World Development, Vol. 17, No. 10, pp. 1585–1596, 1989.
Printed in Great Britain.

0305–750X/89 $3.00 + 0.00

Bread and Butter Issues in Ecuadorian Food Policy: A Comparative Advantage Approach

DEREK BYERLEE*
International Maize and Wheat Improvement Center (CIMMYT), Mexico City

Summary. — The effects of policy interventions on price incentives and resource use in wheat and dairying are analyzed for the Ecuadorian Sierra from 1970 to 1983, a period of rapid economic growth induced by a boom in petroleum revenues. Exchange rate and trade policies combined with subsidized transport services and farm credit, to substantially tax wheat producers while milk producers received significant subsidies. Consequently self-sufficiency in wheat production fell from about 50% in 1970 to near zero in 1983, while imports of dairy products remained very low throughout this period of rapidly expanding demand for both bread and livestock products. Measures of comparative advantage are constructed to show that these price distortions have led to substantial inefficiency in resource use due to the widening gap between private and social profitability for wheat and for dairying.

1. INTRODUCTION

Governments influence price incentives in the agricultural sector through a complex of implicit and explicit interventions, ranging from exchange rate manipulation to pricing of inputs and rules for distributing credit. Although these policy decisions typically involve many ministries and agencies, they are often made without the benefit of effective communication among the decision makers. Consequently, the total effects of policy interventions for different commodities, regions, and types of farmers are often not readily apparent to policy makers. In some cases the resulting effects on producer incentives may even be inconsistent with stated policy goals.

This paper examines the complex of policies influencing producer incentives in the Sierra, the central highlands of Ecuador, with particular emphasis on the differential impacts of policy interventions on wheat and dairy production. During the 1970s the Ecuadorian economy underwent substantial structural change, largely because of the growth in oil export revenues. In this period wheat production decreased sharply (−6.0% annually) while wheat consumption increased rapidly; as a result, wheat imports grew at 12% annually from 1970 to 1982 and self-sufficiency in wheat dropped from 54% to 8%. Meanwhile, the dairy industry expanded, experiencing rapid technological progress, and Ecuador maintained over 90% self-sufficiency in dairy products.

Declining wheat area and stagnating yields contrasted sharply with the dynamic image of the dairy industry. By the early 1980s, when almost all wheat was imported, many Ecuadorian policy makers and others (e.g., Ruff, 1984) were questioning the need for a domestic wheat industry and the rationale for maintaining a strong wheat research program.

A major objective of this paper is to address those issues by estimating the private and social profitabilities of wheat in Ecuador in relation to competing enterprises, particularly dairying, and by determining the roles of technological change and price policy in the relative ranking of these enterprises. A comparative advantage framework is used to calculate various policy effects, private and social profitability, and the aggregate effects of policy interventions on the wheat and dairy sectors.

*This study was conducted in collaboration with INIAP (Instituto Nacional de Investigaciones Agropecuarias), the national agricultural research organization of Ecuador. I would like to thank Patricio Espinoza, Jaime Tola, Carlos Casco and Arturo Figueroa of INIAP and Jesse Dubin and Pat Wall of CIMMYT for their help. Scott Pearson and Jim Longmire made valuable comments on an earlier draft. Views expressed here do not necessarily reflect those of CIMMYT.

2. A FRAMEWORK FOR MEASURING POLICY INCENTIVES AND COMPARATIVE ADVANTAGE

The framework used in this study for estimating policy effects and measures of comparative advantage is adapted from Pearson (1982). Social profitability is calculated by valuing products, inputs, and resources at economic prices. Tradable products and inputs are valued at the world equivalent price converted at an estimated shadow exchange rate. Nontradables are divided into (a) labor and capital, which are mobile and can be used in other regions or industries, and (b) land, which is immobile. Nontradables are valued at their opportunity cost in alternative uses.

