responsible for the secular decline of the agricultural sector as development proceeds is found in Johnston (1970).

1) it has prevented agriculture from providing all of the additional food supplies required as urbanization and industrialization proceeds.[3]
2) it has retarded the export of cash crops, the main source of foreign exchange needed to help finance industrial development.
3) it has reduced the agricultural sector's ability to contribute to the economy's capital formation.
4) it has led to the neglect of agriculture's role as an existing market for the output of the expanding industrial sector.
5) it has hindered the exploitation of comparative advantage.

The developing world is, of course, not unaware of such arguments but "the typical response, however, has not been to turn the TOT sharply in favour of agriculture but to raise the price of particular items in short supply" (Griffin 1974, p. 195). Specifically, a number of countries support domestic foodgrain prices at levels well above world prices within the framework of an overall policy of turning the TOT generally against agriculture. The ultimate goal has been foodgrain self-sufficiency, and in some countries (Pakistan, India, Mexico, for example) progress has been made toward this objective. In part, the decision by a number of countries to support domestic foodgrain prices was taken initially to encourage their respective agricultural sectors to respond in the right direction to the new foodgrain technology which became available in the early 1960's. This new technology has come to be

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[3]While the general development literature has duly recognized the importance of the wage-good constraint on industrial development, there seems to be a failure to recognize that food in a population largely at the subsistence level is by far the most important wage-good. This is rather surprising since the principal implication of the dual model is that industrialization can be stifled if adequate agricultural surpluses are not forthcoming.

called the "green revolution".[4] Despite its yield-increasing benefits, however, the "green revolution" has been introduced in relatively few countries (mainly South-East Asia). There is some evidence that it has not been introduced in a geographically more widespread manner because most countries have not seen fit to implement the measures needed to provide the necessary incentives. It would not make much sense to introduce the new technology "while simultaneously operating in incentive system which discriminates against its use..." (Stewart 1974, p. 104).

In analyzing subsistence farm behaviour in developing countries, one must recognize the dominance of the family farm and that it is the household and not the individual which must be the focus of analysis.[5] This means that individual farm units act as both a unit of production and a unit of consumption. Thus decisions with respect to resource allocation involve "a subjective equilibrium between household and business considerations" (Mellor 1967, p. 37). In modelling the determinants of supply in subsistence agriculture, the tendency, therefore,

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[4]The literature on the "green revolution" is enormous (for example, Falcon 1972, Johnston and Cowie 1969, Johnston and Mellor 1961, Mellor 1967, Johnston and Kilby 1974, Shaw 1970, and Gotsch 1974). It is interesting to note the differences in the flavour of the early literature (early 1960's) and that of the later literature (early 1970's). In effect the promise has exceeded the reality. Despite substantial increases in foodgrain output in areas where the "revolution" has been introduced, it plus the price supports that accompanied it has enhanced the position of the larger foodgrain growers relative to other farmers leading to serious regional and income imbalances as well as discouraging product diversification. Moreover, foodgrains (with the exception of rice) are potentially one of the least labour using of all agricultural activities.

[5]Individual incomes in most traditional subsistence agricultural societies are based on some sort of sharing mechanism and as long as the individual performed some accepted role within the extended family, he received a share of the output.

has been to focus primarily on the behaviour of the farmer with respect to the allocation of the available time between work (or consumption) and leisure.[6] Given the production function, the decision for a small family-oriented farm essentially comes down to comparing the decline in utility of giving up leisure for work with the increase in utility derived from the consumption of more goods and services gained through increases in labour effort.[7]

Economists concerned with the agricultural sector of developing countries have been interested in three main kinds of responsiveness with respect to relative prices: 1) area or supply responsiveness of a single crop, 2) marketed supply (the difference between total supply and on-farm consumption) responsiveness of a single crop and, 3) aggregate agricultural output or supply responsiveness. By far most empirical work has been concerned with how farmers respond to changes in relative crop prices by shifting area amongst individual crops. The results of these studies have almost universally indicated considerable responsiveness with significant non-negative estimates of both the short-run and the

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[6]This approach would not be appropriate for the market oriented family farm. In such an agricultural framework the usual profit maximization, rather than utility maximization, criteria would be applicable.

[7]Sen (Sen 1966, 1968) has demonstrated that for the traditional assumption of diminishing marginal utilities, a positive response of labour supply (and hence crop output) requires that the elasticity of the marginal utility of income be less than one in absolute value. This condition would most probably occur if incomes (or the level of consumption) are low to begin with which of course is typical of third world agriculture.

long-run acreage elasticities.[8] In other words, available empirical evidence clearly indicates that the a priori hypothesis which views most farmers as being systematic in their decision-making as well as responding "quickly, normally and efficiently" (Behrman 1968, p. 3) to changes in relevant economic incentives is the one which corresponds closest with reality.[9] The clearest argument in favour of a positive supply response originates from the inter-relationship that exists between "the opportunities perceived by farmers for acquiring ownership of ... industrial consumer goods" (Ranis and Fei 1966, p. 38) and the cash income needed to acquire them.[10]

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[8] A discussion of the results of a selected number of these studies as well as of the models employed in their estimations will be found in Chapters 4, 5 and 6. Econometric studies measuring price response in third world agriculture have led to a number of conceptual difficulties. One difficulty arises from the failure to distinguish carefully what in fact is being measured, for example, whether the observed responsiveness refers to area, total supply, or marketed supply of a crop. There have also been a number of statistical problems, the most important of which is probably the unavailability and/or unreliability of the basic data. However, there has also been methodological neglect with respect to model specification, the identification problem, the inclusion of abnormal observations, aggregation, and the use of undeflated prices (Falcon 1964, Behrman 1968, Askari and Cummings 1976).

[9] Two alternative "a priori" hypotheses were surveyed by Behrman (Behrman 1968). One is the extreme view which denies the existence of an "economic man" in the traditional parts of the third world so that western economic theory is completely irrelevant. A variant of this view argues that, in addition to social and cultural inhibitions, institutional factors such as market imperfections and inadequate infrastructure limit the ability of factors to reallocate in response to price changes. A second hypothesis is that marketed supply and price are inversely related because farmers have fixed monetary obligations and are ill-fed and hence will sell only as much of any increase in output as is required to meet those obligations. This does not necessarily imply an inverse relationship between total supply and price.

[10] This argument is but an intersectoral application of the "demonstration effect", this is, the filtration of wants and desired consumption levels and patterns from the advanced to the traditional areas.

The aspect of third world farm decision-making of interest here is whether farm supply responds positively and significantly to changes in the TOT. One must, of course, be careful not to conclude that because there is positive responsiveness of a single crop to changes in relative crop prices, there will be necessarily a positive response of aggregate supply to changes in the TOT.[11] It is quite possible that farmers "may show some allocative rationality and yet be unable to increase (or decrease) their total output substantially in response to changes in their terms of trade" (Krishna 1967, p. 513). Yet, within the framework of a dualistic resource allocation model, we would *a priori* expect a decline in aggregate agricultural output in response to policies which lead to a worsening of the TOT. A rise in the price of manufactured goods relative to the price of agricultural goods (or a decline in the latter relative to the former) would *ceteris paribus* tend to result in a transfer of resources from the agricultural sector to the manufacturing sector and hence lead to a decline in agricultural output.[12] This is, of course,

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[11] We can state that aggregate agricultural supply responds positively if for any vector of crop outputs $Q = (q_1, \ldots, q_n)$, $\partial q_i/\partial TOT > 0$, while $\partial q_i/\partial TOT \geq 0$ for any $i \neq j$. In other words, we would have a positive response at least at the margin if, in response to an improvement in the TOT, the output of one crop rose while that of the other crops did not decline.

[12] It may happen, of course, that as resources shift out of the agricultural sector in response to a worsening of the TOT, those remaining are applied more intensely so that, as a consequence, aggregate agricultural output actually increases. This behaviour might reflect the desire among the remaining resources to maintain the same level of real income in terms of purchasing power over manufactured goods. There is some evidence of this in the case of Hungary and India.

not intended to suggest that commodity price policies are solely responsible for the slow growth of agricultural output observed in many developing countries. On the contrary, a host of other sectoral policies, particularly those involving the availability of complementary inputs, land tenure and the supply and delivery of public and merit goods have undoubtedly played an equal if not more important role. Yet, given the wealth of empirical evidence supporting the view that the third world farmer is in fact an "economic man", commodity price policies could not have been entirely unimportant.

The degree of responsiveness of aggregate agricultural output to changes in the TOT would ceteris paribus largely depend on the input substitution possibilities that exist in third world agriculture[13] and on the extent of inelasticity in the supply of inputs. The input inelasticity of principal concern is that of arable land. Since the other inputs are not perfect substitutes for land, they suffer from diminishing returns which raise the average costs of production, and hence lead to a less than perfect elasticity of supply. If the supply of land is inelastic in some absolute sense and the other inputs are very poor substitutes then aggregate supply might approach perfect inelasticity.[14] However where

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[13] If for every crop no substitution was possible and if for any one input inelasticity was absolute, then we could argue eventual complete inelasticity of agricultural output with respect to the TOT. At the other extreme, if all inputs are perfect substitutes, then as long as one input is still in surplus, output would be unbounded with respect to changes in TOT. Agricultural production generally allows some but imperfect substitutability amongst inputs.

[14] In densely settled agriculture with no scope for bringing new land into cultivation, any increase in output which might occur will generally be as a result of increases in yield (output per acre) through such mediums as the "green revolution".

arable land is in surplus, as is the case in Colombia, it would be reasonable to expect that prevailing commodity price policies would not have left unaffected the extent of land cultivation and, ceteris paribus, we would therefore anticipate aggregate agricultural supply to respond positively to changes in the TOT.[15] However, given the nature of agricultural production, we would expect that response to be relatively inelastic.

To conclude the discussion to this point, it seems clear that the set of trade policies required to ensure the viability of the import substitution industrialization has tended to reduce agricultural output in many third world countries below what it could have been if the agricultural sector had been allowed to exchange at international prices rather than at trade distorted prices.

1.3 AGRICULTURAL UNEMPLOYMENT

There exist inherent difficulties in analyzing rural unemployment in developing countries which are not found elsewhere.[16] There is, however, general agreement that open unemployment as such does not exist in rural areas and what does exist is some form of disguised unemployment. The two most important causes of this disguised unemployment appear to be the

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[15] Empirical evidence appears to bear this out. Enormous increases in the exportable output of rice (Burma and Thailand), cocoa (Ghana and Nigeria) and oil and oilseed (Nigeria) occurred over the first half of the 20th century without any concurrent reduction in the output of subsistence crops (Krishna 1967).

[16] Some of the unique difficulties encountered include a "weak" wage system, the prevalence of self-employment and "unpaid family labour", the family rather than the individual as the decision-maker and the determination of individual income on the basis of social or cultural criteria rather than on the basis of productivity (Sen 1975).

existence of only a limited degree of substitution between factors such that the number of man-hours which can be usefully employed per hectare of land is limited and the fact that the pattern of agricultural output is highly seasonal (Robinson 1969).[17]

Much of the theoretical discussion in the literature on the subject of disguised unemployment has been couched in terms of what is referred to as the "surplus labour" problem (Sen 1966, 1968, 1975, Lewis 1954, Guha 1969, Jorgenson 1961, 1966, 1967, Reynolds 1965, 1969, Turnham and Jaeger 1971, Berry and Soligo 1968, Stiglitz 1969 and Ranis and Fei 1961, 1966). Surplus labour has generally come to mean a situation in which the withdrawal of workers would leave agricultural output unchanged. This assumption of zero marginal product of labour was common in the earlier dualistic models (Lewis 1954, Ranis and Fei 1961) but two of its implications have since been questioned. The first is whether the surplus labour thesis implies irrational behaviour and the second is whether such a situation could be observed empirically in third world agriculture.[18]

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[17] In the case of the former, a large supply of family workers would mean that under the usual work sharing arrangements, the average number of hours worked by each might indicate disguised unemployment in terms of the "normal" work day (Robinson 1969). It is generally agreed, however, that the latter cause is probably the most widespread (Sen 1975, Robinson 1969, Stoutjesdijk 1973, Jorgenson 1966 and others).

[18] The implication for irrational behaviour of the existence of zero marginal productivity was first clarified by Sen (1966), (1968), and elaborated upon by Stiglitz (1969), Berry and Soligo (1968), and Reynolds (1969). The implied assumption behind the surplus labour thesis is that a departure of labour from the family farm would require those remaining to increase their own personal effort. Otherwise output would decline. It has been demonstrated that if the production function exhibits diminishing marginal utility with respect to income, and if the work disutility function exhibits increasing disutility with respect to work, any equilibrium solution must have a positive marginal product.

The empirical relevance of the surplus labour doctrine seems to have been settled against the idea of a zero marginal product of labour in the agricultural sectors of developing countries. Empirical work undertaken by Stoutjesdijk (1973) on Peru, Hansen (1969) on Egypt, and Paglin (1965) on India concluded that surplus labour is virtually nonexistent or is no more than a relatively insignificant part of the rural labour force.[19] The evidence is, of course, that at least at some parts of the year the agricultural labour force is fully employed. However, whatever truth might be contained in this statement, the fact remains that for the greater part of the year, disguised unemployment is a significant observable phenomenon of third world agriculture.

Most of the empirical work on the potential for employment generation within the agricultural sector has been undertaken in connection with the introduction of the "green revolution" in Asia.[20] The reason

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[19] Reynolds (1966) argues correctly that disguised unemployment manifests itself in the high rates of internal migration, the fact that many members of the labour force would no doubt accept additional work at the prevailing wage, and the value of the marginal product of agricultural labour is less than that of industrial labour. The approach generally taken to measure disguised unemployment is to measure in mandays the labour needed to produce the current level of agricultural output and compare it with the available mandays. See Jorgenson (1966). Using this method, studies undertaken in West Bengal and Korea concluded that the effective employment rate was about 60 to 65 percent (Robinson 1969), while a study of Peruvian Agriculture indicated an employment rate of 46 percent (if a manyear is assumed to 250 mandays) and 57 percent (if 200 mandays).

[20] The only study encountered in terms of changes in the output mix only was with respect to India (Hazari and Krishnamurty 1970). Using the 77 sector input-output table of India, they calculated the direct and indirect employment potential per unit of final demand for each sector, disregarding their actual size. A ranking of this potential indicated that of the top 30 sectors, 27 were agricultural and that in what are generally considered to be the key industrial sectors, employment generation was quite small.

for this emphasis stems from two characteristics of the high yielding seed varieties (HYV's). The first is that they tend to affect the production in a land-augmenting, labour-utilizing manner. Secondly they tend to be highly divisible and neutral to scale. The beneficial effect anticipated for the agricultural sector's labour absorption potential, however, largely emerges from the complementarity that exists between labour and the other inputs of the "green revolution".[21] Empirical evidence on the employment effects of the "green revolution" have by and large been favourable. Available studies on Taiwan, Japan, Thailand, India and the Philippines suggest that the introduction of the HYV's have led to significant increases in rural employment (Bruton 1974, Mellor and Lele 1972, Shaw 1970, Rao 1974).[22]

The extent to which distortions in relative commodity prices can be blamed for the failure of the agricultural sectors of many third world

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[21]The technology of the green revolution is such that the increased yields per acre do not occur unless substantial amounts of fertilizer are applied, improved weeding and cultivation practices are undertaken, pest and disease control activities are increased and more effort is directed to controlling essential water supplies. In addition, the shorter cropping cycle for some varieties can result in double cropping. The significance of all these is of course that they are all labour using activities.

[22]There is another aspect of the rural unemployment scene which has worried some writers in the field (Johnston 1970, Falcon 1970, Bruton 1974, Johnston and Cowie 1969, Gotsch 1973, and Rao 1974). This is the premature tractor mechanization which has accompanied the rise in farm incomes where the HYV's have been introduced, especially in India and Pakistan. It is generally agreed that the impetus originates from distorted factor prices and overvalued exchange rates which reduce the cost of tractors below their opportunity cost. The discrepancy between the private and social productivity of investment in tractor mechanization is particularly acute in third world agriculture because those workers displaced by mechanization usually cannot find alternative employment opportunities.

countries to generate more productive employment than is generally the case is difficult to assess. Assuming that the marginal product of labour is positive, we would, of course, a priori expect that a worsening of the TOT faced by agriculture would tend to reduce employment opportunities through its impact on aggregate agricultural output. The ultimate effect on employment, however, cannot be examined without reference to the social, institutional, and economic environment in which agricultural production occurs. A hint of this can be found in footnote 22. In addition, land tenure patterns, differing abilities of farmers to alter employment coupled with significant differences in technologies employed in the cultivation of the various crops,[23] and traditional socially-accepted employment customs may all prevent employment from changing significantly in response to changes in the TOT. Nonetheless, it still might be useful to estimate the "potential" loss in employment opportunities as a consequence of TOT distortions, assuming the absence of any social, institutional, or economic constraint.

1.4 INCOME DISTRIBUTION

If one single characteristic common to the agricultural sectors of virtually all developing countries can be isolated, it would be the low income levels of the vast majority of those whose livelihood is derived from agricultural and rural activities. The responsibility for much of

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[23] For example, if the greatest impact on agricultural output due to changes in the TOT occurs with the highly mechanized, capital-using crops, the effects on employment might be minimal. Even the evidence from Colombia tends to indicate that the effects that trade liberalization has had on rural employment are not particularly significant (Nelson, Schultz and Slighton 1971 and Diaz-Alejandro 1976).

this poverty can ultimately be traced to decades of neglect reflected in, among other factors, those policies which maintained the prices of agricultural goods low relative to the prices of manufactured products.[24] Moreover, the poverty existing in the agricultural sectors of most of the third world is not only absolute but it is also a relative poverty and there seems to be little doubt that import substitution and the set of policies that accompanied it have helped to magnify intersectoral income differences.

Lately development specialists including the World Bank and the ILO have come to recognize that a fundamental problem in developing countries is poverty and income inequality and that the objective of maximizing aggregate growth alone often fails to consider explicitly distributional consequences (Edwards 1974, Jarvis 1974, Paukert 1973, Chenery et al 1974, Fishlow 1972, Stoutjesdijk 1973, Jain 1974, Stewart 1974, Morawetz 1974, Tokman 1975). The dualistic nature of most developing countries often makes the maldistribution of the benefits of growth obvious. Although there is increasing evidence that the distributional impact of growth policies may have been less unequal than originally thought and that all major economic groups may have shared to some extent in the fruits of growth, it is still apparent that those who have benefitted the most are the industrial entrepreneurs, civil servants, foreigners and the industrial workers while those who have failed to reap their fair share are largely confined to the rural agricultural sector. In fact, available

[24] Among the other factors especially contributing to poverty and the disparities in incomes in developing countries are the lack of productive employment opportunities, the excessive concentration of wealth, and the enormous differences in regional and sectoral labour productivity. These are in addition to the usual factors such as the extent of supply and distribution of public and merit goods, the direction and size of transfer payments and the extent of progressivity and of the opportunity for tax evasion and avoidance in the tax system.

cross-country evidence indicates that in all of the developing world, the mean income in urban centres exceeds that in rural or agricultural areas while in many countries (especially in Latin America) the "gross" differences are enormous.[25]

While we might not be unduly compromised in concluding that distortions in relative sectoral commodity prices have contributed to poverty in the agricultural sector and to an imbalance in average sectoral incomes, it would be dangerous to conclude that these same distortions have had a deleterious effect on the size distribution of national income. In fact, there is considerable evidence, contained in World Bank Studies (See World Bank 1974), that the size distribution of income in third world countries is largely independent of the trade policy regime in effect. Moreover, there is no way of stating a priori whether the distribution of income would improve or worsen as a result of export promotion policies or, conversely, whether the distribution of income has worsened in those countries which pursued import substitution policies.[26] Available evidence seems to indicate that the distribution of income depends more on factors such as the distribution of wealth, differences in sectoral productivities, and the political commitment to change. Whatever redistribution has occurred in the course of development of some countries,

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[25] It should be noted that when allowance is made for the substantial differences in the income generating characteristics of the urban and rural labour forces such as education and experience the urban-rural income differentials in most countries tends to be considerably smaller than the published "gross" differentials.

[26] There is, of course, considerable cross-country evidence that the size distribution of income has not changed substantially in most third world countries over the last couple of decades or so. In fact, there is evidence that in some countries it has actually worsened (Fishlow 1972, Stoutjesdijk 1973, ILO 1970). Discussion of income distribution in Colombia is found in Chapter 2 and Chapter 10.

including Colombia (Nelson, Schultz and Slighton 1971), it has generally been from the rich to the middle-class rather than to the poor, although there have been cases (e.g. Brazil in the 1970's) where the share of the bottom decile or so has increased.

To some extent, income inequalities have been accepted as a "temporary" cost which must be borne if rapid growth is to be achieved. The justification for this "cost" rests on two commonly-accepted notions of the development process. The first is that an unequal income distribution provides the incentive to ensure a high rate of flow of rural labour to fill the newly created industrial jobs. The second notion is based on a re-working of the "equity vs. efficiency" problem in terms of assumed differing sectoral savings rates in developing countries.[27] It can be argued that since the bulk of the poor live in agricultural areas and since the poor have a higher marginal propensity to consume than the higher income earners who tend to reside in urban areas, a redistribution of income by turning the TOT in favour of the agricultural sector will adversely affect future growth rates and hence the potential for future income redistribution (Mellor 1967, Griffin 1974, Johnston 1970).[28]

1.5 MIGRATION AND OPEN URBAN UNEMPLOYMENT

It was clear from the beginning that the development of the modern industrial sector in most developing countries would progress at a pace

[27] Although most of the discussion in the literature on differing savings behaviour is couched in "functional" terms (Stewart and Streeten 1971, Morawetz 1974, Galenson and Leibenstein 1955, Solow 1970, Sen 1975, Encarnacion 1974, Dasgupta, Marglin and Sen 1972, and Chenery 1972), it can be easily re-worked in inter-sectoral terms.

[28] Moreover, within the modern industrial sector, depressed food prices by partly taking pressure off wage demands by the industrial labour force ensures higher profits for entrepreneurs and perhaps a higher level of savings and future output.

which would be insufficient to absorb all those who would have liked to find employment in that sector and there was little evidence that the situation would improve significantly over the coming decades. There is no doubt that it is the severity and the pervasiveness of the open urban unemployment problem which led to the concern shown in the development literature in recent years. With very few exceptions the literature on third world labour markets has largely directed its attention to a demand-side analysis of the causes and the possible cures of the urban unemployment problem (Eckaus 1955, Ranis 1971, 1973, Morawetz 1974, Hawrylyshyn 1975a, 1975b, Bruton 1974, Reynolds 1965, Harris and Todaro 1969, Stewart 1972, 1974, Hughes 1973, Currie 1971, Pack and Todaro 1969, Lefeber 1968, Healey 1972 and Turnham and Jaeger 1971).[29] However, the major cause of the urban unemployment problem may be the result of supply factors, specifically the rapid rates of population growth, the lack of demographic, political or economic checks on rural-urban migration and the high reservation wages found in many countries. In most developing countries the number of migrants arriving from surrounding rural areas in search of high wage jobs in the industrial section has been far in excess of the modern sectors' ability to absorb them.[30]

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[29] The inability of the industrial sector to absorb more labour stems from the rapid strides in labour productivity which have occurred as import substitution proceeds. These increases in output per worker arise out of the capital intensive, labour-saving nature of the newly formed industrial sector. It is argued that there exist three main factors which encourage entrepreneurs to choose technologies inconsistent with relative factor endowment: 1) distortions which make the price of capital low relative to the prices of labour; 2) technological limits to factor substitution possibilities and; 3) subjective biases exist among decision-makers for capital-intensive technologies or for goods produced with capital-intensive processes.

[30] In attempting to emulate the array of progressive labour legislation common to the industrialized world many developing countries have enacted legislation which favour a small minority of the labour force, the urban industrial worker, who receive a return greatly in excess of their shadow wage.

It is generally agreed that the income differentials which exist between the average urban industrial worker and the average farmer or rural worker act as a magnet to the rural population and are largely responsible for the existence of large pools of unemployed in the main urban centres. However, given the enormous excess supply, the typical new migrant faces the distinct possibility of not finding a job and, according to two models, (Todaro 1971 and Harris and Todaro 1970) urban labour supply is a function not only of income differentials but also of the "probability" of finding employment in the modern sector. Todaro's model uses a permanent income approach to show that the migration will occur if the discounted present value of the stream of "expected" future income resulting from urban employment exceeds that if the individual stayed in the countryside.[31] Given a constant rate of new job openings equal to the rate of increase of non-agricultural output minus the rate of increase of output per worker, then an important policy conclusion which follows from the model is that any attempt to increase industrial output and hence employment opportunities without at the same time lowering real income differences between the urban and rural sectors raises expectations about the probability of finding a job and hence increases the rate of migration and, as a result, the supply of labour. To the extent that distortions in the TOT arising out of the import substitution process may have contributed to the gap between the income

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[31]Since "expected" real future income depends on the probability of finding a job, Todaro assumed for the purposes of the model that there is a random selection from the pool of urban unemployed and that the probability of any one new migrant being selected is equal to the ratio of new employment opportunities to the numbers awaiting employment in the modern sector. The level of urban unemployment therefore tends to act as an equilibrating force.

of the typical rural worker or farmer and that of the average industrial worker, they may have also had an effect on the level of migration and hence on urban unemployment.

Another possible reason why the modern industrialized sector has failed to make a sufficient contribution to the urban unemployment problem emerges from the effect adverse TOT may have had on agricultural incomes and hence on a large segment of the potential domestic market for the output of the industrial sector.[32] The genesis of the renewed awareness in the literature of the possibility than an effective demand constraint might in fact exist after all coincided with the recognition that in many countries excess industrial capacity has become a common feature (Bruton 1974, Healey 1972, Hawrylyshyn 1975a, Jarvis 1974, Morawetz 1974, Winston 1974 and Little, Scitovsky and Scott 1970).[33] Although the evidence does demonstrate quite widespread under-utilization of capital, it does not necessarily follow of course that all observed

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[32]The importance of the role of the agricultural sector in fostering non-agricultural development has for a long time been recognized among the "agricultural" economists (Johnston 1970, Johnston and Kilby 1974, Johnston and Cowie 1969, Hughes 1973, Mellor and Lele 1972, Hayama and Ruttan 1971 and Dubey 1963). These writers have emphasized the need to increase farm cash income in order to provide a market for manufactured inputs and consumer goods. Low agricultural incomes may have had two additional consequences. First the lack of demand may have reduced the industrial sector's ability to take advantage of scale economies. Secondly, the low output of consumer goods may have acted as a disincentive to expanding agricultural output and hence farm incomes.

[33]The neglect of the effective demand constraint can be traced back to the belief that Keynesian analysis is inappropriate to the unemployment problems of developing countries (Rao 1952). Due to inherent aggregate supply inelasticities Keynesian deficit financing, it is argued, would lead to inflation or balance of payments problems or both rather than to increases in output and employment.

instances of idle capital are due to lack of effective demand or whatever idleness there is, it exists in a balanced form. In the first case the excess capacity might be due to restrictions on imports of intermediate goods, or to a lack of complimentary inputs, or to anticipated increases in demand (Morawetz 1974, Hawrylyshyn 1975a). In the second case, constraints in the supply of basic energy requirements may prevent increases in output and employment despite excess capacity in the energy-using industries (Stewart and Weeks 1973).

1.6 MODELS OF DUALISTIC GROWTH

In the literature, analysis of the impact of the TOT on the development process has tended to occur within the framework of a two-sector "dualistic" growth model. Amongst the various growth models which purport to explain economic development, dual models seem to reflect best the development process in countries which have high population growth rates, high levels of disguised rural unemployment, clear-cut distinctions between the lifestyles and incomes of urban dwellers and of farmers, a large part of the total population residing in rural areas most of which are involved in subsistence farming, and which have generally attained only a relatively low level of economic development reflected in a low level of industrial employment (Reynolds 1969). Moreover, dualistic models avoid viewing the development process as being constrained only by a lack of capital by also focusing on such problems as relative prices, income distribution, mobilization of surplus labour, and the supply of wage goods; factors which differentiate the developed from the developing countries.

Dual models can be generally classified into two types; non-optimizing and optimizing. The former can be regarded as being of two kinds;

the "classical" model (Lewis 1954, Ranis and Fei 1961) and the "neo-classical" model (Jorgenson 1961, 1967).[34] The common assumptions of the two types of non-optimizing models are: 1) agricultural output is assumed to be a constant returns to scale function of agricultural labour employment and a constant technological growth parameter with the agricultural wage rate initially defined as the average product of labour, 2) industrial output is assumed to depend on industrial labour employed and the size of the capital stock, plus a parameter reflecting neutral technological change; constant returns to scale is also assumed,[35] 3) savings is equal to the profits of the industrial sector (or the non-agricultural sector in the real world) in its entirety; workers save nothing, and 4) the economy is closed.

The "neo-classical" model differs from the "classical" model in that the "classical" model regards the marginal product of agricultural labour to be zero or at least below income per worker in the early stages of the development process,[36] whereas the "neo-classical" always assumes not only a positive marginal product but one equal to remuneration. One implication of this is that with the "classical" model, the industrial sector, at least initially, is able to obtain all the labour it wants from the

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[34]Although these writers were first to express formally the concept of dualistic growth, their work has since been extended as well as been subject to a great deal of discussion in the literature (Mellor 1967, 1974, Hayami and Ruttan 1971, Johnston 1970, Ranis and Fei 1966, 1975, Guha 1969, Sandee 1969 and Jorgenson 1966).

[35]Employment in the industrial sector is determined from the profit maximizing first order conditions with respect to industrial labour. The usual assumptions abour first and second partial derivatives hold.

[36]This in effect says that there exists a maximum level of agricultural employment beyond which the marginal product of labour is zero or less than income per worker and that maximum is less than the total agricultural labour force available.

agricultural sector at a fixed wage approximating the average product of agricultural labour with no concurrent drop in agricultural output or at least a drop which is less than the wage rate while in the "neo-classical" approach any withdrawal of labour entails a sacrifice of agricultural output equal to the wage rate. Moreover, the TOT in the "classical" model are assumed fixed and exogenously determined, while in the "neo-classical" model, neither the TOT nor the industrial real wage rate are fixed but are endogeneous to the system and depend on relative demands and supplies.

These models essentially focus on the process of labour reallocation arising out of capital accumulation and growth in the industrial sector. Despite travelling slightly different paths, both types of models arrive at the conclusion that the process of industrialization can be hindered and eventually stopped if the agricultural sector, the supplier of the principal wage-good, is neglected. To prevent this from occurring in a closed economy with a fixed amount of arable land, a sufficient condition in the "classical" model is a positive value of the agricultural technology parameter sufficient to offset the decline in output due to the withdrawal of labour from the agricultural sector.[37]

The literature has been critical of the assumptions and methodology employed in such models. Explicit criticisms include the neglect of the distinct possibility that the agricultural sector might have a positive income elasticity for its own output (Guha 1969); the failure to take into consideration the impact of differing intersectoral demand elasticities (Mellor 1974); the fact that most technological change in third world agriculture is of a land-augmenting type and not neutral (Mellor

[37] In the "neo-classical" model a sufficient condition for a viable industrialization strategy is the emergence of a sustained agricultural surplus.

1967); the assumption of a closed economy (Mellor 1974); and the failure to underpin their models with an analysis of microeconomic processes and behaviour (Hayami and Ruttan 1971, p. 25).

There has been only one published work (Stern 1972) which views dualistic growth as a problem in optimal control and which is concerned with the computation of optimal time paths.[38] Stern's problem is to control the level of employment and investment so as to maximize a discounted weighted average of per capita advanced sector and traditional sector consumption over an infinite time horizon subject to constraints on consumption and population growth. It is assumed that the traditional sector does not save. Four sets of canonical differential equations in per-capita capital (k) and the shadow price of investment (ϕ) are derived corresponding to four regions which Stern isolates in (k,ϕ) space according to whether the shadow prices of consumption and employment are positive or zero, that is, whether the constraints are binding or not. Setting the canonicals equal to zero, Stern then describes several optimum paths of development through the various regions, each path depending on the initial value of k and on whether savings is sub-optimal or not.

In an attempt to overcome some of the shortcomings of the

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[38] Optimal control techniques have not been commonly used in development economies. Exceptions, in addition to Stern (1972), are Dixit (1968), Dixit (1971), Newbery (1974) and Dixit and Stern (1974). The Dixit (1968) paper is also concerned with detailed computation of optimal time paths but for a one-sector, labour-surplus economy rather than for a dual economy. This means that the while Dixit employs "Lewisian" assumption, he abstracts from the dual nature of the Lewis model and, as a result, fails to say much about the traditional or subsistence or agricultural sector. The Stern (1972) paper largely arose out of Dixit's failure in this respect.

Dixit-Stern-type models,[39] further work has been undertaken (Dixit 1971, Newbery 1974, Dixit and Stern 1974) which focuses on the role of the TOT and the various demand and supply functions within a general equilibrium framework. This required an assumption of savings sub-optimality which was incorporated by assuming an exogenously given premium on investment. These writers are primarily concerned with the impact on industrial wages and the TOT of intersectoral labour flows and with the optimal employment of labour. They assumed a two-sectoral short-run general equilibrium model incorporating sectoral demand and output functions and that all profits are saved and all labour income is consumed.

Dixit (1971) initially assumes a closed economy and demonstrates that internal migration to the industrial sector tends to push up both industrial wages and the TOT. Dixit then explores the ad valorem tax or subsidy rate required to ensure the optimum-employment of industrial labour, that is, that optimal rate which ensures equality between the shadow wage and the market wage and finds that the size of the tax/ subsidy rate depends on the existence of savings sub-optimality and a positively-sloped supply of labour curve. Moreover, a sensitivity analysis indicates that the key parameters accounting for divergences are the price and income elasticities of demand and not on whether surplus labour in agriculture exists or not.

Dixit briefly extends his analysis to an open economy in which trade

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[39] The shortcomings arise out of the restrictions needed on the model in order to undertake detailed computations of optimal time paths. In effect these models ignore the role of agricultural development and the TOT, particularly the latter's impact on the various sectoral demand and supply functions. This is a rather severe limitation in the context of the purpose of this study.

occurs at a fixed ratio of sector international prices, and examines the causes of divergences in the TOT and the international sectoral TOT. He finds that if there is no savings sub-optimality, the optimal tax (tariff) is zero since we would want to obtain food from the cheapest source. On the other hand, if savings is sub-optimal, a subsidy on food imports would be called for if at the optimum TOT, the domestic and international price ratios are to be equal. Approximately the same conclusion is reached for the optimal tax/subsidy rate on industrial employment in an open economy as was reached in a closed economy.

Newbery (1974) extends Dixit's open economy model to test its implications when consumption is measured in world prices rather than in domestic prices and when an objective of investment maximization (an infinite shadow price of investment) is assumed. Using the same data Dixit employed in his sensitivity analysis, Newbery finds that the adjustment in the tax/subsidy rate required when the industrial labour force is small (20 percent of the total labour force) is 14 percent when consumption is measured in world prices and 185 percent when consumption is measured in domestic prices.[40]

While these short-run general equilibrium models shed light on the consequences for the shadow wage and the TOT of different assumptions

[40] The principal reason for this difference is that the social cost of industrial employment when expressed in foregone foreign exchange (lost exports of food due to the optimal tax on food exports) is significantly greater than labour's market price. Concurrently with Newbery's work, Dixit and Stern (Dixit and Stern 1974) extended Newbery's assumption of investment maximization. The authors were particularly concerned with the possibility of misinterpretation of Newbery's sensitivity analysis result to the effect that since the optimal shadow wage and the market wage expressed in world prices lie close together, the latter can act as a proxy for the former.

made about key parameters, they were largely a theoretical exercise whose relevance in an empirical context is limited by the immeasurability of some of the parameters and the assumption of a short-run situation. Moreover the fact that the TOT are viewed as entirely endogeneous contradicts somewhat the realities of third world economies and the underlying assumption of this study.

In this Chapter, we have been content to explore that part of the development literature which focuses on the interactions that occur between agriculture and manufacturing as development proceeds. In doing this, we have found some evidence that the trade restricting policies needed for industrialization to take hold, by distorting the prices farmers receive for their output relative to what they pay for manufactured goods, may have had deleterious effects on the agricultural sectors of many third world countries. In much of the literature of the 1960's and early 1970's, there was a misleading tendency to blame much, if not all, of the failures in third world development, such as continued poverty, agricultural stagnation, rural unemployment, etc., on the trade regime most countries chose to follow, that is, import substitution. However, as more evidence became available (well-documented in the studies of the NBER and the OECD) it became clear that many of these failures were the result of a wide range of factors, only one of which was the choice of trade regime. Nonetheless, there appears to be sufficient evidence in the literature surveyed in this Chapter that to discount entirely the effects on agriculture of trade policies, and their consequences for relative agricultural and manufacturing prices, would be equally misleading. Our task is to attempt to quantify some of these effects.

CHAPTER 2

COMMODITY PRICE DISTORTIONS IN THE COLOMBIAN ECONOMY

2.1 INTRODUCTION

This chapter is principally concerned with the extent of commodity price distortions in the Colombian economy. However, in the course of examining these, we shall also briefly look at the sectoral structure of economic activity as well as review the trade and other policies which have in part led to the gap between domestic and world commodity prices. We may begin with a global picture of the structure of output of the Colombian economy.

TABLE 2.1

THE RELATIVE IMPORTANCE OF THE MAJOR SECTORS OF THE COLOMBIAN ECONOMY - EXPRESSED AS A RATIO OF VALUE ADDED TO GDP IN EACH SECTOR, IN CONSTANT PRICES, 1945-1975

YEAR	MANUFACTURING	AGRICULTURE	OTHER SECTORS
1945	.097	.456	.447
1950	.139	.401	.460
1955	.151	.355	.494
1960	.165	.346	.489
1965	.174	.314	.512
1970	.182	.291	.528
1975	.194	.273	.533

Source: The Colombian National Accounts

The trends in the relative contributions to national output of manufacturing and agriculture in Colombia are consistent with what has been observed historically in the now developed countries, that is, a decline in the share of agriculture and an increase in the share of industry. Within the manufacturing and agricultural sectors, two trends are worth noting at this point. The first is the increase in the contribution of modern or factory manufacturing relative to that of traditional or cottage-shop manufacturing. The ratio of factory manufacturing value added to total manufacturing value added has shown an almost continuous upward trend from about .75 in 1950 to about .87 in 1975 (Berry and Thoumi 1975). The second is the decline in the relative importance of coffee as a generator of value added in the agricultural sector.

In the next section, we shall examine the trade policies and the resulting distortions in commodity prices behind which the development of manufacturing in Colombia occurred. This shall be followed with an examination of the trends in, the characteristics of, and the policies affecting Colombian agriculture with emphasis on the extent to which the prices received by farmers differ from world prices. Finally, in the last two sections, we shall discuss briefly income distribution patterns and the internal migration process in Colombia, respectively. The distortions in commodity prices estimated for purposes of this study are those which prevailed during the 1960's.

2.2 TRADE POLICY AND PRICE DISTORTIONS IN COLOMBIAN MANUFACTURING[1]

Factory manufacturing value added in Colombia expressed in constant 1958 prices rose on average by about 8 percent per annum between 1950 and 1975. However, as appears typical of modern

[1]The discussion in this section largely stems from Berry and Thoumi (1977), Diaz-Alejandro (1976), World Bank (1972), Nelson, Schultz and Slighton (1971), De Melo (1975), and the ILO (1970).

manufacturing in much of the third world, employment in the factory manufacturing sector grew more slowly over the same period at about 4½ percent annually. This reflects a more than 3 percent average annual increase in labour productivity over the period. As a proportion of Colombia's labour force, employment in manufacturing has remained relatively constant since 1950 at about 14 percent, although as a proportion of the total non-agricultural labour force, it has tended downward over time as a result of rapidly increasing employment opportunities in the service sector. In terms of employment in factory manufacturing as a proportion of the total labour force, it has risen gradually to about 6 percent in 1975.

The Colombian market for manufactured goods as of 1967 was except for capital goods, largely met by domestic production. Domestic production of consumer durables, intermediate goods, and "other" manufactured goods accounted for about 85 percent of their respective markets, the balance being imported.[2] Only 2 percent of the market for consumer non-durables was met by imports while, on the other hand, 70 percent of capital goods' requirements were imported. By most standards, Colombia's domestic market is small with a per capita domestic consumption of manufactured goods of about U.S. $140 in 1969. An inadequate domestic market is reflected in high

[2] In fact, most of the increase in total manufacturing output between 1953 and 1968 was generated by consumer durable and intermediate goods' production (46 and 40 percent, respectively). The remaining 14 percent stemmed from consumer non-durable and capital goods' production. These relative contributions to output growth are not indicative of their respective average growth rates because of the large variation in their relative importance in 1953.

production costs for those manufacturing sectors which are subject to scale economies and in a lack of competition amongst domestic producers. Because of a heavier reliance on direct taxes, business taxation in Colombia tends to be somewhat more progressive than is usually the case in Latin American countries.[3]

The era of price controls on Colombian manufacturing is largely over. Such controls were implemented for the first time in 1961 and reached a peak in 1965 when they covered about 35 percent of all economic activity. Since then price controls have either been eliminated or reduced so that now only certain commodities which enter heavily into the cost of living index remain under control.[4]

Generally speaking, the development of manufacturing activities in Colombia since the end of the war has been pursued much as it has been in other Latin American countries with the emphasis being placed on those manufacturing sectors where the greatest potential for import substitution existed. Import substitution as an industrialization strategy was given particular impetus during the late 1940's and again in the late 1950's, by the economy's increasing

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[3] Income tax rates levied on corporations range from 12 percent to 36 percent while those levied on limited liability companies vary from 4 percent to 12 percent. Since in many cases, there is no significant difference between the size of corporations and the size of limited liability companies, existing tax rate discriminate unduly against the corporation. Income tax rates on partnerships range from 3 to 6 percent.

[4] Quasi-controls continue to exist on a number of basic products produced under monopolistic conditions. Firms are required to give notice of one month of any planned price increase. This allows time for the Price Control Agency to decide whether to restore controls or not, or to negotiate a lower price increase.

vulnerability to events in the foreign sector represented mainly by a declining coffee terms of trade.[5] The relative success of Colombia's import substitution policies has been summarized succinctly by Berry and Thoumi, "Overall, post-war IS was clearly neither so successful as to lead to a high sustained growth rate nor so unsuccessful as to create stagnation" (Berry and Thoumi 1977, p. 96).

The key trade policy behind which import substitution was pursued involved the control of imports. The principal instruments employed to control imports were tariffs, a system of quantitative controls, a system of prior import deposits, and exchange rate controls. The Colombian tariff structure has classified importables into one of three groups: a free list under which imports are controlled only by the tariff height and the nominal exchange rate, a prior license list through which most of the quantitative restrictions were applied; and a prohibited import list. The proportion of goods subject to prior licensing has tended to vary widely from year to year. There variations were largely a response to current or projected balance of payments difficulties so that in "good" years the share of imports requiring prior import licenses were

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[5]This is reflected in the successive tariff revisions and reforms which have occurred since 1950 when new tariffs were adopted. The new 1950 tariffs were less uniform than had previously been the case with higher rates being levied on final goods. Moreover, it was in 1950 that the prohibited list was introduced. The 1959 tariff revision reinforced the import substitution strategy as did the tariff reform in 1962 at which time tariffs on intermediate goods not already domestically produced were lowered and those on final goods raised.

generally under 40 percent of total import value whereas in years in which the balance of payments was in difficulty it could exceed 90 percent, as it did in 1967 (Diaz-Alejandro 1976).

Beginning in about 1967, Colombia started on the long road to trade liberalization. By 1971 significant across the board tariff reductions had occurred as well as a loosening up of quantitative restrictions and exchange controls. As a result of an improving balance of payments situation coupled with domestic inflationary pressures, further liberalization occurred between 1972 and 1974. A comparison of nominal ad valorem duty rates for the years 1962, 1971 and 1973 for selected commodity groupings (involving an overall sample of 125 important commodities) imported from non-LAFTA sources is contained in the following table (standard deviations are given in brackets):

TABLE 2.2

COLOMBIAN DUTIES ON SELECTED COMMODITY GROUPINGS IMPORTED FROM NON-EXEMPT AND NON-LAFTA SOURCES[6]

IMPORTED COMMODITY GROUPING	AD VALOREM DUTIES (PERCENT) 1962	1971	1973
Unprocessed foodstuffs	185 (217)	53 (29)	53 (29)
Processed foodstuffs	341 (326)	91 (51)	90 (53)
Consumer durables	108 (31)	80 (26)	74 (40)
Other consumer durables	163 (145)	87 (66)	87 (66)
Industrial materials	35 (32)	19 (16)	18 (12)
Capital goods	19 (15)	26 (16)	31 (21)

Source: Diaz-Alejandro (1976), Table 4-4, pp. 107-108

[6]Colombia, as a member of the Andean Common Market has agreed to adopt the Andean Common External Tariff by 1980. As of 1975, Colombia adjusted its tariffs to bring them in line with Andean Minimum Common External Tariff. This required only minimal adjustment since the agreed common external rates were not too much different from Colombia's existing tariff rates.

Two observations consistent with liberalization trends since 1967 should be noted in the table. The first is the downward movement in the rates of duty between 1962 and 1973, the only exception being capital goods whose rates have been raised in recent years. Secondly, the level of tariff dispersion measured by the standard deviations has tended to decline. As might be expected, the nominal duties on final goods exceed those on intermediate and capital goods by a significant margin. The average effective rate of protection produced by these nominal rates (including the opportunity cost of prior deposits) was 35 percent 1973, as calculated by the Corden method (Diaz-Alejandro 1976). However, this apparently low rate disguises the fact that the level of dispersion tends to be considerably higher than is the case of the nominal rates.[7]

Further trade restrictions are embodied in a system of prior import deposits. Under this system begun in 1951, an importer is required to hand over to the monetary authorities some percentage of the desired import value prior to making application for an import license. The percentage required varies with the level of domestic production of the commodity in question as well as with how essential it is and as a rule, unless exempt, the required rate is either 1, 10, 30, 70 or 130 percent. The deposit is held until the goods have cleared Colombian customs (on average about six months after the deposit was made) and during that time it earns no interest, is

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[7]Effective rate of protection as calculated by the Corden method ranged from 668 percent on electrical apparatus to -45 percent on coffee. Although substantial, the level of dispersion as well as the average rate is not as large as that found in certain other Latin American countries.

eroded by inflation, and cannot be used as collateral in any other transaction. It has been estimated that between 1960 and 1967 the average ad valorem equivalence of the deposits was 11 percent (Diaz-Alejandro 1976). This has declined in more recent years to somewhere under 5 percent. By 1973, the prior deposits had by and large been eliminated.

Until recently, Colombia's foreign exchange policy centred on the use of a different nominal exchange rate for virtually every type of international transaction. At times, separate rates have been applied to the earnings of coffee exports, the earnings of other exports, transactions on the capital account, and on different categories of commodity imports. The set of trade repressing mechanisms and taxes resulted in a substantial gap between the nominal and effective exchange rates. By 1971, however, Colombia's exchange rate policy had been consolidated and rationalized into one exchange rate for all foreign transactions, other than a special subsidized rate on certain "minor" exports.

Concurrent with Colombia's move to reduce import restrictions there emerged the realization of the need to develop exports of commodities other than coffee. To this end, a number of export promotion policies which still continue to be in operation were introduced in 1967.[8] Dominant among the various export promotion policies is a system of tax credit certificates (CAT's) worth on

[8] Actually the initial steps on the road to export promotion began in the late 50's and early 60's when export taxes (except on coffee) were removed and tax incentives to stimulate exports were introduced for the first time.

average 15 percent of the total export value given to exporters at the time their foreign exchange earnings are surrendered. Other export promotion policies include drawback and similar arrangements (the Vallejo Plan), a funded coordinating agency (PROEXPO) to promote exports, and a system of export financing whereby exporters can obtain advances against the surrender of foreign exchange. Colombia's export promotion policies have on the whole been surprisingly successful. Between 1965 and 1974, exports of commodities other than coffee increased about 25 percent annually (in terms of current U.S. dollars). It is estimated that these export increases explained about 15 to 20 percent of the growth of manufacturing output over the period (Diaz-Alejandro 1976).

Despite these recent trends in trade liberalization, however, it was behind a regime of strict import controls during the 1950's and most of the 1960's that manufacturing activities in Colombia were allowed to develop at the rate they have. The array of trade restricting schemes used to encourage industrialization in Colombia has resulted in the existence of a significant gap between the domestic and world prices of manufactured importables. However, with one exception there have been few attempts at estimating the size of the gap.[9] Using a sample of 385 commodities, Hutcheson calculated an average gap between domestic and world prices by contrasting the domestic price and the export price for a given manufactured commodity under the assumption that the export price reflected the

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[9]The exception in T.L. Hutcheson's Ph.D. dissertation, Incentives for Industrialization in Colombia, University of Michigan 1973. Hutcheson's main results and conclusions are discussed in some detail by Diaz-Alejandro (Diaz-Alejandro 1976).

world price of the commodity in question. Hutcheson found that in 1969 the average gap between domestic and foreign prices at the prevailing import exchange rate was 47 percent. In other words, domestic prices on average were 47 percent above world prices or, alternatively, world prices for tradable manufactured goods were 68 percent of domestic prices. It is this figure that will be employed henceforth as the measure of the level of the distortion in overall manufacturing prices in the late 1960's.[10]

Unlike the distortions in the agricultural commodity prices which did not on average vary much throughout the 1960's, trade liberalization policies during the decade did result in a distinct drop in the extent of manufacturing price distortions between the early 1960's (1962) and the late 1960's (1969). However, there has been no comprehensive study, as there was in 1969, on the size of the gap between world and domestic prices for manufactured goods

[10] In contrast, from De Melo's study (De Melo 1975, 1978) which examined the impact on domestic manufacturing prices of a 100 percent reduction of all tariffs and subsidies, it was possible to calculate that manufacturing prices would decline by a weighted average of 11.2 percent in the short-run (capital stocks fixed) and by 14 percent in the long-run (capital stocks mobile). This of course reflects the gap between the domestic price and free trade price. There would appear to be a considerable difference between the free trade price as calculated by De Melo and the world price as calculated by Hutcheson et al. The difference is largely explained by the food, beverage and tobacco sub-sector. Whereas De Melo calculates that as a result of free trade the prices of this sector would rise by 7.5 percent (indicating that the domestic price lies a little below the free trade price), Hutcheson calculated that the domestic price is about 35 percent above the world price. Since this sub-sector has by far the largest weight (about a third) in total factory manufacturing value added, it could explain a significant amount of the discrepency between world and free trade prices.

in the early 1960's. Nonetheless, from data on the average height of the tariff in 1962 and 1969, we are able at least to obtain an indication of the size of the gap in 1962. It would appear that the extent of manufacturing price distortions in 1962 were probably about double what they were in 1969. Given that in 1969 domestic prices exceeded world prices by 47 percent, then for purposes of this study, we shall consider an overall manufacturing sector price distortion of 100 percent a reasonable approximation of the gap that existed in the early 1960's.

2.3 COMMODITY PRICE DISTORTIONS IN COLOMBIAN AGRICULTURE[11]

After decades of relatively slow annual rates of growth, agriculture in Colombia since about 1965 has grown at an unprecedented rate as indicated in the following table:

TABLE 2.3

RATES OF GROWTH OF AGRICULTURAL VALUE ADDED AND OUTPUT: 1945-1975

PERIOD	AVERAGE ANNUAL RATE OF GROWTH OF AGRICULTURAL VALUE ADDED[12]	AVERAGE ANNUAL RATE OF GROWTH OF AGRICULTURAL OUTPUT
1945-50	2.1	3.2
1950-55	2.8	2.8
1955-60	3.7	4.6
1960-65	2.8	2.8
1965-70	4.5	4.1
1970-75	5.8	5.9

[11]Much of the discussion in this section is drawn from World Bank (1972), Berry and Urrutia (1976), Diaz-Alejandro (1976), Nelson, Schultz and Slighton (1971), ILO (1970), and Berry (1973).

[12]Since 1950, the proportion of total agricultural output which is value added has remained almost constant at 87 percent. Prior to the 1950's, the figure typically exceeded 90 percent.

Much of the increased growth rate can be attributed to the rapid expansion of a number of non-traditional crops cultivated on relatively large modern farms.[13] Among the traditional crops, including coffee, growth (if any at all) has been at a much slower pace. This has in part led to some significant changes in the composition of agricultural output over time. Changes in the relative contributions of the three principal sub-sectors in Colombian agriculture, livestock, coffee and non-coffee crops are indicated in table 2.4:

TABLE 2.4

RELATIVE IMPORTANCE OF THE MAIN AGRICULTURAL SUB-SECTORS (LIVESTOCK, COFFEE AND NON-COFFEE CROPS) OVER TIME: 1945-1975

YEAR	RATIO OF LIVESTOCK OUTPUT TO TOTAL AGRICULTURAL OUTPUT	RATIO OF COFFEE OUTPUT TO TOTAL AGRICULTURAL OUTPUT[14]	RATIO OF NON-COFFEE CROP OUTPUT TO TOTAL AGRICULTURAL OUTPUT
1945	.361	.307	.332
1950	.368	.254	.378
1955	.329	.247	.424
1960	.336	.246	.418
1965	.346	.228	.426
1970	.341	.194	.465
1975	.344	.169	.487

Of greatest interest is the decline in the relative importance of coffee since the end of the second world war. Corresponding to the decline of coffee there has been a significant increase in the relative importance of the non-coffee crop sub-sector from about one-third of agricultural output in 1945 to almost one-half in 1975.

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[13] Among the more important non-traditional crops are cotton, rice, sesame, sorghum, soybeans, sugar and tobacco.

[14] The coffee ratios are biased downward somewhat since they were calculated using domestic prices rather than world prices. Taxes on coffee production are significantly higher than the taxes levied on other agricultural commodities produced in Colombia.

The relative significance of the livestock sub-sector has remained virtually unchanged over the 31 year period.

Increases in employment opportunities in agriculture have not kept pace with the growth of output.[15] It is convenient to sub-divide the growth of agricultural employment and labour force into three distinct phases: 1945 to 1953, 1953 to 1969, and 1969 to 1975. In the first phase, the numbers employed in agriculture rose from 2,186,000 to 2,215,000, a rate of less than one-fifth of one percent per year. The years from 1949 to 1953 were at the height of "La Violencia".[16] During the second phase, available data indicated that employed in agriculture expanded at an average annual rate of about 1.2 percent to 2,644,000 people, well behind the estimated rural population growth rate of 3.2 percent. More recent evidence, however, seems to point to a considerably slower rate of growth of employment over this period, even to a rate which approaches zero percent. Although data is very sketchy at this time, there are some indications that since around 1969, agricultural employment has declined. Very rough estimates point to a fall of something less than one percent per annum, on average.[17] Still, in 1975, 40 percent of the

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[15] Agricultural employment and the agricultural labour force are used synonymously here. Although this implies full employment in the sense that everyone in the labour force has something productive to do, it does not deny the existence of disguised unemployment. The data on which the discussion in this paragraph is based comes from A. Berry's statistical appendix (Tables A-5 and A-9) to his forthcoming book on the development of Colombian agriculture.

[16] "La Violencia" refers to the organized violence which plagued rural Colombia, especially during the early 1950's. It is estimated that somewhere between 100,000 and 200,000 Colombians were killed. The conflict which included mass murders did not have a strong idealogical basis but was rather along class and political party lines.

[17] This is based on very recent sampling, the results of which were provided by A. Berry. It would probably be safer to assume that data on recent tendencies are tentative and the conclusion impressionistic.

economically active population continued to be engaged directly in agricultural activities.

The agricultural sector's importance to the Colombian economy becomes especially clear when one turns to the Balance of Payments. Although in a relative way, coffee's predominant role as an earner of foreign exchange has declined somewhat since 1945, coffee production continues to generate on average about 70 percent of all foreign exchange earned on visible exports.[18] Among the remaining "minor" exports, about half involve the export of agricultural commodities other than coffee and the other half, manufactured goods. A strong feature of Colombian trade policy in recent years has been to diversify the range of agricultural export commodities. This has met with considerable success. Measures such as export subsidies, easy credit for export crops, and the direct intervention of the government controlled marketing board, IDEMA, have all helped to generate between 1957 and 1970 average annual increases of about 12% in foreign sales of crops such as bananas, cotton, sugar and tobacco as well as of cattle (Diaz-Alejandro 1976).[19]

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[18] Its importance as an export commodity, however, has tended to make Colombia an illustrative example of a country which depends on the export of one or two basic commodities which are subject to widely fluctuating world prices.

[19] Export volume of the four crops has expanded at an annual rate of almost 30 percent since 1957 compared with average annual output increases of 13 percent. A weighted average of 55 percent of total production of these crops was exported over the 1965-1969 period. Almost all of the exports are to countries outside LAFTA: This is not so of cattle where over 90 percent are exports to member countries of LAFTA.

Agriculture in Colombia,[20] like much of that of the third world, can be largely characterized by the observation that the majority of the agricultural population exists at not much above a subsistence level. The existence of low incomes earned by most cultivators stems from two principal interrelated features found in much of third world agriculture: enormous inequalities in the distribution of land and low yields per hectare cultivated. Land distribution patterns estimated on the basis of nation-wide data collected during the 1960 agricultural census indicated that about 50 percent of farms families operate production units of less than three hectares involving but 2.5 percent of the arable land available (World Bank 1972). With the exception of a number of highly labour intensive crops, farms of less than three hectares in size do not generate a sufficient level of income in Colombia. This is particularly true of the 25 percent of farm families who farm on plots of less than one hectare. Moreover, there is some evidence that since 1960 population pressures have

[20]For a country which lies within the tropics, Colombia is blessed with a surprising variety of agrarian environmental conditions allowing it to cultivate at least in theory, a far wider range of crops than is usually typical of a tropical country. The western part of the country is dominated by three ranges of the Andes. It is in the central-west temperate highlands that the bulk of the population dwells and most of the agricultural activity is concentrated. The somewhat curious phenomenon of the poorer mountain soils being the most intensively cultivated and most densely populated while the soil-rich savannas are less cultivated and much less densely populated stems from the malarious and swampy nature of the lowlands. Thus the lowlands tended to be avoided by early settlers. Once coffee became the dominant crop the tendency to settle in the highlands was heightened. Eventually large tracts of the lowlands were purchased by the wealthy for cattle raising.

forced continued farm sub-division which would tend to accentuate the already highly unequal distribution.[21]

The problem of low crop yield can be observed from the fact that for most of the traditional crops (corn, yucca, platano, potatoes) any increases in output over the last three decades have largely been the result of area expansion and not of improvements in yields although this has been less true of the last decade. On the other hand, non-traditional crops (cotton, sugar, rice, tobacco) have shown substantial increases in yield. However, since most of the land and a high percentage of the agrarian population are involved in the production of the traditional crops, the problem of low average yields is serious in Colombia. A number of constraints are at work which make it difficult to raise average yields. Such constraints include uneconomically small farms which limit access to credit and the modern inputs, inadequate markets, unfavourable ratios between the prices of output and the prices of the modern inputs, insufficient local research on the best use of the modern inputs, and a high level of illiteracy which makes adoption of more sophisticated techniques difficult.

Legislation affecting the agricultural sector is largely directed toward the low income problem and involves such policies as

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[21] A sample survey conducted in 1968 by DANE showed an increase of 300,000 in the number of farms over 1960 along with an increase of two million hectares in the amount of land used for agrarian purposes. The average size of the new farms is 6.7 hectares compared with an average of 22 hectares in the 1960 census. Most of the additional farm area is the result of colonization of hitherto forest lands with a typical production unit averaging over ten hectares. The fact that overall the average is 6.7 hectares indicates further sub-divisions of existing units (World Bank 1972).

land reform, research and extension, credit access, marketing, and price supports. With the exception of coffee policy which will be examined briefly in the next paragraphs, the practical application of these policies has seemed to have largely bypassed the small cultivator to date and it has been the large commercial farms which have benefitted most. This may be partly due to the relatively high cost per farm family assisted of the various programmes thus limiting the numbers who can be effectively reached. It is, of course, the price support policies which are of particular interest given the context of this study. In an effort to improve the marketing of crops and at the same time provide the grower with a better return, IDEMA (Instituto de Mercadeo Agropecuaria) has been given responsibility for maintaining a set of minimum prices over a fairly wide range of crops including wheat, corn, rice, sugar, cotton, soya and beans. Except for corn and beans, these crops are those typically grown on the larger commercial farms. In addition, only farmers who market their output benefit from such supports, ignoring completely output for subsistence purposes. By and large, the small cultivator has benefitted very little from price supports.

As far as coffee policy is concerned, a number of serious problems plague Colombia.[22] The first of these is the fact that almost a half

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[22]Coffee policy is largely in the hands of the National Coffee Growers Federation, a private body with quasi-official status and an enormous amount of power. Among other things, the Federation's principal function is the orderly marketing of coffee both for export and domestic consumption. It does this by purchasing directly from farmers 60% of the coffee crop each year (another 20 percent is bought by cooperatives which act as agents for the Federation and 20 percent is purchased by private dealers). In addition, the Federation administers the national coffee fund, sets quality standards, and stores surplus production.

of Colombia's coffee growers work plots of less than 3.5 hectares and of these about two-thirds (110,000 farms in 1965) raise coffee on plots of one hectare or less. Very often this does not provide much more than a subsistence standard of living even when coffee prices are relatively high.[23] A second major problem is that of price and hence income instability, a result of the instability of world demand and supply. As a charter member of the International Coffee Organization (ICO), Colombia has generally followed an enlightened policy of keeping supply increases in bounds. This is reflected in the fact that coffee output increased at an average annual rate of only 1.6 percent over the 1945-75 period, only slightly ahead of the annual increase in export volume of one percent. Since 1961 coffee output has remained virtually unchanged. Despite these efforts, Colombia's coffee terms of trade has generally moved in a downward direction, at least between 1945 and 1974.

In an effort to stabilize prices as well as quantities marketed, the ICO requires members who export more than 100,000 bags to participate in its Coffee Diversification Programme. Colombia's efforts along these lines began in 1963 with a limited pilot project called "The Five Year Program for the Development and Diversification of Coffee Zones" which has since been modified and extended to cover

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[23]Unlike coffee cultivation patterns in such countries like Peru, Ecuador and some African Countries, the small farm is the principal coffee production unit in Colombia. In total there were more than 300,000 farms engaged in coffee production in 1965 with an average size of 2.7 hectares.

85 percent of the coffee producing areas. The Program was designed to reduce the relative importance of coffee by encouraging foodstuff and livestock production while at the same time improving the incomes of small farmers.

We now turn to investigate the extent of price distortions affecting the principal agricultural commodities grown in Colombia. Coffee price distortions are examined first. This will be followed by a look at the distortions affecting livestock-derived products and finally we shall explore the distortions which may exist in the prices of non-coffee crops. As noted at the beginning of this chapter, we shall be estimating the level of agricultural price distortions that prevailed during the 1960's. In order to be consistent with the estimates made of the extent of price distortions in the manufacturing sector, we shall investigate the level of agricultural price distortions which existed in the late 1960's (1969) and in the early 1960's (1962). As it turned out, there was no significant difference in the distortion levels between the two periods.

If one ignores the coffee producing sub-sector, the differences in the domestic and world prices of most other crops tend not to be very great. Apart from coffee most other agricultural commodities are taxed minimally. Taxation on coffee, however, is significant with most levies occurring in the form of export taxes.

Coffee taxation in Colombia takes four principal forms. The two most important are an export tax and a coffee retention quota (World Bank 1972, Bird 1970). In 1967 the special coffee exchange rate was abolished and in its stead a 26 percent tax was levied on all coffee exports. This tax was gradually reduced until it reached

20 percent in late 1968, the rate at which it currently stands. 80 percent of the receipts from this tax go to the government and the balance goes to the National Coffee Fund. The coffee retention quota is levied on producers by the National Coffee Federation and is based on the quantity of green coffee sold but payable in equivalent amounts of parchment coffee. The receipts from this tax are used mainly to finance the acquisition and storage of surplus coffee. In 1969, the retention quota was 20 percent during the first quarter, 23 percent during the next two quarters, and 25 percent in the last quarter.[24]

A third form of coffee taxation is the exchange surrender requirement which was introduced at the same time as the coffee export tax. The foreign exchange coffee exporters are required to surrender is established by the Monetary Board and at times is set above the prevailing FOB market price. When it is, the fact that exporters have to acquire extra foreign exchange constitutes an additional tax on coffee exports. However, compared with the previous two taxes, this one is relatively minor. The final form of taxation is a six percent pasilla tax levied on producers by the Federation.

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[24] The coffee retention quota was revamped in late 1969 and a new sharing arrangement was instituted. It was agreed that once the price of coffee exceeded a particular level ($0.57 per pound in New York at the 1969 exchange rate) any future increase in prices would be shared on the basis of 35 percent to growers, 30 percent to the National Coffee Fund and 35 percent to the Banco Cafetero. The $0.57 threshold price was reached in late March of 1970. The result of this policy is that the coffee retention quota which was 25 percent when the threshold price was crossed would increase as coffee prices rise. Thus the effective retention quota which was 18.75 percent in 1969 when the U.S. price of Colombian coffee was $0.45 per pound would rise to about 33 percent when the price reached (for example) $0.75 per pound.

It is based on the volume of green coffee sold but is payable in the same volume of low-grade pasilla coffee. Its objective is to remove inferior coffee from the export market.

Using the information on the different kinds of taxes levied on coffee in Colombia, it is possible to calculate the difference between the world price and the price cultivators received for their coffee in 1969. We begin with an average 1969 New York price per pound of Colombian coffee of U.S. $0.4493 and work backwards from there. This is done in the following table:

TABLE 2.5

COFFEE GROWER RECEIPTS

(1)	New York price per 70-kilo bag (US $)	69.34
(2)	Ocean transport per 70-kilo bag (US $)	4.00
(3)	Colombian FOB price per 70-kilo bag (US $)	65.34
(4)	Applicable exchange rate (Col $ per US $)	18.00
(5)	Colombian FOB price per 70-kilo bag (Col $)	1176
(6)	Export tax at 20 percent	-235
(7)	After tax value per 70-kilo bag (Col $)	941
(8)	Domestic costs and charge (incl. prisilla tax)	-45
(9)	Value at interior collection points (Col $)	896
(10)	Effective retention quota (18.75 percent)[25]	-168
(11)	Price received by grower (Col $)	728

The difference between line (5) and line (11) reflects the difference between what coffee growers could have received if they had been able to trade directly with the outside world and what

[25] The difference between the nominal retention quota of 23 percent in 1969 and the effective retention quota is explained by the fact that it takes 87.5 kilos of parchment coffee to yield a 70-kilo bag of green coffee so that growers must deliver 87.5 plus 0.23 times 87.5 kilos of parchment coffee for each 70-kilo bag of green coffee shipped. The 107.625 kilos of parchment coffee which must be delivered when divided into Col. $ 896 and multiplied by 70 gives a value per 70-kilo bag of parchment coffee of Col. $ 583. The value of the green coffee equivalent is Col. $728 which reflects an effective quota of 18.75 percent.

they actually received. The world price is 61.5 percent above the domestic price or conversely the domestic price is 61.9 percent of the world price. This reflects an overall effective tax rate on coffee of 38.1 percent.[26] Although there was some variation in the effective tax rate during the 1960's, the rate we have calculated for 1969 was not untypical of the tax burden on coffee growers which prevailed throughout most of the decade.

Whether the entire gap between the world and the domestic price of coffee, or even any part of it, can be considered a commodity price distortion depends on the extent to which the difference in the two prices reflects the monopoly position Colombia and other coffee producing countries have strived for as members of the International Coffee Organization. It will be recalled that, as members of the ICO, Colombia and other countries have agreed to implement policies with the objective of keeping coffee supplies in check. This action represents Colombia's willingness to trade-off domestic output for higher international prices. Otherwise, Colombia would logically pull out of the ICO and go its own way. A problem arises in that without an intensive examination of the ICO Agreement

[26] It has been questioned whether all of the coffee tax should be treated as a tax (Berry and Urrutia 1976, pp. 238-239). First of all they argue that since the price received by growers is generally sufficient to bring forth that supply which Colombia can sell on the international market, then it is debatable whether any difference between the world and domestic price should be viewed as a tax since it implies that growers have received and then have had taxed away some part of the domestic price they received. Secondly, Berry and Urrutia argue that a part of the tax comes back to growers in the form of transport and credit subsidies and low cost inventory financing so that part of the tax can be viewed as a fee for services rendered.

and Colombian domestic coffee pricing policies (such an examination would be a dissertation in its own right), it is impossible to determine the proportion of the gap between the world and the domestic price which is the result of efforts to gain a "cartelized" monopoly position in world trade and the proportion which reflects a true distortion as would be the case if the coffee taxes represented solely a desire to raise government revenues. Thus, in order to avoid a misleading picture of the impact of price distortions on coffee as well as total agricultural outputs and incomes, we are forced to view the entire gap as reflecting the desire to achieve a monopoly position and, as a result, the distortion between world and domestic coffee prices shall be assumed to be zero. Given coffee's declining role as a generator of value added in the agricultural sector of Colombia, the effects of this assumption on overall agricultural output, employment and incomes should be minimized. However, as a point of comparison only, the effects on coffee and total agricultural outputs and incomes will also be calculated under the assumption that the gap does not represent in any way an effort to gain monopoly power.

The livestock sub-sector presents a considerably different picture when it comes to the gap between world and domestic prices. Generally, Colombian F.O.B. export prices for beef are sufficiently low to enable it to compete in some markets, especially in neighbouring countries but as noted by the World Bank, a 15 percent export subsidy (in the form of tax rebates) "is crucial and is just sufficient to move beef into export markets" (World Bank 1972, p. 297). In fact, except in marginal cases, Colombian beef producers find it extremely difficult, even with the subsidy, to compete with Argentinian beef in European markets.[27] The price received by the grower is about 80 percent of the FOB export price and the difference is almost entirely made up of transportation and marketing costs. Beef sold locally is subject to a slaughter tax of Col. $50 per head for males and Col. $100 per head for females, but this tax is largely passed on to the consumer. There are two inventory taxes levied directly on beef producers but these are very small. In fact, taxation policy over the years has tended to favour cattle raisers, the larger of which form the highest income segments of the Colombian agricultural community. The evidence therefore seems to indicate that during the 1960's there is no significant difference between the world price of beef and the price received by beef producers in Colombia and whatever difference does exist would appear to point to an excess of the domestic price over the world price. However, the gap is probably only marginal and for the purposes of this study it will be presumed to be zero.

In the case of non-coffee crops, estimation of the gap between the domestic price and the world price should ideally be made on a crop by crop basis.[28] Although agriculture is generally assumed to

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[27] Colombia's competitive problems in international markets for beef rest mainly on inefficiencies at the production end. The "extensive" ranching methods which prevail in much of Colombia as well as a lack of research into tropical livestock raising generally lead to considerable production inefficiencies. This has been recognized by the World Bank. "Ranching methods leave tremendous room for improvement" (World Bank 1972, p. 297).

[28] Seven non-coffee crops are considered separately in this study. These are corn, cotton, panela, platano, potatoes, rice and yucca. See Chapter 4.1 for further details.

be a traded sector, a problem can arise when a proportion of the crops cultivated do not in fact enter into international trade to any significant extent. Consequently, a set of international prices do not exist for such crops. Of the seven crops considered in this study, three (platano, panela, and yucca) do not enter sufficiently into international trade so as to warrant publication of world price data in any specific detail. As a result, some assumptions have had to be made which would allow us to obtain at least an indicative approximation of the gap between the domestic and world prices of these three crops.

Before examining separately the differences (if any) between the domestic and world prices of the seven non-coffee crops in question here, some indication of the extent of the level of overall distortions affecting non-coffee crops in the aggregate would be useful. Perhaps, the most comprehensive study of the effects of trade policy on prices was undertaken by De Melo (De Melo 1975, 1978).[29] The effect on the domestic price of the output (other than coffee) from the agricultural sector of a 100 percent removal of all tariffs and subsidies reflects the gap between the free trade price and the domestic tariff-ridden price. However, the price of agricultural output generated in the free trade solution should be a reasonable approximation of the world price provided Colombia has no monopolistic or

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[29] See Chapter 3.1 for a brief discussion of the objectives and methodology of De Melo's study. Of the 11 traded sectors, two were agricultural, namely coffee and "other" agricultural. The remaining sectors except for minerals (petroleum and mining) were manufacturing sectors.

monopsonistic power over trade in any of the commodities in question. Thus, any difference in the price between the tariff-ridden solution and the free trade solution should be an adequate measure of the gap between domestic prices and world prices.

De Melo calculated that as a consequence of free trade, the domestic price of agricultural output in the short-run (when land is assumed fixed) would rise by 7.6 percent, indicating that the world price lies about 7.6 percent above the current domestic price. The equivalent long-run impact on the domestic price of agricultural output (again other than coffee) would be to increase the domestic price by 5.4 percent. In the long-run, De Melo assumed land to be mobile between coffee and other agricultural commodities.

The price referred to here covers both the output of non-coffee crops as well as the output of livestock-derived products. It has already been determined that for purposes of this study the gap between the domestic and world price of livestock-derived products approaches zero. Thus the gap between the world and domestic price of non-coffee crops would be somewhat higher than the figures given in the previous paragraph. In 1969, the real values of livestock and non-coffee crop output were about 0.45 and 0.55 of real value of agricultural output (other than coffee). Thus, the short-run and long-run free trade solution would seem to indicate that the domestic price of non-coffee crops would increase by 13.8 percent and 9.8 percent, respectively. The short-run gap of 13.8 percent points to domestic prices being 0.879 of world prices in 1969. The equivalent long-run ratio is 0.911. The gap between the domestic and world price of non-coffee crops estimated by De Melo are reasonable and intuitively acceptable given the agricultural policies prevailing in Colombia during the 1960's.

The approach followed in estimating the gap between the domestic and world prices of four of the seven individual non-coffee crops mainly involved comparing the producer price in Colombia converted into U.S. dollars at the existing exchange rate with published export prices of the principal exporters of the same commodity.[30] The four crops are corn, cotton, potatoes and rice. With cotton we had an added advantage of a consistent set of Colombian export prices as, of the seven crops, only cotton was continually exported from Colombia during the 1960's. For yucca, the only available world price is an import price from France (Madagascar was the exporting country). This was the price used after making allowances for shipping costs. In the case of platano and panela, no published world prices exist. However, platano and bananas are closely related and a set of world prices do exist for bananas. Given that Colombia also grows and exports bananas and given that a series of Colombian producer and export prices are available, then it was assumed for purposes of this study that any gap between the world and domestic price for bananas also applies to platano. The same sort of procedure was followed for panela which is made from the same raw material as is raw centrifugal sugar. Colombia also produces and exports raw sugar. Thus as with platano, any difference between the producer price and the world (or export) price for

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[30]Data on export and import prices were obtained from selected volumes of the Food and Agriculture Organization's production and trade yearbooks.

sugar was assumed to apply also to panela.

Because both the Colombia domestic prices and the world prices of some of these crops tend to fluctuate from year to year, average distortions or gaps in the two sets of prices for each crop during the 1960's (1961-1970) were calculated.[31] As it turned out, for one crop, corn, producers received prices well in excess of the world price while for another, rice, the domestic price was probably slightly above the world price. For the remaining five crops, domestic producer prices were either at or slightly below their equivalent world prices.

The results of the calculations are contained in Table 2.6.

TABLE 2.6

DISTORTIONS IN THE PRICES OF THE SEVEN MAJOR NON-COFFEE CROPS GROWN IN COLOMBIA, 1961-1970 AVERAGE

CROP	PERCENTAGE EXCESS OF THE WORLD PRICE OVER THE DOMESTIC PRICE
Corn	-30
Cotton	0 to 20
Panela	0 to 20
Platano	0 to 20
Potatoes	0
Rice	-20 to 0
Yucca	10 to 20

A negative sign indicates an excess of the domestic price over the

[31] Average distortions were also calculated for the early 1960's (1961-1965) and the late 1960's (1966-1970) to check if there had been any trends in the size of the distortions between the early and late part of the decade. It was initially thought that perhaps the distortions had been larger in the early half of the 1960's. This proved not to be the case and no particular trend was found for any of the seven crops.

proportion of migrants were of working age and seeking work. The net effect of these enormous differences in relative population growth rates over the period was to increase the percentage of Colombia's population living in urban areas from 30 to 52 percent, and to increase the total urban labour force by 95 percent.

It is argued extensively throughout the development literature that the high levels of open urban unemployment in major centres of most third world countries can be largely attributed to high levels of internal migration. While this might be true of much of Asia and Africa, it cannot be generalized to most Latin American countries, including Colombia. Available evidence seems to indicate that it would be false to presume that it is the migrant who absorbs the brunt of fluctuations in unemployment levels. Despite disadvantages of less and lower-quality schooling compared with native-born urban workers, migrants tend to spend a relatively short period searching for their first job and as a result tend to have relatively low rates of unemployment.[39] The evidence, on the other hand, indicates that a large share of the openly unemployed in Colombia as in several other Latin American countries consists of the young and the relatively well educated who generally were born and raised in comparatively well-off urban families. Moreover, it appears that much of

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[39]The relatively low unemployment rate among migrants should not be interpreted as evidence that all migrants successfully find jobs in the high-wage factory manufacturing sector. In fact, the vast majority of those employed are concentrated in construction, commerce and personal services. It is in commerce and services in particular that one find the heaviest concentrations. At the same time, wages tend to be relatively low. Disguised rather than open unemployment would therefore seem to the more apt description of the typical "unemployed" migrant.

the unemployment among these people is of a semi-voluntary nature and reflects unsatisified job aspirations rather than an unavailability of jobs (Berry, undated, 1974a, 1975b).[40] Implied in this is the fact that such members of the labour force are in a position to refuse undesirable jobs while waiting for more attractive ones. To the extent that a significant proportion of the open unemployment in Colombia is of this type, then migration response models which interpret open unemployment solely as a function of sectoral income distribution may not be entirely appropriate.

In conclusion, much of the emphasis in the literature on the dire effects of internal migration, particularly with respect to urban unemployment may be unfounded in the context of many Latin American countries including Colombia. This has been well stated by Berry (Berry, undated, p. 1):

> Some of the discussion surrounding the rural-urban process has been ill-informed, especially that of observers who are "surprised" by the strength of the phenomenon, or who feel that it would be possible (or desirable) to prevent it. More reasoned or knowledgeable observers take it as given that a country undergoing a process of fairly continuous increases in income per capita will naturally have an increasing share of its population in urban areas.

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[40] Data on employment and unemployment in Colombia is pretty sketchy (data collection on unemployment only began in 1962). However, during the 1960's the unemployment rate in the four largest cities typically ranged between 10 and 15 percent. The rate of open unemployment in the 1950's was estimated to be somewhat below what was experienced in the 1960's. There is no strong evidence of a secular trend in unemployment rates. In any event, even during the worst of the 1960's, the rates of open unemployment experienced in Colombia are well below what is typical of many African and Asian cities.

While no doubt there is much to say for this point of view, there is still the question of whether the rate of internal migration is in some sense optimal and whether there is a significant proportion of those who have migrated who would not have done so if the differences in urban and rural incomes had not been so large. One of the basic contentions of this study is that urban-rural income differentials are as significant as they are partly as a result of trade restricting policies which distorted relative agricultural and manufacturing prices in favour of the manufacturing sector and against the agricultural sector.

To summerize the Chapter, we have seen that the Colombian economy and its development since 1945 has not been atypical of what has generally been observed among counties at a similar stage of development. By Latin American standards (e.g., Brazil, Chile, Argentina) Colombia's process to industrialization occurred relatively later but, on the other hand, wide variations in topography has resulted in industrial activity being more decentralized than is common in other Latin American countries. Nonetheless, industrialization through import substitution in Colombia as in most other third world countries occurred behind a set of trade barriers whose main purpose was to restrict imports so as to ensure the continued survival of the industrialization process. In this Chapter, we examined the more important Colombian trade restricting policies and found that they had resulted in a significant gap between the domestic and the world price of manufactured goods with the size of the gap diminishing during the 1960's as trade liberalization policies took effect.

It was also noted in this Chapter that the relative importance of agriculture declined significantly since the end of World War II and that, within the agricultural sector, coffee's role as a source of income had also declined, although it continued to be a dominant source of foreign exchange earnings. In addition, unlike the manufacturing sector, we estimated that the level of commodity price distortions in the agricultural sector were not very large, although in the case of coffee, the gap between the world price and the producer price was considerable.

We also examined the patterns of income distribution and concluded that by any yardstick enormous inequalities in the distribution of income exist in Colombia. Finally, we looked at the migration process in Colombia and observed that migration patterns tend to be typical of what has happened in other Latin American countries. The tentative conclusion reached as a result of our examination of the Colombian economy is that the set of trade restrictions policies behind which industrialization occurred probably did not leave the agricultural sector nor those who earn their living in it unaffected.

CHAPTER 3

THE MODEL

3.1 INTRODUCTION

Despite the effort devoted to estimating supply elasticities in third world agriculture, there has been little published work on the formal modelling of the agricultural sector. Such modelling should ideally begin with individual production unit behaviour which then can be used as a basis for empirical estimation of the agricultural parameters needed to analyse the impact of various price policies on the important "dualistic" variables.[1] The two types of models examined in Chapter 1, namely those which study subsistence farm behaviour (most often referred to as the surplus labour models) and those which primarily focus on various aspects of the growth process of the dual economy, fail in these respects.

There has, however, been some recent work on non-linear multi-sectoral general equilibrium modelling for "open" economies (Johansen 1974, Taylor 1974, Taylor and Black 1974, and De Melo 1974, 1978).

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[1] An interesting exception to this has been the work of Jorgenson, Lau and Yotopoulos (Jorgenson and Lau 1974, Lau and Yotopoulos 1972, Yotopoulos and Lau 1974). The latter work is of particular interest since the authors develop first a general equilibrium model of micro-economic behaviour encompassing both the production (profit maximizing) decisions and consumption (utility maximizing) decisions of the farm unit. Given the money wage rate (labour being the only variable input), the price of the output, the unit's fixed obligations and the size of the agricultural labour force and population, a set of reduced form equilibrium values for output and labour supply and labour demand are determined. From these values, the authors aggregate to arrive at the macroeconomic relationships by summing over all farm units. By using illustrative data, the authors then examine the impact on the three endogenous variables of changes in the exogeneous variables, under three regimes; a closed, a regulated and an open agricultural sector.

The Johansen model is essentially a general equilibrium growth model with 20 production sectors corresponding to the 1950 Norwegian input-output table, each of which has a growth path guided by a Cobb-Douglas production function with neutral technological change. Estimates of appropriate demand and supply elasticities enable Johansen to trace out the development path of the Norwegian economy which is then compared with the economy's observed development.

Taylor and Black employ a model similar to that developed by Johansen but use the various elasticity estimates to examine in a general equilibrium comparative static framework the short-run impact of changes in tariff rates on sectoral output and employment in Chile. Finally, Taylor using a two sector short-run model (traded goods and non-traded goods) investigates the effects of changes in relative sectoral prices and the exchange rate on real income, the balance of payments and labour's share. Using data from Chile, Taylor finds that for a considerable range of realistic values of the elasticities, trade-offs amongst the three endogenous variables occur in the sense that an improvement in say, real income occurs at the expense of the balance of payments and/or an improvement in labour's share.

De Melo, within the framework of a general equilibrium non-linear resource allocation model, attempts to measure the effects of protection on resource allocation in the Colombian economy. The model incorporates non-traded goods as well as direct substitution in both supply and demand with market behaviour specifications lending themselves easily to the inclusion of price distortions. The system of structural equations follow the general outline used by Johansen (1974). There are 15 sectors (of which 4 are non-traded) and 4 primary factors. However, unlike

Johansen, a solution is obtained through the Walrasian approach as opposed to the programming approach. The linearization required for solution in the programming approach restricts the size of parametric changes one can experiment with. By using the Walrasian "tâtonnement" process, De Mélo was able to consider quantum changes in various parameters, his principal concern being that of the impact on endogenous variables of a 100 percent tariff reduction. Using 1970 as the base year, De Melo initially solved his model in terms of actual tariff-ridden product and input prices. Then taking the resulting solution as an equilibrium, though distorted, the model was solved again showing the effects on resource allocation and on prices of a one hundred percent removal of all tariffs and subsidies in the traded sectors, except coffee which is a special case. Since there is no money in the model, prices of the 15 sectors were all normalized to equal one so that the free trade solution was expressed in terms of percentage changes only. The general equilibrium results were then compared with partial equilibrium estimates. His principal conclusion is that the adjustments that occur in factor prices and in the prices of non-traded goods as result of tariff changes are "likely to have a bearing on sectoral output responses to changes in tariff structures" (De Melo 1978, p. 40).

The model we propose to develop here abstracts to some extent from the general equilibrium framework of the foregoing writers: It examines within a partial equilibrium macro framework the comparative static impact of changes in the internal terms of trade on the important "dualistic" variables.[2] The "dualistic" variables of concern here, as

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[2]One econometric model which focuses specifically on relationships

specified earlier, are relative sectoral outputs and per capita incomes, income distribution, intersectoral migration and sectoral employment and unemployment.

3.2 AGRICULTURAL SUPPLY

The behavioural model proposed as a basis for the econometric model to be used for the estimation of supply elasticities views the agricultural sector as consisting of K producing units (farms) with the k^{th} unit being sufficiently small that its decisions with respect to the supply of the i^{th} crop ($i = 1,2,\ldots,s;\ s+1,\ s+2,\ldots,m$)[3] do not influence either crop or input prices. We can regard the k^{th} farm as having to make two simultaneous decisions. The first decision concerns which crop or crops are to be grown. At first glance, this would largely be a function of relative crop prices and the type(s) of land to which the k^{th} farm has access. The second decision is concerned with the absolute quantity of the crop or crops that will be brought to market. This will mainly depend on the ratio of the prices

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between agriculture, services and industry, particularly with respect to their role in foreign trade has been developed by Thorbecke and Field (Thorbecke and Field, 1969). However, the model, which employs 8 behavioural and 15 technical or definitional equations, is unabashedly Keynesian including all national income variables being expressed in constant prices. Even though the sectoral consumption functions are in part functions of the TOT, the model's applicability to the sort of problems to be tackled here is somewhat limited. It is interesting to note, however, that the authors found that both in the case of Argentina and Peru investment in agricultural relative to its potential contribution to national income was deficient.

[3] It is assumed that the i^{th} crop given by ($i = 1,2,\ldots,s$) is not land specific, whereas the i^{th} crop given by ($i = s+1,\ s+2,\ldots,m$) can be grown only on land with specific environmental qualities, or is, for example, a crop such as one borne by a tree. Looked at in another way, there exist some units of land which for all feasible relative price ranges, can be profitably used for only specific crops.

of the crops sown to some sort of index of prices indicative of the cost of non-agricultural goods consumed by the k^{th} farm. It is assumed that each producing unit selects that combination of crops and expected crop outputs which maximizes the respective unit profits subject to the different technologies implied in each crop's production function.

The assumption of profit maximizing behaviour made here seems to conflict with the utility maximizing behaviour believed to be characteristic of third world farmers discussed in Chapter 1. Much of the theoretical analysis of grower behaviour found in the literature does view the production unit's objective as one of utility maximization. This approach is quite appropriate in the case of a largely subsistence type of agriculture. However, in the case of Colombia where commercial or market-oriented agriculture activities predominate with the bulk of the farm output and most of the inputs used being sold and purchased in their respective markets, the appropriate formulation of farm behaviour is the maximization of the differences between the farm's sales and its input costs.

In implicit form we can write the production relations for the different crops faced by the k^{th} farm as follows:

$$F_{ik}(Q_{ik}; X_{ik1}, X_{ik2}, \ldots, X_{ikj}, \ldots, X_{ik,r-1}; X_{ikr}; X_{ik,r+1}, \ldots, X_{ikn}) = 0 \qquad (3.1)$$

where Q_{ik} is the output of the i^{th} crop by the k^{th} farm, X_{ikj} ($j = 1, 2, \ldots, r-1$) is the j^{th} variable input required for the production of the ith crop by the k^{th} farm, X_{ikr} ($i = 1, 2, \ldots, s$) is the non-crop specific land available to the k^{th} farm, and X_{ikj} ($j = r+1, r+2, \ldots, n$)

(i = s+1, s+2,...., m) refers to land which is tied to the production of specific crops.[4] It will be assumed that (n−r) = (m−s) and $X_{ik,r+1}$ is written as $X_{s+1,k,r+1}$, $X_{ik,r+2}$ as $X_{s+2,k,r+2}$, etc., that is, there is a one to one correspondence between the i^{th} crop (i = s+1, s+2,.... m) and the j^{th} crop-specific land (i = r+1, r+2,.... n).

Given maximization of profits as the k^{th} farm's objective, we can form the lagrangian:

$$\Pi_k^* = \Pi_k + \lambda_{ik} F_{ik}(Q_{ik}; X_{ik1}, X_{ik2}, \ldots, X_{ikn}) \tag{3.2}$$

where
$$\Pi_k = \sum_{i=1}^{m} P_i Q_{ik} - \sum_{j=1}^{n} v_j \sum_{i=1}^{m} X_{ikj} \tag{3.3}$$

and where P_i is the price of the i^{th} crop, and v_j is the price of the j^{th} input.[5]

By letting the partials of Π_k^* with respect to Q_{ik}, X_{ikj}, and λ_{ik} vanish, we arrive at a set of (2m + m.n) first-order profit maximization conditions for the k^{th} farm. From these first-order conditions and from the implicit function theorem, we have for every pair of output prices holding all other output prices and all input prices constant:

$$-\frac{d\hat{Q}_{2k}}{d\hat{Q}_{1k}} = \frac{\hat{\lambda}_{2k} P_1}{\hat{\lambda}_{1k} P_2}{}^{6} \tag{3.4}$$

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[4]It is assumed that; a) $X_{ikj} \geq 0$, b) F_{ik} is at least twice continuously differentiable with respect to its arguments with all partials different from zero for all nontrivial solutions and, c) the function in its implicit form is written as $Q_{ik} - F_{ik} = 0$ so that $\partial F_{ik}/\partial Q_{ik} > 0$ and $\partial F_{ik}/\partial X_{ikj} < 0$.

[5]It is assumed that there are no "switching" costs involved in reallocating land from one crop to another crop.

[6]The "hats" over the arguments of F_{ik} indicate their respective profit maximizing levels.

This represents for the k^{th} farm, the rate of transformation between Q_1 and Q_2 and, as required, it is equal to the weighted ratio of the two product prices. Next we have:

$$\frac{v_1}{v_2} = -\frac{d\hat{X}_{1k2}}{d\hat{X}_{1k1}} = -\frac{d\hat{X}_{2k2}}{d\hat{X}_{2k1}} = \cdots\cdots = -\frac{d\hat{X}_{mk2}}{d\hat{X}_{mk1}} \qquad (3.5)$$

This states that for every pair of input prices, cost minimization requires equality between the marginal rate of input substitution and the ratio of input prices for each and every crop produced.

Finally, we have:

$$\frac{v_j}{P_i} = -\frac{\partial F_{ik}/\partial \hat{X}_{ikj}}{\partial F_{ik}/\partial \hat{Q}_{ik}} = \frac{d\hat{Q}_{ik}}{d\hat{X}_{ikj}} \qquad (3.6)$$

Thus the value of the marginal product of the j_{th} input used in the production of the i^{th} crop must equal the price of the j^{th} input. This must hold for every m.n output/input pairs:

From these profit maximizing first-order conditions, assuming the second-order conditions are satisfied, we may solve for $\hat{Q}_{ik}$ in terms of P_i and v_j, that is, the supply function:

$$Q_{ik} = f_{ik}(P_1, P_2, \ldots, P_i, \ldots, P_m; v_1, v_2, \ldots, v_j, \ldots, v_n) \qquad (3.7)$$

Assuming that the supply function given in (3.7) is homogeneous of degree zero in all prices, we may deflate all crop prices with a price variable of our choice. Given the context of this study, we deflate (3.7) with a price index of goods produced by the manufacturing sector. Thus we have:

$$\hat{Q}_{ik} = f_{ik}(P_1^*, P_2^*, \ldots, P_i^*, \ldots, P_m^*; v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*) \quad (3.8)$$

where the stars indicate deflated values, that is, P_i^* represents the terms of trade faced by cultivators of the i^{th} crop. We may obtain aggregate supply of the i^{th} crop by summing over K producing units:

$$\sum_{k=1}^{K} \hat{Q}_{ik} = \hat{Q}_i = F_i(P_1^*, \ldots, P_m^*; v_1^*, \ldots, v_n^*)^7 \quad (3.9)$$

A priori, we would expect $\partial\hat{Q}_i/\partial P_i^* > 0$; $\partial\hat{Q}_i/\partial P_h^* < 0$ $(h \neq i)$; and $\partial Q_i/\partial v_j^* < 0$.

Taking the differential of (3.9), we have after manipulation and rearrangement:

$$d\hat{Q}_i = \hat{Q}_i(E_{ii})dP_i^*/P_i^* \quad (3.10)$$

where E_{ii} is the total price elasticity of supply of the i^{th} crop and is defined as:

$$(\varepsilon_{i1}\eta_{1i} + \ldots + \varepsilon_{ii} + \ldots + \varepsilon_{im}\eta_{mi} + \alpha_{i1}\beta_{1i} + \ldots + \alpha_{ij}\beta_{ji}$$

$$+ \ldots + \alpha_{in}\beta_{ni})$$

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[7] As will be discussed in subsequent chapters, it is preferable that area planted with the i^{th} crop rather than output of the i^{th} crop be employed as the dependent variable in estimating the supply responsiveness of the i^{th} crop. By definition, of course, output is equal to area cultivated multiplied by output per area unit.