Individual policy effects are represented by the difference between a particular product, input, or resource valued at market prices and at economic or opportunity prices.[1] These policy effects are summarized in Table 1. For example, a tariff on imports of a product is measured in *K*, a subsidy on an input in *L*, and a subsidy on credit in *M*. These policy effects are usually expressed in the form of nominal and effective protection coefficients. The value *N* in Table 1 represents indirect effects of policies on competing enterprises that lead to distortions in the market value for land. Total net policy effects are represented by *O*, a positive value denoting policy incentives for the production of that commodity.

Social profitability, *J*, is a measure of comparative advantage. The country is efficient in producing a commodity if *J* is positive. Another measure used in this study, which focuses on alternative uses of land in one area, is to assess the social returns to land ($F-G-H$) to rank enterprises by their contributions to national income.

This analysis focuses on how measures of comparative advantage are influenced by production technique and the consequent implications for agricultural research investments. Hence comparative advantage is evaluated at two levels of technology, farmers' current technology and the best available improved technology, to examine the relationship between technological change, comparative advantage, and policy incentives. If a country does not have a comparative advantage in producing a given commodity, *X*, even using the best potential level of technology, clearly there is little economic justification for investment in research on that commodity. On the other hand, if there is a comparative advantage in producing commodity *X* but negative policy incentives make it unprofitable to do so, two situations may prevail, as shown in Table 2. In the first situation, the introduction of improved technology enables *X* to become profitable to farmers despite policy disincentives. The analysis clearly provides a strong argument for investment in research and extension to enable the country to exploit its potential comparative advantage in *X*. In the second case, the change in technology is insufficient to compensate farmers for negative policy incentives, and the main value of the analysis is to quantify the cost to the country of pursuing current policies. It is recognized, however, that this analysis considers only impacts on national income and does not take into account other possible policy objectives, such as income distribution or increasing farmers' incomes.

3. TRENDS IN PRIVATE PROFITABILITY AND LAND USE IN THE ECUADORIAN SIERRA

(a) *Farming systems of the Sierra*

The Sierra of Ecuador forms a central highland corridor of mountains and valleys over 1,000 meters elevation running north to south through

Table 1. *Measures of comparative advantage and policy incentives*

	Tradables		Nontradables		
	Products	Inputs	Capital and labor	Land	Profit
Market prices	*A*	*B*	*C*	*D*	$E = A-B-C-D$
World price equivalent	*F*	*G*			
Opportunity cost of resources			*H*	*I*	$J = F-G-H-I$
Policy effect	$K = A-F$	$L = G-B$	$M = H-C$	$N = I-D$	$O = E-J = K+L+M+N$

Source: Adapted from Pearson (1982).

Table 2. *Possible conflicts between social and private profitability at different levels of technology*

	Private profitability	Social profitability
Case 1		
Current farmer technology	Negative	Positive
Potential or improved technology	Positive	Positive
Case 2		
Current farmer technology	Negative	Positive
Potential or improved technology	Negative	Positive

the country. Technical data for this study were gathered from the Cantons of Tabacundo, Cayambe, and Otavalo, about 100 kilometers north of Quito. The area has traditionally been a center of wheat production and a major focus of the wheat research program of the national research institute, INIAP (Instituto Nacional de Investigaciones Agropecuarias). In the 1970s it became one of the major dairy production zones of Ecuador (Archetti, 1986). By 1982, the area had an estimated 6,000 hectares of wheat, 10,000 hectares of barley, and some 60,000 dairy cows. Soft maize, a subsistence food crop, and potatoes, largely a cash crop, were the other major agricultural enterprises.