ε_{i1} $(i \neq 1)$ is the cross elasticity of supply of the i^{th} crop with respect to the price of the first crop; η_{1i} $(i \neq 1)$ is the ratio of the percentage change in the price of the first crop over that of the i^{th} crop; α_{ij} is the elasticity of supply of the i^{th} crop with respect to the price of the j^{th} input; and β_{ji} is the ratio of the percentage change in the price of the j^{th} input over that of the i^{th} crop. If only the price of the i^{th} crop changes, all other prices held constant, then E_{ii} collapses to ε_{ii}, the own price elasticity.

3.3 MANUFACTURING SUPPLY

Suppose that aggregate output of the manufacturing sector of Colombia can be represented by the following implicit production function:

$$G(Q_m, Z_1, Z_2, Z_3, Z_4, T) = 0^{8} \qquad (3.11)$$

where Q_m is the output of manufactured goods. We may define the Z_i's as the level of capital stock, the employment of labour, inputs employed which originate in the agricultural sector, and all other inputs, respectively. T reflects the level of technological progress.

It will be assumed that firms in the aggregate, in response to a given vector of product and input prices, attempt to choose that level of aggregate output which maximizes profits, subject to available technology and those inputs whose availability may somehow be constrained.[9]

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[8] We assume G is at least twice continuously differentiable with respect to all of its arguments and that Z_i $(i = 1,2,3,4)$ is non-negative. G is written in such a manner that $\partial G/\partial Q_m > 0$ and $\partial G/\partial Z_i < 0$.

[9] The assumption that the manufacturing sector is a "price-taker" in

We may form the Lagrangian:

$$\Pi_m^* = \Pi_m + \lambda_m G(Q_m; Z_1, Z_2, Z_3, Z_4, T) \tag{3.12}$$

where $\Pi_m = P_m Q_m - \sum_{i=1}^{4} r_i Z_i$. P_m is the price of manufactured goods and r_i is the price of the i^{th} input.

By setting the partial derivatives of Π_m^* with respect to Q_m, Z_i, λ_m and T equal to zero, we have seven first-order profit maximizing conditions. Assuming the second order conditions are satisfied, we may solve for $\hat{Q}_m$ in terms of prices and time, that is, the supply function:

$$\hat{Q}_m = g(P_m, r_1, r_2, r_3, r_4, t) \tag{3.13}$$

A priori, we would expect $\partial g/\partial P_m > 0$ and $\partial g/\partial r_i < 0$. Presumably $\partial g/\partial t$ is also positive.

Taking the differential of (3.13), we obtain after manipulation and rearrangement:

$$d\hat{Q}_m = \hat{Q}_m \left| E_m \frac{dP_m}{P_m} + \frac{\partial g}{\partial t} dt \right| \tag{3.14}$$

where $E_m = e_m + \sum_{i=1}^{4} \bar{e}_i a_i$. e_m is the elasticity of supply with respect to the price of output, P_m; $\bar{e}_i$ is the elasticity of supply with respect to the i^{th} input price, r_i; and a_i is the elasticity of the i^{th} input

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no way implies that it operates under competitive conditions. There are, of course, extensive monopoly elements within Colombian manufacturing. Although manufacturing prices in Colombia are hardly arrived at competitively, it is safe to assume that prices are largely exogenously determined by the system of price controls and trade restricting controls which permeate Colombia manufacturing.

price respect to the price of output. Generally, it is assumed that $\partial g/\partial t$ is constant. If r_i is held constant, the E_m collapses to e_m.

3.4 DEFINITION OF PRICE DISTORTIONS

Let us define for time period t the terms of trade faced by cultivators of the i^{th} crop as:

$$P^*_{it} = P_{it}/P_{mt} \tag{3.15}$$

Taking the differential of (3.15) and approximating dP_{it} with $\bar{P}_{it} - P_{it}$ and dP_{mt} as $\bar{P}_{mt} - P_{mt}$, where the barred prices are the corresponding world prices, we have:

$$\frac{dP^*_{it}}{P^*_{it}} = \frac{\bar{P}_{it} - P_{it}}{P_{it}} - \frac{\bar{P}_{mt} - P_{mt}}{P_{mt}} = \dot{P}^*_{it} \tag{3.16}$$

$\dot{P}^*_{it}$ is the percentage change in the internal terms of trade expressed in domestic prices required to equate it with the terms of trade when expressed in world prices, that is, for cultivators of the i^{th} crop, (3.16) expresses the percentage difference in the relative prices they would face if they had been permitted to trade directly with the outside world and the relative prices they actually face. The relative distortion in the TOT for the agricutural sector as a whole, i.e., for all m crops, is given by:

$$\dot{P}^*_t = \sum_{i=1}^{m} \delta_i \dot{P}^*_{it}, \text{ where } \sum_{i=1}^{m} \delta_i = \sum_{i=1}^{m} (\hat{Q}_{it} / \sum_{i=1}^{m} \hat{Q}_{it}) = 1 \tag{3.17}$$

This expresses the percentage difference between the TOT at which the agricultural sector trades domestically and the TOT at which it could potentially trade in absence of trade barriers, that is, world prices.

3.5 IMPACT ON AGRICULTURAL OUTPUT, EMPLOYMENT, AND INCOMES

We first examine the impact on the i^{th} crop. Essentially the problem is to determine the output of the i^{th} crop that would be forthcoming if producers had faced world rather than distorted prices. The difference between that output and the output actually produced would reflect the lost production of the i^{th} crop incurred as a result of trade restricting controls. The output lost can be determined directly from (3.10), that is:

$$\bar{Q}_{it} - Q_{it} = Q_{it} \cdot E_{ii} \cdot \dot{P}^{*}_{it} \qquad (3.18)$$

where $\bar{Q}_{it}$ is the output that would have been forthcoming if world relative prices had prevailed.[10] Total agricultural output lost due to distortions in the terms of trade would be given by:

$$\bar{Q}_{at} - Q_{at} = \sum_{i=1}^{m} (\bar{Q}_{it} - Q_{it}) \qquad (3.19)$$

The employment of labour in the production of the i^{th} crop is given by the profit maximizing first order condition to the effect that the payment to a unit of labour service must equal the value of the marginal product of the last unit employed, that is:

$$P^{*}_{it} F_{ijt} = v_{jt} \qquad (3.20)$$

where F_{ijt} is the partial derivative of F_i with respect to the j^{th} input which in this case we assume to be labour. Taking the differential of (3.20), we obtain, after rearrangement, for the i^{th} crop at time t:

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[10] The "hats" are dropped from now on for purposes of simplicity.

$$dX_{ijt} = \frac{dv_{jt}}{P^*_{it}F_{ijjt}} - \frac{F_{ijt}}{P^*_{it}F_{ijjt}} dP^*_{it} - \sum_{\substack{h=1 \\ (h \neq j)}}^{n} \frac{(F_{ijht}dX_{iht})}{F_{ijjt}} - \frac{F_{ijit}dQ_{it}}{F_{ijjt}} \qquad (3.21)$$

where F_{ijjt} is the second partial of F_i with respect to the j^{th} input (labour), F_{ijht} is the cross partial of the j^{th} input with respect to the h^{th} input ($h \neq j$), and F_{ijit} is the partial derivative of F_{ij} with respect to Q_i.

Assuming $dv_{jt} = 0$ and $F_{ijht} = 0$[11], and defining dX_{ijt} as $\bar{E}_{it} - E_{it}$ where $\bar{E}_{it}$ is the level of employment that could have been realized for the i^{th} crop if producers had been able to trade at world prices, we obtain after substituting in (3.18):

$$\bar{E}_{it} - E_{it} = - F_{ijjt}^{-1}(F_{ijt} + F_{ijit}Q_{it}E_{ii}) \dot{P}^*_{it} \qquad (3.22)$$

Thus $\bar{E}_{it} - E_{it}$ reflects the lost employment opportunities in the production of the i^{th} crop as a result of cultivators producing in response to distorted domestic prices rather than to world prices. Employment opportunities lost for the agricultural sector as a whole would be given by:

$$\bar{E}_{at} - E_{at} = \sum_{i=1}^{m} (\bar{E}_{it} - E_{it}). \qquad (3.23)$$

We now turn to the effect these distortions in relative prices

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[11] As long as $F_{ijht} \neq 0$, then (3.21) is only one of n input demand equations which must be solved simultaneously for the n inputs. By $F_{ijht} = 0$, we are assuming that the additional employment of the h^{th} input leaves the marginal product of the j^{th} input and hence the demand for the j^{th} input unaffected. As will be seen in Chapter 9, this assumption

have had on agricultural incomes. Value added in the production of the i^{th} crop can be defined as:

$$Y_{it} = P^*_{it}Q_{it} - \sum_{j=g}^{r-1} v_{jt}X_{ijt} \tag{3.24}$$

where the expression after the minus sign refers to total payments made to intermediate inputs ($j = g, \ldots, r-1$).[12] Assuming the intermediate inputs are employed in fixed proportions, we have:

$$Y_{it} = (1 - \sum_{j=g}^{r-1} a_{ij})P^*_{it}Q_{it} \tag{3.25}$$

where a_{ij} are the Leontief coefficients. Taking the differential of (3.25), and substituting in (3.18), we obtain:

$$\bar{Y}_{it} - Y_{it} = (1 - \sum_{j=g}^{r-1} a_{ij})P^*_{it}Q_{it}(1 + E_{ii})\dot{P}^*_{it} \tag{3.26}$$

where $\bar{Y}_{it}$ is the value added or income that would be generated in the production of the i^{th} crop had producers been able to trade at world prices. Thus $\bar{Y}_{it} - Y_{it}$ reflects income lost to producers of the i^{th} crop as a result of trade restricting policies which reduced significantly the relative prices against which they based their output decisions. The income lost to the agricultural sector as a whole would be given by:

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makes little difference since data limitations prevent the estimation of crop production functions in any event.

[12]The j^{th} variable input ($j = 1, 2, \ldots, g-1$) therefore refers to variable primary inputs while the j^{th} variable input ($j = g, \ldots, r-1$) refers to intermediate inputs. It should be noted that by including all returns to land as part of agricultural income, it is implicitly assumed that urban-dwelling absentee landlords are relatively unimportant.

$$\bar{Y}_{at} - Y_{at} = \sum_{i=1}^{m} (\bar{Y}_{it} - Y_{it}) \tag{3.27}$$

In the next section, we examine following along the same lines as we did for the agricultural sector the impact of relative product price distortions on manufacturing output, employment and incomes.

3.6 IMPACT ON MANUFACTURING OUTPUT, EMPLOYMENT, AND INCOMES

For simplicity of manipulation, let us set $dr_1 = dr_2 = dr_4 = \partial g/\partial t = 0$. r_3 is, as will be recalled, the price of inputs used in manufacturing which originate in the agricultural sector. Let us define r_3 as P_a. Reformulating (3.14) we have for time t:

$$dQ_{mt} = Q_m(e_m + e_a b_{amt}) dP_{mt}/P_{mt} \tag{3.28}$$

where e_a is the elasticity of manufacturing supply with respect to P_a and b_{amt} is the ratio of the percentage change in the price of agricultural inputs to that of manufactured goods, that is, dP_{at}/P_{at} over dP_{mt}/P_{mt}. Define dQ_{mt} as $\bar{Q}_{mt} - Q_{mt}$, dP_{at} as $\bar{P}_{at} - P_{at}$, and dP_{mt} as $\bar{P}_{mt} - P_{mt}$, where $\bar{Q}_{mt}$ is the manufacturing output that would be forthcoming if the protected manufacturing sector were forced to face world prices. $\bar{P}_{at}$ and $\bar{P}_{mt}$ are of course the world prices of agricultural and manufactured goods. Thus we have from (3.28):

$$\bar{Q}_{mt} - Q_{mt} = Q_m(e_m \dot{P}_{mt} + e_a \dot{P}_{at}) \tag{3.29}$$

where $\dot{P}_{mt} = (\bar{P}_{mt} - P_{mt})/P_{mt}$ and $\dot{P}_{at} = (\bar{P}_{at} - P_{at})/P_{at}$. *A priori*, we would expect e_a to be negative. Hence $Q_{mt} - Q_{mt}$ reflects the increase or gain in manufacturing output that has occurred as a result of a set of domestic prices which differ radically from the same set of world prices.

In much the same manner as was done for the effects on agricultural employment, we may derive the impact on manufacturing employment of TOT distortions by taking the differential of the profit maximizing first order condition with respect to Z_2 (labour employment). Then assuming, as we did for the agricultural sector, the dr_2 and the second cross partial derivative of G with respect to Z_2 and then with respect the i^{th} input (i = 1, 3, 4) are both equal to zero, we obtain:

$$\bar{E}_{mt} - E_{mt} = - G_{22t}^{-1} \left| (G_{2t} + G_{2Qt} Q_{mt} e_m) P_{mt} + G_{2Qt} e_a P_{at} \right| \qquad (3.30)$$

where G_{22t} is the second partial derivative of G with respect to Z_2 (labour), G_{2Qt} is the partial of G_2 with respect to Q_m and $\bar{E}_{mt} - E_{mt} = dZ_{2t}$. $\bar{E}_{mt} - E_{mt}$ would reflect in a partial equilibrium framework, the additional employment in the factory manufacturing employment which could be directly attributable to relative price distortions. $\bar{E}_{mt}$ is of the level of employment that would be generated if manufacturing in Colombia were forced to compete directly with the outside world.

Factor income yielded by factory manufacturing at time t is defined by:

$$Y_{mt} = P_{mt} Q_{mt} - \sum_{i=3}^{4} r_{it} Z_{it} \qquad (3.31)$$

where Z_{it} refers to the employment levels of agricultural and other intermediate inputs. Assuming these inputs are absorbed in a Leontief manner, we have;

$$Y_{mt} = (1 - \sum_{i=3}^{4} b_i) P_{mt} Q_{mt} . \tag{3.32}$$

where b_i is the fixed input-output coefficient. Taking the differential of (3.32) and substituting in (3.29), we obtain:

$$\bar{Y}_{mt} - Y_{mt} = (1 - \sum_{3}^{4} b_i) P_{mt} Q_{mt} (e_m \dot{P}_{mt} + e_a \dot{P}_{at}) \tag{3.33}$$

where Y_{mt} are the returns to the primary factors expressed in world rather than domestic prices. Thus $\bar{Y}_{mt} - Y_{mt}$ represents the gain in income enjoyed in factory manufacturing as a result of protectionist policies, assuming absence of monopolistic or monopsonistic power in trade.

3.7 IMPACT ON INCOME DISTRIBUTION

One of the more interesting questions that this study will examine is the effect that distortions in relative prices have had on income distribution. Our objective will be to compare the existing distribution with the one which would prevail if the agricultural sector had been in a position to trade at world prices.

We may define the total nominal income earned by the k^{th} income class at time t as:[13]

$$Y_{kt} = \sum_{i=1}^{m} Y_{ikt} + Y_{mkt} + Y_{okt}. \tag{3.34}$$

where Y_{ikt} is the nominal income of farmers in the k^{th} income class who produce the i^{th} crop, Y_{mkt} is the nominal income of persons in the

[13] Since available data on income distribution in Colombia is expressed in nominal terms, that is, in terms of money income with respective sectoral prices deflated, the model formulated here will be set up in similar terms.

k^{th} income class associated with factory manufacturing, and Y_{okt} is the nominal income of all other income earners in the k^{th} income class. Other income earners would mainly consist of individuals employed in non-factory manufacturing, services, construction, and government.

Taking the differential of (3.34), assuming dY_{okt} equals zero,[14] we have:

$$\bar{Y}_{kt} - Y_{kt} = \sum_{i=1}^{m} (\bar{Y}_{ikt} - Y_{ikt}) + (\bar{Y}_{mkt} - Y_{mkt}) \qquad (3.35)$$

Rewriting (3.26) in terms of nominal income and then substituting it as well as (3.33) into (3.35), we obtain:

$$\bar{Y}_{kt} - Y_{kt} = \sum_{i=1}^{m} \beta_{ik} \left| (1 - \sum_{j=g}^{r-1} a_{ij}) P_{it} Q_{it} (1 + E_{ii}) \dot{P}_{it} \right| + \beta_{mk} \left| (1 - \sum_{i=3}^{4} b_i) P_{mt} Q_{mt} (e_m \dot{P}_{mt} + e_a \dot{P}_{at}) \right| \qquad (3.36)$$

where β_{ik} is the proportion of the i^{th} crop grown by farmers in the

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[14] This is perhaps an untenable assumption. It is obvious that the removal of distortions in relative prices would have some effect on the nominal incomes of other sectors. Unquestionably, their real incomes would be affected, the extent to which depending on the relative importance of agricultural and manufactured goods in their respective consumption baskets, and the income elasticities of demand for the two commodities. The impact on the incomes of the other sectors is, however, beyond the scope of this study. In any event, it has been demonstrated by De Melo (De Melo 1975, 1978) that the effects of free trade on prices and the value added generated by non-factory manufacturing, transportation and communications, construction and services are minimal. See the first section of this chapter. To the extent that there is some impact on the money incomes of these sectors, then the effects on income distribution of distortions in the terms of trade should be taken as a first approximation and any changes in the distribution as indicative.

k^{th} income class and β_{mk} is the proportion of manufacturing output accruing to the k^{th} income class. The expression (3.36) therefore is a partial measure of the impact of distortions in agricultural and manufacturing prices have had on the distribution of income between those in the k^{th} income class who earn their living in agriculture and those who earn their income in the manufacturing sector. An identical expression may be derived for all K income classes.

Once we have $\bar{Y}_{kt}$ for each of the K income classes, one could calculate the percentage of national income (now expressed in world prices) accruing to each income class and then compare it with current or actual share of income in each of the K income classes. The impact of distortions in relative prices on the distribution of income would be seen most clearly through the change in the Gini coefficient of concentration that would result. An approximation to the Gini coefficient is given by:

$$g = \sum_{k=1}^{K} (Y_{k-1}\eta_k - Y_k\eta_{k-1})10^{-4} \qquad (3.37)$$

where Y_k is the percentage of income accruing to the k^{th} income class and η_k is the accumulated percentage of income earners in the k^{th} interval. We would be interested in determining:

$$\bar{g} = \sum_{k=1}^{K} (\bar{Y}_{k-1}\eta_k - \bar{Y}_k\eta_{k-1})10^{-4} \qquad (3.38)$$

where $\bar{Y}_k$ reflects the percentage of income earned by the k^{th} income class but expressed in world rather than domestic prices.[15]

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[15]It is implicitly assumed throughout that the price elasticity of

3.8 IMPACT ON INTERNAL MIGRATION AND URBAN UNEMPLOYMENT

We postulate that the decision to migrate is largely based on the prospective migrant's ability to compare the income he would earn over his lifetime remaining where he is and the income he would earn by migrating to the city. We further postulate that the migrant's estimate of the income he would earn in the city is based on the expectation of obtaining a job in factory manufacturing. Thus migration would occur if (ignoring the costs of the migration itself):

$$\sum_{t=0}^{T} \frac{(\tilde{Y}_{mt} - \tilde{Y}_{at})}{(1+r)^t} > 0 \tag{3.39}$$

where $\tilde{Y}_{mt} - \tilde{Y}_{at}$ is the expected annual difference in income that the prospective migrant will earn as a result of moving to the city and r is some discount rate. It is of course a basic contention of this study that this difference is to a large extent a result of distortions in relative commodity prices.

Let us, as a first approximation, suggest a migration response function along the following lines:

$$M_t = M_t \left| (\tilde{Y}_{mt} - \tilde{Y}_{at}); r; t; W_1, W_2, \ldots W_n) \right| \tag{3.40}$$

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supply of the i^{th} crop is invariant across income classes. This does not mean of course that the proportion of land allocated to different kinds of crops is invariant across income classes. To the extent that some differences exist in the types of crops cultivated by farmers of different income classes, one might expect that distortions in relative crop prices would have had an impact on intra-agricultural income distribution, that is, distribution within agriculture would not have been unaffected if β_{ik} in (3.36) differs significantly for the K income classes. *A priori*, if farmers in the lower income classes tend to grow crops which are burdened with the largest distortions between domestic and world prices and tend to be more responsive to changes in prices, one would expect that the removal of such distortions would tend to have a beneficial impact on intra-agricultural income distribution.

where W_i represents any other factor influencing the migration decision.[16] Taking the differential of (3.40), and assuming $dW_{it} = dr = dt = 0$, we obtain after manipulation:

$$dM_t = \psi \frac{M_t}{\tilde{Y}_{mt} - \tilde{Y}_{at}} \, d(\tilde{Y}_{mt} - \tilde{Y}_{at}) \qquad (3.41)$$

where ψ is the elasticity of migration in response to the differential between the two sectoral incomes. We may then define dM_t as $\bar{M}_t - M_t$ and $d(\tilde{Y}_{mt} - \tilde{Y}_{at})$ as $(\bar{\tilde{Y}}_{mt} - \tilde{Y}_{mt}) - (\bar{\tilde{Y}}_{at} - \tilde{Y}_{at})$, where the "barred" variables reflect sectoral incomes expressed in world prices. Thus $\bar{M}_t - M_t$ is a measure of the extent to which migration levels in Colombia are explained by distortions in the TOT brought about by the trade restricting policies required to ensure the survival of the manufacturing sector.

The effects on urban unemployment as a result of distortions in relative prices can be derived from the identity:

$$dU_t = dL_t^* + dM_t - dE_{mt} \qquad (3.42)$$

where dU_t is the change in the level of unemployment, dL_t^* is the change

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[16] The model derived here is expressed in its most general form. The exact specification or definition of such variables as M_t, Y_{mt}, Y_{at}, and Z_{it} is left to Chapter 10, at which time the various approaches and definitions employed in modelling migration response by investigators in the field will be examined in some detail. One such model is Todaro's which was discussed in the first chapter. Use of Todaro's model would require Y_{mt} to be redefined as $\rho_t Y_{mt}$, where ρ is a measure of the probability of finding employment in the factory manufacturing sector. To the extent that ρ_t does not equal one, the urban-rural income differential will differ from that given in (3.39).

in the internal urban labour force, dM_t is the change in the net migration level, and dE_t is the change in the level of employment in factory manufacturing. We would define dU_t as $\bar{U}_t - U_t$, dM_t as $\bar{M}_t - M_t$, and dE_t as $\bar{E}_{mt} - \dot{E}_{mt}$. dL_t^* would be given. We may solve for $\bar{U}_t - U_t$ by substituting in (3.41) and (3.30). $\bar{U}_t - U_t$ would then represent the increase or decrease in urban unemployment which may occur in the absence of distortions in relative commodity prices.[17]

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[17] The proposed model presented in this chapter will be used as a basis in the attempt to estimate the impact on the various "dualistic" variables of distortions in the internal terms of trade. It goes without saying that limitations in data availability and quality may prevent the use of the model exactly as presented here. As required, appropriate adjustments to the model as well as the reasons for them will be outlined in subsequent chapters of this study.

CHAPTER 4

SUPPLY RESPONSIVENESS OF NON-COFFEE CROPS

4.1 INTRODUCTION

This chapter will be concerned with the estimation of the supply responsiveness of non-coffee crops (agricultural commodities other than coffee and livestock-derived products) in Colombia. We begin by devoting our attention to the estimation of aggregate non-coffee crop supply responsiveness. It will be recalled from Chapter 2 that the relative importance of non-coffee crops in Colombian agriculture has risen almost constantly since the end of the second world war from 34 percent to 50 percent of total agricultural output.

We then direct our attention to efforts to estimate the supply responsiveness of the most important of the individual non-coffee crops. In terms of the value of output the most important non-coffee crops are cotton, rice, corn, potatoes, yucca, panela[1], and platano. Between 1950 and 1975, output of these seven crops on average accounted for between 50 and 60 percent of total non-coffee crop output. Other valuable crops grown but of significantly less importance than the above are sesame, onions and garlic, cocoa, bananas, sugarcane for centrifugal sugar, barley, beans, tobacco, and wheat. Approximately 85 percent of non-coffee crop output can be considered as annual crops. Among the key seven crops only platano is unambiguously not an annual crop. Other important perennials besides coffee are bananas which are almost all

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[1]Panela is a form of non-centrifugal sugar and is a basic caloric foodstuff amongst the Colombian peasantry. Its manufacture is almost entirely a rural or agricultural activity. About 70 percent of the sugarcane crop ends up as panela.

exported and cocoa but these are one-third and one-eigth of platano output, respectively.

The next section develops more precisely the model given in Chapter 3 as well as reviews the various approaches that have been taken in the modelling of the behaviour of cultivators of annual crops with respect to the prices they receive for their output.[2] Section 4.3 examines the procedures used and problems encountered in the estimation of aggregate non-coffee crop response in Colombia. Section 4.4 presents the aggregate estimation results. In section 4.5, the nature of the production processes of the seven key crops and the econometric problems encountered in their estimation are discussed while in the various sub-sections of 4.5, the results of the area response estimations are given. Finally, in section 4.6, the responsiveness of yields to changes in crop prices is estimated and estimated output elasticities are calculated.

4.2 MODELLING ANNUAL CROP SUPPLY RESPONSIVENESS

Virtually all investigators of agricultural commodity supply responsiveness have approached the problem on the basis of the generalized behaviour model developed in the previous chapter. While the supply function given by equation (3.9) might be acceptable for estimating the responsiveness of most non-agricultural commodities, its direct application to an agricultural environment would as a rule require a redefinition of the dependent and independent variables to reflect the uncertainty that exists in making supply decisions. This uncertainty enters into the problem in two ways. The first is with respect to the price the

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[2]This review was made significantly easier as a result of the work of Askari and Cummings (Askari and Cummings 1976 and 1977).

farmer receives for his output. The uncertainty arises because the amount of a crop harvested largely depends on the decision to plant and the planting decision in turn depends on the price the farmer expects to receive at harvest time. Since at the time when the decision to plant is made this price is unknown, we would be more accurate to speak of expected rather than actual prices.

The second way in which uncertainty may enter into the supply response model developed in Chapter 3 is through the dependent variable. Even if all prices are known, any number of exogeneous technological or economic constraints may prevent the grower from realizing the output he would have liked to produce in response to given values of the independent variables. To the extent that such constraints exist, therefore, it is useful to distinguish between desired output and actual output. The growers ability to achieve desired output levels depends on the extent to which these constraints are binding and since this is not known until harvesting occurs, some degree of uncertainty tends to prevail.

In view of these comments, we may rewrite equation (3.9) as follows (dropping the "stars" and "hat" for notational simplicity):

$$Q_i^D = f_i(P_1^E, \ldots, P_i^E, \ldots, P_m^E; v_1, \ldots, v_j, \ldots v_n) \qquad (4.1)$$

where Q_i^D is desired output and P_i^E $(i = 1, \ldots, m)$ refers to expected relative prices. Expressed in a linear stochastic functional form, (4.1) may be written as follows (with "t" subscripts included to reflect the fact that observations on all variables have a time dimension):

$$Q_{it}^D = \alpha_0 + \sum_{i=1}^{m} \beta_i P_{it}^E + \sum_{j=1}^{n} \gamma_j v_{jt} + u_t \qquad (4.2)$$

where u_t is the disturbance term which is assumed to be distributed randomly with a mean of zero and a constant variance of σ^2, and α_0, β_i, and γ_j are the m + n + 1 parameters to be estimated.

We may simplify (4.2) for illustrative purposes and to make it more consistent with the kinds of specifications employed in the empirical estimations found later in the chapter by, first, redefining the dependent variable in terms of desired area or hectareage, H_t^D,[3] and by consolidating into one expression all variables, other than the price of the commodity in question, which one might a priori expect to influence the planting decision. Thus, we have:

$$H_t^D = \beta_0 + \beta_1 P_t^E + \sum_{i=2}^{n} \beta_i Z_{i,t-j} + u_t \qquad (4.3)$$

where H_t^D is desired area planted in a given crop, P_t^E is the expected price of that crop, and $Z_{i,t-j}$ $(j = 0,1,2....)$[4] refers to any other variable affecting area response.

The problem with equation (4.3) is that neither H_t^D nor P_t^E are observable and, as a result, we require statements which would allow us to translate desired area into actual area which can, of course,

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[3]Statistically, a dependent variable expressed in terms of area is generally to be preferred to one expressed in terms of output, whether in terms of the real value of output or in terms of tonnage. Compared with planting or hectareage decisions, output decisions are subject to greater random errors since output depends in part on yield and a large number of random and non-random factors can influence yield potentials. In employing area as the dependent variable, one is of course estimating area responsiveness and for a given yield one is only indirectly estimating output or supply response. Most empirical estimates of supply response of annual crops found in the literature used some measure of area or its first difference as the dependent variable.

[4]The "j" indicates that lagging of some of these "other" variables may be the appropriate approach in specifying the supply responsiveness of some crops.

be observed and expected prices into actual prices which are also observable. The most often used and most widely accepted approach to this problem can be attributed to Nerlove (Nerlove 1956). The model developed by Nerlove is generally referred to as the Adaptive Expectations Model.

The Adaptive Expectations approach to translating desired area into actual area is generally given by the statement:

$$H_t = H_{t-1} + A(H_t^D - H_{t-1}) \quad (4.4)$$

where H_t^D is desired area in the current period while H_t and H_{t-1} are actual area planted in the current and the pervious period, respectively. A is the adjustment coefficient where $0<A<2$.[5] Thus the actual or observed area planted in the current period depends on the area planted in the previous period plus some proportion of the difference between the area cultivators would like to plant in the current period and what they actually planted in the previous period.

The second problem concerns how producers subjectively formulate the prices that they expect to prevail in the future. Nerlove's argument is that "farmers react, not to last year's prices but rather to the price they expect, and this expected price depends only to a limited extent on what last year's price was" (Nerlove 1956, p.48). More

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[5]The area adjustment coefficient, A, is itself to be estimated by the data. It will be noted that (4.4) is a first order non-homogeneous difference equation which requires for a non-explosive solution that $0<A<2$. Note that if $A = 1$, then cultivators are able to adjust completely to desired area in the current period and $H_t = H_t^D$. If $A = 0$, cultivators are not able to expand area at all in the current period and $H_t = H_{t-1}$. A priori, we would expect $0<A<1$. The fact that A is assumed to be constant is subject to some criticism.

specifically, Nerlove argues that expected prices are a function of past prices generally and not just last year's price or the previous period's price. Price expectations are thus formulated on an adaptive expectations basis. This implies that expected prices are a weighted average of past prices with the value of the weights declining geometrically as we move backward through time. These expectations can be expressed as follows:

$$P_t^E = P_{t-1}^E + E(P_{t-1} - P_{t-1}^E) \qquad (4.5)$$

where P^E is the price expected to prevail and E is the coefficient of expectations where $0<E<2$.[6] Thus the price expected in the current period is a function of the price expected in the previous period plus some proportion of the difference between the actual or observed price in the previous period and the expected price in the previous period, or as Nerlove expressed it, "each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period" (Nerlove 1956, p. 500).

Equations (4.3), (4.4), and (4.5) form the structural system of equations which make up the Adaptive Expectations Model. It is possible after substitution and rearrangement to obtain from these three equations a single reduced form supply equation which can be estimated directly:

[6] As was the case with A, the price expectations coefficient, E, is also estimated from the data. (4.5) is also a first order non-homogeneous difference equation which requires that E be restricted to values greater than zero and less than two for a non-explosive solution. Of course, a priori, we would expect $0<E<1$. Like A, E is also assumed to be constant.

$$H_t = \emptyset_0 + \emptyset_1 P_{t-1} + \emptyset_2 H_{t-1} + \emptyset_3 H_{t-2} + \sum_{i=4}^{n} \emptyset_i Z_{i,t-j}$$

$$+ \sum_{i=4}^{n} \emptyset_i^* Z_{i,t-j-1} + v_t \qquad (4.6)$$

where $\emptyset_0 = AE\beta_0$, $\emptyset_1 = AE\beta_1$, $\emptyset_2 = (1-A)+(1-E)$, $\emptyset_3 = (1-A)(1-E)$, $\emptyset_i = A\beta_i$, $\emptyset_i^* = -A(1-E)\beta_i$, and $v_t = Au_t - A(1-E)u_{t-1}$. One of the advantages of this model is that it enables us to distinguish between short-run and long-run responsiveness, the latter referring to supply response after cultivators have made full adjustment in response to the independent variables. The long-run responsiveness is given by the estimated value of β_1 while the short-run response is given by the product of the estimated values of A, E, and β_1, i.e., $\emptyset_1$ above. If the estimated values of A and E are less than one, then the short-run response would be less than the long-run response as we would a priori expect.

Equation (4.6) shall be referred to as the complete Nerlove model. Three subsets of the complete model may be estimated by putting restrictions on the values of the adjustment and expectations parameters, A and E, respectively. These restrictions would normally involve setting A and/or E equal to one.[7] If E is set equal to one, we would be estimating an area adjustment model only, while if we set A equal to one, it would be a price expectations model only that would be estimated. Finally, if both A and E are restricted to equal one, we end up with the standard Cobweb model. The Cobweb model, of course, has achieved a

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[7]From equation (4.4), if A equals one, then $H_t^D = H_t$, that is, desired equals actual area. From equation (4.5), the setting of E equal to one means that $P_t^E = P_{t-1}$, that is, the expected price is the previous period's price only.

hallowed place in economic theory as well as in empirical studies of agricultural supply response.

The type of agricultural environment in which cultivator response behaviour can be justifiably represented by the Cobweb model is one where changes in supply occur at discrete time intervals. This is to say, harvesting occurs at one particular time period and the amount harvested solely depends on the area planted prior to the harvest and yield, with virtually no further supplies forthcoming until the next harvest. This is, of course, true of most situations in which one is estimating the responsiveness of single crops in specific geographical regions. The greater the aggregation of different crops and the more varied the regions over which responsiveness is being estimated, the more continuous changes in supply become.[8]

Two variations of the complete Nerlove model have at times been used in estimating supply responsiveness. The first involves an attempt to correct for exogenous impacts on expected prices, particularly those which occur as a result of unusual quantum changes in supply, by incorporating in the price expectations equation an expression showing the impact on P_t^E of differences in expected and observed outputs or yields in the previous period. This is equivalent to making the coefficient of expectations stable. The second variant is generally used when desired output is the dependent variable and involves the inclusion of expected yield in the structural supply equation. Such a regressor is

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[8] With the Cobweb model, problems of dynamic instability might arise. Equilibrium is dynamically stable if the slope of the supply curve exceeds the absolute value of the slope of the demand curve. Since both the demand for and the supply of agricultural commodities tends toward relative inelasticity, there is no a priori way of determining whether equilibrium is dynamically stable or not.

potentially capable of picking up the effects of both short-run (weather) and long-run (technological change) changes in yield.

The literature on the estimation of agricultural supply responsiveness in the third world is extensive involving the use of the full range of models discussed above and the estimation of a wide variety of crops and livestock products. It is not proposed here to survey the empirical literature on supply response in the third world as this has already been done by Askari and Cummings (Askari and Cummings 1976 and 1977).[9] However, some general comments may be warranted. First, most of the attention has been directed toward two types of crops: foodgrains or cereals and cash crops.[10] Secondly, estimated long-run elasticities tend to be less than one in value. Thirdly, non-food crops tend to be more elastic in response than food crops and commercialized food crops more responsive to price changes than subsistence food crops. Fourthly, as might be expected, estimated long-run elasticities tend to be larger than short-run elasticities. Finally and most important, although the various studies indicate inelastic response, the estimated elasticities are almost always positive. All in all, "price responsiveness in underdeveloped agriculture is of an order of magnitude quite comparable to that observed in the agriculture of high-income areas" (Behrman 1968, p. 19).

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[9]The results of the estimated responsiveness of the various Colombian crops under study here will be briefly compared with studies on the same crops in other countries later on in this chapter and in Chapters 5 and 6.

[10]Almost all of the studies involve estimations of supply responsiveness of individual crops, although those studies in which the individual crop estimated utilizes a significant proportion of a country's or a region's arable land, could be considered as studies in aggregate response.

4.3 ESTIMATION PROCEDURES AND PROBLEMS - AGGREGATE NON-COFFEE CROPS

Estimations were begun with tests to check for the most appropriate dependent variable. A series on the real value of non-coffee crop output involving 31 observations (1945-1975) and two series on area (hectareage) allocated to non-coffee crops involving 25 observations each (1948-1972) were available.[11] As might be expected, the two area data series (see footnote 3) performed significantly better than the output series. There was only a very marginal difference between the two sets of data on area with series B (HN^B) performing slightly better. Thus HN^B became the dependent variable.

The procedure followed in the regressions was to begin with two specifications; the first involved the price of non-coffee crops only (PN), while the second employed the terms of trade faced by non-coffee crop producers (PN/PM). A search procedure was then carried out for other appropriate specifications of aggregate non-coffee crop responsiveness. This largely involved the examination of the effects of including other *a priori* acceptable explanatory variables.[12] However, this search

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[11] The two series on area (see Data Appendix for difference in the two) are the shortest data series available to undertake this study. There is no data on agricultural land allocation prior to 1948 and at the time this study was written no data available after 1972. Apparently, the Colombian authorities stopped collecting this data in 1973 but at the urging of a number of people data collection was recently resumed but it will be some time before the series can be brought up to date.

[12] Among such variables, one can justify the inclusion of the agricultural wage rate (WA), the price of intermediate inputs (PNI), the user cost of capital (VN), the price of products which compete in land with non-coffee, and a trend variable (T). The inclusion of a trend variable is designed as an attempt to pick up any area expansion resulting from opening up new lands hitherto considered wilderness. As noted in Chapter 2, Colombian policy is to encourage land resettlement on the frontier. In dealing with individual crop supply functions, the prices of competing crops would tend to play an important role. This role would tend to diminish, however, the greater the aggregation over different crops. In

process was hindered by a serious problem of multicollinearity among many of the regressors. The existence of multicollinearity prevented the use of any more than two independent price variables and one of these of course was either the price of non-coffee crop output or the terms of trade faced by non-coffee crop growers. A trend variable almost always improved the performance of the various specifications.[13]

Equation (4.6) formed the basic behavioural model upon which the estimations of non-coffee supply responsiveness were undertaken. We shall henceforth refer to equation (4.6) as the AE-model. Three variants of equation (4.6) were also estimated with the different variants depending on the restrictions we put on the parameters in the AE-model. If we restrict E to equal one, price expectations are then formulated as in the Cobweb model. This variant of the Nerlove model is usually referred to as the area adjustment model, henceforth called the A-model here. If, on the other hand, we restrict A to equal one, we assume growers can make full adjustment to desired area in the current period but price expectations are formulated in a Nerlove manner. We shall refer to this variant as the E-model. Finally, in the third variant, we restrict both A and E to equal one and as a result equation (4.6) collapses into the standard Cobweb model:

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the case of non-coffee crops as a whole, the only potential substitutes would be coffee and livestock, neither of which in the Colombian context can be considered to be serious contenders for land with non-coffee crops.

[13]The inclusion of a trend variable not only usually improved the performance of a specification but also got rid of the autocorrelation which was present when the trend variable was absent. Autocorrelation, however, was readily corrected when the Cochrane-Orcutt iterative technique or one of the variants of the Nerlovian model with the lagged dependent variable appearing as a regressor, was used.

Ordinary least squares (or Cochrane-Orcutt iterative technique) was used to estimate responsiveness in the case of the Cobweb model while non-linear least squares was required to estimate Nerlovian responsiveness to take into account the restriction on the parameters implied by the model. In the results obtained throughout this study, the values of the log of the likelihood function yielded by the different variants when used on the same specification were tested to determine whether the differences were significant or not. The likelihood-ratio test statistic is given by: $\chi^2(1) = -2(L_1 - L_2)$ where L_1 and L_2 are the logs of the likelihood function of the two variants one is comparing. In effect, we are testing whether the restrictions implied by the regression model used are fulfilled.

To simplify the recording of the regression results in the following sections, some abbreviations should be noted:

(1) LLF is the log of the likelihood function;

(2) RHO is the estimated coefficient of autocorrelation;

(3) DW is the Durbin-Watson statistic;

(4) $\hat{A}$ is the estimated area adjustment coefficient;

(5) $\hat{E}$ is the estimated price expectations coefficient;

(6) the figures bracketed beneath the estimated regression coefficients are their respective t-statistics and unless otherwise indicated, the estimated coefficients are significant at the 0.05 level or not acceptably significant at all.

Finally, information on the sources of the data used in the estimations and, for some data used here, their derivation, can be found in the Data Appendix at the end of this study.

4.4 SPECIFICATIONS AND RESULTS - AGGREGATE NON-COFFEE CROPS

The results of the linear specifications shall be examined first.

Regardless of the specification, the unrestricted model (the AE-model) or partially restricted model (the A and E models) performed significantly better than the fully restricted model (the Cobweb model). However, the estimates of the coefficients (as well as their level of significance) varied little amongst the various models.

Among the better performing of the specifications in which the explanatory prices left undeflated was the following:

$$(1)\quad HN_t^B = \underset{(36.4)}{1811} + \underset{(3.60)}{2.65}\, PN_{t-1} - \underset{(-4.54)}{3.05}\, PM_{t-1} + \underset{(7.29)}{48.23}\, T - 0.078\, HN_{t-1}^B$$

$$LLF = -128.8 \qquad R^2 = 0.965 \qquad DW = 1.744 \qquad \hat{E} = \underset{(6.52)}{1.078}$$

The same specification but in which PM_{t-1} was replaced first by WA_{t-1} and then by PNI_{t-1}, generated marginally lower values for the LLF but almost identical estimates (and levels of significance) of the coefficient for PN_{t-1} of 2.60 (3.22) and 2.62 (3.40), respectively. Moreover, the estimated coefficients for WA_{t-1} and PNI_{t-1} were of the correct sign and strongly significant, while those of the trend variable corresponded closely to that above. Even in the specification where PN_{t-1} appears by itself, the estimate of the coefficient was similar to those above at 2.69 (3.63). As noted in the previous section, however, the inclusion in a specification of more than one price regressor in addition to PN_{t-1} and T, resulted in an unacceptable level of significance and/or the incorrect sign for the estimated coefficients of those regressors. Yet the estimate of the coefficients for PN_{t-1} and T continued to correspond to the estimates determined above.[14]

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[14] For example, a specification which included both WA_{t-1} and PNI_{t-1}

The following in which the terms of trade were employed as an explanatory variable is the best linear specification overall:[15]

$$(2)\quad HN^B_t = \underset{(7.86)}{1203} + \underset{(4.14)}{670.35}\,(PN/PM)_{t-1} + \underset{(17.2)}{40.96}\,T - 0.116\,HN^B_{t-1}$$

$$LLF = -126.2 \qquad R^2 = .971 \qquad DW = 1.785 \qquad \hat{E} = \underset{(6.00)}{0.884}$$

Finally, in an attempt to reduce the level of multicollinearity, a number of specifications were adjusted so that all explanatory price variables were deflated by the agricultural wage rate. The specification which seemed to perform best, at least in terms of LLF, was the following:

$$(3)\quad HN^B_t = \underset{(4.50)}{1522} + \underset{(2.17)}{31.16}\,(PN/WA)_{t-1} - \underset{(-1.35)}{84.86}\,(VN/WA)_{t-1}$$

$$-11.28\,\underset{(-1.13)}{(PNI/WA)_{t-1}} + \underset{(15.04)}{50.54}\,T + 0.130\,HN^B_{t-1}$$

$$LLF = -128.2 \qquad R^2 = 0.969 \qquad DW = 1.912 \qquad \hat{E} = \underset{(6.24)}{0.870}$$

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as well as PN_{t-1} and T resulted in the estimates for both WA_{t-1} and PNI_{t-1} being an unacceptable level of significance but the estimated coefficient for PN_{t-1} was 2.70 which is consistent with those obtained in other specifications, as was the level of significance.

[15]This specification was expanded to include as separate regressors WA_{t-1}, PNI_{t-1}, respectively, but none of their estimated coefficients were close to being significant. Moreover, their inclusion made no improvement in the value of the LLF compared with that of (2) and did not significantly affect the estimate of $(PN/PM)_{t-1}$ which maintained a value of roughly 670 and the same level of significance.

The estimated coefficients for the three price variables are significant at the 0.025, 0.10, and 0.15 levels, respectively. Other specifications were attempted but the results did not change substantially.

In the case of the first specification recorded here, an average long-run area elasticity was 0.1669.[16] The short-run average elasticity was 0.1800. The long-run and short-run average area elasticities with respect to PM were -.1847 and -.1991, respectively. Specification (2) yielded a long-run average elasticity with respect to PN (PM held constant) of 0.2687, and a short-run average elasticity of 0.2375. Finally, specification (3) produced a long-run average area elasticity with respect to PN (WA held constant) of 0.2367. The equivalent short-run elasticity was 0.2059.

Turning now to the foregoing specifications as expressed in their log functional form, there are three comments which can be made immediately. The ranking of the log specifications in accordance with the value of the LLF corresponds closely to the ranking of their linear equivalents. Secondly, the inclusion of a trend variable consistently improves a specification's performance as well as eliminating a moderate degree of autocorrelation that existed. Finally, unlike in the linear specifications where the Nerlovian E-model consistently generated the highest value for the LLF, in the case of the log specifications, it was the Cobweb model which consistently produced the highest value, implying in this case that the regression restrictions are fulfilled.

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[16]An average elasticity can be calculated from the expression: $\hat{\beta}_x$ times $(\sum^{T} x/T) / (\sum^{T} y/T)$ where $\hat{\beta}_x$ is the estimated regression coefficient, x and y are the independent and dependent variables, respectively, and T is the number of observations.

Among the specifications in which prices were left undeflated, the best performing specification (as was the case with the linear form) was the following:

$$(4)\quad \log HN_t^B = \log \underset{(44.7)}{1901} + \underset{(5.34)}{0.254} \log PN_{t-1} \underset{(-4.39)}{-0.248} \log PM_{t-1} + \underset{(3.27)}{0.0155}\, T$$

$$LLF = 54.2 \qquad R^2 = 0.968 \qquad DW = 1.749$$

Ordinary least squares was used to estimate this regression. For comparison purposes, the results when the E-model was applied to this specification using non-linear least squares are as follows:

$$(4a)\quad \log HN_t^B = \log \underset{(34.7)}{1939} + \underset{(4.03)}{0.307} \log PN_{t-1} \underset{(-3.91)}{-0.308} \log PM_{t-1} + \underset{(2.50)}{0.016}\, T$$

$$+ 0.142 \log HN_{t-1}^B$$

$$LLF = 52.1 \qquad R^2 = 0.968 \qquad DW = 1.655 \qquad \hat{E} = \underset{(6,47)}{0.858}$$

The employment of additional regressors to this specification while leaving the estimated coefficient for PN_{t-1} (as well as its significance level) largely unaffected, destroyed the significance of PM_{t-1} as well as that of additional regressor(s) and/or produced the incorrect sign. The results for five other specifications which, in addition to PN_{t-1}, included alternately WA_{t-1}, WA_{t-1} and T, PNI_{t-1}, PNI_{t-1} and T, and WA_{t-1}, PNI_{t-1} and T produced lower values of the LLF but similar estimates (and levels of significance) to the coefficient for PN_{t-1}. For the five specifications, the estimated coefficients ranged from 0.226 to 0.272 when produced by the better performing Cobweb model, with an average of 0.252.[17]

The specification in which the ratio of non-coffee crop to manufacturing prices is used is now examined. The results of the regressions using the Cobweb model and the Nerlovian E-model are as follows:

$$(5) \quad \log HN_t^B = \underset{(550.2)}{\log 1939} + \underset{(5.80)}{0.252} \log (PN/PM)_{t-1} + \underset{(20.2)}{0.016}\, T$$

$$LLF = 54.8 \qquad R^2 = 0.968 \qquad DW = 1.759$$

$$(5a) \quad \log HN_t^B = \underset{(406.8)}{\log 1939} + \underset{(4.23)}{0.316} \log (PN/PM)_{t-1} + \underset{(14.6)}{0.016}\, T + 0.170 \log HN_{t-1}^B$$

$$LLF = 52.8 \qquad R^2 = .968 \qquad DW = 1.1626 \qquad \hat{E} = \underset{(5.84)}{0.830}$$

Note that the estimated coefficients approximate very closely the results obtained from specifications (4) and (4a). The addition of other explanatory variables to this specification leads to the same problems of multicollinearity as encountered in the linear version.

Finally we examined the specifications in which prices are deflated by WA_{t-1}. The best performing amongst these and the best overall but only marginally is the following:[18]

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[17] The range of estimated elasticities when the E-model was applied to these specifications was from 0.28 to 0.34.

[18] Virtually identical estimates for these regressors were produced when the E-model was used but the value of the log of the likelihood function was 6.0 below that generated by the following Cobweb estimation.

$$(6)\quad \log HN_t^B = \underset{(34.8)}{\log 1200} + \underset{(3.00)}{0.180} \log (PN/WA)_{t-1} - \underset{(-2.98)}{0.133} \log (VN/WA)_{t-1} + \underset{(23.6)}{0.021} T$$

$LLF = 55.3 \qquad R^2 = 0.969 \qquad DW = 1.994$

The estimated coefficient for PN_{t-1} (WA_{t-1} held constant) is somewhat lower in value than to which we have become accustomed. When $(VN/WA)_{t-1}$ is replaced by $(PNI/WA)_{t-1}$, a marginally lower value for the log of likelihood function results but the estimate of the coefficient for PN_{t-1} of 0.254 is more consistent with previous results.

The problem of choosing the more appropriate functional form was determined by the Box-Cox transformation procedure. This test was applied to all three specifications which were recorded in detail here and for all three the Box-Cox test indicated that both functional forms cannot be rejected at the 0.05 level of significance. However, the log functional unambiguously could not be rejected at the highest significance level. As to the selection of the most appropriate specification, it is felt that specification (5) is the most acceptable within the context of this study. The estimated price elasticity in (5) is consistent with the estimates yielded by most other specifications attempted here.

The set of elasticity estimates discussed to this point reflect area and not output responsiveness. To translate them into output elasticities, one would have to examine the factors which influence yield over time where yield (YN_t) is defined as output per hectare.[19]

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[19] By definition, of course, $\ln QN_t = \ln YN_t + \ln HN_t$, where QN_t is

We would be principally interested in determining whether prices in any way explain some of the variations in output per hectare over time. If they do not, then the output elasticity with respect to prices is identical to the estimated area elasticity.[20] *A priori*, one would expect yield at time t to be influenced by PN_{t-1}, PM'_{t-1}, and PNI_{t-1} as well as perhaps some sort of trend variable. The models employed in estimating yield response follow closely those used in estimating area responsiveness and are based on the same assumption regarding grower behaviour. Various specifications were regressed in both their linear and log functional forms. As it turned out, the linear functional form performed especially well.

Regressions were commenced with a check of the importance of time in explaining exogeneous yield increases over time. The results using non-linear estimation techniques are:

$$(7) \quad YN_t = \underset{(7.01)}{0.772} \; EXP \; (\underset{(4.68)}{0.031} \; TIME)$$

$$LLF = 25.52 \qquad R^2 = 0.907 \qquad DW = 1.669 \qquad \hat{RHO} = \underset{(3.80)}{0.691}$$

It would appear that aggregate non-coffee crop yields increase at a

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aggregate output of non-coffee crops. This study is concerned ultimately with how output in the agricultural sector responds to relative prices. However, as mentioned earlier in this chapter, the more reliable yardstick with respect to how growers respond to changes in such prices is to examine their planting or area decisions rather than their output decisions. Throughout this study area response more adequately measures grower behaviour in Colombia.

[20] In view of the fact that the primary focus of this study is on the effects on agriculture of pricing policies, it would seem important to have some indication of any causal relationships which might exist between yield and relative prices.

significant rate of 3.1 percent per year.

Efforts to determine whether various prices played any role in determining increases in yield of aggregate non-coffee crops were not very successful. The only specification which produced *a priori* correct signs and acceptable levels of significance for the estimated coefficients contained the price of non-coffee crops and the lagged dependent variable only. However, this would be generally unacceptable in an agricultural environment in which crop prices are highly corre- lated with time and technological change in an observed phenomenon. An appropriate specification would call for either a trend variable and/or an appropriate deflator for the price of non-coffee crops. Nevertheless, the results of this specification are as follows:

$$(8)\quad YN_t = \underset{(9.67)}{0.947} + \underset{(4.34)}{0.0031}\, PN_{t-1} + 0.682\, YN_{t-1}$$

$$LLF = 25.98 \qquad R^2 = 0.910 \qquad DW = 1.796 \qquad \hat{A} = \underset{(1.90)}{0.318}$$

$\hat{A}$ is significant at the 0.05 level. The average long-run elasticity estimate yielded by (8) is 0.365. The short-run equivalent is 0.116. In view of the inadequacy of this specification it would be safer to attempt to obtain a rough indication of aggregate non-coffee yield responsiveness on the basis of how the yields of the individual crops which make up the aggregate behave with respect to changes in prices. Consequently, for the time being we shall assume that the increases in aggregate yield reflect technological rather than pecuniary factors. This means of course that the output elasticities are identical with the area elasticity estimates given in (5) and (5a).[21]

4.5 SPECIFICATIONS AND RESULTS - INDIVIDUAL CROPS

The production process characteristics of the seven non-coffee crops whose supply responsiveness we shall examine here can be summarized in the following table:

TABLE 4.1

PRODUCTION PROCESS CHARACTERISTICS OF THE SEVEN MOST IMPORTANT NON-COFFEE CROPS

CROP	DEGREE OF MECHANIZATION	LABOUR USAGE	OTHER INPUT USAGE	OTHER COMMENTS	MAIN SUBSTITUTION CROPS
Cotton	Considerable mechanization	Little usage except at harvest when migrant workers used	Heavy use of pesticides & moderate use of fertilizers	A heavily commercialized crop	Rice, cattle, soyabeans, sorghum & sugar
Rice	Considerable mechanization	Moderate labour usage	Heavy use of pesticides & fertilizers	A heavily commercialized crop	Cotton, cattle, soyabeans, sorghum & sugar
Corn (1)*	Considerable mechanization	Little labour usage	Some use of pesticides & fertilizers	A commercialized crop	Sugar, sorghum, soyabeans

[21] If (8) had been acceptable, the long and short-run output elasticities with respect to the price of output would have been 0.368 and 0.617 in the case of (5) and 0.378 and 0.681 in the case of (5a), respectively.

TABLE 4.1 CONT'D.

CROP	DEGREE OF MECHANIZATION	LABOUR USAGE	OTHER INPUT USAGE	OTHER COMMENTS	MAIN SUBSTITUTION CROPS
Corn (2)*	No mechanization	Moderate labour usage	None	A traditional or subsistence crop	Potatoes, yucca
Potatoes	Some mechanization	Heavy labour usage	Heavy use of pesticides & fertilizers	Mostly a traditional crop	Corn, wheat, yucca
Yucca	No mechanization	Moderate labour usage	None or very little use	A traditional crop	Corn, potatoes
Panela	No mechanization	Moderate labour usage	Few inputs such as fertilizer used	A traditional crop	Corn, coffee, sugarcane, rice
Platano	No mechanization	Little labour usage	Few if any inputs such as fertilizer, etc. used	A complement to coffee growing used to shade young coffee trees	None

*The corn production characteristics in Colombia are such that it is more accurately represented by two separate production functions, even though available data does not allow such a separation for estimation purposes.

Of the seven crops, four are traditional and/or partly subsistence crops while two (rice and cotton) are modern commercialized crops. Corn is both a commercialized (hybrid corn grown on modern farms) and a traditional crop with each grown by two distinct classes of farmers. However, it is the latter which continues to dominate corn production in Colombia. The information on the characteristics of the various production functions forms the basis upon which the area response functions written in their general form are formulated.[22] These area response functions begin the discussion on the estimation results found in the following sub-sections.

For each crop only the "best" specification expressed in the more appropriate functional form as determined by a Box-Cox transformation procedure is recorded in detail throughout the following sub-sections. The term "best" is used to refer to the specification which generated the highest value for the LLF consistent with the correct a priori sign and an acceptable level of significance for each of the estimated coefficients. Except for two crops, corn and cotton, the gaps between the "overall best" specification (the highest valued LLF ignoring signs and levels of significance) and the "best" specification (the highest valued LLF consistent with correct signs and acceptable levels of significance) were not significant.

The following is a list of variables used in the regressions undertaken for the seven crops (the t subscripts are ignored):

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[22] This information was kindly provided by A. Berry. It will be noted that responsiveness of each crop was formulated in terms of area response and not output response. The reason for this has been described earlier in this chapter. For all seven crops, the overall fit of the regressions in terms of area was superior to that in terms of output. For some crops, the gap in the LLF's for the same specification was enormous.

Dependent Variables

HCOR – area devoted to the cultivation of corn
HCOT – area devoted to the cultivation of cotton
HPAN – area devoted to the cultivation of panela
HPLA – area devoted to the cultivation of platano
HPOT – area devoted to the cultivation of potatoes
HRIC – area devoted to the cultivation of rice
HYUC – area devoted to the cultivation of yucca

Independent Variables (the price of output)

PCOR – producer price of corn
PCOT – producer price of cotton
PPAN – producer price of panela
PPLA – producer price of platano
PPOT – producer price of potatoes
PRIC – producer price of rice
PYUC – producer price of yucca

Independent Variables (others)

VN – user cost of capital
PM – price of manufacturing output
PN – price of aggregate non-coffee crops
WA – average daily agricultural wage rate
PNI – price of intermediate inputs
HC – area devoted to coffee cultivation[23]
PC – producer price of coffee[23]
PS – producer price of cane to make centrifugal sugar[24]
T – a trend variable

For each crop, the regressions were commenced with several specifications, in both their linear and log functional forms. They involved the price of output, the price of manufacturing output, and a trend variable.[25]

[23] These two dependent variables were part of the platano area response function only. A priori, we would expect the relationship between the area devoted to platano cultivation and HC and PC to be positive.

[24] PS was used as a regressor in the panela response specification only. Sugar cane can be grown either for the manufacture of centrifugal sugar or for non-centrifugal sugar (panela). We would therefore expect a priori that the relationship between the area devoted to sugar cane for the making of panela and the price of sugar cane used in the manufacture of centrifugal sugar to be negative.

[25] As will be noted in the discussion of the results, however, these

Additional explanatory variables were then included, as dictated by the area response functions of the various crops. The Cobweb and Nerlove regression models were used throughout the estimations. 23 observations (1950 - 1972) were available for the estimation of the responsiveness of all crops except platano for which only 19 observations (1950 - 1968) were available. The same regression techniques were employed as was used in the case of the aggregate specifications discussed in the previous section. As will be seen in the subsequent results, the "other" explanatory variables when included in the various specifications for the different crops either destroyed the significance of the estimated coefficient for the price of output or changed its sign from positive to negative. Moreover, these "other" independent variables were themselves hardly ever significant or the estimates of the *a priori* correct sign. For a couple of crops, some were not only of the incorrect sign but also strongly significant.

The reason for the failure of these "other" explanatory variables to explain any part of the variations in area cultivated is to some extent due to multicollinearity amongst some of the regressors. However, there is probably a more important reason and this is the difference in the level of aggregation found among the different variables. Explanatory variables such as PNI, VN, and WA involve a high level of aggregation. For example, WA is the average agricultural wage rate in Colombia and PNI is a price index of all intermediate inputs used in all non-coffee crop production. On the other hand, the dependent variables and the prices of

"other" regressors added little to the performance of the various specifications used to estimate the responsiveness of six of the seven crops. The only exception is corn which we will discuss in due course.

output are much more disaggregate, more micro. Thus in using such explanatory variables as PNI, VN, and WA to explain variations in area devoted to cotton or corn, etc., we are implicitly assuming that the wages paid to cotton or corn workers is proportional to the average wage, or that the types of inputs or the kinds of capital equipment used by cotton or corn producers are identical to the proportions which make up the weights upon which the indexes were calculated. This is an assumption one should probably try to avoid. What is needed of course is data on the actual wages paid by cotton or corn producers to labour that they employ. These actual wages may be quite different from the national average. The same applies to the intermediate inputs used by growers of a particular crop or to the types of capital used. There is no reason to expect that cotton producers, for example, employ the same types of intermediate inputs or in the same proportions as that which is done on a "national average" basis. Unfortunately, data on such variables at the level of disaggregation required is just not available from Colombia.

Finally, it should be mentioned that a number of crops are potential substitutes. Separate price indexes of potential substitute crops were not calculated and as a rule PN was used as a proxy. It was felt that the time required to calculate the seven indexes would not be justified by the probable results. Moreover, there is some variation in potential substitute crops depending on the region in which the crop in question is grown. It was also felt to be not worthwhile to remove from PN the price of the crop whose responsiveness is being estimated since none of the seven crops considered here accounts for more than ten percent of the real value of non-coffee crop output.

Some of the principal characteristics of the area response regression results are summarized in the following table:

TABLE 4.2

MAIN CHARACTERISTICS OF THE AREA RESPONSE REGRESSION RESULTS

CROP	BEST REGRESSION MODEL[1]	EXISTENCE OF AUTO-CORRELATION	TYPICAL R^2 RANGE[2]	PREFERRED FUNCTIONAL FORM[3]	CONSISTENCY WITH OTHER STUDIES[4]
Corn	E-model	Moderate in some specs.	0.5-0.8	Log	Yes
Cotton	E-model	Moderate	0.9-1.0	Log	Yes, but on high side
Panela	Cobweb	Moderate in some specs.	0.9-1.0	Log	N.A.
Platano	E-model	Moderate in some specs.	0.6-0.7	Log	N.A.
Potatoes	E-model	None	0.5-0.6	Log	Yes
Rice	Cobweb	Heavy in all specs.	0.8-0.9	Log	Yes
Yucca	E-model	Moderate	0.7-0.9	Log	N.A.

[1]The model which generated the highest value for the LLF of the "best" specification for each crop.

[2]The range of the R^2 in the better performing specifications of each crop.

[3]The preferred functional form according to the Box-Cox test applied to the "best" specification for each crop.

[4]The consistency of the long-run elasticity estimates undertaken in this study with those undertaken in other studies in other parts of the world. N.A. refers to the absence of other studies for that crop.

Generally speaking, for most crops, satisfactory estimates of the price elasticity of area response were obtained, except for rice, with significance at the 0.05 level or better.[26] Again for most crops, differences in the estimated price elasticities between the linear and log functional forms for a given specification and a given regression model were generally small. However, in the case of some crops, considerable differences in the elasticity estimates were found for a given specification depending on the model employed, particularly for yucca and corn. The R^2's were generally satisfactory with the exception of perhaps potatoes. Autocorrelation was not a serious econometric problem except for rice. For the other crops, Cochrane-Orcutt iterative technique or one of the Nerlove models easily corrected for the existence of any autocorrelation. As will be noted from the foregoing table as well as from the aggregate results in the previous section, the relationship between area devoted to the cultivation of the i^{th} crop and the price of the i^{th} crop is strongly logarithmic.

For four of the crops, namely panela, potatoes, platano and rice, the estimated response coefficients were by and large relatively unaffected by either the specification or regression model employed or by the functional form selected. In the cases of corn, cotton, and yucca, however, there were considerable variations in the estimated response. For corn, the estimates were at times sharply affected by both the specification used and by the behavioural model (Cobeb or Nerlovian) employed. Cotton's estimates of responsiveness varied considerably depending on one's choice of specification. Finally, the estimated

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[26] The rice estimations were probably the most disappointing of all. As will be noted in the sub-section on rice, the best level of significance for the estimated coefficient for price was 0.15. Reformulating the specifications in terms of output did not improve significance levels.

coefficients derived in the regressions on yucca varied according to the regression model and to some extent according to the functional form used. The regression results of the various crops are presented in alphabetical order.

4.5.1 CORN

The information contained in table 4.1 on the nature of the production processes for the various crops under consideration in this study indicates that for corn the following area response function should be examined:

$$HCOR_t = F_1 (PCOR_{t-1}, PM_{t-1}, PN_{t-1}, WA_{t-1}, T)$$

As was noted in section 4.5, considerable variations in the estimated elasticities occurred depending especially on the behavioural model used. The Nerlove models consistently yielded larger response estimates than the Cobweb model, usually about double the elasticity coefficient produced by the Cobweb model. There was some variation in the estimates according to the specification employed but not too much above what one might expect. The results of the best specification, that is, the one which yielded the greatest value for the LLF subject to all signs of the estimated coefficients being a priori correct and an acceptable level of significance for all of the estimates are as follows:

$$\log HCOR_t = \log 311.06 + \underset{(13.26)}{0.687} \log (PCOR/PM)_{t-1} + \underset{(2.46)}{0.521} \log HCOR_{t-1}$$

$$LLF = 32.38 \qquad R^2 = 0.600 \qquad DW = 2.168 \qquad \hat{E} = \underset{(4.05)}{0.479}$$

The short-run response is 0.329. The value of the LLF yielded by the

Cobweb model was 30.69, indicating that the restrictions implied in the Cobweb model are unfulfilled. The linear functional form of the foregoing specification generated an average elasticity of 0.714.[27]

4.5.2 COTTON

The information available on the characteristics of the production process for cotton leads one to investigate the following area response function which in its general functional form can be written as:

$$HCOT_t = F_2(PCOT_{t-1}, PM_{t-1}, PN_{t-1}, VN_{t-1}, PNI_{t-1}, T)$$

The specification which yielded the "best" results is the following:

$$\log HCOT_t = \underset{(25.91)}{1.455} \log (PCOT/PM)_{t-1} + \underset{(7.18)}{0.072} T + 0.514 \log HCOT_{t-1}$$

$$LLF = 12.52 \qquad R^2 = 0.942 \qquad DW = 1.604 \qquad \hat{E} = \underset{(3.80)}{0.486}$$

The Cobweb model version of this specification elicited an almost identical elasticity estimate of 1.461 (23.65) but generated a somewhat

[27] The wage rate WA was added to the various specifications and although its estimated coefficient was usually a priori correct in sign and acceptably significant, its inclusion not only destroyed the level of significance of the estimate for the price of output but also changed its sign. The addition of PN as an explanatory variable to any specification consistently eradicated the level of significance of the price of output and more often than not, changed its sign. The estimated coefficient of PN was always a priori incorrect in sign and strongly significant. More serious, however, and unlike the wage rate, the inclusion of PN in any specification always resulted in a very significant improvement in the value of the LLF. For example, the LLF of the specification recorded above is valued at 32.38. The values of the LLF of specifications which included PN as an explanatory variable were typically around 40.0. No explanation has been found for the erratic behaviour of PN.

lower value for the LLF of 10.98. Cotton is a recent "introduced" crop in Colombia and the area devoted to cotton cultivation back in 1950 was quite small. Thus, as expected, the constant term estimate proved not be be significant. The short-run elasticity corresponding to the long-run estimate of 1.455 is 0.707.[28]

4.5.3 PANELA

Using the information contained in the previous section as to the nature of the production process for panela, the following generalized area response function was examined:

$$HPAN_t = F_3\,(PPAN_{t-1},\ PS_{t-1},\ PM_{t-1},\ WA_{t-1},\ T)$$

The overall "best" specification regressed using ordinary least squares was the restricted Cobweb model:

$$\log HPAN_t = \underset{(38.3)}{\log 111.05} + \underset{(1.85)}{0.083} \log\,(PPAN/PM)_{t-1} - \underset{(5.64)}{0.252} \log\,(PS/PM)_{t-1}$$

$$+ \underset{(14.6)}{0.025}\,T$$

$$LLF = 46.3 \qquad R^2 = 0.947 \qquad DW = 2.128$$

The estimated value of the coefficient for (PPAN/PM) is significant at

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[28]The inclusion of other regressors in most instances largely destroyed the significance of the price estimate and even if the level of significance was not completely destroyed, the signs of the estimated coefficients of these other explanatory variables were either incorrect and/or were not acceptably significant. Only specifications in which PNI was included as a regressor recorder higher values of the LLF, averaging between 15.0 and 18.0. These values are significantly above those produced by the two specifications recorded here. However, in all instances the sign of the estimated coefficient for PNI was incorrect and highly significant with a t-statistic in excess of 3.00.

the 0.05 level. The E-model version of the above generated a slightly lower LLF but an almost identical estimate for (PPAN/PM) of 0.080. $\hat{E}$ was 0.903 with a t-statistic of 4.24. Moreover, the above when regressed in the linear functional form produced an estimated average elasticity of 0.082, virtually identical to the log estimate.

4.5.4 PLATANO

Platano is a perennial crop which in large part is grown side by side with coffee. Platano trees provide the shade required by immature coffee trees. Attempts at estimating area responsiveness were based on the following function as expressed in its general form:

$$HPLA_t = F_4\ (PPLA_{t-1},\ PM_{t-1},\ HC_t,\ T)$$

where HC_t is area devoted to coffee. We would a priori expect $HPLA_t$ to increase as HC_t increases. PC_{t-1} replaced HC_t in several specifications. The "best" specification amongst the various attempted is the following:

$$\log HPLA_t = \log \underset{(22.8)}{192.5} + \underset{(1.74)}{0.071} \log PPLA_{t-1} + 0.614 \log HPLA_{t-1}$$

$$LLF = 32.1 \qquad R^2 = 0.650 \qquad DW = 1.948 \qquad \hat{E} = \underset{(2.05)}{0.386}$$

The estimated elasticity is significant at the 0.05 level. The estimated average elasticity of the linear version of this specification is similar at 0.067. The estimated short-run elasticity of the above is 0.0275.[29]

[29] The addition of other explanatory variables either destroyed the sign of the estimated price coefficient or destroyed the significance

4.5.5 POTATOES

The information available on the production process for potatoes indicates that an investigation of the following area response function, expressed in it general form, is warranted:

$$HPOT_t = F_5 (PPOT_{t-1}, PN_{t-1}, PM_{t-1}, PNI_{t-1}, WA_{t-1}, T)$$

A number of specifications employing various combinations of the six independent variables were estimated in an attempt to explain variations in area devoted to potatoe cultivation. However, only one specification was capable of producing the correct a priori sign for all of the estimated coefficients as well as an acceptable level of significance. This "best" specification regressed with the E-model is as follows:

$$\log HPOT_t = \underset{(17.7)}{\log 50.9} + \underset{(3.73)}{0.134} \log PPOT_{t-1} + 0.128 \log HPOT_{t-1}$$

$$LLF = 25.15 \qquad R^2 = 0.519 \qquad DW = 2.387 \qquad \hat{E} = \underset{(2.97)}{0.872}$$

The corresponding short-run elasticity is 0.117. Both the Cobweb and AE models generated marginally lower LLF's but identical long-run elasticity estimates of 0.127. The linear functional form of the above specification resulted in an estimated average long-run elasticity of 0.141, a figure very close to the one produced with the

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of the estimate. The "overall best" specification was one in which the price of output was deflated by PM. A trend variable was included as well. However the estimated coefficient for (PPLA/PM) was negative and significant at the 0.01 level. The value of the LLF was 34.04, compared with 32.1 given above. HC_t never contributed anything to explaining variations in area devoted to platano trees.

log functional form.[30]

4.5.6 RICE

The characteristics of the production process for rice would appear to indicate the need to explore the following area response function:

$$HRIC_t = F_6\ (PRIC_{t-1},\ PM_{t-1},\ PN_{t-1},\ PNI_{t-1},\ UC_{t-1},\ WA_{t-1},\ T)$$

The results of the various specifications based on this response function were largely disappointing. In the first place, the Nerlove model in all of its variants failed in every respect and never performed as well as the Cobweb model. Secondly, only two specifications were capable of generating the correct *a priori* signs for all of the coefficients coupled with a t-statistic in excess of one for each. The results of the one with the higher level of significance for the estimated price coefficient are given as follows:

$$\log HRIC_t = \underset{(9.33)}{\log 127.74} + \underset{(1.14)}{0.199} \log (PRIC/PM)_{t-1} + \underset{(1.15)}{0.02}\ T$$

$$LLF = 20.79 \qquad R^2 = 0.883 \qquad DW = 1.404 \qquad RHO = \underset{(6.33)}{0.810}$$

[30]The addition of any other regressor along with the price of output, PPOT, consistently destroyed the significance of the estimated coefficient of PPOT. Moreover, the additional regressors more often than not produced estimated coefficients which were incorrect in sign or if correct were not acceptably significant. Almost all of the estimates which had *a priori* incorrect signs were either not acceptably significant or only marginally significant. However, none of the numerous specifications attempted was capable of yielding a value of their respective LLF's which exceeded by a significant margin the value of the LLF of the specification recorded here. In addition, no specification estimated here, even one which included all six acceptable explanatory variables, was able to produce an R^2 exceeding 0.6.

The estimated coefficient for the relative prices in this specification is significant at the 0.15 level. Incidentally the linear functional form of the above specification yielded a similar elasticity estimate 0.187 but with an identical level of significance.[31]

4.5.7 YUCCA

The following area response function for yucca was examined:

$$HYUC_t = F_7\ (PYUC_{t-1},\ PM_{t-1},\ PN_{t-1},\ WA_{t-1},\ T)$$

As was noted in section 4.5, considerable variations in the estimated coefficients for the price of output occurred depending on the functional form and the regression model employed. The Box-Cox transformation procedure indicated that while both functional forms cannot be rejected at the 0.05 level of significance, the log form is less ambiguous. Amongst the log specifications, the E-model performed best. The results of the "overall best" specification are as follows:

$$\log = HYUC_t = \underset{(4.52)}{\log 36.23} + \underset{(2.11)}{0.653} \log PYUC_{t-1} - \underset{(-1.77)}{0.507} \log PM_{t-1}$$

$$+ 0.774 \log HYUC_{t-1}$$

$$LLF = 25.04 \qquad R^2 = 0.721 \qquad DW = 1.617 \qquad \hat{E} = \underset{(2.10)}{0.226}$$

[31] The use of other regressors as dictated by the area response function did little to alter the estimated values and level of significance of the coefficient for PRIC/PM. However, these additional regressors were either not significant or their estimated coefficients were incorrect in sign. Moreover, the "overall best" of the various specifications attempted produced a value of the LLF of 21.90 which is only marginally greater than the value produced by the specification recorded above.

The linear version of this specification yielded an average elasticity estimate of 1.036 (2.30), considerably above the log estimate. However, as noted above, the Box-Cox transformation procedure indicated that the log functional form is to be preferred, so we shall accept the estimated elasticity of 0.653.

4.6 YIELD RESPONSE, OUTPUT RESPONSE AND SUMMARY

All of the response coefficients estimated in the previous section are with respect to area. These must be converted to an estimated output responsiveness. This is done in a manner similar to the way it was accomplished for aggregate non-coffee crops. Of primary importance, given the context of this study, is to determine whether yields in any way causally respond to prices. As might be expected, for some of the seven crops yields do respond to changes in prices while for others they do not. We begin by examining for each crop whether yields have grown over time by estimating the parameters, via non-linear techniques, in the following equation:

$$Y_{it} = B_0 \, \mathrm{EXP} \, (B_1 \, \mathrm{TIME})$$

where Y_{it} is the yield (output per hectare) of the i^{th} crop at time t. The results for corn and yucca show no significant growth in yields over time. The results of the other five crops are summarized in the following table with all estimates significant at the 0.025 level or better:

TABLE 4.3

YIELD GROWTH RATES FOR THE i^{th} CROP OVER TIME

CROP	B_0	B_1	LLF	R^2
Cotton	0.726	0.036	8.02	0.764
Panela	1.580	0.043	-0.08	0.851
Platano	3.350	0.023	9.58	0.929
Potatoes	5.280	0.014	-29.37	0.285
Rice	-	0.054	3.33	0.882

As was the case for aggregate non-coffee crops, the specifications used to determine the price responsiveness of yields for all crops involved the use of the price of output, the price of manufactured goods and a trend variable as regressors. In addition, in the case of cotton, potatoes and rice, the price of intermediate inputs was also employed as an explanatory variable. We may begin by noting that yields of three of the seven crops, namely panela, rice, and yucca, demonstrated no responsiveness with respect to prices. Regardless of the specification employed, it proved impossible to obtain a significant positive price response for these three crops.[32] In the case of rice, this was somewhat surprising as rice is a modern commercialized crop with high growth rates for yield over time. In any event, in the absence of any yield responsiveness with respect to prices for these three crops means that the estimated output and area responsiveness are identical.

[32] In the case of yucca, the estimated coefficient with respect to relative prices (PYUC/PM) was negative and significant with a long-run and short-run value of -0.249 (-2.38). Moreover, this was the best performing specification attempted. There is no peculiar characteristics of yucca cultivation which would explain these results. However, we must accept what the data dictates. This leads to an estimated output elasticity which lies below the area elasticity estimate. In fact, the short-run output elasticities as noted in Tables 4.4 and 4.5 below become negative.

For the other four crops, significant yield responses were obtained. In the case of corn and cotton, the linear functional form of the various specifications attempted universally behaved better than the log functional form. In the case of potatoes, both functional forms behaved well with estimated price elasticity varying little between functional forms. The estimates of platano yield performed exceptionally well in both the linear and log functional forms but since there was some difference in the estimates depending on the functional form, a Box-Cox transformation procedure was run to determine which of the two was less rejectable. The results of the yield estimates of corn and potatoes lose some of their impact because of the low R^2. This reflects the existence of some important explanatory variable which we have failed to include in the various specifications. More likely than not the missing variable is some index of weather conditions. Regretfully such data was not available at the time of this study. For cotton, corn, potatoes and rice 23 observations on yield were available while for the others only 18 were available.

The results of the yield response regressions for corn, cotton, potatoes and platano are as follows:

$$YCOR_t = \underset{(24.7)}{1.05} + \underset{(2.91)}{0.00035}\, PCOR_{t-1} - \underset{(-3.14)}{0.027}\, T$$

$$LLF = 23.48 \qquad R^2 = 0.343 \qquad DW = 1.884$$

$$YCOT_t = \underset{(5.93)}{0.416}\, (PCOT/PM)_{t-1} + \underset{(6.06)}{0.044}\, T + 0.287\, YCOT_{t-1}$$

$$LLF = 9.40 \qquad R^2 = 0.792 \qquad DW = 1.751 \qquad \hat{A} = \underset{(3.38)}{0.713}$$

$$YPOT_t = 3.43 + 0.383\,(PPOT/PM)_{t-1} + 0.109\,T$$
$$\quad\quad (3.33) \quad (1.76) \quad\quad\quad\quad\quad (4.21)$$

$$LLF = -27.2 \qquad R^2 = 0.387 \qquad DW = 1.954 \qquad RHO = -0.323\ (-1.56)$$

$$\log YPLA_t = \log 21.3 + 0.154 \log (PPLA/PM)_{t-1} + 0.017\,T$$
$$\quad\quad (26.5) \quad (2.93) \quad\quad\quad\quad\quad (8.55)$$

$$LLF = 35.90 \qquad R^2 = 0.940 \qquad DW = 2.251$$

The average long-run and short-run price elasticity of yield for corn is 0.283. The long-run and short-run elasticities for cotton are 0.547 and 0.390, respectively. The average long-run and short-run elasticity estimate for potatoes is 0.241.

We are now in a position to combine yield with area response in order to obtain some indication of output response. Table 4.4 summarizes all of this with respect to the price of output for the aggregate non-coffee crops and each of the seven individual crops while Table 4.5 does the same but with respect to the price of manufactured goods (PM).[33]

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[33]The long-run output elasticities estimated for 4 of the 7 crops stack up very well indeed with estimates of responsiveness for the same crop undertaken in other regions of the world. There was always a significant subset of studies on the supply responsiveness of corn, cotton, potatoes and rice in various parts of the world which yielded results similar to what we have obtained here for Colombia. In the case of panela, platano and yucca, no comparative studies exist. It should be noted in passing that for the same crop the variance in the estimated elasticities obtained in the various studies is very large. The reader is referred to Askari and Cummings (1976) for further information.

TABLE 4.4

SUMMARY OF AREA, YIELD AND OUTPUT RESPONSIVENESS OF NON-COFFEE CROPS WITH RESPECT TO THE PRICE OF OUTPUT IN COLOMBIA

CROP	AREA ELASTICITIES SHORT-RUN	AREA ELASTICITIES LONG-RUN	YIELD ELASTICITIES SHORT-RUN	YIELD ELASTICITIES LONG-RUN	OUTPUT ELASTICITIES SHORT-RUN	OUTPUT ELASTICITIES LONG-RUN
Aggregate	0.262	0.316	-	-	0.262	0.316
Corn	0.329	0.687	0.283	0.283	0.612	0.970
Cotton	0.707	1.455	0.390	0.547	1.097	2.002
Panela	0.083	0.083	-	-	0.083	0.083
Platano	0.028	0.071	0.154	0.154	0.182	0.225
Potatoes	0.117	0.134	0.241	0.241	0.358	0.375
Rice	0.199	0.199	-	-	0.199	0.199
Yucca	0.148	0.653	-0.249	-0.249	+0.101	0.404

TABLE 4.5

SUMMARY OF AREA, YIELD AND OUTPUT RESPONSIVENESS OF NON-COFFEE CROPS WITH RESPECT TO THE PRICE OF MANUFACTURED OUTPUT (PM) IN COLOMBIA

CROP	AREA ELASTICITIES SHORT-RUN	AREA ELASTICITIES LONG-RUN	YIELD ELASTICITIES SHORT-RUN	YIELD ELASTICITIES LONG-RUN	OUTPUT ELASTICITIES SHORT-RUN	OUTPUT ELASTICITIES LONG-RUN
Aggregate	-0.262	-0.316	-	-	-0.262	-0.316
Corn	-0.329	-0.687	-	-	-0.329	-0.687
Cotton	-0.707	-1.455	-0.390	-0.547	-1.097	-2.002
Panela	-0.083	-0.083	-	-	-0.083	-0.083
Platano	-	-	-0.154	-1.154	-0.154	-0.154
Potatoes	-	-	-0.241	-0.241	-0.241	-0.241
Rice	-0.199	-0.199	-	-	-0.199	-0.199
Yucca	-0.115	-0.507	+0.249	+0.249	+0.134	-0.258

The following table presents the weighted average area and output responsiveness of the seven non-coffee crops considered in this study. The weights are based on the proportion of hectares devoted to the cultivation of the i^{th} crop in 1969 (first column) and on the proportion of the value of output of the i^{th} crop to the value of output of all seven crops in 1966, the year closest to 1969 with a consistent set of output data (second column).

TABLE 4.6

WEIGHTED AVERAGE RESPONSIVENESS
WITH RESPECT TO THE PRICE OF OUTPUT
OF THE 7 MOST IMPORTANT NON-COFFEE CROPS

	AVERAGE AREA RESPONSIVENESS (AREA WEIGHTS)[34]	AVERAGE AREA RESPONSIVENESS (OUTPUT WEIGHTS)[34]	AVERAGE OUTPUT RESPONSIVENESS (OUTPUT WEIGHTS)
Short-run	0.256	0.215	0.346
Long-run	0.514	0.425	0.574

The first thing that should be noticed is the substantial difference between the average long-run area estimate given in Table 4.6 and the long-run area estimate of 0.316 derived from the aggregate non-coffee crop regressions. This is, of course, to be expected. In the context of Colombian agriculture, there exist only limited substitution possibilities amongst non-coffee crops, as an aggregate, and livestock and coffee. Thus aggregate area responsiveness of non-coffee crops must largely be reflected in the cultivation of new land hitherto uncultivated. The responsiveness of growers with respect to individual crops, on the other hand, not only reflects the bringing into production of new lands but also the allocation of existing cultivated land amongst

[34]The discrepancy that exists between the average area responsiveness when weighted by area and when weighted by output is largely due to corn. Whereas corn accounts for 40 percent of the area devoted to the cultivation of the seven crops, it only accounts for 16 percent of the value of output.

competing crops. This additional aspect of responsiveness representing the allocative efficiency of growers in response to changing relative crop prices would tend to result in an average area response of single crops estimated individually which is higher in value than that obtained from estimations of aggregate area responsiveness.

In the case of the output elasticities, the short-run and long-run estimates based on the aggregate non-coffee crop model are well below those calculated from the weighted average elasticity estimates of the seven crops. The reason for this is obviously the fact that we were unable to obtain an acceptable estimate of the price responsiveness of aggregate non-coffee crop yields while for at least some of the individual crops it did prove possible to arrive at some appropriate indication of yield responsiveness. It would probably be unduly cautious to suggest that prices play no role whatsoever in determining aggregate yields given that yields on some of the individual crops making up the aggregate do indicate a reaction to price changes. There are of course a number of crops whose relative output values are low and hence were not investigated separately in this study, but are part of the aggregate, which have enjoyed substantial increases in yield over the period in question. On the other hand, several of the crops estimated in this study are important in terms of value of output but are traditional crops with zero or slow rates of growth in yields. Given this then we can probably roughly approximate the price responsiveness of aggregate non-coffee crop yields as a figure which may be a little above the weighted average yield responsiveness of the seven individual crops. No effort is made to provide a figure as the results of the aggregate estimations are not used in attempting to calculate the impact price distortions have had on the

Colombian economy.

Our objective in this study was to obtain a reasonable indication of the extent to which cultivators of crops other than coffee and livestock-derived products in Colombia respond to changes in price incentives. Despite some data limitations and doubts about the quality of some of the data, it is felt that this objective has been largely achieved. No doubt the results of some of the estimations, especially with respect to rice, leave something to be desired. Nonetheless, one is left with the distinct impression that farmers in Colombia do indeed respond in the predicted direction to appropriate price incentives. Yet one must remind the reader of the caveat made at the end of "The Introduction To and Objectives of the Study". The absence of a general equilibrium framework might tend to bias these results upward but it is thought that the bias would in all probability not be very large. In addition, the calculation of the weighted average responsiveness in Table 4.6 was done without reference to the confidence one has in the elasticity estimates of the various crops. If one were to approximate an average responsiveness weighted by the standard deviation of the estimated elasticities of each crop, it would seem that the average responsiveness given in Table 4.6 is biased downward, that is, the crops which yielded the higher elasticity estimates are also the ones in whose estimates the most confidence can be expressed.

CHAPTER 5

LIVESTOCK PRODUCT SUPPLY RESPONSIVENESS

5.1 INTRODUCTION[1]

Livestock raising has historically formed a large part of agricultural activities in Colombia, with livestock production having maintained a constant 35 percent share of total agricultural output over the 1945-1975 period. Given the importance of livestock raising to Colombian agriculture, an indication of the extent to which ranchers respond to changes in prices would seem essential if we are to obtain a reasonably accurate picture of how distortions in the TOT have affected Colombian agriculture as a whole.

Over 85 percent of livestock-derived products originate from cattle. About 85 percent of the national cattle herd is beef cattle, the remaining 15 percent representing dairy cattle.[2] The national beef herd increased at an average annual rate of slightly over 3 percent from 1945 to 1951. From 1951 to 1957, herd sizes remained unchanged largely as a result of "la violencia". Since 1957 the herd has increased at an average annual rate of a little under 4 percent.

It is in the tropical savannah zones of Colombia (principally in Los Costa and Los Llamos) that the bulk of the national beef herd is raised, although there are considerable differences in the ability

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[1]The principal source for the discussion in this section is the World Bank (1972).

[2]Almost the entire beef herd genetically stems in whole or in part from native breeds but only about 20 percent are pure "criolla". The balance are mix-breeds, the result of a policy to upgrade the native breeds with Zebu breeds, mainly U.S.-type Brahman, which are especially suited to tropical conditions.

of various regions to maintain cattle. The number of cattle carried per hectare depends on factors such as rainfall, the species of grass found, the extent of artificial pastures, etc. Estimates of the distribution of herd size in La Costa zone indicate that the typical herd comprises about 400 head with only a few herds exceeding 1500 head. Herd management throughout most of the country is based on "extensive" methods.[3]

Dairy farming is a relatively minor agricultural activity with the growth of milk production since 1950 barely keeping pace with that of population. Roughly half of all milk production is destined for fluid milk markets. Only 5 percent is commercial manufacturing milk. Most of the remaining milk production is consumed on the farm or to produce farm butter and cheese, a part of which is marketed. Modern large scale dairy production using European breeds is confined to a few farms found near major cities. However, this involves only a small percentage of milk production. Most production is derived from the milking of beef cattle in the months immediately following calving. This leads to large seasonal variations in supply. The enormous off-season excess demand especially in urban areas has resulted in price controls on milk. Current dairy policies do not make it attractive for farmers to raise dairy cattle.

The following section (5.2) reviews the literature on the various approaches employed by investigators in their attempts to estimate livestock product supply responsiveness. Some of the results obtained in

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[3]Such methods have tended to result in relatively high mortality rates among calves, inadequate health control measures, and relatively poor feeding in the crucial growth phase of calves. Calving percentages tend to be relatively low and slaughtering ages relatively high.

the different studies are also recorded. Section 5.3 outlines the approach taken in this study in an effort to estimate livestock product responsiveness in Colombia. In addition, the econometric problems which arose in the estimations are discussed. Finally, in section 5.4 the various specifications employed and the results of the better performing ones are recorded and discussed.

5.2 MODELLING LIVESTOCK RESPONSIVENESS[4]

The Nerlovian price expectations approach (the E-model) for estimating livestock products supply responsiveness has been the dominant model used in the empirical literature to study the determinants of livestock supply. The principal livestock derived products investigated have been milk, hogs, wool, and beef.[5] Products such as milk and wool are perennials in the sense that a given "producing unit" or "unit of capital stock" can generate output over many periods while products such as beef and hogs are more akin to annual crops with their single "cropping". Since 85 percent of the real value of livestock output originates from cattle and of that a further 85 percent is beef, it would be safe to approach the estimation of livestock supply responsiveness in Colombia as a problem similar to that of the estimation of an annual crop supply. Consequently,

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[4] Much of this section is based on the work of Askari and Cummings (Askari and Cummings, 1976 and 1977).

[5] All attempts at estimating supply responsiveness of livestock-derived products have been in the context of developed countries, especially the United States, Britain, and Australia. With their more extensive data bases, authors were able to include in their specifications variables for which data is just not available in countries such as Colombia. Such variables include feed concentrate prices, hay production in the preceding season, substitute livestock product prices, cows in calf, etc. In addition, estimates were sometimes undertaken on the basis of quarterly data. Most attention seems to have been directed toward milk products.

some of the models employed in the literature to measure the determinants of beef supply only will be examined briefly here.

Two approaches have been taken in estimating beef supply response (as well as the response of other livestock derived products). The most common has been to treat cattle as capital stock and to use some sort of Nerlovian adjustment mechanism within the framework of a capital stock model. As a rule, the size of the herd, either in terms of the number of animals or in terms of the real value of the herd, has been used as the dependent variable in this approach. The second approach has been to employ some measure of output as the dependent variable. Both tonnage and the value of output appropriately deflated are suitable measures here. Prices were generally but not always formulated using the usual Nerlovian expectations hypothesis. Where they were not, both the Cobweb and the "ordinary" supply models have been employed.[6]

The usual Nerlovian price expectations approach are highlighted in two studies on beef supply responsiveness in Britain and Ireland. The Jones study on British beef (Jones, 1962) involved a capital stock specification in which the expected prices of beef, milk and feed were incorporated as regressors. In addition, Jones experimented with alternative lag lengths in his Nerlovian price expectation formulations

[6] By "ordinary" supply model, it is meant current output as a function of current prices as opposed to lagged prices.

as well as with the most appropriate dependent variable.[7] In Buttimer's study on Irish beef (Buttimer, 1972), a variety of specifications were employed including the expected price of beef, this price plus a trend variable, the expected price of beef plus the expected price of milk, and the expected price of beef deflated by that of milk. Moreover, two shift variables were incorporated in all specifications reflecting years in which there were subsidy and bonus schemes in effect. Price expectations were formulated in the usual Nerlovian manner. He obtained an estimated short-run elasticity of 0.14 over the period 1953 to 1970.

Another study by Powell and Gruen on Australian beef (Powell and Gruen 1967) argued that "what determines the proportion of any beef herd brought to market are expected current prices as well as expected future prices. It is the relationship between these two sets of prices which largely determines current output, with current output expanding as the expected current price rises relative to expected future prices. Thus a priori one would anticipate the estimated coefficient for the expected current price to be positive while that of expected future prices to be negative. They obtained an estimated short-run output responsiveness of 0.16 over the period 1947-1964. Finally, a pure capital theory approach was taken by Jarvis with respect to Argentinian beef (Jarvis, 1974) in which he views ranchers as portfolio managers who seek to optimize the slaughter age of each animal. The present discounted value

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[7]Among the alternative dependent variables measures, the number of cows, calves reared, calves, steers and heifers were used. Experiments with different expected price lags revolved mainly around whether Nerlovian lagging begins with current price or with the price lagged one period. For the period 1924-1958, Jones estimated a short-run response which ranged from 0.10 to 0.38 and a long-run response which exceeded one. In a similar study in West Germany for the period 1951 to 1964, an estimated long-run responsiveness of 1.06 was derived (Jones, 1965).

of each animal is represented as:

$$V = W(\theta).P^{E}(\theta)e^{-r\theta} \tag{5.1}$$

where θ is the age of the animal, W(θ) is the weight at age θ, $P^{E}(\theta)$ is the expected price per kilo at age θ, and r is the discount rate. Unfortunately the data requirements needed for adapting this approach to Colombian cattle is currently beyond the ability of the existing Colombian agricultural data base.