The area is diverse with respect to physical characteristics, especially slope and elevation, and farmers' socioeconomic characteristics. To simplify the analysis, two basic types of farming system were selected: (1) irrigated land in the valleys that allows either intensive year-round dairying with improved pastures, or the production of two crops per year; and (2) unirrigated land on the sides of the valley where extensive dairying with natural pastures is practiced and usually only one crop per year can be grown. In both systems, wheat technologies used by small and large farmers differed substantially.[2]

(b) *Private profitability of competing enterprises under alternative technologies*

Farm level budgets were constructed for each crop and livestock enterprise using information from three sources: (1) informal interviews with farmers and extension agents in the area: (2) estimates of production costs, published by the Ministry of Agriculture and the Development Bank; and (3) surveys undertaken in the area as part of this study. Prices used were those prevailing in June, 1983. Returns in intensive dairying were calculated for a six-month cycle to make valid comparisons with returns from cropping activities. Reasonable confidence can be placed in the data, except those for the extensive dairy system, for which little secondary information was available and estimates were based on informal surveys of farmers.

Profitability of each enterprise was calculated under two levels of technology — farmers' current technology and recommended technology. The recommended technology was an improved technology that could be applied profitably given current knowledge from agricultural research. Technical coefficients were based on data from on-farm experiments, informed estimates of INIAP scientists, and the experiences of some farmers that had higher than average productivity.[3] Returns for extensive dairying at improved levels of productivity were not estimated; given the lack of research directed toward this sector, it is unlikely that significant gains in productivity are possible in the medium term.

To simplify presentation, returns are given only for large farmers, those with over 30 hectares (Table 3).[4] Both at farmers' current level of technology and the improved level, potatoes, followed by dairying, were the most profitable enterprises. Intensive dairy operations gave more than double the returns to wheat even when measured over a six-month cycle. For wheat to compete with intensive dairying, farmers would need to obtain yields of 3.5 tons per hectare (t/ha) at the same costs.

Significantly, returns in the extensive dairy operation expressed on an annual basis were also higher than those for wheat, even wheat produced with the recommended improved technology. Returns to wheat were generally comparable to those for other cereal crops, although slightly lower than for barley.

(c) *Changes in relative profitability over time*

The relative profitability of crop and livestock

Table 3. *Farmer profitability of competing crop and livestock enterprises under different technological assumptions, Ecuadorian Sierra, 1983*

	Returns to land (Sucre/ha)	
	Farmer technology	Recommended technology
Wheat	6,080	13,360
Barley	5,990	13,890
Maize	6,660	14,930
Potatoes	36,160	64,200
Intensive dairy system	14,920*	26,545*
Extensive dairy system	15,540	na†

*Returns for a six-month cycle.
†Not calculated.

activities has changed markedly since 1971. In 1971, potatoes and wheat gave similar returns whereas returns in dairying were substantially lower than in wheat (Nelson Flores, 1974). By 1983, real returns had increased by 145% in dairying and 124% in potatoes, while real returns in wheat had decreased by over 50%. These changes in relative profitabilities reflect two major factors. First, real producer prices of potatoes increased by 25% from 1970 to 1980 while those of wheat fell by 25% over the same period. Second, technological change was rapid in the dairy sector (Barskey and Cosse, 1981) and to a lesser extent in potatoes, while productivity in wheat changed little.

Dramatic shifts in the relative profitabilities of these enterprises were reflected in changing land use patterns. While wheat area was reduced to one-third of its 1970 level, pasture area is estimated to have doubled and milk production increased at 5% annually between 1969 and 1978 (Barskey and Llovet, 1982; Commander and Peek, 1986).[5] High returns in dairying have also been capitalized into land prices. Returns in intensive diarying implied a 10% return on capital invested in land in 1983. At these land prices, net returns in cereal production were significantly negative even at recommended levels of technology.

4. POLICY INFLUENCES ON ECUADORIAN AGRICULTURE, 1970–83

A wide range of policy interventions, from trade and exchange rate policies to specific input subsidies, markedly influenced the shifting relative profitabilities of crop and livestock enterprises in the Ecuadorian Sierra. The policy environment from 1970–83 was characterized by two fairly distinct periods: 1970–80, corresponding to the oil boom, and 1981–83, when oil prices stagnated or declined and Ecuador faced a foreign exchange and debt repayment crisis.