5.3 ESTIMATION PROCEDURES AND PROBLEMS

The range of specifications used in an attempt to estimate supply responsiveness in the livestock sub-sector of Colombian agriculture depends on whether one takes an output or a capital stock approach to the problem. The output decision is essentially a decision to slaughter or to bring to market some part of the existing herd. The appropriate variable to be explained would be some acceptable measure of output.[8] The costs involved in maturing and maintaining the herd up to the point when the output decision is made have been met and hence can be viewed as sunk costs. A priori acceptable explanatory variables can therefore be confined to the expected price of livestock-derived products (PL), some measure of the cost of obtaining desired manufactured goods (PM), either as a separate regressor or as a deflator for PL and perhaps to a trend variable (T).

The output supply functions were estimated in both their linear and log functional forms. Output was expressed in terms of desired

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[8]The value of the output of livestock-derived products appropriately deflated was used as the dependent variable here. Although the term livestock is used, it is in reality cattle only and the output is almost entirely beef. Output at time t is henceforth denoted as QL_t.

output. The output adjustment mechanism and price expectations are formulated in the usual Nerlovian manner.[9] Regressions were initially run with the restriction that both the output adjustment coefficient (A) and the price expectations coefficient (E) are equal to one. Where appropriate, the Nerlovian E, A, and AE models as developed in the previous chapter were then regressed. The data base involved 31 observations (1945-1975). This is six more observations than was available for the non-coffee crop estimations.

An alternative approach to estimating livestock responsiveness is to examine the rancher in his capacity as a holder of capital stock and to explore the determinants of the level of capital stock he will maintain. This would require as a dependent variable some measure of the size of the herd at each point in time.[10] The range of *a priori* acceptable explanatory variables would be considerably larger for the herd size decision than was the case of the output decision. Clearly the costs involved in maturing and maintaining the herd would have a role to play in determining herd size, as would the price of alternative or competing products. The specifications examined involved, in addition to PL, various combinations of the following explanatory variables: WA, PM, VL, PLI, and PN. WA, PM, and PN are defined exactly as in the

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[9]The use of either the current price or the price lagged one period can be justified in examining the output decision depending on the time lag between when output is brought to market and when the output decision is made. The poorer the communications and transportation network, the more likely the lagged price would be the appropriate regressor.

[10]As a proxy for the number of cattle, the value of the cattle herd at time t appropriately deflated was employed as the dependent variable, henceforth denoted as HS_t.

previous chapter. VL is the user cost of capital[11] while PLI is the price of intermediate inputs used in livestock raising. As with the output decision, the Cobweb model, the "ordinary" supply model and where appropriate, the three variants of the Nerlove model were employed in the estimations. 31 observations were available (1945-1975) on the relevant variables.

The level of autocorrelation encountered in all of the livestock regressions was by any standard serious. In those estimations in which an attempt is made to explain the output decision, autocorrelation, although fairly serious, was largely eliminated by using either the Cochrane-Orcutt iterative technique or one of the variants of the Nerlovian model in which the dependent variable lagged by one or two periods appears as a regressor. However, in those estimations in which herd size was employed as the dependent variable, autocorrelation was so serious that neither the Cochrane-Orcutt iterative technique nor the use of the Nerlovian model could correct for it. The only way in which a non-rejectable Durbin-Watson statistic could be generated involved re-writing the Nerlovian specifications to take into consideration the existence of overpowering autocorrelation.[12]

5.4 SPECIFICATION AND RESULTS

The output decision will be discussed first. Among specifications expressed in their linear functional form, the Cobweb model generated a

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[11] The derivation of this data series is discussed in the Data Appendix at the end of this study.

[12] This can be done, for example, by re-writing the general Nerlovian specification $Y_t = f(X_t, Y_{t-1})$ as $Y_t = f(X_t, Y_{t-1}) - RHO(f(X_{t-1}, Y_{t-2}) - Y_{t-1})$, and then using nonlinear least squares. As will be seen in the next section this led to problems with respect to convergence.

higher value of the LLF than did any variants of the Nerlovian model. The results of the "best" performing specification regressed using the Cochrane-Orcutt iterative technique are as follows:[13]

$$\text{(1)} \quad QL_t = \underset{(7.52)}{1219} + \underset{(4.81)}{1.43}\, PL_{t-1} + \underset{(7.33)}{78.46}\, T$$

$$LLF = -163.1 \qquad R^2 = 0.992 \qquad DW = 1.801 \qquad \hat{RHO} = \underset{(5.10)}{0.694}$$

In comparison with the above, the Nerlovian E-model regressed using non-linear least squares produced the following results:

$$\text{(1a)} \quad QL_t = \underset{(9.00)}{1546} + \underset{(3.05)}{2.92}\, PL_{t-1} + \underset{(4.25)}{63.46}\, T + 0.75\, QL_{t-1}$$

$$LLF = -168.8 \qquad R^2 = 0.992 \qquad DW = 1.802 \qquad \hat{E} = \underset{(2.11)}{0.2465}$$

The Cobweb model's estimated price coefficient of 1.43 produced an average elasticity of 0.1099 while that of the Nerlovian model produced a long-run average elasticity of 0.2244 and an average short-run elasticity of 0.0553. The difference in the values of the two LLF's was found to be sufficiently large to allow us to accept the restrictions implied in estimating the Cobweb model. Thus, the 0.1099 estimate is the appropriate measure of responsiveness.

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[13]Regardless of the dependent variable or the functional form employed, the inclusion of regressors other than PL and a trend variable not only destroyed the significance of the estimated coefficients of the price of output but often changed their sign from positive to negative. Moreover, these additional regressors were never significant and more often than not were of the _a priori_ incorrect sign. This situation was, however, not especially distressing for two reasons. First, price alone consistently explained at least 98 percent of the variation of the two dependent variables. Secondly, according to the likelihood-ratio test, the values of the LLF generated by those specifications in which additional explanatory variables were included were not significantly different from the values yielded when only the price of output and a trend variable were used.

When the log functional form is employed, the following is the best model and specification consistent with the correct *a priori* sign and an acceptable level of significance for the estimated coefficients:[14]

$$(2)\quad \log QL_t = \log \underset{(22.62)}{523.22} + \underset{(5.07)}{0.378} \log PL_{t-1} + 0.84 \log QL_{t-1}$$

$$LLF = 53.19 \quad R^2 = 0.984 \quad DW = 1.91 \quad \hat{E} = \underset{(1.48)}{0.16}$$

$\hat{E}$ is significant at the 0.10 level. The Nerlovian short-run estimated elasticity is 0.06. The Box-Cox test was employed and both functional forms could not be rejected at the 0.05 level of significance but the log functional form was more unambiguously unrejectable. Thus it would appear that the results given by (2) would at this stage, be the more acceptable measure of rancher responsiveness.

We now turn to the results of the herd-size decision. The level of autocorrelation encountered here was extremely serious. The only way in which a reasonably respectable DW statistic could be generated was by rewriting the Nerlovian model as suggested

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[14] The use of the term "correct *a priori* sign" in this context should be treated with some caution since it is only correct if the underlying model is correct, and in the case of livestock especially, that is open to question. This is particularly true if price expectations play a role in determining supply responsiveness. For example, if a rise in price is accompanied by the expectation of further price increases, ranchers might react by expanding herds and this can be done in the aggregate only by reducing current supply. Thus the sign of the price variable may be negative.

in footnote 12 of this chapter. In doing this, however, it was possible to obtain viable estimation results only for the specification in which the price of output appeared alone.[15]

The results of the log functional form for this specification are as follows:

$$(3)\ \log HS_t = \log 3103 + \underset{(19.2)}{}\ \underset{(3.05)}{0.225} \log PL_t + 0.888 \log HS_{t-1}$$

$$LLF = 84.64 \quad R^2 = 0.996 \quad DW = 1.500 \quad \hat{RHO} = \underset{(3.20)}{0.717} \quad \hat{E} = \underset{(0.65)}{0.112}$$

It should be noted that $\hat{E}$ is not acceptably significant.[16] As noted earlier in this chapter, attempts to incorporate other regressors, particularly that of the price of manufacturing output (PM) into the various output specifications generally proved unsuccessful. The exact same sort of problems arose with the herd size specifications. There was, however, one exception and that is the specification in which PL and PM appeared alone as separate regressors. The regression results are as follows:

$$(4)\ \log HS_t = \log 2426 + \underset{(17.4)}{}\ \underset{(2.35)}{0.319} \log PL_{t-1} \underset{(-1.03)}{-0.045} \log PM_{t-1} + 0.882 \log HS_{t-1}$$

$$LLF = 81.69 \quad R^2 = 0.996 \quad DW = 1.543 \quad \hat{E} = \underset{(0.86)}{0.118} \quad \hat{RHO} = \underset{(3.92)}{0.688}$$

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[15] Computational difficulties with non-linear least squares were encountered with specifications other than this one. Either convergence to the minimum sum of the squared residuals proved impossible, or the convergence process was unable to improve the objective function after a set number of iterations leading to unacceptable estimates, or if convergence was obtained, the resulting parameter estimates were nonsensical.

[16] The results of the linear version of this specification were disappointing in that the estimated coefficient for price was negative and significant at the 0.15 level. Moreover, $\hat{RHO}$ exceeded one in value and was powerfully significant.

The estimated coefficient for PM_{t-1} is significant only at the 0.20 level, as is $\hat{E}$. The value of the LLF is, however, less than that yielded by (3) by a significant margin.

The regression models denoted by specifications (3) and (4) involve estimated elasticities which reflect herd size and not output responsiveness. To translate these estimates into approximate output elasticities, we must have some indication of the factors which influence yield or output per cow, particularly as to whether prices play any role in explaining variations in yield over time. Yield here is defined as the ratio of the value of cattle output in constant prices to the value of the Colombian cattle herd also expressed in constant prices and, in the absence of more appropriate data, is used as an approximation of output per member of the cattle herd. It is designed to reflect increase cow weight and quality due to better health standards, feeding, and husbandry.

Following the convention established in Chapter 4, the rate of growth of yield over time was determined to be a significant 1.3 percent per annum. In an effort to determine whether prices have a role in explaining changes in yield a number of specifications were regressed employing as explanatory variables various combinations of PL_{t-1}, PM_{t-1}, and PLI_{t-1} as well as a trend variable. As was the case with non-coffee crops, the Cobweb, A and AE-models were used as the results warranted. The overall "best" of the various specifications produced the following results with the A-model, where YL_t is yield at time t:

$$(6) \quad YL_t = \underset{(13.9)}{0.368} \, (PL/PM)_{t-1} + 0.894 \, YL_{t-1}$$

$$LLF = 88.90 \qquad R^2 = 0.909 \qquad DW = 1.862 \qquad \hat{A} = \underset{(2.32)}{0.106}$$

Generally, a very strong linear relationship between yield and prices was found. The constant was found to be not significant but the estimated coefficient for the relative prices did not differ significantly from that provided above. The sample average long-run elasticity calculated from the above was 1.193. The short-run elasticity estimate was 0.126.

Combining the results obtained in (6) with those contained in (3) we obtain a long-run output elasticity with respect to PL of 1.415 and a long-run elasticity with respect to PM of -1.193. Assuming the estimated value of the coefficient of price expectations in specification (3) to be not significantly different from zero, we then observe that in the short-run herd size does not respond at all to changes in price. Thus the short-run output elasticity is identical to the short-run yield elasticity of 0.126.

The question now arises as to whether it is the output regression model as embodied in specification (2) or the herd size plus yield regression model as given by (3) and (6) which best explains rancher responsiveness in Colombia. Despite the autocorrelation problems encountered in (3), we are forced to go with the herd size plus yield regression model for two reasons. First, only with the latter model did it prove possible to obtain a significant estimate for PM and, given the context of this study, this was felt to be important. The second and perhaps more important reason is that empirical studies of livestock responsiveness undertaken for other countries almost universally indicate long-run elasticity estimates in excess of one in value, as well as large differences between the short-run and long-run elasticities. These results are much more consistent with those obtained with the herd size plus yield regression model rather than with the output model.

CHAPTER 6

COFFEE SUPPLY RESPONSIVENESS

6.1 INTRODUCTION

It is proposed in this chapter to attempt to estimate the extent to which coffee supplies in Colombia have responded to changes in coffee prices since the end of the second world war. As was seen in Chapter 2, coffee's historic role in the Colombian economy has declined significantly since the end of the war. For example, in a typical year in the mid-1940's coffee accounted for about 30 percent of the real value of total agricultural output whereas in a typical year in the early 1970's this figure fell to about 18 percent. In terms of crops alone, these figures were 45 percent and 28 percent respectively.[1]

The Arabica species of coffee predominates in Colombia and its output tends to show little in the way of fluctuations from year to year, largely as a result of the geography of the growing areas which are such that if weather is unfavourable in one area it is compensated by generally favourable conditions in another. In contrast to coffee cultivation in some other countries, the small farm is the principal production unit, with the majority five hectares or less in size.

In the next section, we shall explore the various approaches investigators have used in modelling the supply behaviour of growers of perennial crops such as coffee and cocoa. In addition, the planting,

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[1] Nonetheless, the coffee industry in Colombia still provides on average 70 percent of Colombia's foreign exchange receipts, continues to employ directly and indirectly an estimated two million people (25 percent of the labour force) and generates about 10 percent of the government's current revenues.

maturation and yield characteristics of coffee will be examined. Section 6.2 will conclude with a survey of the coffee supply elasticities obtained by investigators in Colombia and other coffee-producing countries. In section 6.3, the results of our estimations of Colombian coffee supply responsiveness will be given and discussed.

6.2 MODELLING PERENNIAL CROP SUPPLY RESPONSIVENESS

What distinguishes a perennial crop from an annual crop is that it lasts for longer than the current growing season. Thus once a planting decision has been made, a perennial grower can expect for N + i years (i = 1,2,......T) a yield, where N and T are the beginning and end of the plant's economic life. Of course, one would expect those yields to vary to some extent with the age of the tree.

One may examine the response behaviour of growers of perennials such as coffee from two distinct but interrelated approaches, namely the decision to harvest or to bring to market and the decision to plant.[2] The harvesting decision might involve the use of a specification similar to the following, with all variables defined as in Chapter 4.

$$Q_t = \beta_0 + \beta_1 P_t + \sum_{i=2}^{n} \beta_i Z_{i,t-j} + u_t \quad {}^{3} \qquad (6.1)$$

Variations of this specification were used by Frederick (1965) for coffee

[2] The problem facing the coffee grower when making the harvesting decision is to determine how much of the currently ripe fruit he will bring to market from his existing stock of trees. This is largely a short-run decision, although how much the cultivator brings to market now in part depends on planting decisions made well into the past.

[3] The price lagged one period may be the appropriate price regressor if as a result of poor communications, the grower is unaware of the current price.

in Uganda and Williams (1972) for coffee in Jamaica.[4] Stern (1965) for cocoa in Nigeria employed the same basic specification but expressed in terms of desired output under the assumption that growers might not be able to adjust fully to desired output in the current period.[5]

The weakness of using the harvesting decision as a realistic measure of grower response behaviour can be traced to the observation that current output also depends on planting decisions made in the past which in turn is a function of some set of past prices. One approach to modelling this would be to include a price variable reflecting the price to which growers responded when making the planting decision which resulted in plants bearing significant yields for the first time in the current season. A specification reflecting this behaviour would tend to look like the following:

$$Q_t = \beta_0 + \beta_1 P_t + \beta_2 \Delta H_{t-k} + \sum_{i=3}^{n} \beta_i Z_{i,t-j} + u_t \tag{6.2}$$

$$H_t = \alpha_0 + \alpha_1 P_{t-1} + v_t \tag{6.3}$$

where k is the year in which trees currently yielding for the first time were planted. Substitution of equation (6.3) into (6.2) yields a reduced form equation for estimation purposes. Stern (1965) for cocoa in Africa used a variation of this specification.

The main failing of the foregoing is that is neglects the fact that current output does not just depend on area or planting decisions made k

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[4]Unless otherwise indicated, reference to the empirical literature is derived from the Askari and Cummings' survey (Askari and Cummings, 1976 and 1977).

[5]The expression connecting observed and desired output is analogous to that used for area in equation (4.4).

years ago but on all past decisions. A specification reflecting this is:

$$Q_t = \beta_0 + \beta_1 P_t + \beta_2 \sum_{h=k}^{T} \Delta H_{t-k} + \sum_{i=3}^{n} \beta_i Z_{i,t-j} + u_t \qquad (6.4)$$

$$H_t = \alpha_0 + \alpha_1 P_{t-1} + v_t \qquad (6.5)$$

where T-k is the economic life of the plant or tree. Substituting (6.5) into (6.4) and taking first difference to get rid of the summation sign we again obtain a single reduced form equation which can be estimated directly.

There are three aspects of this approach to modelling perennial crop responsiveness which make it less desirable than it appears. The first is that equation (6.5) has area as a function of the previous period's price only. A more realistic approach should have area depend on expected prices expressed in the Nerlovian manner, that is:

$$H_t = \alpha_0 + \alpha_1 P_t^E + v_t \qquad (6.6)$$

with P_t^E defined as in equation (4.5). Ardy (1968) for coffee and cocoa in Africa used a variation of equation (6.6) combined with equation (6.4).

The second aspect which makes the above somewhat less than a completely accurate representation of coffee cultivation is that it ignores the fact that yields of perennials such as coffee are partly a function of the age of the tree, that is, it ignores variations in yields over time.[6] A specification which incorporates such yield variations might look like the following (ignoring Z_1) in its structural form:

$$Q_t = \beta_0 + \beta_1 P_t + \beta_2 \sum_{h=k}^{m-1} \Delta H_{t-h} + \beta_3 \sum_{h=m}^{n-1} \Delta H_{t-h} + \ldots\ldots + u_t \quad (6.7)$$

$$H_t = \alpha_0 + \alpha_1 P_t^E + v_t \quad (6.8)$$

where k is the year the trees first bear significant yields of fruit. Thus for years k to m-1 we would have an average yield which would be different from the average yields generated in years m to n-1, and so forth. The reduced form equation can derived through appropriate substitution. Bateman (for cocoa in Ghana) used a variation of this model (Bateman, 1965).[7]

The final aspect is that an area adjustment statement to account for the possibility that cultivators might not be able to adjust to desired area in the current period is lacking. This can be incorporated by rewriting H_t in equation (6.8) as H_t^D, that is, desired area and including equation (4.4) in the structural model. Behrman (for cocoa in Ghana) used a version of this model incorporating, like Bateman, the expected price of coffee as a regressor (Behrman, 1968).

Up to this point we have been examining specifications in which output

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[6]For Colombian coffee, yields are zero up until the second year following which they rise until the fourth year. In the fifth year yields drop off as the trees devote their energies to extending branches. Yields then jump sharply in the sixth year after which they climb rapidly and peak at about the 12th year and then decline at a decreasing rate until about age 25. From then on, yields decline more slowly. Coffee trees still bearing fruit at 80 years of age are not uncommon. Of course, the yield-age profile of fruit-bearing trees varies considerably for different tree species.

[7]Along with the expected price of cocoa, Bateman also included the expected price of coffee as a separate regressor as in Ghana, coffee and cocoa cultivation are substitute activities. Bateman confined to two discrete time periods differences in average yields. The prices of coffee and cocoa as they have been specified here are not as Bateman defined them and, as a result, we shall return to this model below.

is the variable to be explained. However, the use of output as the dependent variable, particularly in the work of Ardy, Bateman and Behrman was an obvious second best solution. Initially each formulated their models in terms of either area or desired area and then recast their models in terms of output only because requisite data on area was not available.[8] When area data was available to researchers, the problem was of course simplified, and Nerlovian model as discussed above was often used to estimate supply responsiveness of perennials such as coffee and cocoa.[9]

The various ways in which perennial crop responsiveness have been modelled up to this point still leave something to be desired. Two weaknesses can be isolated. The first is that investigators have largely ignored the fact that the planting decision is equivalent to the cultivator acquiring a piece of capital and that the decision to plant is not just based on the current expected price (however defined) but on the income stream expected over the economic life of the tree. One of the few investigators recognizing this is Bateman (Bateman, 1965 and

[8]The reformulation of responsiveness in output terms can potentially lead to problems. Ideally one would wish to employ data series sufficiently long so as to maintain enough degrees of freedom to allow a satisfactory significance level in the estimations and yet not so long so as to increase the possibility of events having occurred which lead to structural shifts in the supply curve. The use of output as the dependent variable necessitates information on prices being available well before the year at which the study begins. For example, in the case of the work of Bateman and Behrman, an additional 12 years of price observations would have to be inserted before the beginning observation on output. Of course, if one can identify such structural changes one can overcome the problem with the use of appropriate dummy variables.

[9]Examples are Stern (1965) for cocoa in Nigeria, Frederick (1965) for coffee in Uganda, and Saylor (1974) for coffee in Sao Paulo.

and 1969).[10] Assuming that it is expected discounted real prices which dominate the planting decision, Bateman in his 1965 paper re-writes equation (6.8) to take this into consideration, that is:

$$H_t = \alpha_0 + \alpha_1 \frac{\sum^{T} (P^E_{t+k}/(1 + h)^k)}{T + 1} + v_t \qquad (6.9)$$

Thus area planted in coffee trees is a function of the mean value of expected discounted future prices, where T is the economic life of the tree. Price expectations are expressed in the usual Nerlove manner as given by equation (4.5). However, as noted above, a lack of area data required Bateman to formulate his model in terms of output along the lines as given in equation (6.7).

The second weakness of the various specifications discussed to this point is that the principal focus on cultivator behaviour has been with respect to his decision to devote area to coffee cultivation rather than to plant coffee trees. Although output does depend on the number of hectares in coffee trees, it more accurately depends on the number of coffee trees yielding fruit. The use of area as the dependent variable assumes the absence of any relationship between prices and productive tree density. It is quite possible to have increases in new areas devoted to coffee production and yet have the total stock of trees decline if the uprooting of diseased or uneconomic trees on existing coffee hectare-age exceeds the number of new trees planted. Moreover, output per hectare as a measure of yield can be misleading unless defined in terms of trees planted in a specific season since yields tend to vary with the age of the

[10] Others who have to some extent viewed perennial crop response in this way are Arak, Bacha, Behrman and Wickens and Greenfield. See Askari and Cummings (1976).

trees. This still ignores variations in tree density. Even output per tree as a measure of yield would be misleading unless one knew the age distribution of the trees.

There have been three investigators who have viewed grower responsiveness in terms of changes in the desired stock of trees and in yield per tree; namely, Arak (1967) for coffee in various Brazilian states, Bacha (1968) for coffee in Brazil and Colombia, and Bateman (1969) for coffee in Colombia.[11] Because growing conditions differ according to the region in Brazil in which the coffee is grown, Arak developed and experimented with a number of different models of coffee grower response. They all basically viewed the age-induced planting of new coffee trees as a function of the existing age distribution of the trees and of the optimal age distribution which in turn depends on grower price expectations. Any difference between the existing and optimal age distribution is assumed to be reflected in differences between the desired and the actual stock of trees of a given age. Response of growers to such differences is through their planting of new trees and their eradication of existing trees.

Both Bacha and Bateman used, as a basis for their models on coffee supply response in Colombia, the approach taken by Arak. However, Colombia does not have the extensive data on coffee that Brazil has collected over the years and, as a result, both Bacha and Bateman were

[11] The Arak and Bacha models as well as the results of their regressions are presented in detail in Bateman (1969), along with of course Bateman's own model.

estimates cover quite different time spans. Whereas our study is based on the 1945-1975 period, Bacha's effort covers an earlier period (1939-1964). As will be recalled from our discussion on the coffee sector in Colombia in Chapter 2, Colombian coffee policy since the early 60's has been dominated by the need to keep supplies in check. The success of this policy is reflected in the fact that while coffee output showed a general upward trend during the 40's and 50's, reaching a peak in 1961, it has since moved in the opposite direction. In fact between 1962 and 1972 coffee output was in no year greater than it was in 1961. Since 1972, however, coffee output has begun to trend upward again. Thus we would *a priori* expect a lower supply responsiveness as a result of using a later set of data.

These comments also apply to the elasticities we obtain from the estimation of Bateman's model. Bateman's results are based on the 1947-1965 period while ours cover the 1945-1975 period (or the 1950-1975 period when the lagged dependent variables are included). In addition, there are small differences for some observations in the data on price and output employed in Bateman's and this study. Although the differences are marginal, they could have an effect on the resulting estimates. It will be assumed that the data used in our study is the more accurate.[18] A final difference is that we deflate the price of coffee with the price of manufactured goods whereas Bateman uses a consumer price index as a deflator. Despite the fact

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[18] As is well known, economic data from third world countries are continually being corrected and updated so that the accuracy of the data tends to increase the longer the time span between the data years and the date of the published source of the data. Bateman had two sources of data on coffee output, the FAO whose data is based on the crop year and the national accounts which records the data on the basis of the calendar year. Our data which was obtained from A. Berry (see Data Appendix) corresponds to the latter.

that the two deflators have a high correlation, the differences that do exist can result in divergence in the results.

We shall estimate the Bateman model as defined in equation (6.20) which may be written as follows:[19]

$$\begin{aligned}\Delta QC_t = {} & AE\beta_1 \left| \sum_{i=k}^{m} \Delta Y_i \Delta P^*_{t-i} \right| + \gamma_2 \Delta P^*_t - \gamma_2 \left| (1-A)+(1-E) \right| \Delta P^*_{t-1} \\ & + \gamma_2 (1-A)(1-E)\Delta P^*_{t-2} + \gamma_1 \Delta^2 QC_{t-1} - \gamma_1 \left| (1-A)+(1-E) \right| \Delta^2 QC_{t-2} \\ & + \gamma_2 (1-A)(1-E)\Delta^2 QC_{t-3} + \left| (1-A)+(1-E) \right| \Delta QC_{t-1} \\ & - (1-A)(1-E)\Delta QC_{t-2} + w_t\end{aligned}$$

We shall follow Bateman's convention of defining m = 8 and k = 3. Thus we shall be examing the impact on QC_t of the effects of planting and of harvesting, with the former a function of the change in relative prices lagged 3 to 8 years and the latter a function of the change in the current prices. As a result of identification problems it will not be possible to separate β_1 from Y_i. Thus the estimated coefficient for P^*_{t-i} is the product of β_1 and Y_i.

The Bateman model as specified in the above equation was initially estimated. The estimated coefficient for the current price, γ_2, was found

[19] We shall ignore equation (6.22) for two reasons. First, the elasticity estimates obtained by Bateman from equations (6.20) and (6.22) are almost identical. Secondly, we are not interested in the estimated coefficients of the lagged dependent variables. In addition we shall ignore the large drops in output that occured in 1950, 1955 and 1960. Our longer data series will tend to wash away the effects of these one period declines in output. Moreover, as noted in Table 6.1, the differences in the estimated elasticities are rather small.

to be not significant.[20] It was therefore dropped from the model. This significantly improved the value of the LLF as well as increasing the significance of the lagged price estimated coefficients. The results of this specification of the Bateman model are recorded in the following table:

TABLE 6.3

ESTIMATED LAGGED PRICE COEFFICIENTS DERIVED FROM THE BATEMAN MODEL

COEFFICIENT	ESTIMATED VALUE	T-STATISTIC
$\beta_1 Y_3$	200.8	1.75*
$\beta_1 Y_4$	- 70.4	-0.59
$\beta_1 Y_5$	120.6	1.01***
$\beta_1 Y_6$	- 71.9	-0.57
$\beta_1 Y_7$	149.8	1.12**
$\beta_1 Y_8$	140.2	1.13**

*Significant at the 0.05 level.
**Significant at the 0.15 level.
***Significant at the 0.20 level.

The results are somewhat disappointing particularly with respect to the level of significance of the estimated coefficients. Bateman, in his own regressions, obtained non-significant estimates for all price coefficients except for $\beta_1 \Delta Y_5$ and $\beta_1 \Delta Y_7$. However, the levels of significance of the estimated values of these two coefficients were much higher than what we have been able to obtain here. The long-run elasticity

[20]Bateman also found the estimated coefficient for the current price to be not significant. However, whereas Bateman's estimate had a negative sign, our's at least was *a priori* correct in sign, though not significant.

calculated from the estimated price coefficients derived in the foregoing regression is 0.216.[21] This elasticity lies very close to the elasticity coefficient of 0.227 produced in the Bacha model. As was the case with the Bacha model, the elasticity coefficient we obtained in our estimation of the Bateman model has a value well below those yielded in Bateman's own regressions.[22]

The probable reasons for the differences have already been mentioned briefly. Although we a priori expected lower elasticity estimates than those obtained by Bacha and Bateman, we did not expect that they would turn out to be as low as they were. As already noted, the principal reason for the divergence in the elasticity estimates probably stems from the Colombian Coffee Foundation's committment to the International Coffee Organization from the early 60's and onward to play its role in keeping coffee supplies in check. One can see in just a casual examination of the output data from 1961 to 1972 the effects of the various Federation policies discussed in Chapter 2 on coffee growers.[23] A second factor which might account for the divergent results is the fact that we employed in our regressions a different deflator for the producer price of coffee than was used by Bateman and Bacha. Although the two deflators

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[21] Inconsistencies and problems of identification prevented us from obtaining acceptable and reasonable estimates for the adjustment and expectation coefficients, A and E. Consequently, it has not proved possible to calculate the short-run elasticity from the Bateman model. Bateman, of course, had the same problem in his own regressions.

[22] The results of Bateman's regressions are recorded in Table 6.1.

[23] The Bacha model was estimated using a sample beginning in 1961 and ending in 1975 to examine supply responsiveness during the years when growers were encouraged to keep supplies in check. The estimated coefficient for P^*_{t-7} was -252.7 and significant at the 0.10 level. This result helps to explain why we have been obtaining significantly lower elasticity estimates compared with those of Bacha and Bateman.

are highly correlated the price of manufactured goods has tended to increase at a slightly faster rate than the consumer price index.

From the results of our estimations, it would therefore appear that a long-run price of output elasticity of about 0.22 and a short-run price of output elasticity of about 0.05 would be the appropriate Colombian coffee response measures. The long-run and short-run elasticities with respect to PM are of course -0.22 and -0.05, respectively.[24] In comparing the estimates of coffee supply responsiveness we have obtained in this study with those listed in Table 6.2, one cannot help but note the relatively low value of the long-run elasticity we have calculated for Colombia. Although one cannot say for sure, the difference might be explained by the fact that our study covered a later period compared with the other studies and, consequently, our results may have been affected to a greater extent by ICO policies.

[24] These estimates are also very similar to those we obtained when we regressed the ratio of the price of output over the price of manufactured goods on area devoted to coffee in a standard Nerlovian forumulation. An estimated long-run elasticity of 0.134 was derived. Coffee yield was then regressed on price (only the price of coffee undeflated was significant) and an estimated elasticity of 0.097 was obtained. Summing the two we get a long-run output elasticity with respect to the producer price of coffee of 0.231 and an elasticity with respect to the price of manufactured goods of -0.134.

CHAPTER 7

MANUFACTURING SUPPLY RESPONSIVENESS

7.1 THE MODEL

It is proposed in this chapter to estimate aggregate supply responsiveness of Colombian factory manufacturing. Although the main focus of this study is on the effects of distortions in the TOT on the agricultural sector in Colombia, we must also be concerned with the impact on manufacturing output, incomes and employment if we are going to investigate the effects such distortions have had on income distribution and rural-urban migration.

Two different regression models will be employed in an attempt to obtain an indication of manufacturing supply responsiveness. The first involves the estimation of a gross output supply function as derived in equation (3.13), that is:

$$\hat{Q}_m = G(P_m, r_1, r_2, r_3, r_4, t) \qquad (7.1)$$

It will be recalled that r_1 and r_2 represent primary input or factor prices while r_3 and r_4 represent intermediate prices.

The second regression model involves the estimation of a value added supply function which may be derived from the profit maximizing first order conditions of the following constrained profit function:

$$\Pi_{VA}^{*} = \Pi_{VA} + \lambda_{VA} G^{*}(VA_m; Z_1, Z_2, T) \qquad (7.2)$$

where Z_1 and Z_2 represent the two primary inputs, capital and labour. In comparing (7.2) with equation (3.12), it will be noted that Z_3 and Z_4, the two intermediate inputs are dropped. Assuming the second order conditions are satisfied, we may solve for VA_m in terms of the price of value added (P_{VA}), the prices of the two primary factors, r_1 and r_2, and time, that is:

$$VA_m = G^* (P_{VA}, r_1, r_2, t) \tag{7.3}$$

It is assumed that both (7.1) and (7.3) are homogeneous of degree zero in all prices.

In the next section of this chapter (7.2) we examine the procedures followed in attempting to estimate factory manufacturing supply responsiveness as well as the sorts of econometric problems which arose in the regressions. In section 7.3, the specifications employed and the results of those which performed "best" according to criteria established in section 7.2 are recorded and discussed.

7.2 ESTIMATION PROCEDURES AND PROBLEMS

In estimating both the value added and gross output supply responsiveness of total factory manufacturing in Colombia, three basic regression techniques were employed: ordinary least squares, Cochrane-Orcutt iterative technique, and non-linear least squares. For some specifications of the supply function, an assumption was made that factory managers, in response to changes in price, are unable to adjust completely to "desired" output or value added levels in the current period.[1] This might be the result of bottlenecks with respect to imported inputs, skilled labour, etc..

[1] This is essentially the Nerlovian A-model derived in Chapter 4. In addition, under the assumption that in the long-run the level of capital stock might constrain the growth of value added or output, a number of specifications replace a measure of the rental rate of capital with the absolute level of the capital stock in each period. In doing this, we are re-interpreting the specification as a short-run supply function and as a result the estimated elasticities generated are short-run elasticities.

The value added specifications employed as regressors various combinations of the following variables:

1) the price of factory manufacturing value added at time t ($PVAM_t$);
2) the factory manufacturing money wage rate at time t (WM_t);
3) the rental rate on factory manufacturing capital stock at time t (VM_t);
4) a trend variable (T);
5) the value of factory manufacturing capital stock at time t in in constant 1958 Colombian pesos (KM_t).

The dependent variable (VAM_t) is the value of factory manufacturing value added at time t expressed in constant 1958 Colombian pesos. For VM_t, two series of data were calculated, denoted henceforth as VM_t^A and VM_t^B. Both series were employed as regressors. The regressions were based on 26 annual observations (1950-1975) when VM_t^A was used, and on 25 annual observations (1950-1974) when VM_t^B was used.

The regressors employed in the gross output specifications involve various combinations of the following variables:

1) WM_t, VM_t, T, and KM_t as defined above;
2) the price of factory manufacturing gross output at time t (PM_t);
3) the price of intermediate inputs used in factory manufacturing at time t (PMI_t);
4) the price of intermediate inputs originating in the agricultural sector at time t ($PMAI_t$);
5) the price of non-agricultural or "other" intermediate inputs at time t ($PMOI_t$).

The dependent variable is the value of gross output of factory manufacturing at time t expressed in constant 1958 Colombian pesos. All estimates of gross output responsiveness are based on 24 annual observations (1950-1973). In addition to the two data series on VM_t, two data series were also available on PM_t, PMI_t, and $PMOI_t$, denoted as with VM_t by the superscripts A and B.[2]

Since there was insufficient a priori information to choose amongst the alternative data sets, some experiments were conducted by running regressions on alternative data set combinations. From these, the "best" data series for each of the 4 sets in which 2 series existed was selected. The criteria for "best" is the data set which generated the highest value of the log of the likelihood function and the highest level of significance for the estimated coefficients.[3] In cases of conflict, a likelihood-ratio test was performed to determine the most appropriate data set.

The most serious econometric problem encountered throughout these estimations was that of autocorrelation. There was not one specification in which intertemporal correlation amongst the disturbances did not exist regardless of the data series employed or whether value added or gross output responsiveness was being estimated. Thus the ordinary least squares estimations are inefficient and, even worse, the formula for the standard error of the coefficients is no longer valid. However, autocorrelation was particularly serious with the value added specifications. The usual "correcting" procedures such as Cochrane-Orcutt iterative

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[2]The Data Appendix attached to this study provides information on how the two data series for each of these prices differ and on how VM_t^A and VM_t^B were calculated. Differences in the alternative data series were not large and in most cases did not involve all observations.

[3]Differences in the values of the log of the likelihood function for different data series were not large with a maximum range of about 5.0 between the highest and lowest values. Only PM_t^A was unambiguously superior to its alternative series, PM_t^B; that is, regardless of the specification, the use of PM_t^A always generated a significantly higher value of the log of the likelihood function and a higher level of significance for its estimated coefficient.

technique and non-linear least squares which the specification is adjusted to incorporate the existence of autocorrelation failed to produce a Durbin-Watson statistic which indicated an unambiguous absence of autocorrelation. In the case of the gross output specifications, the "correcting" techniques were able to generate a Durbin-Watson statistic which indicated an absence of auto-correlation.

A second econometric problem encountered in some of the gross output specifications was that of multicollinearity amongst the regressors. This was the result of a high degree of correlation between output price and intermediate input prices. The multicollinearity was particularly severe in those specifications in which $PMAI_t$ and $PMOI_t$ were included as separate regressors rather than as a single intermediate input price series, PMI_t. As will be seen in the next section, attempts to reduce the level of multicollinearity by experimenting with alternative deflators were made under the assumption that the supply functions are all homogeneous of degree zero in all prices.

7.3 SPECIFICATIONS AND RESULTS

We shall examine the value added supply regressions first.[4] In their generalized form, the value added specifications examined were the

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[4] An attempt was initially made to estimate a factory manufacturing value added production function using two different production specifications; the Cobb-Douglas and the CES. The results were exceedingly poor. Autocorrelation was so rampant that the only parameter which was statistically very significant was the estimated coefficient of autocorrelation. Its value approached one and had a t-statistic in excess of 100. In addition, estimated returns to scale in both production functions was about 1.5. Although some increasing returns to scale would *a priori* be expected, it would hardly be of the order suggested by the estimates. Finally, the estimated distribution of product amongst the primary inputs was reversed from one what one would normally expect and what empirical evidence indicates. No doubt a large part of the difficulty here could be attributed to the quality of the data.

following (ignoring the error term), with all variables defined as in Section 7.2:

$$(1)\quad VAM_t = F_1(PVAM_t, WM_t, VM_t)$$

$$(2)\quad VAM_t = F_2(PVAM_t, WM_t, VM_t, T)$$

$$(3)\quad VAM_t = F_3(PVAM_t, WM_t, KM_t)$$

All these specifications were estimated in both their linear and log-linear functional forms. It was assumed that all three are homogeneous of degree zero in all prices. WM_t was selected to deflate all price variables. In all respects, the log-linear functional form of the foregoing specifications was superior to the linear version. Based on the critieria defined in the previous section, the "best" performing of the three is (2), the results for which are given as follows:

$$(2)\quad \log VAM_t = \underset{(40.6)}{\log 862} + \underset{(2.49)}{0.176} \log (PVAM/WM)_t - \underset{(-2.39)}{0.080} \log (VM^A/WM)_t + \underset{(21.9)}{0.076}\, T$$

$$LLF = 62.92 \qquad R^2 = 0.999 \qquad DW = 1.163 \qquad \hat{RHO} = \underset{(6.38)}{0.787}$$

The estimated coefficients for both price (of value added) and the cost of capital are significant at the .025 level. The Cochrane-Orcutt iterative technique was employed here but non-linear least squares generated virtually identical results. Neither the A-model when applied to the above nor the use of VM^B_t rather than VM^A_t as a regressor were capable of yielding results superior to those produced by the above. However, the estimates of the price coefficient were similar to that produced in the foregoing specification.

Two problems remain with the results of the above regression. The first is the fact that one would like to see less of the growth of value added over time being explained by a trend variable. Secondly, the Durbin-Watson statistic, after correction for autocorrelation, was also tested for autocorrelation with inconclusive results.

In comparing specification (2); the one we have been examining up till now, with the first specification in which the trend variable is suppressed, three comments are warranted.[5] First, the inclusion of trend variable as a regressor significantly improves the performance of the estimates. Secondly, the level of autocorrelation in specification (1) appears to be even more serious than in specification (2). Finally, the suppressing of the trend variable did not alter significantly the estimated values of the remaining coefficients except for the constant.

Turning now to output responsiveness, the following specifications were initially examined in both their linear and log-linear functional forms:

$$(1) \quad QM_t = G_1(PM_t, WM_t, VM_t, PMI_t)$$

$$(2) \quad QM_t = G_2(PM_t, WM_t, VM_t, PMI_t, T)$$

$$(3) \quad QM_t = G_3(PM_t, WM_t, VM_t, PMAI_t, PMOI_t)$$

$$(4) \quad QM_t = G_4(PM_t, WM_t, VM_t, PMAI_t, PMOI_t, T)$$

Specification (1) includes a series on the price of intermediate inputs as does (2) plus a trend variable. Specification (3) breaks down PMI_t into two series of intermediate input prices (agricultural and "other"

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[5]Specification (3) did not perform as well as either (1) or (2). Moreover, the estimated coefficient of KM_t was incorrect in sign although not significant. However, the estimated value of the price coefficient was reasonably close to those yielded by specifications (1) and (2).

inputs) while (4) adds a trend variable to specification (3).[6] Unlike the value added regressions, the linear functional form performed significantly better here.

Assuming the supply function is homogeneous of degree zero in all output and input prices, each of the above specifications was initially deflated by WM_t, the money wage rate. However, the results were disappointing largely as a result of the multicollinearity among the output and input price regressors. Great difficulty was encountered in obtaining an acceptable level of significance for the estimated coefficients. Consequently, it was decided to deflate with an input price series (PMI_t in the first two specifications and $PMOI_t$ in the second two). This action led to an improvement in both the overall fit and the significance of the estimates. From the criteria established in the previous section, output specification (2) generated the most acceptable results.

$$(2)\quad \underset{}{QM_t} = \underset{(-2.47)}{-4625} + \underset{(2.73)}{4700.2}\,(PM^A/PMI^B)_t - \underset{(-3.34)}{22016.0}\,(WM/PMI^B)_t$$

$$- \underset{(-0.03)}{95.5}\,(VM^B/PMC^B)_t + \underset{(13.1)}{1302.4}\,T$$

$$LLF = -169.3 \qquad R^2 = 0.997 \qquad DW = 2.025 \qquad \hat{RHO} = \underset{(6.45)}{0.802}$$

The estimated coefficients for price of output and the wage rate are significant at the .01 and .005 level, respectively. The constant is

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[6] An additional specification was tested in which the cost of capital (and the trend variable) was replaced by KM_t, as in value added specification (3). The results were, however, distinctly inferior and the estimated coefficient for KM_t was consistently negative but not significant. The use of A-model on all specifications produced significantly inferior results. Either convergence to minimum SSR proved impossible, or the estimated value of A, the adjustment coefficient, was negative and/or the estimated coefficients were incorrect in sign and/or not significant.

significant at the .025 level. However, the estimator for the user cost of capital is not significant at all, although it is of the correct sign.[7] The non-linear least squares estimate of the same specification provided a virtually identical set of estimates for the coefficients. The inclusion of a trend variable in (2) significantly improved the estimates as well as reducing the level of autocorrelation.

In specification (3) and (4), the problem of multicollinearity crept back in. As a result, most of the estimated coefficients had an unacceptable level of significance (except for the trend variable and $\hat{RHO}$) and at least one had an a priori incorrect sign. These disappointing results occurred regardless of whether the supply functions were deflated by WM_t or $PMOI_t$. An average elasticity of output supplied with respect to PM_t^A (holding the deflator, PMI_t^B, constant) as calculated from specification (2) is 0.4275.

In an effort to improve the estimates of gross output responsiveness, an attempt was made to separate the coffee-threshing sub-sector from the rest of factory manufacturing and to run two sets of regressions; one for coffee-threshing and one for other manufacturing.[8] Unfortunately, preliminary estimations on a number of specifications were not encouraging. The results were distinctly inferior compared with those of manufacturing as a whole. The estimated coefficients were either not significant at

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[7] The same specification was run but with VM_t^B suppressed. This resulted in virtually no change in the estimated values of the remaining coefficients and in their respective levels of significance.

[8] The relative importance of coffee threshing in manufacturing (it is a 4-digit sub-sector of the 2-digit food sector) has been declining over time from about 17.5 percent of the real value of manufacturing output in 1950 to less than 5 percent in 1973. However, between 1950 and 1960 it did account for an average of 15 percent of the value of manufacturing output in real terms, and somewhat less in money terms.

an acceptable level or had a priori incorrect signs.

Only the log version of the value added specifications and the linear version of the gross output specifications produced acceptable estimates for the parameters. The choice between the two as to the more appropriate regression model was dictated solely by the criteria of which model best met the needs of this study. Given the objective and concerns of this thesis, the gross output regression model was the more appropriate. In addition, as will be seen in the next chapter, available data on price distortions in the Colombian economy are expressed in terms of the price of output and not in terms of the price of value added. Regardless of which regression model is the more appropriate, however, the results obtained here do indicate that Colombian manufacturing as a whole does respond positively, through inelastically, to appropriate price incentives.

CHAPTER 8

IMPACT OF TOT DISTORTIONS ON SECTORAL OUTPUT, EMPLOYMENT AND INCOMES

8.1 INTRODUCTION

We are now in a position to examine the effects that distortions in the terms of trade have had on agricultural and manufacturing output, employment and factor incomes. In the next section (8.2), we shall calculate the impact of distorted relative prices on the output of the i^{th} crop and livestock-derived products as well as on aggregate agricultural output. In the next two sections (8.3) and (8.4), we continue as in the previous section but with respect to agricultural employment and incomes, respectively. Finally, in section (8.5), we calculate the effects of price distortions on manufacturing output, employment, and factor incomes.

8.2 IMPACT ON AGRICULTURAL OUTPUT

Our objective here is to compare the output of the i^{th} crop and livestock-derived products which would have been forthcoming in 1962 and 1969 if farmers in Colombia had faced a terms of trade expressed in world prices with the output actually produced in response to distorted domestic relative prices. We may begin by summarizing the distortions in agricultural commodity prices calculated in Chapter two in the following tables:

TABLE 8.1

DISTORTIONS IN AGRICULTURAL COMMODITY PRICES EXPRESSED AS A PERCENTAGE OF WORLD PRICE OVER DOMESTIC PRICE

COMMODITY	ESTIMATED CROP PRICE DISTORTIONS LOW	AVERAGE	HIGH
Aggregate non-coffee crops	–	13.8[1]	–
Corn	–	-30*	–
Cotton	0	10	20
Panela	0	10	20
Platano	0	10	20
Potatoes	–	0	–
Rice	0	-10*	-20*
Yucca	10	15	20
Livestock-derived products	–	0	–
Coffee	0	–	61.5

*Percentage excess of domestic price over the world price.

Low, average, and high estimates of the level of commodity price distortions are given for those crops where data limitation prevent the derivation of a single reasonably accurate figure. For the other commodities, except coffee, the distortion level is given under the average column. In the case of coffee, the distortion appearing under the low column applies to the presumption that the gap between the world and domestic price is solely the consequence of a desire for monopoly power in trade. The distortion appearing under the high column reflects of course the opposite.

Table 8.2 gives the estimated distortions in the terms of trade faced by producers of each commodity for the years 1962 and 1969. It will be recalled from Chapter two that the estimated distortions in the price of manufactured goods for the two years are -100 percent and -47 percent, respectively.

[1]This is the estimated short-run difference between the world price and the domestic price for non-coffee crops in the aggregate based on De Melo's results. The corresponding long-run excess of the world price over the domestic price was 9.8 percent.

TABLE 8.2

ESTIMATED DISTORTIONS IN THE TERMS OF TRADE EXPRESSED AS A PERCENTAGE OF THE TERMS OF TRADE IN WORLD PRICES OVER THE TERMS OF TRADE IN DOMESTIC PRICES

	1962			1969		
COMMODITY	LOW	AVERAGE	HIGH	LOW	AVERAGE	HIGH
Aggregate non-coffee crops	–	113.8[2]	–	–	60.8[2]	–
Corn	–	70	–	–	17	–
Cotton	100	110	120	47	57	67
Panela	100	110	120	47	57	67
Platano	100	110	120	47	57	67
Potatoes	–	110	–	–	47	–
Rice	100	90	80	47	37	27
Yucca	110	115	120	57	62	67
Livestock-derived products	–	100	–	–	47	–
Coffee	100	–	161.5	47	–	108.5

The elasticities estimated for the aggregate and individual non-coffee crops can be found in Table 4.3. The estimated supply responsiveness of livestock raisers and coffee growers is summarized in Table 8.3:

TABLE 8.3

ESTIMATED RESPONSIVENESS OF LIVESTOCK RAISERS AND COFFEE GROWERS

	ELASTICITY WITH RESPECT TO PRICE OF OUTPUT		ELASTICITY WITH RESPECT TO PM	
	SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN
Livestock-derived products	0.126	1.415	-0.126	-1.193
Coffee	0.050	0.220	-0.050	-0.220

The percentage increase in output of the various agricultural commodities which would have been forthcoming if producers had faced relative

[2] The corresponding long-run distortions are 109.8 for 1962 and 56.8 for 1969. See the previous footnote.

prices expressed in world prices rather than domestic prices can be calculated by substituting the various elasticity estimates and price distortion estimates into equation (3.18). The results will reflect the agricultural output lost as a result of the gap between world and domestic prices in Colombia. Table 8.4 presents the calculations for 1962 while Table 8.5 pertains to 1969. It will be noted that each table has six columns. The first three show the short-run increase in output (based on the short-run elasticity estimates) for the three estimates of relative price distortions, while the second three show the long-run increase in output (based on the long-run elasticity estimates).

TABLE 8.4

PERCENTAGE INCREASE IN OUTPUT OF THE ith CROP AND LIVESTOCK-DERIVED PRODUCTS IF FARMERS HAD FACED WORLD RATHER THAN DOMESTIC PRICES, 1962

	SHORT-RUN			LONG-RUN		
COMMODITY	LOW	AVERAGE	HIGH	LOW	AVERAGE	HIGH
Aggregate non-coffee crops[3]	-	29.8	-	-	34.6	-
Corn	-	14.5	-	-	39.6	-
Cotton	109.7	120.7	131.6	200.2	220.2	240.2
Panela	8.3	9.1	10.0	8.3	9.1	10.0
Platano	15.4	17.2	19.0	15.4	17.4	19.9
Potatoes	-	24.1	-	-	24.1	-
Rice	19.9	17.9	15.9	19.9	17.9	15.9
Yuçca	-14.4	-14.9	-15.4	29.8	31.9	33.9
Livestock-derived products	-	12.6	-	-	119.3	-
Coffee	5.0	-	8.1	22.0	-	35.5

[3] Although the results of the effect on aggregate non-coffee output based on our estimated elasticity of total non-coffee response and the distortions calculated from De Melo's results are presented in both Tables 9.4 and 9.5, they play no role in the calculation of the total agricultural output lost as a result of distorted terms of trade, but rather are presented as a point of comparison only.

TABLE 8.5

PERCENTAGE INCREASE IN OUTPUT OF THE ith CROP AND LIVESTOCK-DERIVED PRODUCTS IF FARMERS HAD FACED WORLD RATHER THAN DOMESTIC PRICES, 1969

COMMODITY	SHORT-RUN LOW	SHORT-RUN AVERAGE	SHORT-RUN HIGH	LONG-RUN LOW	LONG-RUN AVERAGE	LONG-RUN HIGH
Aggregate non-coffee crops	-	15.9	-	-	17.9	-
Corn	-	-2.9	-	-	3.1	-
Cotton	51.6	62.6	73.5	94.1	114.1	134.1
Panela	4.0	4.8	5.7	4.0	4.8	5.7
Platano	7.2	9.0	10.8	7.2	9.5	11.7
Potatoes	-	11.3	-	-	11.3	-
Rice	9.4	7.4	5.4	9.4	7.4	5.4
Yucca	-7.3	-7.8	-8.3	16.1	20.1	24.2
Livestock-derived products	-	6.0	-	-	56.1	-
Coffee	2.4	-	5.4	10.3	-	23.9

For ease of analysis let us confine our discussion here as well as any future calculations to the figures which appear in the "average" column only. The figures in Tables 8.4 and 8.5 showing the percentage short-run and long-run loss of output in 1962 and 1969 as a result of distortions in the terms of trade faced by agricultural producers in Colombia are straight forward.[4] Only the short-run and long-run effects on the output of cotton and coffee and the short-run effects on yucca output warrant specific comment. The enormous losses in cotton output

[4]For example, in Table 8.4, we observe a short-run impact for corn of 14.5 percent. This figure indicates that corn output initially would have been 14.5 percent higher than it actually was if corn growers had been in a position to make their supply decisions in response to a terms of trade which reflected world prices rather than domestic prices. Alternatively, the 14.5 percent could be read as the corn production foregone due to trade restricting import substitution policies.

(for example, if in 1962 cotton growers had faced terms of trade expressed in world prices, output in the long-run would have been over triple what it actually was) is largely due to the high value of the elasticity coefficient estimated for cotton. The fact that yucca output declines in the short-run is a result of the negative elasticity estimate we obtained for yield response which outweighed the short-run positive area response. The low and high figures for coffee correspond, of course, to the two different assumptions we made about the cause of the gap between the world and domestic price of coffee. The differences in the low and high long-run figures are quite significant. In future calculations we shall emphasize the assumption of zero price distortion and confine our comments on the effects of the assumption of a 61.5 percent distortion to footnotes.

Table 8.6 translates the percentage change data in Tables 8.4 and 8.5 into the levels of output that would have been produced ("potential" output) if growers had been in a position to trade directly with the outside world.[5]

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[5]Since we are primarily interested in obtaining an indication of the impact of price distortion on total agricultural output, we must take into consideration the "other" non-coffee crops. "Other" non-coffee crops accounted for 42.9 and 39.3 percent of aggregate non-coffee output in 1962 and 1969, respectively, or 18.4 and 17.9 percent of total agricultural output in 1962 and 1969, respectively. In the absence of data on elasticities and price distortions, it shall be assumed that the effect on the output of "other" non-coffee crops is equal to the weighted average effect of the seven non-coffee crops which played a direct role in this study.

TABLE 8.6

ACTUAL OUTPUT AND "POTENTIAL" OUTPUT, 1962 AND 1969 (ALL FIGURES EXPRESSED IN MILLIONS OF CONSTANT COLOMBIAN PESOS)

	1962			1969[6]		
COMMODITY	ACTUAL	SHORT-RUN POTENTIAL	LONG-RUN POTENTIAL	ACTUAL	SHORT-RUN POTENTIAL	LONG-RUN POTENTIAL
Non-coffee crops:						
Corn	306	350	427	379	368	391
Cotton	338	746	1082	516	839	1105
Panela	326	356	356	417	437	437
Platano	297	348	349	365	398	400
Potatoes	323	401	401	375	417	417
Rice	366	432	432	589	633	633
Yucca	156	136	206	173	160	208
Other	1589	2083	2447	2023	2338	2581
Total of non-coffee crops[7]	3701	4852	5700	4837	5590	6172
Livestock-derived products[8]	2868	3230	6290	3562	3773	5560
Coffee	2057	2160	2510	2135	2186	2355
TOTAL	8626	10242	14500	10584	11549	14087

[6] Although the year 1969 appears here, the actual or base year output for the seven non-coffee crops is 1968. The reason for this can be found in one of those data quirks in which one observation happens to be missing. This happens to be 1969 and it applied to the seven non-coffee crops only. Since total non-coffee crop output in 1969 was known as was livestock and coffee output then the difference between the 1968 output and the 1969 output figures for the seven individual non-coffee crops would be absorbed by "other" non-coffee crops. As a result of the assumption made in footnote 5, it was felt that we would not cause an undue distortion by using 1968 output data for the seven crops.

[7] According to Table 8.6, total non-coffee crops in 1962 and 1969 have increased in the short-run by 31.1 and 15.6 percent, respectively, and in the long-run by 54.0 and 27.6 percent, respectively. The corresponding short-run figures derived when the elasticity estimated from the aggregate non-coffee crop response model was used coupled with the distortions based on De Melo's results are 29.8 and 15.9 percent, respectively, while the corresponding long-run figures are 34.6 and 17.9 percent, respectively. A close similarity in the short-run impact on output should be noted. This is the result of similarities in the short-run elasticity based on the aggregate model and in the weighted average short-run elasticity of the seven crops. See Table 4.5. Similarily, the divergence in the long-run impact on output is mainly the result of the higher value of the weighted average elasticity of the seven crops.

[8] The 1962 short-run and long-run "potential" outputs under the assump-

The overall impact of relative price distortion on total agricultural output may now be calculated. If the agricultural sector as a whole in Colombia had faced in 1962 a set of relative prices expressed in world values, total agricultural output would have been 18.7 percent higher than it actually was in the short-run and 68.1 percent higher in the long-run. The corresponding figures for 1969 are 9.1 and 33.1 percent, respectively.[9] The difference between "potential" and actual outputs in the two years is, of course, a reflection of the agricultural output lost to the economy as a result of distortions in relative agricultural and manufacturing prices. The question is, of course, whether the cost in terms of foregone agricultural output is more than made up for by the benefits of the additional output produced in a manufacturing sector enlarged by trade restricting, price distorting policies.

Before moving on to the effects on agricultural employment, it would be worthwhile to glance at the commodities whose output have been most affected by the distortions in relative prices. Table 8.7 presents a ranking of the more important commodities in terms of their "potential" contribution. The figure appearing beside the commodity represents its "potential" percentage contribution to the long-run increase in total agricultural output that would have been forthcoming in absence of distortions in the terms of trade.

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tion that the gap between the world and domestic price of coffee represents a "true" distortion are 2224 and 2787, respectively. The corresponding 1969 figures are 2250 and 2645, respectively.

[9] If we had used 61.5 percent as the measure of the distortion in the price of coffee, total agricultural output in 1962 would have been 19.5 percent higher in the short-run and 71.3 percent higher in the long-run. The corresponding 1969 figures would have been 9.7 and 35.8 percent, respectively.

TABLE 8.7

"POTENTIAL" CONTRIBUTION TO TOTAL AGRICULTURAL OUTPUT, 1962

COMMODITY RANKING	PERCENT CONTRIBUTION TO TOTAL LONG-RUN "POTENTIAL" OUTPUT INCREASE
Livestock-derived products	57
Cotton	12
Coffee	8
All other non-coffee crops	23

As can be readily seen, the relative contribution to agricultural output growth in response to the removal of distortions in relative prices are highly unequal. Livestock-derived products would contribute more than half of the increase while cotton alone which accounted for only 4 percent of total agricultural output in 1962 would contribute 12 percent or 36 percent of the total contribution of all non-coffee crops. Coffee's contribution of 8 percent compared with the 20 percent share it had in agricultural output in 1962, reflects its declining role in Colombian agriculture.

8.3 IMPACT ON AGRICULTURAL EMPLOYMENT

In the normal course of events, one would be able to estimate from the profit maximizing first order conditions with respect to labour employment, that is, equation (3.22), the impact of agricultural employment stemming from the changes in output which would occur as a result of the removal of relative price distortions. In the absence of production functions for the various crops, however, we are forced to resort to the assumption that employment and output are related through fixed input coefficients, that is:

$$E_{it} = b_i Q_{it} \tag{8.1}$$

where b_i is the level of labour employment per unit of output of the i^{th} crop.[10]

Taking the differential of (8.1), we have:

$$dE_{it} = b_i dQ_{it} \tag{8.2}$$

We may define dE_{it} as $\bar{E}_{it} - E_{it}$ and dQ_{it} as $\bar{Q}_{it} - Q_{it}$ where the bars again reflect the levels of employment and output that would have been forthcoming if farmers had responded to world rather than domestic relative prices. Since $\bar{Q}_{it}$ has already been estimated in the previous section, then all that is required is an indication of output per unit of labour employed for each and every crop, the reciprocal of which is, of course, b_i.

Unfortunately, very little data is available on labour productivity in Colombian agriculture, although data on output per hectare abounds. In fact, no data exists on output per unit of labour employed on a crop by crop basis. As a consequence, we have had to resort to an indirect way of obtaining an indication of average labour productivity. We begin with the data which is available and this consists of: (1) output per unit of labour employed for the agricultural sector as a whole plus output per unit of labour employed according to the size of the farm; (2) the distribution of farm size according to the crop cultivated; (3) the number of hired and family workers according to size of farm; and (4) qualitative data on the

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[10] The assumption of a constant labour-output ratio over time used here may require some justification. If we assume that output per worker is mainly a function of the degree of mechanization and the level of modern input usage, then for most crops the assumption of a constant b_i would not be excessively burdensome. However, in the case of cotton, rice and perhaps potatoes, the assumption of a constant b_i would most likely not be appropriate. Nonetheless, the paucity of data on output per worker in Colombian agriculture forces us to make this assumption. In effect, available data allowed us to calculate only one b_i applicable to the early 1960's.

crops which tend to be mechanized and vice versa and on the crops which tend to be relatively intensive in labour usage and vice versa. These four sets of data enabled us to calculate what seems to be a reasonable and acceptable estimate of output per unit of labour employed, and hence b_i, for each crop. More specifically, the calculation of output per unit of labour employed for the different crops commenced with the adjusting of the data on the distribution of farm size according to the crop cultivated with the data on the number of hired and family workers according to the size of the farm. The former data only gives the number of farms of different sizes which produce the various crops. The latter data is an attempt to translate the former into the number of workers on farms of different sizes which produce the various crops. This adjusted data was then combined with the data on output per unit of labour employed according to farm size. A weighted average output per worker was calculated for each crop adjusted to take into account of the fact that the distribution of farm sizes and hence workers varies according to the crop cultivated. However, the adjusted average labour productivity calculated is based solely on national average output per unit of labour employed. Thus two further adjustments were felt warranted. The first is based on the extent of mechanization of the crop in question.[11] A second adjustment was made according

[11] Available data indicated that average output for mechanized crops is 90% above the national average while average output for non-mechanized crops is half the national average. Thus output per unit of labour employed for the mechanized crops (cotton and rice) were increased by a factor of 1.9 while that for the non-mechanized crops (panela, platano and yucca) were reduced by a factor of 0.5. Output per unit of labour employed was not adjusted for the two semi-mechanized crops, corn and potatoes. In addition, no adjustment was made for the extent of mechanization in the case of coffee and livestock.

to labour usage in the cultivation of the different crops.[12] The results are given in the following table:

TABLE 8.8

OUTPUT PER UNIT OF LABOUR EMPLOYED AND ITS RECIPROCAL, b_i: 1960

COMMODITY	VALUE OF OUTPUT PER WORKER IN CONSTANT PRICES	b_i
Non-coffee crops:		
Corn	4,314	.000232
Cotton	12,967	.000077
Panela	2,062	.000485
Platano	4,065	.000246
Potatoes	2,461	.000406
Rice	12,498	.000080
Yucca	1,890	.000529
Livestock-derived products	12,544	.000080
Coffee	3,168	.000315

The short-run and long-run $\overline{E}_{it} - E_{it}$ for each crop and for livestock-derived products for the years 1962 and 1969 are given in Table 8.9. We shall maintain the same assumption about "other" non-coffee crops regarding employment changes as we did for the changes in output (see footnote 5 in this chapter). A negative sign indicates a decrease in employment.

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[12]The crops were somewhat arbitrarily divided into 5 classifications according to labour usage: heavy, above average, moderate or average, below average and light. It was then arbitrarily assumed that crops which were heavy labour users employed 50 percent more workers than the average, above average user of labour employed 25 percent more, below average user 25 percent less, and light users of labour employed half of the average. Qualitative data indicated that potato cultivation involves heavy labour usage; coffee and yucca above average labour usage; rice, panela and corn average labour usage; cotton below average usage; and platano and livestock light labour usage. Thus the adjusted average output calculated above was further adjusted by reducing it by factors of 0.66 and 0.8 in the cases of heavy and above average users of labour and by increasing it by factors of 1.25 and 1.50 in the case of below average users of labour.

TABLE 8.9

THE CHANGES IN THE LEVEL OF LABOUR EMPLOYMENT IN THE AGRICULTURAL SECTOR THAT WOULD HAVE BEEN FORTHCOMING IF AGRICULTURAL OUTPUT HAD BEEN PRODUCED IN RESPONSE TO WORLD RELATIVE PRICES, 1962 AND 1969

	1962		1969	
COMMODITY	SHORT-RUN CHANGE IN EMPLOYMENT	LONG-RUN CHANGE IN EMPLOYMENT	SHORT-RUN CHANGE IN EMPLOYMENT	LONG-RUN CHANGE IN EMPLOYMENT
Non-coffee crops:				
Corn	10,200	23,432	-2,552	2,784
Cotton	31,415	57,288	24,794	45,353
Panela	14,550	14,550	9,700	9,700
Platano	12,546	12,792	8,118	8,610
Potatoes	31,668	31,668	17,152	17,052
Rice	5,280	5,280	3,520	3,520
Yucca	-10,580	26,450	-6,877	18,515
Other	71,727	128,595	34,940	68,597
Total non-coffee crops	166,805	300,055	88,695	174,131
Livestock-derived products	28,960	273,760	16,880	159,840
Coffee	32,445	142,695	16,065	69,300
TOTAL	228,210	716,510	121,640	403,301

Given that the levels of total agricultural employment in 1962 and 1969 were 2,447,000 and 2,644,000 respectively, then the 1962 short-run and long-run total changes in employment would have reflected a 9.3 percent and a 29.3 percent increase in labour usage, respectively, if farmers in Colombia had been in a position to trade directly with the outside world. The corresponding 1969 increases in employment reflect a 4.6 percent and 15.3 percent rise in the ability of the agricultural sector to absorb farmers into productive employment.[13] Unlike the changes in output that

[13]The 1962 short-run and long-run changes in agricultural employment under the assumption that the distortion in coffee prices was 61.5 percent reflect a 10.1 and a 32.8 percent increase in total labour usage, respectively. The corresponding 1969 increase would have been 5.4 and 18.7 percent, respectively.

would be forthcoming at world prices, it will be noted that the relative contributions of the three major sub-sectors (non-coffee crops, livestock, and coffee) to the long-run improvements in labour employment reflect their relative importance to Colombian agriculture, although there are some large differences among the contributions of individual non-coffee crops. The differences in the relative contribution of the various commodities to output and to employment are, of course, the result of the fact that there are significant differences in the quantities of labour employed per unit of output among different commodities. In any event, it can be clearly seen that the employment opportunities lost as a result of trade restricting policies which turn the internal terms of trade against Colombia's agricultural sector are not insignificant.

8.4 THE IMPACT ON AGRICULTURAL INCOMES

The effects of distortions in relative agricultural and manufacturing prices on the incomes of those who earn their living in the agricultural sector can be estimated by substituting into equation (3.26) the size of the distortions facing the cultivators of each crop. Initially, however, we should like to calculate the impact on nominal agricultural incomes. This necessitates re-writing equation (3.26) as follows:

$$\bar{Y}_{it} - Y_{it} = (1-\sum_{j=g}^{r-1} a_{ij})\, P_{it} Q_{it} (1 + E_{ii})\, \dot{P}_{it} \qquad (8.3)$$

Given data on a_{ij}[14] and E_{ii}, the percentage short-run and long-run impact

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[14] Available data on intermediate input coefficients is highly aggregated. Typically during the 1960's the coefficients for non-coffee crops, livestock-derived products and coffee averaged 0.15, 0.14 and 0.03, respectively. However, there did not seem to be any specific data on the input coefficients for individual non-coffee crops. Consequently, we had to resort mainly to qualitative data on intermediate input usage, although some data on the percentage of area planted in different crops which were

on the nominal incomes of growers of the i^{th} crop and livestock-derived products for the year 1962 and 1969 is provided in Table 8.10.

TABLE 8.10

THE PERCENTAGE IMPACT ON NOMINAL INCOMES OF THE REMOVAL OF DISTORTIONS IN THE INTERNAL TERMS OF TRADE, 1962 AND 1969

COMMODITY	1962 SHORT-RUN % CHANGE	1962 LONG-RUN % CHANGE	1969 SHORT-RUN % CHANGE	1969 LONG-RUN % CHANGE
Non-coffee crops:				
Corn	-16.9	9.6	-32.6	-27.2
Cotton	104.5	184.2	60.1	101.3
Panela	18.1	18.1	14.6	14.6
Platano	25.8	25.8	18.6	19.1
Potatoes	18.1	18.1	8.5	8.5
Rice	6.3	6.3	-4.1	-4.1
Yucca	.0	44.5	7.6	34.1
Livestock-derived products	10.8	102.6	5.2	48.2
Coffee[15]	5.0	22.0	2.4	10.3

Those farmers whose nominal incomes would increase the most in the long-run as a result of trading at world prices rather than domestic prices

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inorganically fertilized was availble. We subdivided the level of input usage into six somewhat arbitrary classifications: heavy, moderately heavy, moderate (average), some, very little, and none. Input coefficients of 0.25, 0.20, 0.15, 0.10, 0.05, and 0.00, respectively, were assigned to each of the classifications. From the available qualitative (see Table 4.1) and quantitative data, potatoes are heavy employers of intermediate inputs (0.25), cotton and rice are moderately heavy users (0.20), corn uses some inputs (0.10), while panela, platano and yucca use very little in the way of intermediate inputs (0.05). The weighted average coefficient is 0.138, which is very close to the aggregate figure of 0.15 given above.

[15] The percentage changes in the 1962 nominal incomes of coffee growers under the assumption that none of the gap between the world and domestic price of coffee is the result of policies designed to attain monopoly power would have been 69.4 percent in the short-run and 95.9 percent in the long-run. The corresponding 1969 figures would have been 66.7 and 84.7 percent, respectively. It is with respect to the effects on nominal incomes of coffee cultivators that the greatest difference occurs depending on the interpretation assigned to the gap between domestic and world coffee prices.

are generally those farmers who grow crops whose output would increase the most. The data in the foregoing table can be translated into the levels of nominal incomes that would have been enjoyed by Colombian farmers in 1962 and 1969 in the absence of the distorted internal terms of trade that they faced in making their output decisions. This is done in Table 8.11. As previously, we shall assume that the nominal incomes of growers of "other" non-coffee crops would have increased at the same rates as the weighted average of the seven non-coffee crops considered in detail in this study.

TABLE 8.11

ACTUAL AND "POTENTIAL" NOMINAL INCOMES EXPRESSED IN MILLIONS OF CURRENT COLOMBIAN PESOS, 1962 AND 1969

	1962			1969		
COMMODITY	ACTUAL	SHORT-RUN POTENTIAL	LONG-RUN POTENTIAL	ACTUAL	SHORT-RUN POTENTIAL	LONG-RUN POTENTIAL
Non-coffee crops:						
Corn	376	322	412	1273	960	1000
Cotton	322	658	915	1275	2041	2566
Panela	335	396	396	942	1079	1079
Platano	451	567	567	1188	1409	1415
Potatoes	191	226	226	832	903	903
Rice	358	381	381	1655	1590	1590
Yucca	250	250	361	825	868	1106
Other	1675	2054	2390	6885	7642	8324
Total non-coffee crops	3958	4854	5648	14875	16512	17983
Livestock-derived products	3327	4385	6740	10732	11290	15905
Coffee	1827	1918	2229	4370	4475	4820
TOTAL	9112	11207	14617	29977	32277	38708

Total nominal income lost to the agricultural sector in 1962 as a result of distortions in relative prices is calculated to have been Col $2,095,000,000 in the short-run and Col $5,505,000,000 in the long-run.

The corresponding income losses in 1969 are Col $2,300,000,000 and Col $8,731,000,000, respectively.[16] The long-run 1969 agricultural income lost represents approximately U.S. $436,000,000, at the existing exchange rate, or U.S. $165.00 per agricultural labour force member.

The effects on agricultural "real" incomes (agricultural purchasing power over manufactured goods) as a result of distortions in the TOT may be calculated from equation (3.26). For the agricultural sector as a whole in 1962, it would have potentially been able in the short-run to purchase 75.0 percent more manufactured goods in the absence of relative price distortions. The 1962 long-run figure is 131.3 percent while the corresponding 1969 short-run and long-run figures are 26.1 and 58.9 percent, respectively. These percentage figures reflect a real loss to the agricultural community in Colombia of manufactured goods that it potentially could have enjoyed but did not because of trade restricting policies which forced it to trade at distorted relative prices.

8.5 THE IMPACT ON THE MANUFACTURING SECTOR

The effect on manufacturing output in 1962 and 1969 of distortions in commodity prices would normally be calculated directly from equation (3.29). However, in Chapter 7, the price elasticity of output was estimated with respect to the of price output deflated by a price index of all intermediate inputs employed in manufacturing. Thus, equation

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[16] In terms of percentage, total 1962 farm nominal income (or value added generated by the agricultural sector in current prices) in the short-run would have been 23.0 percent higher in the absence of distortions in relative prices while in the long-run the increase would have been 60.4 percent. The corresponding 1969 short-run and long-run increase in total farm nominal income would have been 7.7 and 29.1 percent, respectively. The 1962 figures assuming a 61.5 percent distortion in coffee prices would have been 35.4 and 75.2 percent, respectively. The corresponding 1969 figures would have been 17.0 and 40.0 percent, respectively.

(3.29) must be modified to take this into account. This can be done as follows:

$$\bar{Q}_{mt} - Q_{mt} = Q_{mt} \left(e_m \dot{P}_{mt} + e_I \alpha \dot{P}_{at}\right) \tag{8.4}$$

where e_I is the elasticity of output with respect to the price of all intermediate inputs and α is the ratio of agricultural sector originating inputs to total intermediate inputs employed in manufacturing. Input-output data indicate that α is 0.27. Of the agricultural commodities whose gaps between world and domestic prices were estimated in this study only three; namely, coffee, livestock and cotton, enter into manufacturing in sufficient quantities to merit separate consideration. For simplicity, therefore, we may define:

$$\alpha \dot{P}_{At} = \alpha_1 \dot{PC}_t + \alpha_2 \dot{PL}_t + \alpha_3 \dot{PCOT}_t \tag{8.5}$$

where the α's indicate the proportion of total agricultural intermediate inputs which are coffee, livestock and cotton, respectively, and the "dotted" prices are the percentage changes in the prices of coffee, livestock, and cotton, respectively, which would be forthcoming upon the removal of price distortions. According to input-output information, $\alpha_1 = 0.12$, $\alpha_2 = 0.12$, $\alpha_3 = 0.03$. Recalling that $\dot{PC}_t = 0$, $\dot{PL}_t = 0$, and $\dot{PCOT}_t = .10$, appropriate substitution into (8.5) gives a value to $\alpha \dot{P}_{mt}$ of 0.003.[17]

In Chapter 7, we estimated a sample average elasticity of manufactur-

[17] In view of this low value for αP_{At}, we shall assume it not to be significantly different from zero. If, on the other hand, we had presumed $\dot{PC}_t = 0.615$, then $\alpha \dot{P}_{At}$ would have had a value of 0.0768.

ing gross output with respect to the ratio of the price of output to that of total intermediate inputs of 0.4275. Thus from equation (8.4), e_m = 0.4275 and e_I = 0.4275. Substituting into equation (8.4), a value of $\dot{P}_{mt}$ of -1.00 for 1962 and -0.47 for 1969, where $\dot{P}_{mt}$, of course, is the percentage difference in the domestic price of manufactured goods over the world price, we can easily derive the impact on manufacturing output of distortions in relative commodity prices. In 1962, manufacturing output was estimated to be 42.75 percent above what it would have been in the absence of trade restricting policies which raised the domestic price of manufactured goods above the world price and lowered the price of many agricultural commodities below the world price. The corresponding figure for 1969 was calculated to be 20.1 percent.[18] The following table shows the effects of price distortions in 1962 and 1969 on output and the value of output.

TABLE 8.12

THE IMPACT OF PRICE DISTORTIONS ON MANUFACTURING OUTPUT AND THE VALUE OF MANUFACTURING OUTPUT, 1962 AND 1969

YEAR	ACTUAL OUTPUT IN MILLIONS OF CONSTANT COLOMBIAN PESOS	UNDISTORTED OUTPUT IN MILLIONS OF CONSTANT COLOMBIAN PESOS	DIFFERENCE IN MILLIONS OF CONSTANT COLOMBIAN PESOS	ACTUAL VALUE OF OUTPUT IN MILLIONS OF CURRENT COLOMBIAN PESOS	UNDISTORTED VALUE OF OUTPUT IN MILLIONS OF CURRENT COLOMBIAN PESOS	DIFFERENCE IN MILLIONS OF CURRENT COLOMBIAN PESOS
1962	13468	9435	-4033	16202	5675	-10527
1969	18947	15776	-3171	49792	28203	-21589

As can be seen in the foregoing table, the effects on the nominal

[18] The corresponding figures under the presumption that $\dot{PC}_t$ = 0.615 are 46.0 and 23.4 percent for 1962 and 1969, respectively.

value of output of a manufacturing sector suddenly forced to face world prices are enormous. In 1962, the value of output in the absence of price distortions is only 35.0 percent of the actual value while in 1969 the undistorted value is only 56.6 percent of the actual 1969 value.

We now turn to the impact on employment in manufacturing. Had it proved possible to estimate a manufacturing production function, we could have estimated the effects of distorted prices on manufacturing employment directly from the profit maximizing first order conditions with respect to labour employment, that is, equation (3.30). However, we are forced to resort to an assumption of proportionality between output and labour usage, that is:

$$E_{mt} = n_t Q_{mt} \qquad (8.6)$$

where n_t is the labour employed per unit of output or the reciprocal of the average product of labour. Because in the modern manufacturing sectors of most third world countries including Colombia, labour productivity has increased significantly over time, a t is subscripted to n to indicate that n is a function of time, i.e., $n_t = n_o e^{\lambda t}$. In 1962 and 1969, the average products of labour in manufacturing were 46845 and 52426, respectively, with both values expressed in constant 1958 prices. Thus n_t in 1962 and 1969 were 0.00002135 and 0.00001907, respectively.

Taking the differential of equation (8.6) and defining dE_{Mt} as $\bar{E}_{mt} - E_{mt}$ and dQ_{mt} as $\bar{Q}_{mt} - Q_{mt}$ where the "barred" variables reflect the values at world prices, and then making appropriate substitution, we may calculate the impact on manufacturing employment of distortions in relative commodity prices. In 1962, we calculated that there were 86104 more workers employed in manufacturing than would have been the case had the manufacturing sector been forced to compete on the basis of world prices. In other words, manufacturing gained 86104 jobs as a result of being able to produce behind high tariff barriers. The corresponding figure for 1969 was 60471. These figures represent 29.9 and 16.8 percent, respectively, of actual total factory manufacturing employment in the two years. Thus employment in manufacturing in the two years was 42.7 and 20.1 percent higher than would have been the case under a regime of undistorted commodity prices.

In order to obtain the effects on factor nominal incomes, all we are required to do is make appropriate substitution into equation (3.33) but modified in accordance with equation (8.4). Input-output data indicates $\sum_{i=3}^{4} b_i$ to be equal to 0.518. The results are contained in the following table:

TABLE 8.13

THE IMPACT ON FACTOR INCOMES IN THE MANUFACTURING SECTOR AS A RESULT OF REMOVING DISTORTIONS IN COMMODITY PRICES, 1962 AND 1969

YEAR	ACTUAL FACTOR INCOME IN MILLIONS OF CURRENT COLOMBIAN PESOS	UNDISTORTED FACTOR INCOME IN MILLIONS OF CURRENT COLOMBIAN PESOS	DIFFERENCE IN MILLIONS OF CURRENT COLOMBIAN PESOS	PERCENTAGE DIFFERENCE
1962	7809	2735	- 5074	-65.0
1969	24000	13594	-10406	-43.4

Clearly, the benefits which have accrued to factors employed in manufacturing as a result of Colombia's protectionist policies have been enormous. If we assume that shares of blue-collar labour in manufacturing value added has remained relatively constant over the period in question, then the manufacturing wage rate of Col.$2.60 per hour including fringe benefits in 1962 would have been in the absence of distortions Col. $1.30 per hour. The corresponding figures for 1969 were Col. $7.58 and Col. $5.16, respectively. Of course, the effects on real factor income or real wages in terms of purchasing power over manufactured goods would not be nearly as large since the price of manufactured goods would be correspondingly lower.

It would be appropriate at this point to examine the net effects of agricultural/manufacturing price distortions on the Colombian economy as a whole. It is in this respect, however, that the use of a partial equilibrium model, in which the analyses of the agricultural and manufacturing sectors were undertaken independently, can be seriously questioned. Although such a model can be justified in the analysis of each sector, its appropriateness for inter-sectoral analysis in terms consistency in the calculations is considerably more difficult to justify. Thus the net effects calculated below should be approached with a certain amount of caution. Added to this is the fact that the supply response estimate for the manufacturing sector is based on too high a level of aggregation to warrant a great deal of confidence when it comes to examining the impact of distortions on manufacturing output. The extent of price distortions varies considerably across the different manufacturing sub-sectors as no doubt would the supply elasticities. Thus, the impact on manufacturing output and employment if response estimates had been made at say, the two-digit level, might be quite different from the impact calculated in this study. In fact, we would expect that the removal of commodity price distortions would result in considerable resource reallocation within manufacturing away from those sectors which are not internationally competitive and toward those which are. Hence, the overall impact would in all probability be considerably smaller than that obtained here. It should also be mentioned that the manufacturing response estimate was undertaken in the context of growth and that the possibility of asymmetrical firm behaviour may make it less relevant in the context of a sudden decline in prices.

With the foregoing caveat in mind, the long-run net effects on the Colombian economy as a whole expressed in percentage terms which would occur in response to a dismantling of the structure of price distortions, assuming all sectors other than manufacturing and agriculture are unaffected, are contained in the following table:

TABLE 8.14

THE NET PERCENT CHANGE IN LONG-RUN OUTPUT, EMPLOYMENT AND NOMINAL INCOMES OF REMOVING DISTORTIONS IN RELATIVE COMMODITY PRICES, 1962 AND 1969

YEAR	NET EFFECT ON THE VALUE OF REAL OUTPUT %	NET EFFECT ON EMPLOYMENT %	NET EFFECT ON NOMINAL FACTOR INCOMES %
1962	+7.7	+7.5	+1.3
1969	+1.0	+3.3	-1.6

The figures for 1962 and 1969 in the first column show the net effect on national output of distortions in relative commodity prices. Thus real output in Colombia would have risen by 7.7 percent in 1962 in the absence of distorted prices. This figure reflects a real cost to the economy in terms of foregone output. The corresponding figure for 1969 is 1.0 percent. The second column gives the net impact on employment, as a percentage of existing employment levels, that would have been forthcoming in the absence of price distortions. These reflect 630,406 more job opportunities in 1962 and 342,830 more in 1969. Finally the third column shows the net percentage impact on nominal incomes (value added or

GDP) that would have resulted from the removal of commodity price distortions in the two years. The decline in nominal income in 1969 is largely due to fact that the size of distortions in the two sectors were such that when combined with the changes in real value added, the resulting decline in manufacturing factor incomes stemming from the removal of distortions outweighed the rise in agricultural nominal income.[19]

When we examine the two sectors in isolation, it is difficult to escape the conclusion that distortions in the internal terms of trade have had an undeniable impact on agricultural output, employment and factor incomes. It is readily apparent from the results contained in this chapter that Colombian farmers have suffered considerable losses as a consequence of policies which have tended to favour the manufacturing sector. In addition, these results become even more significant when one considers that distortions in agricultural commodity prices were minimal during the 1960's. On the other hand, the "potential" gains in the agricultural sector, especially in the case of employment gains, should be used with some caution as it is unlikely that such gains would occur without some fundamental institutional reforms within Colombian agriculture.

The effects on manufacturing output, employment and factor incomes and the net effects, as noted earlier, should be treated with extreme caution. This is especially true of the net effects, the calculation of which is based on an inappropriate partial equilibrium framework. The results should at best be interpreted as suggestive.

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[19] In contrast, the net effects on factor incomes in 1962 and 1969 would have both been positive if the gap between the world price and the domestic price of coffee had in no way been the result of policies to achieve monopoly power in trade. The net percentage increase in factor incomes would have been 5.3 in 1962 and 1.2 in 1969. Thus it would appear that only in the case of nominal factor incomes does the problem of the definition of distortions in coffee prices lead to significantly diverging results.

CHAPTER 9

THE IMPACT ON INCOME DISTRIBUTION

9.1 INTRODUCTION

In this chapter, we shall attempt to obtain an indication of the effects of distortions in relative commodity prices on the distribution of income in Colombia. The significance of this attempt rests on the observation that in many third world countries, it has been the upper and middle income groups which have enjoyed the greatest benefits from the process of import substitution industrialization. This is probably no less true of Colombia. The effects of industrialization via import substitution on access to employment opportunities in the modern sector and on inequalities in income earned from labour services have been discussed in Chapter 1. More generally, the impact on income distribution of import substitution policies can theoretically have two effects. The first is derived from the two-factor version of the Samuelson-Stopler Theorem which implies that the protection accorded certain sectors tends to increase the real return to the factor used intensively in those sectors and lower the real return to the other factor.[1] The second effect is that import substitution policies tend to result in high levels of industrial concentration and consequently to

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[1]Since much of import substitution industrialization is of a capital intensive nature, then the Samuelson-Stopler Theorem would seem to indicate that commodity price distortions may have improved the position of the upper income groups (owners of capital) relative to the lower income groups (owners of labour services).

generate monopoly profits.[2]

It is a fairly common belief that in view of the probable impact industrialization via import substitution has on income distribution, a move toward trade liberalization and export promotion would tend to improve income distribution patterns. This may be true if one were referring to the distribution of urban income but whether it is true of the distribution of national (urban plus rural) income is entirely another question. In fact, it has been argued (Diaz-Alejandro 1976, pp. 239-246) that in the case of Colombia trade liberalization may worsen rather than improve the distribution of national income, at least in the short or medium-run. There are three possible reasons. First trade liberalization may just substitute one kind of rent for another. Secondly, the elimination of the controls associated with import substitution "would still leave a multitude of similar mechanisms through which the rich and powerful could take advantage of state power to buttress and further their position" (Diaz-Alejandro 1976, p. 240). Finally, export promotion policies coupled with continued modernization with respect to export-oriented agricultural crops may uproot the family farm and destroy the hopes of the landless, and as a result cause a deterioration in the distribution of agricultural income.

While not ignoring the importance of such arguments, however, one would like to have a glimpse at the potential consequences for income distribution, under <u>ceteris paribus</u> assumptions, which might arise from

[2] The lack of demand for industrial output tends to lead to production occurring under economies of scale which in turn makes increasing concentration almost inevitable. It is this lack of competition which, of course, generates the monopoly profits.

the elimination of the trade controls needed to ensure the survival of the import substitution strategy. In other words, can we say anything about the effects on income distribution of a country which suddenly found itself trading at world rather than distorted domestic prices. In this chapter, we principally wish to examine such effects with respect to intra-agriculture distribution as well as with respect to the distribution of national income. Data limitations with respect to some aspects of this investigation will limit our analysis to one which tends to be more qualitative than we would have wished. However, quantitative estimations will be carried out to the extent that the data allows.

9.2 THE IMPACT OF PRICE DISTORTIONS ON INTRA-AGRICULTURE INCOME DISTRIBUTION

In order to have some indication of the effects of price distortions on intra-agricultural income distribution, we must have some idea of the relationship between the type of crop cultivated and the income level of the production unit. Unfortunately, this kind of data is not available from Colombia. However, there does exist data based on the 1960 Agricultural Census on the number of farms involved in the production of the different crops. This would allow us to calculate the income per farm or production unit derived from the cultivation of the i^{th} crop or from raising livestock. When we combine this with other qualitative information we might be able to obtain at least an indicative picture of the probable direction intra-agriculture income distribution would move in the absenoe of relative price distortions or, what amounts to the same thing, an indication of the impact distortions in relative prices have had on income distribution within the agricultural sector of Colombia. In view of the fact that much of the data pertains to years around 1960, our discussion and analysis will be based on the results for the year 1962 obtained in the previous chapter.[3]

TABLE 9.1

DATA COMPILED AS A BASIS UPON WHICH THE PROBABLE IMPACT OF PRICE DISTORTIONS ON INTRA-AGRICULTURE INCOME DISTRIBUTION CAN BE ASSESSED, EARLY 1960's

COMMODITY	(1) TOTAL NOMINAL INCOME (MILLIONS OF COL. PESOS)	(2) NUMBER OF PRODUCERS[4]	(3) PERCENT OF TOTAL NUMBER OF PRODUCERS	(4) PERCENT OF FARMS IN EXCESS OF 50 HECTARES	(5) AVERAGE INCOME PER PRODUCER DERIVED FROM EACH COMMODITY (COL. PESOS)
Aggregate non-coffee crops:					
Corn	376	539,245	44.6	8	697
Cotton	322	7,332	0.1	20	43917
Panela	335	223,076	18.4	6	1502
Platano	451	448,167	37.0	8	1006
Potatoes	191	108,404	9.0	3	1762
Rice	358	53,283	4.4	27	6719
Yucca	250	255,221	21.1	11	979
Livestock-derived products	3327	166,676	13.8	26	19961
Coffee	1827	429,041	35.5	5	4258

Sources: (1) Table 8.11
(2) and (4) From the Statistical Appendix of A. Berry's forthcoming book on the Development of Colombian Agriculture, Tables A-110 and A-111.

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[3] The principal problem with respect to the available data stems from the fact most farms or production units cultivate more than one crop. In order to make some sort of definitive comment on the effects of price distortions on income distribution in agriculture we would ideally need to have data on crop proportions cultivated by the k^{th} farm in the j^{th} income class. Data at this level of detail is just not available from Colombia. The best we are able to calculate is the income per producer derived from the production of the i^{th} crop or livestock-derived product without any reference to whether the producers allocate all or just a small part of their available area to the cultivation to the commodity in question.

[4] The total number of farms or producers in 1960 was estimated to be 1,209,672. The fact that this column sums to a number greater than this obviously reflects the fact that farms generally grow more than one crop.

As indicated in the foregoing table, farmers who concentrate production in or allocate the most area to either cotton, rice or livestock tend to enjoy the highest incomes. In addition, it should be noted from column (4) that these three commodities also tend to be produced on the larger farms, a further indication of the higher incomes derived by producers of these commodities. Column (3) further indicates that these commodities tend to be produced on the fewest number of farms. It should also be recalled that cotton and rice are highly mechanized crops and that livestock raisers have traditionally been a favoured sub-sector. On the other hand, producers who tend to concentrate on the more traditional non-coffee crops of corn, panela, platano, potatoes and yucca have the lowest incomes. In addition, these crops tend to be grown on the smaller farms and with the exception of potato cultivation which is perhaps the most market-oriented of the five crops, tend to be grown on the greatest number of farms. Coffee falls somewhere in the middle. Although coffee production bears some of the characteristics of the traditional non-coffee crops in terms of farm size and the number of producers, the income enjoyed by those farms emphasizing coffee cultivation tend to be somewhat above the incomes derived from the traditional non-coffee crops but not as high as the incomes enjoyed by cotton, rice and livestock producers.

In the following table, we have ranked in column (1), on the basis of the information contained in column (5) in Table 9.1, the various commodities according to the income per farm derived from their production. Column (2) gives the long-run change in nominal income that would have occurred in 1962 in the absence of relative price distortions. This information is taken directly from Table 8.10. Column (3) gives the change in nominal income per farm, i.e., column (2) in Table 9.2 divided by column (2) in Table 9.1. Column (4) ranks the information contained in column (3) according to the size of the change.

TABLE 9.2

COMMODITY RANKINGS ACCORDING TO INCOME PER PRODUCER AND TO THE EFFECTS ON NOMINAL INCOME IN THE ABSENCE OF RELATIVE PRICE DISTORTIONS, EARLY 1960'S

(1) COMMODITY RANKING ACCORDING TO INCOME PER PRODUCER	(2) THE CHANGE IN NOMINAL INCOME IN THE ABSENCE OF RELATIVE PRICE DISTORTIONS (MILLIONS OF COL. PESOS)	(3) THE CHANGE IN NOMINAL INCOME PER PRODUCER (COL. PESOS.)[5]	(4) COMMODITY RANKING ACCORDING TO SIZE OF THE INCOME CHANGE IN COLUMN (3)
Cotton	593	80878	Cotton
Livestock	3413	20477	Livestock
Rice	23	432	Coffee
Coffee	402	937	Yucca
Potatoes	35	323	Rice
Panela	61	273	Potatoes
Platano	115	257	Panela
Yucca	111	435	Platano
Corn	36	67	Corn

Perhaps the most significant observation to be made from the rankings in columns (1) and (4) is that the two highest commodities in terms of the income per producer are the same two which would yield the greatest change in income. These changes in income are largely due to the especially large estimates of supply responsiveness obtained

[5]These changes could have also been expressed in relative terms (See Table 8.10). However, except for rice which would be ranked last, no significant changes in the rankings in column (4) would have occurred. The figures below constitute an upper limit to the true increase in per producer income as they assume no change in the number of producers. Presumably one would anticipate such an increase especially with the high elasticity crops. In addition, the figures could be biased upward if the price increases entice higher cost suppliers into production and/or cause supply curve shifts among existing producers causing producer net gains per unit of output to decline.

for cotton and livestock-derived products and are not a result of especially large distortions in their respective prices.

Coffee which was ranked fourth in terms of the income yielded per coffee producer increased its rank to third in terms of the "potential" change in per producer income.[6] However, the gap between the per producer change in income of coffee growers and that of cotton cultivators and livestock raisers is substantial. The remaining six commodities, except for rice, are the largely traditional non-coffee crops. Although there are some adjustments with respect to relative positions within the two ranking, the "potential" increases in income which might have been enjoyed by producers of these six crops are well below those which would have accrued to producers of cotton, livestock-derived products, and coffee.