(a) *The macrolevel policy environment*

The dominant influence on the Ecuadorian economy after 1971 was the petroleum boom. Revenues from oil exports increased at a real rate of 4% annually to account for 60% of export revenues in 1981. Led by petroleum exports, Ecuador's economic growth was the highest in Latin America, averaging 8.6% per year from 1972 to 1980. But it was also uneven: although construction advanced by 8.4% and manufacturing by 11.5% annually, agriculture grew at only 2.7%.

The petroleum boom had a number of important implications for macrolevel policy that worked to reduce the growth rate of the agricultural sector:

(i) *Overvaluation of the exchange rate*

The effect of increased oil export earnings on the exchange rate was a classic illustration of the so-called Dutch Disease effect.[6] Ecuador maintained a fixed exchange rate during the 1970s even though its inflation rate was 20–25% higher than those of its main trading partners. The fixed exchange rate was made possible by rapid increases in oil prices and, in the late 1970s, by heavy foreign borrowing. Rapid industrial growth was supported by high tariff protection averaging over 25%. The combination of these exchange rate and trade policies led to the overvaluation of the Ecuadorian currency, the Sucre, by almost 50% by the end of the period (Byerlee, 1985; Scobie and Jardine, 1988).

(ii) *Demand effects*

The urban middle class was the largest beneficiary of economic growth in the 1970s (see for example Ortiz Crespo, 1983 and Commander and Peek, 1986). This increase in middle-class incomes led to a rapidly rising demand for food products with a relatively high income elasticity, particularly livestock products. Given the reasonable assumptions that urban population and real incomes each grew at close to 5% annually, and an income elasticity of 0.8, the potential demand for livestock products increased at 9% annually.[7] Demand for bread increased less rapidly, perhaps at 7.5% annually, assuming an income elasticity of 0.5. Changes in demand patterns placed upward pressure on prices and imports of these products.

(iii) *Increased rural-urban migration and rising rural wage rates*

The rapid growth rate of the nonagricultural sector accelerated rural-urban migration and provided more off-farm employment (Commander and Peek, 1986). Real wages paid by farmers in the Sierra almost doubled between 1972 and 1980, raising the costs to farmers who could not increase product prices because of competition from imports (e.g., wheat) or who could not substitute for labor through mechanization (e.g., farmers on steep slopes). This situation also encouraged producers to substitute livestock enterprises, especially extensive dairying, for more labor-intensive crop enterprises.

(iv) *Subsidized transport costs*

While prices of petroleum products in world markets increased significantly in real terms in the 1970s, they fell sharply in Ecuador. The effective subsidy on diesel reached 90% in 1980 and was then reduced to about 70% in 1983 (Byerlee, 1985). Hence, long-distance transport costs declined substantially in real terms and reduced the inland prices of imported and bulky commodities, such as wheat.

Beginning in 1982, the economic crisis began to reverse some effects of the petroleum boom in the 1970s. Devaluations of the Sucre to the extent of 70% in 1982 and 1983 brought its free market value close to the estimated shadow exchange rate of S80/$US1.00. However, commodities classified as "essential," including wheat, were imported at a lower official exchange rate of about S50/$US1.00. In this study, calculations of social profitability were made using the estimated shadow exchange rate (S80/$US1.00).

(b) *Effects of macrolevel policies on relative prices of crop and livestock products*

Relative price changes between crop and livestock products can be traced to the combined effects of the macrolevel policy environment discussed above and commodity-specific trade policies. For traded commodities, nominal protection coefficients (NPCs) and adjusted NPCs (ANPCs) were calculated. The NPCs and ANPCs for wheat, for example, were computed as follows, using flour mills near Quito as the reference point:

$$\text{NPC} = P_d / (E_o P_i + f_s q + M) \text{ and,}$$

$$\text{ANPC} = P_d / \{E_s(P_i + f_u q + M_t) + M_{nt}\},$$

where:

- P_d = price of domestic wheat at the mill,
- P_i = CIF price of imported wheat (in US$),
- E_o = official exchange rate,
- E_s = estimated shadow exchange rate,
- f_s = market price for diesel fuel (in Sucres),
- f_u = estimated unsubsidized price for fuel (in US$)
- q = quantity of fuel to transport one ton of wheat to interior mill,
- M = marketing and nonfuel transport cost for imported wheat,
- M_t = tradable component of M (e.g, trucks) (in US$), and
- M_{nt} = nontradable component of M (e.g., labor, storage).