Based on the information presented here, there seems to be some evidence that the abandonment of the set of trade restricting policies largely responsible for the distortions in the internal terms of trade faced by agricultural producers in Colombia would do little to improve the distribution of intra-agricultural income. On the contrary, the evidence tends to point to the opposite, that is, those farmers who emphasize the production of the higher income yielding crops (and hence who tend to have the highest levels of income within the agricultural sector) are the same farmers whose incomes would likely increase the most in a distortionless environment. This is reflected in the high level of

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[6]The change in income calculated for coffee in Table 9.2 is of course based on the presumption that the gap between the world and the domestic price of coffee reflects solely the desire for a monopoly price. If this was not the case, then the change in the nominal income per farm in column (3) would have been 4062 and not 937.

correlation in the rankings given by columns (1) and (4) in Table 9.2. It would appear, therefore, that the existence of distortions in relative commodity prices in Colombia may have prevented the distribution of agricultural incomes from being worse than it actually is. It goes without saying that the conclusion reached here is tentative and should be accepted as indicative with respect to any policy implications. In any event, the evidence does seem to support Berry's contention that..."there is no quick solution for the very unequal distribution of income in agriculture which does not involve land redistribution as an important and probably the major component" (Berry 1973, p. 227).

9.3 THE IMPACT OF PRICE DISTORTIONS ON INTER-SECTORAL AND NATIONAL INCOME DISTRIBUTION

The effects of distortions in relative agricultural and manufacturing prices on the level of nominal incomes in the two sectors have been calculated in Tables 8.11 and 8.13. The results indicate that a considerable redistribution of income from the manufacturing sector to the agricultural sector would have occurred if both sectors had made their output decisions in response to world rather than domestic prices. Conversely, it appears that the existence of price distortions in Colombia has resulted in a redistribution of income from the agricultural to the manufacturing sector. The long-run gains and losses in sectoral incomes in 1962 and 1969 are summarized in Table 9.3.

TABLE 9.3

LONG-RUN GAINS AND LOSSES IN SECTORAL INCOMES AS A RESULT OF DISTORTIONS IN RELATIVE PRICES, 1962 AND 1969

SECTOR	1962	1969
Agriculture	Col $ -5,505,000,000	Col $ -8,731,000,000
Manufacturing	Col $ 5,074,000,000	Col $ 10,406,000,000

As Table 9.3 indicates, the Col $5,505,000,000 loss of income to the agricultural sector in 1962 as a result of relative price distortions (or the gain in agricultural income that would have occurred in the absence of such distortions) represents a level of income which is 62.3 percent of what the agricultural sector might have enjoyed in a distortionless environment (or would represent a 60.4 percent increase in income if production had been in response to world rather than domestic prices). Similarly, the gain in manufacturing income of Col $5,074,000,000 in 1962 that occurred because of price distortions represents a 186 percent increase over the level of income that would have been generated in the absence of such distortions. Conversely, the same figure indicates that manufacturing income in a distortionless situation would only be 35 percent of what it actually was in 1962. The corresponding 1969 gain and loss in income in the two sectors in the absence of distortions in relative prices are 29.1 and 43.0 percent, respectively, or conversely, the existence of price distortions has resulted in agricultural income being 22.5 percent below and manufacturing income being 75.4 percent above the levels that would have existed had producers faced world rather than domestic prices.

Although we are able to say something definitive on the effects of distorted relative prices on the distribution of income between sectors, it is impossible with the available data to come to any definitive conclusions on the effects on the size distribution of income. We might, as a first approximation, conclude that since there would have been a redistribution of income from the manufacturing sector to the agricultural sector with the removal of price distortions and since average incomes in the non-agricultural sector are higher for every decile except the first two, the distribution of national income would tend to improve in a "distortionless" environment (or conversely, the existence of price distortions has made the distribution of income worse than otherwise would have been the case). Such a conclusion would, of course be naive and generally unacceptable without a strong indication of the income deciles from which individuals who gain the most and individuals who lose the most come. Unfortunately, there is no way of determining this with any degree of accuracy from available Colombian data.

As to the impact on the distribution of urban income in Colombia, approximately 12 to 15 percent of the urban E.A.P. derived their incomes from employment in factory manufacturing over the period in question. However, evidence strongly indicates that this 12 to 15 percent are largely concentrated in the top half of the urban income distribution, particularly in the 6th to 9th deciles, inclusive (Berry 1975, Diaz-Alejandro 1976). If we assume all other income earners unaffected, then it would appear that the existence of distortions in the prices of manufactured goods contributed to the maldistribution of income in urban Colombia and that the abandonment of such distortions would, as a result, tend to improve the distribution of urban income. On the other hand, distortions in agricultural prices by cheapening food may have improved the relative position in real terms of the lower income groups who spend a larger proportion of the incomes on food so that the removal of such distortions by raising food prices may have an adverse effect on the distribution of real urban income.

The impact of price distortions on the distribution of national income would depend, of course, on the strength of the relative distributional impacts in the urban and agricultural sectors. If the worsening of urban income distribution that appears to have occurred in the presence of distorted prices "outweighed" the more equitable distribution of income which is more likely to have occurred in the agricultural or rural sector, then we might agree that the existence of distortions in relative prices has tended to make more serious what would have been in any case a highly unequal income distribution. Conversely, if in an environment in which all producers found themselves facing relative prices expressed in world terms, the resulting improvement in the urban distribution of income "outweighed" the worsening of the distribution of income in the agricultural or rural sector hypothesized in the previous section, then we might conclude that the absence of such distortions would tend to improve the distribution of national income, and vice versa.

In view of the fact that there is insufficient data to allow us to determine the relative effects on the two sectors, we are unable to give even an indicative or tentative direction in which the distribution of national income might move. If any concluding comment can be made, it would seem that the overall effect of removing price distortions would involve a redistribution of income from the top half of the urban income distribution to the top half of the agricultural income distribution, although in absolute terms, farmers in the bottom half of the agricultural distribution would make marginal gains. Whether this results in an improvement or worsening of the distribution of overall national income, it is impossible to say.

CHAPTER 10

THE IMPACT ON INTERNAL MIGRATION AND THE URBAN LABOUR SUPPLY

10.1 INTRODUCTION

As was seen in Chapter 8, distortions in relative agricultural and manufacturing commodity prices in Colombia appear to have had a significant impact on the relative incomes of the two sectors. Our objective in this Chapter is to investigate the effects these distortions have had on the migration process in Colombia. We begin in Section 10.2 with a review of the migration response models employed by investigators of this phenomenon. In Section 10.3, we estimate migration responsiveness with respect to existing urban-rural income differentials in Colombia. Finally, in Section 10.4, the effects on migration and on the urban labour supply of that part of the income differentials which can be attributed to relative price distortions are estimated.

10.2 MODELLING MIGRATION RESPONSIVENESS

One approach to estimating migration responsiveness involves the use of differences in current urban and rural incomes as explanatory variables. A generalized stochastic migration response function incorporating this approach is the following:

$$m_t = m_t(\tilde{Y}_{mt}, \tilde{Y}_{at}, W_1, W_2, \ldots\ldots, W_n; \mu_t) \qquad (10.1)$$

where m_t is a measure of the rate of migration defined as the level of migration as a proportion of the rural or agricultural labour force, $\tilde{Y}_{mt}$ and $\tilde{Y}_{at}$ are measures of average urban and agricultural incomes,

W_i (i = 1, 2, ... n) represents other variables which may influence the migration decision, and μ_t is the stochastic error term. Since a prospective migrant is more likely to be interested in expected incomes in the two sectors over a working lifetime, however, a human capital approach to the problem (see equation 3.39) would be more realistic. A response function which utilizes this approach is as follows (ignoring for now, the W_i's):

$$m_t = m_t[\sum_t \tilde{Y}_{mt}/(1+r)^t, \sum_t \tilde{Y}_{at}/(1+r)^t; \mu_t] \qquad (10.2)$$

where $\sum \tilde{Y}_{mt}/(1+r)^t$ and $\sum \tilde{Y}_{at}/(1+r)^t$ are the discounted present values of the streams of expected future urban and agricultural incomes.[1]

The recent heightened interest in the internal migration problem began with Todaro's seminal contribution (Todaro 1969). Todaro's effort, however, finds its novelty not so much in its theoretical framework but in its policy implications.[2] The theory largely revolves around a variation on the standard human capital approach to the effect that the migration decision also depends on the probability of a prospective migrant finding a job in the modern urban sector. Equation (10.2) can be revised to incorporate this probability as follows:

$$m_t = m_t[\sum_t \tilde{Y}_{mt}/(1+r)^t, \sum_t \tilde{Y}_{at}/(1+r)^t, \rho_t; \mu_t] \qquad (10.3)$$

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[1]The characteristics of the typical migrant discussed in Chapter 2.5, that is, they tend to be the young, the single, and the better educated relative to the rural population as a whole, are all consistent with what the simple human capital approach would *a priori* tend to predict. The dependent variable, m_t, can of course be disaggregated according to sex, education, marital status, age, region, etc., as one desires.

[2]See Chapter 1.5 for a discussion of the policy implications imbedded in the Todaro model.

where ρ_t $(0 \leq \rho \leq 1)$ is a measure of the probability of finding a job in the modern sector and can be defined as:

$$\rho_t = \frac{\delta_t(1 - U_{t-1})}{U_{t-1}} \qquad (10.4)$$

where U_{t-1} is the rate of urban unemployment in the previous period, and δ_t is the net rate of growth of new job openings in the urban modern sector.[3]

The Todaro contribution as well as his collaborative effort (Harris and Todaro 1970) have been the genesis of a number of theoretical and empirical papers, some of which are supportive while others are critical. Of the theoretical contributions to the migration literature, those of Blomqvist (1977), Bhagwati and Srinivasan (1974), Fields (1975), and Stiglitz (1969) (1974) are particularly noteworthy.[4] However, the

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[3]The incorporation of ρ_t into a migration response function can be done in two ways. The first way is to employ ρ as a separate regressor whose parameter is to be estimated along with others. An alternative manner of incorporating ρ is to use its value as a weight for $\bar{Y}_{mt}$ so that the present value of the discounted stream of future urban income becomes: $\Sigma\rho_t Y_{mt}/(1+r)^t$.

[4]Blomqvist attempts to reconcile diverging policy implications of the Todaro (1969) paper and the Harris and Todaro (1970) paper with respect to urban job creation and finds among other things that the Harris and Todaro interpretation of the migration process as a static phenomenon prevents anything useful being said about different tax/subsidy policies on the question of resource allocation. Bhagwati and Srinivasan use the basic Harris and Todaro model to examine the rankings of various tax/subsidy policies in an environment in which wage rigidity occurs in some sectors. They find that the Todaro-Harris first best solution of a subsidy on wages plus physical restrictions on migration is unnecessary and that there exist different tax-subsidy alternatives which will lead to a first-best solution. Fields extends the Harris and Todaro model with a view to investigating the impact on the unemployment rate of job-search activities, the existence of a urban traditional (murky) sector, the overall level of education of the labour-force and in the efficiency with which labour markets operate. Fields concludes that such extensions to the basic Harris-Todaro model would tend to result in a lower rate of unemployment that would be typically forthcoming without them.

discussion in this section will be largely confined to two subsequent Todaro papers (Todaro 1976a and 1976b) as these are particularly relevant to the context of this study.

In the first paper (Todaro 1976a), Todaro attempts to construct a simplified model which would provide the framework within which the most important policy implications of his original paper could be tested, that is, whether policies directed toward the creation of jobs in the modern sector will in fact lead to either an increased level and/or to an increased rate of urban unemployment. Obviously the role ρ_t as an independent statistically significant variable will be crucial here. Todaro demonstrates that an autonomous increase in modern sector jobs will result in an increased level of unemployment if, ceteris paribus:

$$\xi_\rho > \delta E/M \tag{10.5}$$

and an increased rate of unemployment if, ceteris paribus:

$$\bar{\xi}_\rho > \delta L/M \tag{10.6}$$

where ξ_ρ and $\bar{\xi}_\rho$ is the elasticity of migration with respect to ρ, the probability of finding a job, δE is the "normal" level of job creation (the number of additional jobs that would be created in the absence of an autonomous job increase), M is the "normal" level of migration, and L is the urban labour force.

Using data on δ, E, M, and L from a number of third world countries, Todaro was able to calculate "threshold" elasticities, ξ^*_ρ and $\bar{\xi}^*_\rho$, against which estimated elasticities, $\hat{\xi}_\rho$ and $\hat{\bar{\xi}}_\rho$, could be compared. If $\hat{\xi}_\rho > \xi^*_\rho$, then autonomous job creation will lead to an increase in the level of unemployment and, if $\hat{\bar{\xi}}_\rho > \bar{\xi}^*_\rho$, it will also result in an increase in the rate of urban unemployment. Values of ξ^*_ρ ranged from 0.106 in

Uganda to 0.712 in Chile with an average value of 0.426 for the 14 countries for which the "threshold" elasticities were calculated. Values of $\bar{\xi}_\rho^*$ ranged from 0.13 to 0.84, with an average of 0.56.[5] The Asian and Latin American countries generally produced higher "threshold" elasticity estimates than the African countries; the former because δ tends to be relatively high, the latter because E/M tends to be relatively large.

Up until recently, empirical investigation of migration responsiveness was largely done on an ad hoc basis with little rigour or precision. However, a number of studies on the migration process have been completed in recent years which are based on extensive survey and census data which make up for the lack of sophistication of the earlier efforts.[6] Many of these studies involving such countries as Venezuela, Brazil, Jamaica, Tanzania, Kenya, Tunisia, India, Taiwan and Sierra Leone have been summarized by Todaro (Todaro 1976a, and 1976b). While all of the papers were concerned with the estimation of the responsiveness of migration to urban-rural income differentials, a significant number were also concerned with testing the theoretical and policy implications of Todaro's hypothesis, specifically with respect to whether the probability of obtaining a job in the modern sector plays an important role in the migration decision, whether efforts to create new urban jobs will result in increased urban unemployment, and whether wage subsidies to urban

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[5]The values ξ_ρ^* and $\bar{\xi}_\rho^*$ calculated for Colombia were about average at 0.46 and 0.59, respectively.

[6]It should be noted that interest in the rural-urban migration phenomenon among economists occurred only when it became apparent that economic factors played an important role in the migration decision. Until then, the migration process was largely the perogative of sociologists, anthropologists and demographers who by and large lack the economist's tool kit.

workers are self-defeating. Support for Todaro's hypothesis and its various implications appears universal. Migration response elasticities with respect to sectoral income differentials were found to be surprisingly large, in some countries in excess of two. Moreover, in those studies in which the different implications of the Todaro model were tackled, it was found that ρ_t was statistically significant as an explanatory variable and that $\hat{\xi}_\rho$ exceeded ξ^*_ρ by considerable margins, e.g., 0.65 versus 0.21 for Tanzania. Needless to say, many of these studies suffer from the kinds of data, specification and estimation problems one would expect to observe when one is estimating this type of human behaviour.[7]

To close off this section, a brief discussion of the only significant empirical investigation of migration in Colombia is warranted.[8] The brevity of the discussion is justified as Schultz's objectives were different from those of this study (intersectoral income differentials were not considered as an explanatory variable). In addition, the dependent variable was net inter-regional migration rates rather than gross rural-urban migration rates. The former could act as a proxy for the latter, of course, provided there is a clear distinction between urbanized regions and rural regions. Schultz's model of inter-regional migration tests the impact on average annual migration rates over the

[7]These problems are discussed in Yotopoulos and Nugent (1976), Chapter 13, Appendix. Some of the problems mentioned will no doubt be encountered in our own investigation of migration responsiveness in Colombia, at which time they will be discussed.

[8]T. Paul Schultz, "Internal Migration: A Quantitative Study of Rural-Urban Migration in Colombia" in Nelson, Schultz and Slighton (1971), Chapter III. Other investigators have done empirical work on the migration process in Colombia but these are largely descriptive works based on the interpretation of the results of unitemporal survey data.

period 1951-1964 of local wage rates in agriculture, the local rate of natural population increase, the distance to the nearest large town, the level of violence, and two measures of school enrollment rates. All variables behaved as expected except for one of the schooling measures. The R^2 was low, around 0.35. The migration rates were then disaggregated according to origins of the migrants (rural, small towns, cities), sex, and age of the migrants. All of the explanatory variables behaved as expected, significance levels varying as expected. Again one of the measures of schooling (the enrollment rate for children between 5 and 9 years old) continued to produce an incorrect a priori sign. Schultz could find no explanation for the unexpected behaviour. Nonetheless, Schultz's results, despite the low R^2's, tend to confirm that migration patterns are dominated by the young, the better educated, and the unmarried. Finally a strong relationship was observed between the local agricultural wage rate and whether the net in-migration rate was positive or negative, that is, regions with higher wage rates tended to have positive net rates of in-migration and vice versa.

10.3 ESTIMATION OF MIGRATION RESPONSIVENESS IN COLUMBIA

Efforts to estimate the influence of urban-rural income differentials on the migration process in Colombia were based on the following migration response equation:

$$m_t = \beta_0 + \beta_1 DW_t + \beta_2 PROB_t + \beta_3 DUM_t + \mu_t \qquad (10.7)$$

where m_t is the rate of migration of economically active males to urban centres, DW_t represents various formulations of the differential between the manufacturing and agricultural wage rates, as defined in equations (10.8) to (10.11), $PROB_t$ is the probability of the migrant finding employment in factory manufacturing, as defined in equation (10.4), DUM_t is a dummy variable included for years in which rural violence was an important consideration, and μ_t is the error term. Twenty-six observations (1950-1975) on all variables were available.

Considerable difficulty was encountered in trying to obtain an appropriate measure of m_t. Given the focus of this study, we would ideally want a time series of gross migration rates for males of working age. Unfortunately, such data does not exist.[9] Thus a proxy had to be devised based on available time series data on the size of the rural labour force and on the rate of growth of the rural population. It was assumed that the "expected" size of the rural labour force at time t+1 is equal to the rural labour force at time t multiplied by one plus the rate of growth of the rural population at time t-15 under the assumption that at 15 years of age a rural dweller has become a member of the labour force and is in a position to consider the prospect of migrating. The "expected" size of the labour force at time t+1 was then compared with the observed or estimated rural labour force size at time t+1 and any difference was presumed to reflect the level of migration during time t, M_t. Dividing by the rural labour force at time t, we obtain the rate of migration, m_t.[10]

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[9] In fact, there is very little in the way of migration data on Colombia at all and what is available usually involves average net figures for all migrants over five or ten year periods. This would not be suitable for our purposes.

[10] The use of such a proxy is, of course, a "second best" practice. Yet when one considers the rural labour force is almost wholly males of working age, the use of this proxy may be preferable to using total migration data since women and children do not generally migrate to find jobs in factory manufacturing.

Four alternative formulations of the urban-rural wage differentials were employed in the regressions. These are:

$$DW_t = \sum_t (WM_t^E/(1+r)^t - WA_t^E/(1+r)^t) \qquad (10.8)$$

$$DW_t = \sum_t (\overline{WM}_t^E/(1+r)^t - \overline{WA}_t^E/(1+r)^t) \qquad (10.9)$$

$$DW_t = WM_t - WA_t \qquad (10.10)$$

$$DW_t = \overline{WM}_t - \overline{WA}_t \qquad (10.11)$$

Formulation (10.8) expresses the wage differentials as the difference between the sum of the discounted expected future manufacturing money wage rates and that of agricultural money wage rates. Formulation (10.9) is the same is (10.8) except that $\overline{WM}_t^E$ and $\overline{WA}_t^E$ refer to expected real wage rates, that is, the money wage rates deflated by a consumer price index. Formulation (10.10) just expresses the wage differentials as the difference between the current manufacturing money wage rate and the current agricultural money wage rate while in (10.11) the wage rates are expressed in real terms.

Estimation of the parameters in equation (10.7) was commenced using wage rate differentials formulations (10.8) and (10.9). This human capital approach to the migration phenomenon led to "degrees of freedom" problems. Ideally, the time span over which the present value of expected future wages are defined should be the prospective migrant's working lifetime. However, with only 26 observations available this is hardly possible. We would, of course, prefer to include as many observations as possible on expected future wages but for each additional wage rate observation included in the calculation of present value we would lose one degree of freedom.

In the end, it was decided to attempt three alternative time spans over which present value would be defined, namely 5, 10, and 15 years. Regardless of the definition employed, however, the results yielded by the regressions were most unsatisfactory. The estimation of the specification given by equation (10.7) generated a priori incorrect signs for the estimates of all three parameters, and in the case of β_1 and β_2, the estimated values were significant at a level which could not be rejected. The estimated coefficient, β_2, was of the correct sign but significant at the 0.20 level only.[11] As a consequence of these results, it was necessary to resort to the wage rate differentials as defined in formulations (10.10) and (10.11) to explain the migration process in Colombia. The results obtained were unquestionably more acceptable empirically but are based on a theoretically less appealing model. Nonetheless, the values of the LLF and the F-statistic yielded by the regressions using formulations (10.10) and (10.11) were significantly above those yielded by the regressions employing the present value formulations of the wage rate differentials.

The estimation of the specification given in equation (10.7) yielded correct a priori signs for all the parameters regardless of whether the money or real wages were used. However, the money wage specification

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[11]Revised specifications in which $PROB_t$ and DUM_t were alternatively dropped continued to produce a priori incorrect signs for β_1, although the value estimated could not be accepted at any reasonable level of significance. Even when both $PROB_t$ and DUM_t were eliminated, no improvement was encountered.

yielded a value of the LLF which exceeded that produced by the real wage specification by a margin which statistically could not be rejected. The results of the estimation of equation (10.7) using wage rate differential formulation (10.10) are as follows:

$$(1)\quad m_t = \underset{(5.30)}{0.0168} + \underset{(4.64)}{0.000241}(WM_t - WA_t) + \underset{(0.98)}{0.00411}\,PROB_t + \underset{(1.24)}{0.004}\,DUM_t$$

$$LLF = 90.35 \qquad R^2 = 0.520 \qquad DW = 1.939$$

Ordinary least squares were used. The estimated coefficients for $PROB_t$ and DUM_t are significant at the 0.20 and 0.15 levels, respectively. Using sample means for m_t and $(WM_t - WA_t)$, the estimated migration response elasticity derived from the estimated coefficient of $(WM_t - WA_t)$ is 0.271. The same specification but employing formulation (10.11) as an explanatory variable generated a value of only 83.94 for its LLF as well as producing lower levels of significance for its estimated coefficients. However, the estimated migration response elasticity of 0.347 is not greatly different from that estimated from the money wage specification recorded above. These elasticities reflect the impact on the rate and not the level of migration. The estimated elasticities derived here appear somewhat low in constrast to estimates obtained in other third world countries, discussed briefly in the previous section. This is most probably due to the somewhat less than satisfactory measure of the dependent variable used in the regressions.

10.4 THE IMPACT OF TOT DISTORTIONS ON MIGRATION AND THE URBAN LABOUR SUPPLY

After adjusting rates of migration to levels of migration, we would in the normal course of events be able to derive the impact of distortions in the TOT on the migration process in Colombia by applying directly equation (3.41). However, equation (3.41) expresses migration responsiveness in terms of average manufacturing and agricultural incomes whereas the estimation of migration undertaken in the previous section viewed migration as responding to wage rate rather than average income differentials. In Chapter 8, we were able to calculate the effects on agricultural and manufacturing incomes of distortions in relative commodity prices. We saw that the existence of TOT distortions led to manufacturing incomes in 1962 being 185.5 percent, and in 1969, 76.5 percent, above the incomes which would have prevailed in a distortionless environment while the short-run and long-run effects on 1962 agricultural incomes led to their being 18.7 percent and 37.7 percent, respectively, below what would have prevailed in the absence of such distortions. The corresponding 1969 figures are 7.1 and 22.6 percent, respectively. Alternatively, the removal of TOT distortions would have led to a 65.0 percent decline in manufacturing incomes in 1962 and a 43.4 percent decline in 1969, while in the agricultural sector would have risen in 1962 by 23.0 percent in the short-run and 55.0 percent in the long-run. In 1969, the corresponding figures are 7.6 percent and 29.1 percent, respectively.

In the absence of estimates of agricultural and manufacturing production functions, there is, of course, no way of determining the effects on sectoral wage rates of distortions in the TOT without some <u>a priori</u> assumption about the movement of factor shares. For purposes of this study, it shall be assumed that labour pools in both the manufacturing and agricultural sectors are in a position to maintain constant their relative shares in their respective sectoral incomes.

The existing "distorted" daily wage rates in 1962 and 1969 in the factory manufacturing sector were Col.$26.00 and Col.$75.80, respectively, while those prevailing in the agricultural sector were Col.$6.92 and Col.$17.03, respectively. The manufacturing daily wage rates which would have existed in the absence of relative price distortions were Col.$13.00 in 1962 and Col.$51.60 in 1969. The corresponding short-run and long-run daily agricultural wage rates would have been Col.$7.86 and Col.$9.07, respectively, in 1962, and Col.$17.56 and Col.$19.38, respectively, in 1969.[12] The daily wage rate differentials ($WM_t - WA_t$) for t = 1962 and 1969 in both a "distorted" and "distortionless" environment as well as the percentage increase in the differentials arising out of trade restricting policies are contained in the following table:

TABLE 10.1

SECTORAL WAGE RATE DIFFERENTIALS IN THE COLOMBIAN ECONOMY, 1962 and 1969

YEAR	"DISTORTED" SECTORAL WAGE RATE DIFFERENTIALS	"UNDISTORTED" SECTORAL WAGE RATE DIFFERENTIALS		PERCENTAGE INCREASE IN DIFFERENTIALS	
		SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN
1962	Col.$19.08	Col.$ 5.14	Col.$ 3.93	271.2	385.5
1969	Col.$58.77	Col.$34.04	Col.$32.22	72.6	82.4

[12] The "undistorted" manufacturing hourly wage rates were calculated on p.197. Those figures were then multiplied by ten, the typical number of hours per day worked during the period, to obtain the daily wage rate needed for equivalence with agricultural wage rate data which is available on a daily basis only. The "undistorted" agricultural wage rates were calculated in a manner similar to the "undistorted" manufacturing wage rates, that is, assuming constant factor shares, from the expression $W_t E_t = b y_t$ where y_t is total sectoral income, b is the share of total sectoral income accruing to labour, W_t is the sectoral wage rate, and E_t is the level of sectoral employment.

The "undistorted" sectoral wage rate differentials between the two sectors calculated for 1962 seem very low when compared with the 1969 "undistorted" differentials. This is particularly true of the small differential in 1962. Given the difference in average skill levels between the two labour forces in 1962, the figures seem implausible. The figures in Table 10.1 are of course derived from the results obtained in Chapter 8 of this study and of course reflect to some extent the accuracy of those results, especially those concerning the impact of price distortions on manufacturing output and employment about which the reader was cautioned on pp. 197-198.

With the foregoing reservations in mind, it will be recalled from the previous section that the elasticity of the rate of migration of economically active males with respect to sectoral money wage differentials was estimated to be 0.271. The observed 1962 and 1969 rates and levels of migration and the rates and levels of migration that would have existed in the two years in the absence of relative commodity price distortions are summarized in Table 10.2.[13]

TABLE 10.2

OBSERVED AND "UNDISTORTED" RATES AND LEVELS OF MIGRATION IN COLOMBIA, 1962 AND 1969

YEAR	OBSERVED MIGRATION RATES	OBSERVED MIGRATION LEVELS	MIGRATION RATES IN THE ABSENCE OF DISTORTIONS		MIGRATION LEVELS IN THE ABSENCE OF DISTORTIONS	
			SHORT-RUN	LONG-RUN	SHORT-RUN	LONG-RUN
1962	2.056	50,310	1.185	1.005	28,978	24,591
1969	2.708	71,600	2.262	2.214	59,807	58,538

[13]The rate of migration in the absence of distortions can be calculated from the following expression: $\bar{m}_t = m_t/(1 + \xi(DW - \overline{DW})/\overline{DW})$ where the "bars" indicate the "undistorted" values of the variables, ξ is the elasticity, and $DW = WM - WA$.

Based on the results obtained in this study, it would appear that distorted prices in 1962 led to 22,537 more economically active males migrating to urban centers in the short-run and 25,719 more in the long-run than would have been the case in the absence of such distortions. These reflect 73 percent and 105 percent higher levels of migration, respectively. Conversely, the migration level in a "distortionless" environment would have been only 57.6 percent in the short-run of what was actually observed in 1962 and only 48.9 percent in the long-run. Relative price distortions in 1969 led to levels of migration in the short-run of 11,793 and of 13,062 in the long-run above what would have prevailed in their absence. These figures point to percentage increases in migration levels of 19.7 and 22.3, respectively. Alternatively, the migration levels which would have occurred at world prices would have been 83.5 percent and 81.8 percent of observed levels, respectively.

It would appear, therefore, that <u>ceteris paribus</u> the factory manufacturing labour force which in 1962 was observed to be 638,200 was 22,537 larger in the short-run and 25,719 larger in the long-run than would have been the case in the absence of distortions in commodity prices.[14] This represents a 3.5 percent short-run increase and 4.0 percent long-run increase in the size of the factory manufacturing labour force. In 1969, the existence of distorted prices led to the observed labour force of 841,000 <u>ceteris paribus</u> being 1.4 percent larger in the short-run and 1.6 percent larger in the long-run than would have existed

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[14] The term "factory manufacturing labour force" refers to that part of the urban labour force seeking employment in the factory manufacturing sector and includes those currently employed in factory manufacturing, those currently employed in the urban cottage-shop industries and the openly unemployed. See Data Appendix, Table A.8 for data and sources. Also see footnote 15 below.

in a "distortionless" environment. It would seem that the impact on the factory manufacturing labour force of the migration levels forthcoming as a result of relative price distortions was fairly small, especially in 1969.

In order to determine the effects on urban unemployment, it would be necessary to contrast the relative impacts of distorted prices on the labour force and on the level of manufacturing employment. Employment in factory manufacturing in 1962 and 1969 was observed to be 287,500 and 361,400, respectively.[15] It will be recalled from Chapter 8 that as a consequence of trade restrictions, the resulting commodity price distortions meant that factory manufacturing employment levels in 1962 and 1969 were 86,104 and 60,471, respectively, above what they would have been in the absence of such distortions. These results, therefore, seem to point to the conclusion that policies which led to distorted prices actually reduced unemployment levels by 53,095 in the short-run and 44,237 in the long-run in 1962 and, in 1969, by 48,679 in the short-run and 47,409 in the long-run, all else held constant.[16]

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[15] The enormous differences between the observed labour force and observed employment in 1962 and 1969 should be clarified. These differences should not be interpreted as indicative of open unemployment levels. While the size of the labour force reflects individuals seeking employment in factory manufacturing, it does not mean that until such employment is found, they are unemployed. The vast majority are, of course, employed in the traditional urban sector. In fact, open unemployment levels in 1962 and 1969 were estimated to be 51,100 and 84,100, respectively. Moreover, it will be recalled from Chapter 2.6 that those who are openly unemployed tend not to be recent migrants.

[16] See equation (3.42). We would, of course, expect that the part of the labour force comprised of native urban workers would be substantially larger as a result of manufacturing wage rates which lie above their world price values. Consequently, the impact of relative price distortions on unemployment levels recorded here are unquestionably biased upward, the size of the bias depending on the labour supply elasticity of native urban workers.

The estimates of the effects of commodity price distortions on urban unemployment should not be taken as very reliable for two reasons. First, the calculations were done indirectly and rely on the accuracy of the estimations of the effects of distortions on both manufacturing employment and on migration. Secondly, the conclusion that distorted relative prices reduced the level of urban unemployment is at variance with what one would predict on the basis of the Todaro model. There might be two explanations for this. One is the surprisingly low elasticity of migration response estimated for Colombia. This, as mentioned earlier, may be the result of inadequate data on the dependent variable. The second explanation brings us back to the caveat on pp. 197-198 regarding the confidence one can place in the impact of price distortions on manufacturing output calculated in Chapter 8. If we can safely assume that that the calculated impact is biased severely upward, then the effect on manufacturing employment of removing distorted prices would not be nearly as large. As a consequence, if we take both of these explanations into consideration, the results with respect to the effects of the removal of price distortions on urban unemployment are undoubtedly biased so as to result in a direction of change inconsistent with the predictions of the Todaro model. It is for these reasons that one should not place too much confidence in these results.

SUMMARY AND CONCLUSIONS

Observations made about third world development over the last two or three decades have pointed to three main shortcomings of the overall growth process in many countries; namely, the slow growth of their agricultural sectors, the continued high levels of poverty and inequalities in the distribution of income, and the inability of even growing economies to provide productive employment for their growing labour forces. There are unquestionably many reasons for these shortcomings but some may be traced directly to the set of trade-restricting policies which, on the one hand, were needed to ensure the survival of import substitution industrialization but, on the other hand, left the agricultural sector facing TOT below what it could have obtained if it had been in a position to trade directly with the outside world.

The purpose of this study involved an attempt to measure the comparative static effects of sectoral commodity price distortions in Colombia on the growth of the agricultural sector, income distribution, and the internal migration process. Our main attention was therefore directed toward comparing observed "distorted" levels of agricultural and manufacturing output, employment, and factor income with the levels which would have existed if sectoral production decisions had been made in response to TOT expressed in world prices rather than domestic prices. Two sets of information were required to accomplish this task: 1) the extent to which commodity price distortions exist in the Colombian economy, and 2) the responsiveness of the two sectoral outputs to changes in the TOT.

We saw in Chapter 2 that commodity price distortions in Colombia are largely confined to the manufacturing sector. From estimates of the size of the distortion made by other investigators, it appeared that the domestic price of aggregate factory manufacturing output exceeded the corresponding world price in the early 1960's (1962) by about 100 percent and in the late 1960's (1969) by 47 percent. The decline in the size of the distortion reflected considerable trade liberalization that had occurred over the intervening period. The 1962 figure is a reasonable estimate of the size of the distortion during much of the 1950's. Except for coffee, gaps between world and the domestic prices of agricultural commodities tended to be rather small.[1]

Chapters 4, 5, and 6 were devoted to estimating supply responsiveness in Colombian agriculture. Using a constrained profit maximization adaptive expectations model, developed in Chapter 3 and the first part of Chapter 4, the supply responsiveness of the livestock, coffee, and the aggregate non-coffee crop sub-sectors were estimated. The non-coffee crop sub-sector was then broken down and the supply responsiveness of the seven most important non-coffee crops (corn, cotton, panela, platano, potatoes, and yucca) were also estimated. With one minor exception, the estimated output response elasticities with respect to the TOT faced by producers derived from the regression results were all positive and significant at a non-rejectable level. Estimated values otherwise ranged from less than 0.1 to more than 2.0, with a weighted average short-run and long-run elasticity for the agricultural sector as a whole of 0.21 and 0.80, respectively. The results obtained allowed us to conclude that farmers in Colombia respond in the <u>a priori</u> correct direction to appropriate

[1] In the case of coffee, despite the fact that the world price was 61.5 percent above the domestic producer price, it was impossible to determine whether this gap or part thereof reflected a true distortion or an attempt by Colombia, through it's membership in the International Coffee Organization, to obtain monopoly power in trade. To avoid biased results, the latter was presumed to be the case.

price incentives.[2]

In Chapter 7, we estimated aggregate factory manufacturing responsiveness, also based on a constrained profit maximization model. Regression results yielded an estimated elasticity in excess of 0.4.

In Chapter 8, we combined the information on sectoral estimated responsiveness and the extent of distortions in the TOT which allowed us to calculate for the years 1962 and 1969 the short-run and long-run impact of distortions on agricultural output, employment and nominal factor income. The following table summarizes the aggregate impact and shows the percentage increases that would have occurred if the agricultural sector had been able to trade at world prices.

TABLE C.1

IMPACT OF TOT DISTORTION ON AGGREGATE AGRICULTURAL OUTPUT, EMPLOYMENT, AND INCOME

	1962		1969	
	Short-Run %	Long-Run %	Short-Run %	Long-Run %
Output	18.7	68.1	9.1	33.1
Employment	9.3	29.3	4.6	15.3
Income	23.0	60.4	7.7	29.1

In the case of the modern manufacturing sector, it was calculated that in 1962 and 1969 observed "protected" manufacturing output and employment were 42.7 and 20.1 percent, respectively, above the levels which would have existed in a distortionless environment. The gap between observed nominal factor income and the income that would have existed if the

[2] Moreover, the estimates of responsiveness derived here for each commodity were similar to some subset of estimates obtained for the same commodity by investigators in other countries. As anticipated, the more market-oriented commercialized commodities tended to generate higher response estimates than the more traditional subsistence crops.

manufacturing sector has been forced to face world prices was even more significant with "protected" incomes exceeded "distortionless" incomes by 185 percent in 1962 and 77 percent in 1969. The net effects on GDP expressed in both constant and current prices (assuming all sectors other than agriculture and manufacturing unaffected) were not particularly significant and as noted in the Chapter should be interpreted with caution.

An attempt to estimate the impact of TOT distortions on income distribution was undertaken in Chapter 9. From available evidence, it appears that the existence of distortions in the TOT may have prevented the distribution of intra-agricultural income from becoming worse than it already was, since the larger production units would have tended to benefit most from the removal of such distortions. On the other hand, there seems to be some evidence to indicate that a modern manufacturing sector forced to face world prices would have tended to improve the distribution of urban income. However, available data prevented anything definitive being said about the distribution of national income. The only tentative conclusion we could make with respect to intersectoral redistribution was to the effect that a removal of distortions would tend to lead to a redistribution from the upper urban income groups to the upper rural income groups.

Finally, in Chapter 10, an internal migration response function was estimated. An estimated elasticity of the rate of migration of economically active males with respect to sectoral wage rate differentials of 0.27 was estimated. Assuming constant factor shares in both sectors, it was determined that the long-run migration level of economically active males in 1962 in the absence of TOT distortions would have been a third of the observed level while in 1969 it would have been about 80 percent of the observed level. The effects on the levels of open urban unemployment of an environment in which trade occurred at world prices indicated increased unemployment levels but this conclusion is reached with little confidence.

Before we can make any tentative conclusions about the relationship between the well-being of the agricultural sector and the trade regime in operation in Colombia, a number of qualificating remarks on the results derived in this study must be made.[3] The first major qualification that must be made is the partial equilibrium nature of the results obtained in this study. An attempt at justifying the use of such a model was undertaken in the Introduction to the thesis and at a number of places throughout the text caveats were given as to the biases and inconsistencies which might result from partial equilibrium analysis. Such inconsistencies are particularly obvious when it came to examining the net inter-sectoral effects of commodity price distortions. The results calculated there must be treated with caution. The absence of a general equilibrium model in the estimation of the supply responsiveness of the different crops is less serious a handicap and could be justified to some extent in the context of Colombian agriculture. However, some bias upwards in the elasticity estimates might be expected and to the degree that this is true, the calculations with respect to the effects price distortions have had on the agricultural sector would be biased upward somewhat. However, as explained at the beginning this bias should not be unacceptably large.

Whatever the qualifications we might assign to the agricultural

[3] One cannot be too cautious of course in interpreting the results of an investigation based on third world data in general, and on third world agricultural data in particular. Yet to some extent we are reassured by the fact that much of the data used was based on the extraordinary work of Prof. R. A. Berry in sifting through Colombian raw data to arrive at the most accurate sets of time series possible. Consequently, there is every reason to believe that the data from which the results of this study are derived is the best available.

sector results, the impact on the manufacturing sector of a sudden return to a distortionless environment calculated in this study must be treated with even more caution. The level of aggregation used in estimating manufacturing supply responsiveness yielded results which could be misleading. The reason for this is that we would normally expect changes in the composition of output in the long-run after moving to a world price environment. In this study we have disregarded the fact that the extent of manufacturing price distortions varies within the manufacturing sector itself. Thus we would expect some resource reallocation amongst the various manufacturing sub-sectors. This would tend to lead to changes in the composition of output toward those manufacturing sub-sectors which have a comparative advantage and away from those that do not. In the long-run, after the adjustments have been completed, the possibility exists that aggregate manufacturing output may not have changed significantly at all. Thus, if any interpretation of the responsiveness of the manufacturing sector derived in this study is to be made, it would probably be best to think of it as a short-run impact only.

The second major limitation which must be recognized is that the results obtained in this study form only part of an overall evaluation of protection and as such must not be thought to be a condemnation of the desirability of industrialization via the import substitution route. This thesis has been largely a comparative statics analysis and, as a result, an entire host of dynamic implications stemming from the import substitution process have been ignored. Although we were not concerned with an evaluation of the overall import substitution strategy, one should not interpret this partial evaluation as indicating that protectionist policies in a third world context always affect non-manufacturing sectors adversely or lower growth rates, or that import substitution does not yield welfare gains of a dynamic nature which may offset the static welfare losses of the price distortions calculated in this study. The fact that third world countries at some stage generally pursue import substitution policies of some sort must reflect a real desire for industrialization and the dynamic economic gains associated with it.

These gains are, of course, the main justification for the "infant industry" argument for the level of tariff protection needed to allow import substitution industrialization to take hold. In this sense, "industrialization is simply a proxy for concomitant changes in labour productivity, technological diffusion, 'learning by doing' and the resulting economic environment which appears to be relatively more conducive to development."[4] The pursuit of these long-run gains would naturally tend to result in the failure to realize in some countries certain conditions for static efficiency which arise out of the neo-classical paradym. Yet sufficient evidence exists to the effect that in the long-run certain dynamic benefits accrue to many countries through, for example, the learning process that arises from the structural changes associated with industrialization.

Unquestionably, import substitution policies have not been a panacea for the economic ills of the third world and the intensity of the attacks on such policies found in a large subset of the development literature may in part be a reflection of unrealistic expectations as to what import substitution industrialization was supposed to accomplish. To suggest that the structural changes to economic activity stemming from industrialization

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[4]Ahmad, Jaleel, Import Substitution, Trade and Development, Contemporary Studies in Economic and Financial Analysis Vol. II, Jai Press, Greenwich, Connecticut, 1978, p. 3.

should have been costless is naive but whatever the costs are, they may be less than the costs to a society for not having undertaken the changes.[5]

The objective of this study has been to examine within a restricted framework a limited subset of the static costs which could potentially arise out of the pursuit of industrialization behind high tariff barriers. In doing this, we are not suggesting that import substitution is undesirable but rather that as a development strategy it is not costless and may not leave the welfare of other sectors of the economy unaffected. The results reached in this study, despite the weaknesses inherent in a partial equilibrium comparative statics analytical framework, do seem to point to the conclusion that the agricultural sector in Colombia not only did not share equally in the fruits of industrialization but in all probability suffered a static welfare loss of a significant magnitude. Whether these losses were offset by gains elsewhere in the economy was not the concern of this study.

In fact, recent efforts by many countries including Colombia to open up their economies may be indicative of an increased realization that development over the long-run may be best achieved through a fostering of comparative advantage rather than its disavowal. However, this should be qualified by the observation that many of those countries which have commenced a more open policy have absorbed a sufficient level of dynamic benefits from import substitution programmes that they are now in a position to withstand the test of international competition. The suggestion that in the long-run third world countries should move

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[5]Op. cit., p. 93.

toward a world price environment is not the same thing as advocating the implement the "Chilean Option" and one should not attempt to interpret the results obtained in this study as an indication of what would occur if Colombia had dismantled in one quantum move the entire array of trade-restricting policies to return to an economy governed by world prices.

If some sort of justification can be found for this study, it might be in at least suggesting to countries now considering industrialization programmes the possibility that import substitution may not be costless and that such costs may weigh most heavily on those members of society who derive their livelihood from agriculture.

BIBLIOGRAPHY*

Adelman, I. and Taft-Morris, C., "An Econometric Model of Socio-Economic and Political Change in Underdeveloped Countries," American Economic Review, Vol. 58, No. 5, December 1968, pp. 1184-1218.

Adelman, I. and Taft-Morris, C., "An Anatomy of Income Distribution Patterns in Developing Nations - A Summary of Findings", Mimeo, Development Research Centre, World Bank, Working Paper No. 116, September 1971.

Adelman, I. and Taft-Morris, C., "Who Benefits from Economic Development?", in Planning Income Distribution Private Foreign Investment, OECD, Development Centre, Paris, 1974.

Ahluwalia, M.S., "Income Distribution and Development: Some Stylized Facts", Mimeo, Development Research Centre, World Bank, Washington, December 1975.

Allande, L.B., "Regional Agricultural Growth and Economic Development", in Islam, N., (ed.), Agricultural Policy in Developing Countries, The MacMillan Press Ltd., 1974, pp. 363-380.

Anand, S., "Input-Output Analysis Applied to Employment: A Case Study of Yugoslavia", Mimeo, Economics Department, World Bank, April 1972.

Askari, H. and Cummings, T., "Estimating Agricultural Supply Response with the Nerlove Model: A Survey", International Economic Review, Vol. 18, No. 2, 1977, pp. 257-292.

Askari, H. and Cummings, T., Agricultural Supply Response: A Survey of the Econometric Evidence, Praeger, New York, 1976.

Baer, W. and Hervé, M.E.A., "Employment and Industrialization in Developing Countries", Quarterly Journal of Economics, Vol. 80, No. 1, February 1966, pp. 88-107.

Bardhan, K., "Price and Output Response of Marketed Surplus of Foodgrains: A Cross-Sectional Study of Some North Indian Villages, American Journal of Agricultural Economics, Vol. 52, No. 1, February 1970, pp. 51-61.

*See also Bibliography on data sources at the end of the Data Appendix.

Bardhan, P. and Bardhan, K., "Price Response of Marketed Surplus of Foodgrains", Oxford Economic Papers, Vol. 23, No. 2, July 1971, pp. 255-267.

Bateman, M., "Aggregate and Regional Supply Functions for Ghanaian Cocoa, 1946-62", Journal of Farm Economics, Vol. 47, May 1965, pp. 384-401.

Bateman, M., "Supply Response in the Colombian Coffee Sector", Prepared for A.I.D., Rand Corporation, Memo RM-5780-RC/AID. October 1969.

Behrman, J., Supply Responses in Underdeveloped Agriculture, North-Holland Publishing Co., Amsterdam, 1968.

Behrman, J., "Monopolistic Cocoa Pricing", American Journal of Agricultural Economics, Vol. 50, August 1968, pp. 702-719.

Berry, A., "A Positive Interpretation of the Expansion of Urban Services in Latin America, with some Colombian Evidence", (Mimeo), undated.

Berry, A., "Changing Income Distribution Under Development: Colombia", Review of Income and Wealth, September 1974, pp. 289-316.

Berry, A., "Constant Utilization of the Labour Force Despite Rising Open Unemployment in Colombia", Journal of Economic Studies, Vol. 2. No. 2, November 1975, pp. 114-130.

Berry, A., "Factor Proportions and Urban Employment in Developing Countries", International Labour Review, Vol. 109, No. 3, March 1974a, pp. 217-233.

Berry, A., "Farm Size Distribution, Income Distribution, and the Efficiency of Agricultural Production: Colombia", American Economic Review, Vol. 62, No. 2, May 1972, pp. 403-408.

Berry, A., "On the Efficiency of the Migration Process in Colombia", (Mimeo), undated.

Berry, A., "Open Unemployment as a Social Problem in Urban Colombia: Myth and Reality", Economic Development and Cultural Change, Vol. 23, No. 2, January 1975b, pp. 276-291.

Berry, A., "Urban Labour Surplus and the Commerce Sector: Colombia", Economic Growth Center, Discussion Paper No. 178, Yale University, June 1973.

Berry, A., "Wage Employment, Dualism, and Labour Utilization in Colombia: Trends over Time", The Journal of Developing Areas, Vol. 9, No. 4, July 1975a, pp. 563-576.

Berry, A., and Soligo, R., "Rural-Urban Migration, Agricultural Output, and the Supply Price of Labour in a Labour Surplus Economy", Oxford Economic Papers, Vol. 20, No. 2, July 1968, pp. 230-249.

Berry, A., and Thoumi, F., "Import Substitution and Beyond: Colombia", World Development, Vol. 5, 1977, pp. 89-109.

Berry, A., and Urrutia, M., Income Distribution in Colombia, Yale University Press, New Haven, 1976.

Bird, R.M., Taxation and Development: Lessons from Colombian Experience, Harvard University Press, Cambridge, 1970.

Bhagwati, J.N., and Srinivasan, T.N., "On Reanalyzing the Harris-Todaro Model: Rankings in the case of a Sector Specific Sticky Wages", American Economic Review, Vol. 64, 1974, pp. 502-508.

Blomqvist, A.G., "Urban Job Creation and Unemployment in LDC's", Journal of Development Economics, Vol. 4, 1977, pp. 3-18.

Brigg, P., "Some Economic Interpretations of Case Studies of Urban Migration in Developing Countries", Mimeo, Development Economics Department, World Bank, Working Paper No. 151, March 1973.

Bruno, M., "A Programming Model for Isreal", in Adelman, I. and Thorbecke, E., The Theory and Design of Economic Development, The John Hopkins Press, Baltimore and London, 1966, pp. 327-356.

Bruton, H.J., "Economic Development and Labour Use: A Review", in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 49-82.

Carynnyk-Sinclair, N., "Rural to Urban Migration in Developing Countries, 1950-1970: A Survey of the Literature", ILO World Employment Program Working Paper, February 1974.

Chenery, H.B., et al, Redistribution with Growth, Oxford University Press, London, 1974.

Cline, W.R., Potential Effects of Income Redistribution on Economic Growth - Latin American Cases, Praeger Publishers, New York, 1972.

Contini, B., "Conflicts Between Output and Employment in Planning: Empirical Evidence from the Agriculture of Northern Italy", Oxford Economic Papers, Vol. 26, No. 1, March 1974, pp. 54-65.

Currie, L., "The Exchange Constraint on Development - A Partial Solution to the Problem", Economic Journal, Vol. 81, No. 324, December 1971, pp. 886-903.

Dasgupta, P., Marglin, S. and Sen, A., Guidelines for Project Evaluation, Project Formulation and Evaluation Series, No. 2, UNIDO, Vienna, New York, 1972.

de Melo, J., "The Effects of Distortions in the Factor Market: Some General Equilibrium Estimates", A.I.D. Discussion Paper No. 34, July, 1976.

de Melo, J., "Estimating the Costs of Protection: A General Equilibrium Approach", A.I.D., December 1975.

de Melo, J., "A General Equilibrium Approach to Estimating the Costs of Domestic Distortions", American Economic Review, Vol. 67, No. 1, 1977, pp. 423-427.

de Melo, J., "Measuring the Effects of Protection on Resource Allocation", A.I.D. Discussion Paper No. 35, August 1976.

de Melo, J., A Multi-Sector, Price Endogeneous Trade Model Applied to Colombia, A.I.D., May 1975.

de Melo, J., "Protection and Resource Allocation in a Walrasian Trade Model", International Economic Review, Vol. 19, No. 1, 1978, pp. 25-43.

Diaz-Alejandro, C., Foreign Trade Regimes and Economic Development: Colombia, NBER, New York, 1976.

Dixit, A., "Short-Run Equilibrium and Shadow Prices in the Dual Economy", Oxford Economic Papers, Vol. 23, No. 3, November 1971, pp. 384-400.

Dixit, A., and Stern, N., "Determinants of Shadow Prices in Open Dual Economies", Oxford Economic Papers, Vol. 26, No. 1, March 1974, pp. 42-53.

Dorfman, R., "An Economic Interpretation of Optimal Control Theory", American Economic Review, Vol. 59, No. 5, December 1969, pp. 817-831.

Dow, J.K., Colombia's Foreign Trade and Economic Integration in Latin America, University of Florida Press, Gainesville, 1971.

Dubey, V., "The Marketed Agricultural Surplus and Economic Growth in Underdeveloped Countries", Economic Journal, Vol. 73, No. 4, December 1963, pp. 689-702.

Eckaus, R.S., "The Factor Proportions Problem in Underdeveloped Areas", American Economic Review, Vol, 45, No. 4, September 1955, pp. 539-565.

Edwards, E.O., "Employment in Developing Countries", in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 1-46.

Encarnacion, J., "On Appropriate Technology, Saving and Employment", Journal of Development Economics, Vol. 1, No. 1, June 1974, pp. 71-80.

Falcon, W., "Farmer Response to Price in a Subsistence Economy: The Case of West Pakistan", American Economic Review, Vol. 54, No. 3, May 1964, pp. 580-591.

Falcon, W., "The Green Revolution: Generations of Problems", American Journal of Agricultural Economics, Vol. 52, No. 5, November 1970, pp. 698-709.

Fei, J., and Ranis, G., "A Model of Growth and Employment in the Open Dualistic Economy: The Cases of Korea and Taiwan", The Journal of Development Studies, Vol. 11, No. 2, January 1975, pp. 32-63.

Fields, G.S., "Rural-Urban Migration, Urban Unemployment and Job Search Activity in LDC's", Journal of Development Economics, Vol. 2, No. 2, 1975, pp. 165-187.

Flanders, M.J., "Agriculture vs. Industry in Development Policy: The Planner's Dilemma Re-examined", Journal of Development Studies, Vol. 5, No. 3, April 1969, pp. 171-189.

Galenson, W. and Leibenstein, H., "Investment Criteria, Productivity, and Economic Development", Quarterly Journal of Economics, Vol. LXIX, No. 3, August 1955, pp. 343-370.

Guha, A., "Accumulation, Innovation, and Growth under Conditions of Disguised Unemployment", Oxford Economic Papers, Vol. 21, No. 3, November 1969, pp. 360-372.

Gotsch, C., "Economics, Institutions and Employment Generation in Rural Areas", in Edwards, E.O., Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 133-162.

Gotsch, C.H., "Tractor Mechanization and Rural Development in Pakistan", International Labour Review, Vol. 107, No. 2, February 1973, pp. 133-153

Griffin, K., "Rural Development: The Policy Options" in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 181-200.

Hansen, B., "Employment and Wages in Rural Egypt", American Economic Review, Vol. 59, No. 3, June 1969, pp. 298-313.

Harris, J.R., and Todaro, M.P., "Migration, Unemployment, and Development: A Two-Sector Analysis", American Economic Review, Vol. 60, No. 1, March 1970, pp. 126-142.

Harris, J.R. and Todaro, M.P., "Wages, Industrial Employment, and Labour Productivity: The Kenyan Experience", East African Economic Review, Vol. 1, No. 1, June 1969, pp. 29-46.

Hawrylyshyn, O., "Biases Towards Capital-Intense Techniques and the Employment Problem in LDC's", Institute for Economic Research, Discussion Paper 187, Queen's University, September 1975.

Hawrylyshyn, O., "The Causes of Under-Employment in Developing Economies", Mimeo, Institute for Economic Research, Discussion Papers 173 and 174, Queen's University, 1975.

Hayami, Y. and Ruttan, V.M., Agricultural Development: An International Perspective, The John Hopkins Press, Baltimore and London, 1971.

Hazari, B.R. and Krishnamurty, H., "Employment Implications of India's Industrialization: Analysis in an Input-Output Framework", Review of Economics and Statistics, Vol. 52, No. 2, May 1970, pp. 181-186.

Healey, D.T., "Development Policy: New Thinking About an Interpretation", Journal of Economic Literature, Vol. 10, No. 3, September 1972, pp. 757-797.

Helleiner, G.K., International Trade and Economic Development, Penguin Modern Economics Texts, (1972).

Herdt, R., "A Disaggregate Approach to Aggregate Supply", American Journal of Agricultural Economics, Vol. 52, No. 5, November 1970, pp. 512-520.

Hirschman, A.O., The Strategy of Economic Development, Yale University Press, New Haven, 1958.

Hornby, J.M., "Investment and Trade Policy in the Dual Economy", Economic Journal, Vol. 78, No. 309, March, 1968, pp. 46-107.

Hsieh, C., "Approaches to Fixing Employment Targets in Development Plans", International Labour Review, Vol. 97, NO. 3, March 1968, pp. 273-296.

Hughes, H., "The Scope for Labour Capital Substitution in the Developing Economies of Southeast and East Asia: A Sectoral Approach", Mimeo, Development Economics Department, World Bank, Working Paper No. 140, January 1973.

International Labour Office, Towards Full Employment: A Programme for Colombia, Geneva, (1970).

Intrilligator, M., Mathematical Optimization and Economic Theory, Prentice-Hall, Englewood Cliffe, N.J., (1971).

Jain, S., "The Size Distribution of Income: A Compilation of Data", Mimeo, Development Research Centre, World Bank, Working Paper No. 190, November 1974.

Jarvis, L.S., "The Limited Value of Employment Policies for Income Inequality", in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 165-179.

Johansen, L., A Multi-Sectoral Study of Economic Growth, Second Edition, North-Holland Publishing Co., Amsterdam, 1974.

Johnston, B.F., "Agriculture and Structural Transformation in Developing Countries: A Survey of Research", Journal of Economic Literature, Vol. 8, No. 2, June 1970, pp. 369-404.

Johnston, B.F., and Cownie, J., "The Seed-Fertilizer Revolution and Labour Force Absorption", American Economic Review, Vol. 59, No. 3, September 1969, pp. 569-582.

Johnston, B.F., and Kilby, P., "Interrelations between Agricultural and Industrial Growth", in Islam, N., (ed.), Agricultural Policy in Developing Countries, The MacMillan Press Ltd., London, 1974, pp. 41-57.

Johnston, B.F., and Mellor, J.W. "The Role of Agriculture in Economic Development", American Economic Review, Vol. 51, No. 4, September 1961, pp. 566-593.

Jorgenson, D.W., "The Development of a Dual Economy", The Economic Journal, Vol. 71, No. 282, June 1961, pp. 309-334.

Jorgenson, D.W., "Surplus Agricultural Labour and the Development of the Dual Economy", Oxford Economic Papers, Vol. 19, No. 3, November 1967, pp. 288-312.

Jorgenson, D.W., "Testing Alternative Theories of the Development of a Dual Economy", in Adelman, I., and Thorbecke, E., (eds.), The Theory and Design of Economic Development, The John Hopkins Press, Baltimore, 1966, pp. 45-60.

Krishna, R., "Agricultural Price Policy and Economic Development", in Southworth, H., and Johnston, B., (eds.), Agricultural Development and Economic Growth, Cornell University Press, Ithaca, New York, 1967, pp. 497-540.

Krishna, R., "Farm Price Response in India - Pakistan: A Case Study of the Punjab Region", Economic Journal, Vol. 73, No. 3, September 1963, pp. 477-487.

Krishna, R., "Measurement of the Direct and Indirect Employment Effects of Agricultural Growth with Technical Change", in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, London and New York, 1974, pp. 273-295.

Lancaster, K.J., "A New Approach to Consumer Behaviour", Journal of Political Economy, Vol. 74, No. 2, April 1966, pp. 132-157.

Lau, L.J., and Yotopoulos, P.A., "Profit, Supply and Factor Demand Functions", American Journal of Agricultural Economics, Vol. 54, 1972, pp. 11-18.

Lefeber, L., "Planning in a Surplus Labour Economy", American Economic Review, Vol. 58, No. 3, June 1968, pp. 343-373.

Lewis, Jr., S.R., "Agricultural Taxation in a Developing Economy", in Southworth, H., and Johnston, B., (eds.), Agricultural Development and Economic Growth, Cornell University Press, Ithaca, New York, 1967, pp. 453-492.

Lewis, Jr., S.R., "Effects of Trade Policy on Domestic Relative Prices: Pakistan, 1951-64", American Economic Review, Vol. 58, No. 1, March 1968, pp. 60-78.

Lewis, W.A., "Economic Development with Unlimited Supplies of Labour", The Manchester School, May 1954, Reprinted in Agarwala, A.N., and Singh, S.P. (eds.), The Economics of Underdevelopment, Oxford University Press, 1963, pp. 400-449.

Little, I., Scitovsky, and Scott, M., Industry and Trade in Some Developing Countries, OECD Development Centre, Paris, 1970.

McKinnon, R.I., Money and Capital in Economic Development, The Brookings Institute, 1973.

Mellor, J., "Toward a Theory of Agricultural Development", in Southworth, H., and Johnston, B., (eds.), Agricultural Development and Economic Growth, Cornell University Press, Ithaca, New York, 1967, pp. 21-60.

Mellor, J.W., "Models of Economic Growth and Land-Augmenting Technical Change in Foodgrain Production", in Islam, N. (ed.), Agricultural Policy in Developing Countries, The MacMillan Press Ltd., London, 1974, pp. 3-30.

Mellor, J., and Lele, U., "Growth Linkages of the New Foodgrain Technologies", Occasional Paper No. 50, Department of Agricultural Economics, Cornell University Press, Ithaca, New York, May 1972.

Morawetz, D., "Employment Implications of Industrialization in Developing Countries: A Survey", Economic Journal, Vol. 84, No. 335, September 1974, pp. 491-542.

Morely, S., and Williamson, J., "The Impact of Demand on Labour Absorption and the Distribution of Earnings: The Case of Brazil", Mimeo, Paper No. 39, Program of Developing Studies, Rice University, Houston, Spring 1973.

Nerlove, M., "Estimates of Elasticities of Supply of Selected Agricultural Commodities", The Journal of Farm Economics, Vol. 37, 1956, pp. 496-509.

Newbery, D., "The Robustness of Equilibrium Analysis in the Dual Economy", Oxford Economic Papers, Vol. 26, No. 1, March 1974, pp. 32-41.

Oshima, H.T., "The Ranis-Fei Model of Economic Development: Comment", American Economic Review, Vol. 53, No. 3, June 1963, pp. 448-452.

Pack, H. and Todaro, M., "Technological Transfer, Labour Absorption, and Economic Development", Oxford Economic Papers, Vol. 21, No. 3, November 1969, pp. 395-403.

Paglin, M., "Surplus Agricultural Labour and Development: Facts and Theories", American Economic Review, Vol. 55, No. 4, September 1965, pp. 815-833.

Paukert, P., "Income Distribution at Different Levels of Development A Survey of Evidence", International Labour Review, Vol. 108, 1974.

Ranis, G., "Industrial Sector Labour Absorption", Economic Development and Cultural Change, Vol, 21, No. 3, April 1973, pp. 387-408.

Ranis, G., "Output and Employment in the Seventies: Conflict or Complements", in Ridker, H., and Lubell, H., (eds.), Employment and Unemployment Problems of the Near East and South Asia, Vol. 1, Vikas, 1971, pp. 59-76.

Ranis, G., and Fei, J.H.C., "Agrarianism, Dualism, and Economic Development", in Adelman, I., and Thorbecke, E., (eds.), The Theory and Design of Economic Development, The John Hopkins Press, Baltimore, 1966, pp. 3-41.

Ranis, G., and Fei, J.H.C., "The Ranis-Fei Model of Economic Development: Reply", American Economic Review, Vol. 53, No. 3, June 1963, pp. 452-454.

Ranis, G., and Fei, J.H.C., "A Theory of Economic Development", American Economic Review, Vol. 51, No. 4, September 1961, pp. 533-558.

Rao, C.H.H., "Employment Implications of the Green Revolution and Mechanization: A Case Study of the Punjab", in Islam, N., (ed.), Agricultural Policy in Developing Countries, The MacMillan Press Ltd., 1974, pp. 340-350.

Rao, V.K.R.V., "Investment, Income and the Multiplier in an Underdeveloped Economy", Indian Economic Review, February 1952, Reprinted in Agarwala, A.N. and Singh, S.P., The Economics of Underemployment, Oxford University Press, New York, 1963, pp. 205-218.

Reynolds, L.G., "Economic Development with Surplus Labour: Some Complications", Oxford Economic Papers, Vol. 21, No. 1, March 1969, pp. 88-103.

Reynolds, L.G., "Wages and Employment in Labour-Surplus Economy", American Economic Review, Vol. 55, No. 1, March 1965, pp. 19-39.

Robinson, W.C., "Types of Disguised Rural Unemployment and Some Policy Implications", Oxford Economic Papers, Vol. 21, No. 3, November 1969, pp. 373-386.

Ruttan, V., Mangahas, M., and Recto, A., "Price and Market Relations for Rice and Corn in the Philippines", Journal of Farm Economics, Vol. 48, No. 4, August 1966, pp. 685-703.

Sandee, J., "A Programming Model for a Dual Economy", in Thorbecke, E., (ed.), The Role of Agriculture in Economic Development, NBER, New York, 1969, pp. 219-230.

Sen, A., Choice of Techniques, Third Edition, Oxford, Basil Blackwell, 1968.

Sen, A.K., Employment, Technology and Development, Clarendon Press, Oxford, 1975.

Sen, A.K., "Peasants and Dualism with or without Surplus Labour", The Journal of Political Economy, Vol. 74, No. 5, October 1966, pp. 425-450.

Shaw, R., Jobs and Agricultural Development, Monograph No. 3, Overseas Development Council, Washington, D.C., 1970.

Soligo, R., "Factor, Intensity of Consumption Patterns, Income Distribution and Employment Growth in West Pakistan", Mimeo, Rice University Program of Development Studies, November 1972.

Soligo, R., "Interpreting Domestic Terms of Trade Changes in Pakistan", Mimeo, Program of Development Studies, Paper No. 11, Rice University, Houston, 1971.

Soligo, R., and Land, J.W., "Income Distribution and Employment in Labour Redundant Countries", Mimeo, Program of Development Studies, Paper No. 9, Rice University, Houston, 1971.

Soligo, R., and Land, J.W., "Models of Development Incorporating Distribution Aspects", Mimeo, Program of Development Studies, Paper No. 22, Rice University, Houston, 1972.

Solow, R.M., Growth Theory: An Exposition, Oxford, (1970)

Stewart, F., "Choice of Techniques in Developing Countries", Journal of Development Studies, Vol. 9, No. 1, October 1972, pp. 99-121.

Stewart, F., "Technology and Employment in LDC's" in Edwards, E.O., (ed.), Employment in Developing Nations, Report on a Ford Foundation Study, Columbia University Press, New York and London, 1974, pp. 83-132.

Stewart, F., and Streeten, P., "Conflicts between Output and Employment Objectives in Developing Countries", Oxford Economic Papers, Vol. 23, No. 2, July 1971, pp. 145-168.

Stewart, F., and Weeks, J., "The Employment Effects of Wage Changes in Poor Countries", Mimeo, Economic Department, Birbeck College, University of London, May 1973.

Stiglitz, J.E., "Alternative Theories of Wage Determination and Unemployment in LDC's: The Labour Turnover Model", Quarterly Journal of Economics, Vol. 88, 1974, pp. 1153-1169.

Stiglitz, J.E., "Rural-Urban Migration, Surplus Labour, and the Relationship between Urban and Rural Wages", East Africa Economic Review, Vol. 1, No. 2, December 1969, pp. 1-27.

Stoutjeskijk, A., "Employment and Income Distribution in Peru", Mimeo, Development Research Centre, World Bank, 1973.

Streeten, P.P., "A Critique of Development Concepts", European Journal of Sociology", Vol. 11, No. 1, 1970.

Taylor, L., "Short-Term Policy in Open Semi-Industrialized Economies", Journal of Development Economics, Vol. 1, No. 2, September 1974, pp. 85-104.

Taylor, L., and Black, S.L., "Practical General Equilibrium Estimation of Resource Pulls under Trade Liberalization", Journal of International Economics, No. 4, 1974, pp. 37-58.

Thorbecke, E., "The Employment Problem: A Critical Evaluation of Four ILO Comprehensive Country Reports", International Labour Review, Vol. 107, No. 5, May 1973, pp. 393-423.

Thorbecke, E., and Field, A.J., "Relationships Between Agriculture, Nonagriculture and Foreign Trade in the Development of Argentina and Peru", in Thorbecke, E., (ed.), The Role of Agriculture in Economic Development, NBER, New York, 1969.

Thorbecke, E., and Sengupta, J., "A Consistency Framework for Employment, Output and Income Distribution Projections Applied to Colombia", Mimeo, Development Research Centre, World Bank, January 1972.

Todaro, M., "Income Expectations, Rural-Urban Migration and Employment in Africa", International Labour Review, Vol. 104, No. 5, November 1971, pp. 387-413.

Todaro, M.P., "A Model of Labour Migration and Urban Unemployment in Less Developed Countries", American Economic Review, Vol. 59, No. 1, March 1969, pp. 138-148.

Todaro, M.P., "Rural-Urban Migration, Unemployment and Job Probabilities: Recent Theoretical and Empirical Research", in Coale, A.J., (ed.), Economic Factors in Population Growth, MacMillan, London, 1976b, pp. 367-385.

Todaro, M.P., "Urban Job Expansion, Induced Migration and Rising Unemployment: A Formulation and Simplified Empirical Test for LDC's", Journal of Development Economics, Vol. 3, No. 3, 1976a, pp. 211-225.

Tokman, V.E., "Income Distribution, Technology and Employment in Developing Countries: An Application to Ecuador", Journal of Development Economics, Vol. 2, No. 1, March 1975, pp. 49-80.

Tolley, G., and Gwyer, G., "International Trade in Agricultural Products in Relation to Economic Development", in Southworth, H., and Johnston, B., (eds.), Agricultural Development and Economic Growth, Cornell University Press, Ithaca, New York, 1967, pp. 403-447.

Turnham, D., and Jaeger, I., The Employment Problem in Less Developed Countries: A Review of Evidence, OECD, Paris, 1971.

Uppal, J.S., "Work Habits and Disguised Unemployment in Underdeveloped Countries - A Theoretical Analysis", Oxford Economic Papers, Vol. 21, No. 3, November 1969, pp. 387-394.

Ward. R.J., "Absorbing More Labour in LDC Agriculture", Economic Development and Cultural Change, Vol. 17, No. 2, January 1969, pp. 178-188.

Weisskoff, R., "Income Distribution and Economic Growth in Puerto Rico, Argentina, and Mexico", Review of Income and Wealth, December 1970, pp. 303-332.

Winston, G.C., "Factor Substitution, Ex Ante and Ex Post", Journal of Development Economics, Vol. 1, No. 2, September 1974, pp. 145-163.

Yotopoulos, P.A. and Lau, L.J., "On Modeling the Agricultural Sector in Developing Economics", Journal of Development Economics, Vol. 1, No. 2, September 1974, pp. 105-127.

Yotopoulos, P.A. and Nugent, J.B., Economics of Development: Empirical Investigations, Harper and Row, New York, 1976.

APPENDIX

This Appendix provides in tabular form most of the data used in this study. The sources of the data as well as interpretive notes on the data are also provided.

TABLE A.3 - Cont'd.

KEY LIVESTOCK DATA

Year	5 Price of intermediate inputs in livestock (1959 = 100)	6 Rental rate or user cost of capital for livestock Series A	7 Rental rate or user cost of capital for livestock Series B
45	36.5	2.32	2.76
46	41.7	2.49	3.05
47	50.3	3.29	3.99
48	55.9	3.44	4.21
49	59.9	4.22	4.99
50	63.7	4.54	5.18
51	64.4	5.45	6.16
52	55.0	5.95	6.57
53	60.6	6.27	6.97
54	70.3	6.95	7.64
55	68.7	7.09	7.81
56	71.2	7.33	8.04
57	88.7	9.01	9.39
58	100.0	11.00	11.00
59	120.3	12.62	12.52
60	135.3	13.63	13.54
61	146.2	14.02	13.79
62	163.7	14.77	14.34
63	210.4	22.21	21.51
64	224.3	25.14	24.49
65	246.9	29.26	27.82
66	275.4	34.90	32.89
67	285.6	39.04	36.62
68	302.5	41.83	38.59
69	325.5	44.77	40.96
70	365.2	73.87	68.60
71	410.5	83.96	77.68
72	465.1	97.68	92.40
73	579.0	123.89	119.58
74	784.5	175.14	170.36
75	988.5	204.19	196.18

Table A.3 - Notes on the Data and their Sources

Cols.

1 (1), Table A-1, 1945-1969. The 1970-1975 observations were provided by A. Berry, verbally.

2 Column (1) minus the value of intermediate inputs employed. Data on the value of intermediate inputs come from (1), Table A-95b, 1950-1959. The 1967-1975 observations were provided by A. Berry, verbally. For the 1945-1949 and 1961-1966 periods, it was assumed that value added was 0.85 of gross output.

3 (1), Table A-2, 1945-1966. The observations for 1967 to 1975 were provided by A. Berry, verbally.

4 (1), Table A-10, 1945-1949. (1), Table A-16, 1950-1970. (6) provided the data for 1971-1975.

5 (1), Table A-95b, 1950-1959. Since these were the only observations available, a proxy for the other years was employed and spliced on to the 1950-1959 data. Five proxies were tested and the one with the highest correlation coefficient with the available 1950-1959 data was used. This was the price of factory manufacturing value added. The coefficient was 0.98.

6 The rental rate or user cost of captial stock of cattle farmers. It was calculated using a price index of investment (PIL), and interest rate (r) and a rate of depreciation (δ), that is $VL_t = PIL_t \cdot (r_t + \delta_t)$. On the advice of A. Berry, δ_t was assumed constant at 0.04. Few observations were available on the interest rate. However, farmers do obtain a favoured interest rate and from the data available, it appears on average to be about two percentage points above the Central Bank rediscount rate. Since a series on the rediscount rate is available, r_t was calculated using that plus two percentage points. The capital stock of cattle raisers is comprised of about 60 percent cattle and 40 percent "other", that is, barns, fences, land improvements, etc. Using the foregoing as weights, the price index of investment was calculated as a weighted average of the price of livestock output (as a proxy for the price of investment in cattle) and the price of gross domestic investment (as calculated in the national accounts) as representing the price of "other" investment.

7 Identical with column (6) except the price of factory manufacturing output rather than the price of gross domestic investment was used as a proxy for the price of investment in "other" capital.

TABLE A.4

KEY AGGREGATE NON-COFFEE CROP DATA

Year	1 Total value of non-coffee crop output in constant 1958 prices*	2 Total non-coffee crop value added in constant 1958 prices*	3 Price of non-coffee crop output (1958 = 100)	4 Land in non-coffee crops Series A (thousands hectares)
45	1657	1499	32.3	
46	1864	1694	34.1	
47	1891	1714	39.0	
48	1798	1624	43.1	1780
49	2308	2113	42.7	1876
50	2092	1910	57.5	1754
51	2183	1960	61.6	1970
52	2530	2299	54.4	2103
53	2421	2199	49.9	1952
54	2677	2393	71.1	2050
55	2734	2421	66.2	2194
56	2446	2126	73.0	2188
57	2250	1894	90.4	1997
58	2726	2385	100.0	2076
59	3082	2781	107.8	2170
60	3293	2977	109.6	2213
61	3135	2764	125.1	2196
62	3701	3298	125.8	2299
63	3347	2914	168.4	2262
64	3585	3128	229.2	2426
65	3864	3329	222.6	2619
66	3998	3372	256.0	2620
67	4255	3618	261.8	2489
68	4633	3968	286.2	2492
69	4839	4007	307.4	2639
70	5155	4263	267.1	2630
71	5308	4415	309.4	2473
72	5676	4688	356.6	2557
73	5921	4809	471.7	
74	6688	5485	577.4	
75	7111	5829	635.1	

*Millions of Colombian Pesos.

TABLE A.4 - Cont'd.

KEY AGGREGATE NON-COFFEE CROP DATA

Year	5 Land in non-coffee crops Series B (thousands hectares)	6 Price of intermediate inputs in non-coffee crops (1958 = 100)	7 Rental rate or user cost of capital in non-coffee crops
45		31.6	3.41
46		36.0	3.88
47		43.2	4.66
48	1954	48.4	5.22
49	2060	50.9	5.49
50	1926	51.9	5.60
51	2111	53.4	6.53
52	2349	51.0	6.51
53	2246	57.4	6.64
54	2203	56.0	6.83
55	2371	54.0	7.12
56	2345	56.6	7.69
57	2321	72.5	9.21
58	2494	100.0	11.00
59	2542	104.4	11.74
60	2587	110.4	12.41
61	2542	114.0	12.82
62	2739	121.0	13.60
63	2667	153.6	21.97
64	2714	166.5	23.81
65	2901	181.7	25.98
66	2903	212.6	30.41
67	2919	236.0	33.73
68	2881	252.8	36.11
69	3045	274.0	39.14
70	3037	301.9	61.64
71	2863	338.1	69.06
72	2957	392.2	80.12
73		475.0	97.02
74		660.7	148.50
75		810.7	182.23

Table A.4 - Notes on the Data and their Sources

Cols.

1 Total value of crop output minus the value of coffee output (in constant prices). Data on the total value of crop output comes from (1), Table A-1, 1945-1969, and from A. Berry, verbally, 1970-1975.

2 Total value of non-coffee crop output minus the value of intermediate inputs used in non-coffee crops (in constant prices). Data on intermediate input values for 1950-1959 come from (1), Table A-95b. For the years 1967-1975, the data was obtained from A. Berry, verbally. These missing observations (1945-1949 and 1960-1966) were calculated by extrapolation using the ratio of value added (for the known years) to total output.

3 (1), Table A-2, 1945-1966. For the years 1967-1974, the price of non-coffee crop was calculated from the weighted difference between total crop prices and coffee prices and spliced on to the 1945-1966 non-coffee price series. Total crop prices for the years 1967-1975 were provided by A. Berry, verbally.

4 (1), Table A-153, 1948-1968. The 1969-1972 observations were provided by A. Berry, verbally.

5 (4), "Cuadro" 2.6, 1950-1972. The 1948-1949 observations were obtained by splicing on the appropriate years in column (4).

6 (1), Table A-95a, 1950-1959. No other observations were available so a proxy was used for the missing years and spliced on to the 1950-1959 data. Five proxies were tested and the one with the highest correlation coefficient with the available 1950-1959 data was used. This was the price of manufacturing output except coffee threshing. The correlation coefficient was .9792.

7 Rental rate or user cost of capital stock of non-coffee crop cultivators. This was calculated using the equation: $\dot{V}_t = PI_t (r_t + \delta_t)$ where PI_t is the price of investment in non-coffee crop capital, r_t is the interest rate and δ_t is the depriciation rate. At the suggestion of A. Berry, δ_t was assumed constant at .04. Few observations were available on r_t. However, farmers do obtain a preferred interest rate which from the data available averages about two percentage points above the Central Bank rediscount rate. Since a complete series on the rediscount rate is available, r_t was derived using that series plus two percentage points. There is no data on the price of investment and, as a result, the price of manufacturing output except coffee threshing was used as a proxy. This price series was taken from (7), Table A-105a and A-105b for 1950 to 1972. For 1945 to 1949, the price of manufacturing value added with the price of threshed coffee

Table A.4 - Notes on the Data and their Sources Cont'd.

Cols.

7 removed was used. The weight given to coffee threshing was .2. For the years 1973 and 1974, the same basic technique was used but with a lower weight for coffee threshing.

TABLE A.5

KEY DATA ON MAJOR NON-COFFEE CROPS

AREA DATA

Arable Land Allocated to the Principal Non-Coffee Crops - (Thousands of Hectares)

YEAR	COTTON	RICE	CORN	POTATOES	YUCCA	PANELA	PLATANO
1950	37	133	666	74	125	214	256
1951	40	145	738	100	124	218	261
1952	55	150	903	110	134	218	266
1953	67	153	804	105	127	215	267
1954	82	175	735	103	115	219	257
1955	84	188	894	119	111	220	251
1956	69	190	874	106	110	220	275
1957	63	190	839	110	109	220	272
1958	77	196	967	101	113	223	286
1959	131	206	908	119	115	221	292
1960	151	227	941	119	100	227	303
1961	151	237	885	105	98	231	303
1962	176	280	964	129	108	228	298
1963	141	260	930	109	112	252	295
1964	150	302	932	98	102	254	275
1965	134	365	984	123	127	246	281
1966	165	350	958	117	129	235	281
1967	175	300	970	128	115	271	313
1968	199	277	944	140	118	278	305
1969	236	255	970	128	134	287	347
1970	267	229	915	138	148	296	333
1971	218	251	865	130	145	300	312
1972	240	276	850	125	155	300	320

TABLE A.6

OUTPUT DATA

Output of the Principal Non-Coffee Crops - (Thousands of Metric Tons)

YEAR	COTTON	RICE	CORN	POTATOES	YUCCA	PANELA	PLATANO
1950	21	261	620	360	768	360	943
1951	19	289	845	550	870	349	940
1952	32	288	929	600	870	394	960
1953	51	294	890	610	870	338	987
1954	80	318	850	650	870	334	1013
1955	70	346	770	665	674	538	1049
1956	64	370	790	545	700	550	1091
1957	58	378	746	540	700	506	1100
1958	73	411	823	700	700	518	1130
1959	157	456	857	685	720	554	1220
1960	194	431	865	653	741	561	1255
1961	197	418	757	545	752	609	1275
1962	218	488	795	871	780	653	1292
1963	187	459	782	573	800	699	1309
1964	176	500	968	867	820	745	1345
1965	162	571	871	762	840	790	1384
1966	209	542	895	832	865	836	1423
1967	265	661	950	900	900	836	1590
1968	333	786	984	1012			
1969	352	720	1006	1069			
1970	276	702	877	913	1200		
1971	322	852	819	823	1240		
1972	412	997	806	782	1280		
1973	335	1151	739	984	1450		
1974	420	1540	792	903	1320		
1975	401	1614	723	1320	1927		

TABLE A.7

P R I C E D A T A

Average Producer Price of the Principal Non-Coffee Crops - (Per Metric Ton in Colombian Pesos)

YEAR	COTTON	RICE	CORN	POTATOES	YUCCA	PANELA	PLATANO
1950	807	350	290	337	110	184	128
1951	897	465	280	282	130	205	138
1952	953	345	205	212	100	233	137
1953	938	400	240	278	107	256	138
1954	882	470	330	319	173	243	180
1955	858	475	300	211	193	217	185
1956	883	485	350	312	198	[illegible]	188
1957	1173	615	430	311	215	[illegible]	221
1958	1550	750	385	370	200	500	230
1959	1770	770	450	304	250	460	265
1960	1726	883	474	550	303	392	224
1961	1752	954	629	504	378	377	305
1962	1844	919	526	291	338	541	368
1963	2236	1046	794	730	398	933	459
1964	2567	1347	1040	1054	755	1133	672
1965	3506	1703	903	612	658	885	668
1966	3550	1884	1104	983	691	1005	747
1967	3753	1914	1203	876	795	854	747
1968	3830	2106	1294	822	954	1127	
1969	3880	1978	1392	933	922	1307	
1970	3929	1850	1490	1044	891	1487	
1971	4687	1930	1696	1042	1361	1385	
1972	5114	1882	2170	1446	1466	2254	
1973	8808	2514	3329	2047	1318	3198	
1974	9369	3694	3364	2215	2155	3921	
1975	10527	3913	4103	4042	3252		

Tables A.5, A.6, A.7 - Notes on the Data and their Sources

Area Data (Table A.5)	-	(4), "Cuadro" 2.6, 1950-1972.
Output Data (Table A.6)	-	(1), Table A-8, 1950-1967. The 1968-1969 observations for cotton, rice, corn, and potatoes were taken from (2), Table 14-1. Observations on yucca, panela and platano for these years were not available. The 1970-1975 observations on cotton, rice corn, potatoes and yucca were provided by A. Berry, verbally. The 1970-1975 figures on panela and platano were not available.
Price Data (Table A.7)	-	(1), Table A-8, 1950-1967. The 1969 observation on all crops comes from (2), Table 35. For the 1969-1975 period, figures for all crops except platano were provided by A. Berry, verbally.

TABLE A.8

KEY MANUFACTURING DATA

Year	1 Value of gross output factory manufacturing in constant 1958 prices (millions of pesos)	2 Value added* factory manufacturing in constant 1958 prices (millions of pesos)	3 Price of manufacturing value added (1958 = 100)	4 Price of factory manufacturing gross output Series A (1958 - 100)
50	5006	1446	63.2	55.1
51	5185	1480	65.4	59.7
52	5632	1593	64.0	59.8
53	6476	1767	65.1	61.4
54	6972	1948	67.3	66.6
55	7381	2141	70.7	65.9
56	8134	2297	74.0	72.8
57	8492	2394	88.2	87.3
58	8939	2478	100.0	100.0
59	9913	2706	107.4	98.9
60	11328	2926	120.9	109.6
61	12200	3113	130.6	114.4
62	13468	3334	146.3	120.3
63	13611	3512	188.0	152.8
64	14547	3733	200.5	171.1
65	15484	3924	220.8	186.6
66	16085	4150	246.5	213.9
67	16696	4369	255.6	236.3
68	18109	4656	270.7	253.0
69	18947	5013	291.3	274.6
70	20122	5472	326.7	304.1
71	21244	5964	367.2	335.1
72	23770	6556	416.2	383.6
73	25438	7349	518.2	472.6
74	27117	7866	702.1	654.5
75	28109	8189	884.7	836.5

*At factory cost.

TABLE A.8 Cont'd.

KEY MANUFACTURING DATA

Year	5 Price of factory manufacturing gross output Series B (1958 = 100)	6 Average hourly wage rate in factory manufacturing including fringe benefits	7 Rental rate or user cost of capital Series A	8 Rental rate or user cost of capital Series B
50	51.3	0.58	2.4	4.0
51	55.8	0.62	3.5	5.2
52	57.3	0.63	3.7	5.5
53	58.6	0.68	3.9	5.8
54	64.7	0.73	3.9	5.8
55	63.2	0.81	4.1	6.2
56	71.6	0.92	4.5	6.7
57	85.4	1.26	6.9	10.2
58	100.0	1.46	10.3	15.3
59	105.2	1.62	10.9	17.3
60	106.1	1.89	11.2	17.8
61	110.7	2.21	11.4	19.1
62	116.1	2.60	11.9	19.9
63	146.6	3.70	20.0	25.4
64	165.3	4.24	20.8	27.6
65	179.2	4.75	24.1	33.9
66	204.2	5.52	30.9	47.5
67	224.0	6.18	34.3	52.6
68	241.6	6.87	40.3	57.6
69	262.8	7.58	42.1	51.2
70	294.4	8.93	69.9	55.6
71	320.4	10.09	79.2	82.1
72	368.7	10.99	87.7	98.4
73	454.2	12.60	101.2	143.6
74	629.1	14.98	150.9	173.3
75	804.0	18.50	190.2	

TABLE A.8 Cont'd.

KEY MANUFACTURING DATA

Year	9 Price of all inputs used by factory manufacturing Series A (1958 = 100)	10 Price of all inputs used by factory manufacturing Series B (1958 = 100)	11 Price of agricultural inputs used by factory manufacturing (1958 = 100)	12 Price of other inputs used by factory manufacturing Series A (1958 = 100)
50	46.1	41.2	51.0	45.3
51	53.3	47.6	57.2	52.6
52	53.4	48.4	58.0	52.6
53	53.5	49.2	62.6	51.9
54	56.7	53.2	75.1	53.4
55	56.0	52.9	71.3	53.8
56	63.0	56.1	79.9	60.0
57	81.4	79.0	93.0	79.3
58	100.0	100.0	100.0	100.0
59	100.7	103.6	104.3	100.1
60	105.9	101.2	111.3	104.9
61	108.1	103.6	120.5	105.8
62	115.3	108.1	124.0	113.8
63	138.0	131.4	152.2	135.5
64	154.2	148.4	191.9	147.5
65	165.5	158.1	203.9	158.7
66	187.2	177.0	231.9	179.3
67	203.1	191.9	247.7	195.2
68	218.8	208.5	266.0	210.5
69	225.5	226.9	288.0	214.8
70	265.6	259.3	316.9	256.6
71	284.1	272.8	352.1	272.1
72	318.5	308.4	413.2	301.8
73	390.5	378.1	544.9	363.8
74	545.5	528.2	671.8	527.4
75	701.5	679.3	815.7	686.5

TABLE A.8 Cont'd.

KEY MANUFACTURING DATA

Year	13 Price of other inputs used by factory manufacturing Series B. (1958 = 100)	14 Estimates of value of factory manufacturing capital stock in constant 1958 prices (millions of Pesos)	15 Estimates of factory employment (thousands of bodies)	16 Estimates of factory manufacturing labour force (thousands of bodies)
50	39.5	6301	180.0	460.0
51	45.9	6505	185.5	474.7
52	46.8	6705	192.2	488.9
53	46.9	6896	199.1	503.6
54	49.4	7316	208.7	518.7
55	49.7	7766	218.8	534.3
56	51.9	8171	229.4	550.3
57	76.5	8576	240.0	564.1
58	100.0	8761	248.4	578.2
59	103.5	8774	257.3	592.6
60	99.4	8829	266.9	607.4
61	100.6	8895	277.0	622.6
62	105.3	9083	287.5	638.2
63	127.8	9541	298.3	654.1
64	140.7	9633	310.0	669.1
65	150.0	10055	318.0	699.2
66	167.3	10573	325.0	731.4
67	182.0	11065	336.7	765.7
68	198.4	11552	348.8	802.5
69	216.1	11636	361.4	841.0
70	249.2	11839	380.0	885.0
71	258.8	11952	361.8	929.3
72	289.9	12132	420.3	975.8
73	349.2	12370	470.4	1024.6
74	497.3	12570	490.5	1075.8
75	646.0	12682	502.8	1129.6

TABLE A.8 Cont'd.

KEY MANUFACTURING DATA

Year	17 Estimates of cottage shop employment and unemployment (thousands of bodies)	18 Estimated unemployment rate	19 Estimated unemployed (thousands of bodies)	20 Estimates of cottage shop employment (thousands of bodies)
50	280.0	6.0	27.6	252.4
51	289.2	6.0	28.5	260.7
52	296.7	6.0	29.3	267.4
53	304.5	6.0	30.2	274.3
54	310.0	6.0	31.1	278.9
55	315.5	5.0	26.7	288.8
56	320.9	5.0	27.5	293.4
57	324.1	5.0	28.2	295.9
58	329.8	6.0	34.7	295.1
59	335.3	6.0	35.6	299.7
60	340.5	7.0	42.5	298.0
61	345.6	7.0	43.6	302.0
62	350.7	8.0	51.1	299.6
63	355.8	9.0	58.9	296.9
64	359.1	8.0	53.5	305.6
65	381.2	9.0	62.9	318.3
66	406.4	11.0	80.5	325.9
67	429.0	14.0	107.2	321.8
68	453.7	12.0	96.3	357.4
69	479.6	10.0	84.1	395.5
70	505.0	10.0	88.5	416.5
71	567.5	12.0	111.5	456.0
72	555.5	12.0	117.1	438.4
73	554.2	12.0	123.0	431.2
74	585.3	13.0	139.8	445.5
75	626.8	14.0	158.1	468.7

Table A.8 - Notes on the Data and their Sources

Cols.

1 (7), Table A-10; (2), Table 26 and (8), various selected volumes.

2 Total manufacturing value added minus manufacturing value added generated in the traditional sector. Total manufacturing value added is taken directly from the national accounts. Traditional manufacturing value added is available in (7), Table A-8, for 1950-1959 and in (2), Table 6-1, for 1960, 1967 and 1968. The ratio of factory value added to total manufacturing value added was then regressed on time for the years in which data was available. A strongly significant coefficient was estimated allowing acceptable extrapolation for the missing years. The ratio rose from .7553 in 1950 to .8704 in 1975.

3 From the National Accounts of Colombia (implicit deflator).

4 (7), Tables A-105a and A-105b, 1950-1972. Calculated as a weighted average of the price of coffee threshing output and the price of other manufacturing output with the weights corresponding to the ratio of each to total output for each year. The weights for coffee threshing declined from .175 in 1950 to .050 in 1972. The observations for 1973-1975 were taken from column (3) and spliced on to this series.

5 As in column (4) but unweighted as to coffee threshing and other input.

6 Wage rate data come from (9), Tables A-10, B-4, and B-6, 1950-1969, and from (5), 1970-1975. Data on fringe benefits were taken from (9), Table B-1, 1955-1968, and then extrapolated for this missing year with the advice of A. Berry.

7 Defined as the price of manufacturing investment times the interest rate plus the rate of depreciation. The price deflator for manufacturing investment was taken from (7), Tables A-10a and A-32, 1950-1970. For the years 1971-1975, the price of gross domestic fixed investment was used and spliced on to the 1950-1970 series. The interest rate was taken from (10). The rediscount rate of the Central Bank was used on the assumption that all interest rates tend to move together. The rate of depreciation was taken from (7), Table A-186.

8 As in (7) except that the interest rate used was the nominal return on equity investment in manufacturing. A substantial proportion of new investment in Colombian manufacturing is financed through the issue of new equity.

9 (1), Tables A-106a and A-106b, 1950-1972. This column was calculated as a weighted average of the price of inputs used by coffee threshing and the price of inputs used by other factory manufactur-

Table A.8 - Notes on the Data and their Sources Cont'd.

Cols.	
9	ing, with the same weights as used in column (4). As a proxy for the price of inputs used by coffee threshing, the producer price of coffee (Table A.2, Col. 5) was employed. The prices of intermediate inputs for 1973-1975 were calculated as a weighted difference between the price of gross output and the price of value added and spliced thereon.
10	As in column (9) but unweighted as to coffee threshing and other output.
11	Taken directly from Table A.1, column (5).
12	The weighted difference between column (9) and column (11). The ratio of agricultural intermediate inputs to total inputs was about 0.45.
13	The weighted difference between column (10) and column (11).
14	(7), Tables A-184 and A-186, 1950-1975. For the years 1971-1975, capital stock was calculated using data on manufacturing investment (in constant prices) and the rate of depreciation used to calculate the rental rate on capital.
15	(7), Table A-183, 1951-1970 and 1974. (8), 1971-1973 and 1975. The 1950 observation is a guestimate.
16	(7), Table A-183, 1951-1970. The 1971-1975 data were provided by A. Berry, verbally.
17	Column (16) - column (15).
18	For the years 1963 to 1970, the data is based on estimates contained in (11), (12) and (7). No data on rates of unemployment for other years is available in published form. The rates shown in column (18) are the best estimates that A. Berry could come up with and which he provided verbally.
19	Column (16) times column (18).
20	Column (17) minus column (19).