The results presented in Figure 1 show that the government closely linked the price of domestic wheat to the world price equivalent (calculated using the official exchange rate and actual transport costs). However, when allowance is made for the overvalued exchange rate and subsidized diesel prices, wheat producers received on average 27% less than the world price equivalent (that is, ANPC = 0.73). The overvalued exchange rate explained about 70% and subsidized transport about 30% of the difference between the world price equivalent and the producer price.

Dairy products are tradable commodities and their import prices, like those of wheat, were subject to the same effects of an overvalued exchange rate and fuel subsidies.[8] However, tariffs and import controls tended to raise the price of imported dairy products (Table 4). Some dry milk was imported duty free and distributed to poorer urban areas at subsidized prices. Those imports, together with strongly regulated controls on producer and consumer prices for liquid milk, tended to contain increases in domestic milk prices (Figure 2). However, no price controls were placed on butter, cheese, and other dairy products, which consumed about half of the domestic milk supply, especially outside the main cities (Park, 1985). High import tariffs, unregulated prices, and quickly rising demand worked to increase real prices by 120% for butter and 40% for cheese between 1970 and 1982 (Figure 2).

Estimated NPCs and ANPCs for milk and butter are compared to those for wheat in Table 5. At the official exchange rate, the domestic price of dairy products was consistently above the import price. However, at the shadow exchange rate, only butter and probably cheese were

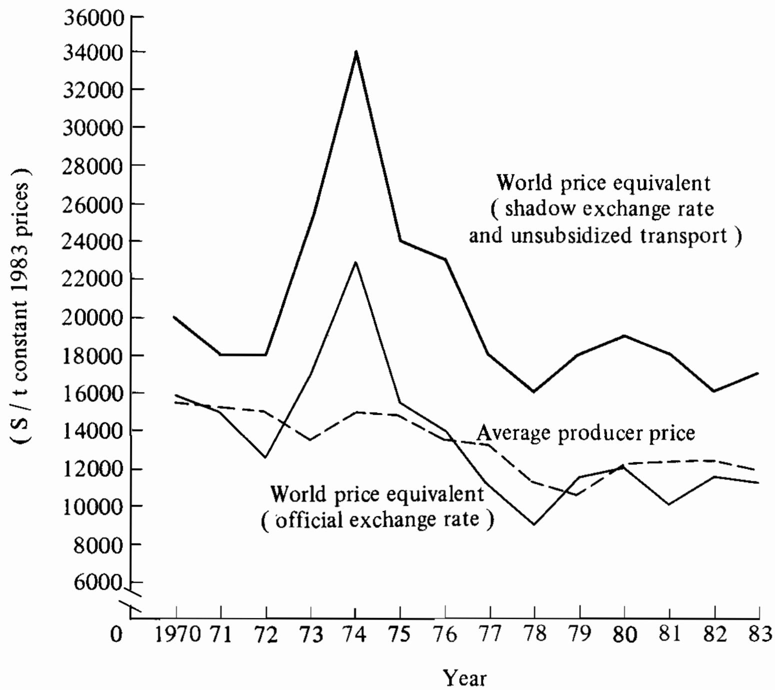

Figure 1.

Table 4. *Import tariffs for wheat and competing crop and livestock commodities, Ecuador*

	1979 (percent ad-valorem)	1983 (percent ad-valorem)
Wheat	0	0*
Dry milk	85†	Prohibited†
Butter and cheese	95	Prohibited
Barley	85	50
Potatoes	80	Prohibited
Maize	80	Prohibited

*Wheat was also imported at the official exchange rate, while other agricultural products (e.g., barley), if imported, were imported at close to the shadow exchange rate.
†Limited amounts of dry milk powder were imported by the government free of import duties.

protected.[9] If milk, butter, and cheese are taken together, dairy producers received close to world prices (at the shadow exchange rate) while wheat producers were significantly taxed.

In sum, the following policy influences seem to have prevailed in the wheat and dairy industries in the 1970s:

Wheat:
(a) The guaranteed price of wheat was pegged to the import price.
(b) Duty-free wheat imports, combined with an overvalued exchange rate and subsidies on the fuel used to transport wheat inland, led to significant negative incentives for domestic wheat production.

Dairy:
(a) Rapid growth of incomes, especially in the urban middle class, promoted a strong demand for dairy products.
(b) Imports of dairy products were either limited in quantity, as in the case of dry milk, or subject to high tariffs.
(c) The guaranteed producer price of milk was kept relatively constant in real terms. Producers obtained somewhat higher prices because they could sell their product to cheese and butter manufacturers or to distributors of raw milk.
(d) The ratio of butter and cheese prices to milk prices was high in Ecuador relative to other countries and increased sharply in the 1970s. Butter and cheese received substantial protection from imports.
(e) On balance, the domestic price of dairy products was sufficiently above the import

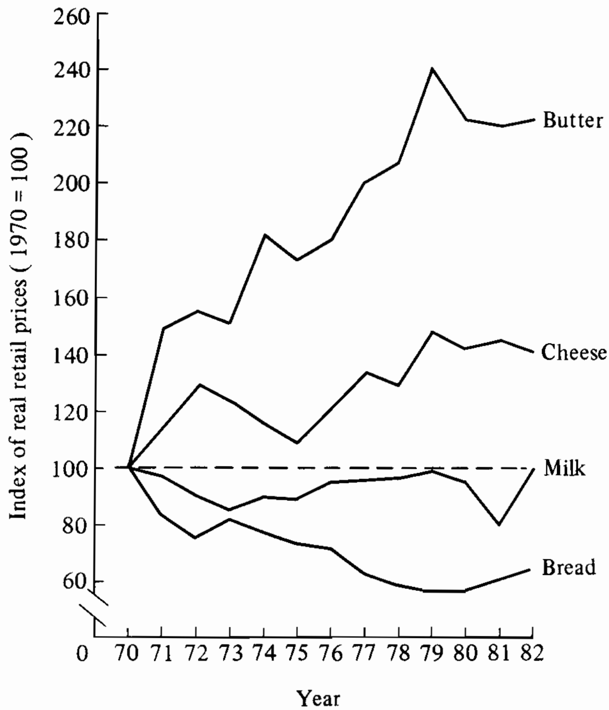

Figure 2.

Table 5. *Estimated protection levels for wheat and dairy products*

	Nominal Protection Coefficient			Adjusted Nominal Protection Coefficient*		
	Wheat	Milk	Butter	Wheat	Milk	Butter
1970–73	0.98	0.94	0.94	0.81	0.72	0.79
1974–76	0.88	1.11	1.31	0.60	0.76	1.00
1977–80	1.09	1.27	1.65	0.74	0.86	1.32
1981–83	1.04	1.25	1.44	0.75	0.82	1.11
Average, 1970–83	1.00	1.14	1.33	0.73	0.79	1.07

*Adjusted for exchange rate overvaluation.

price (at the official exchange rate) to compensate for the overvalued exchange rate.

Together, these policy effects resulted in very different scenarios for wheat and dairy production. While consumption of both commodities grew rapidly, production of wheat declined and self-sufficiency in wheat was reduced to near zero as imports were needed to substitute for decreasing domestic production and to supply increased demand. At the same time, Ecuador had become 93% self-sufficient in dairy products (in milk equivalents) in 1979–81, a level substantially higher than in neighboring countries.

Higher-income consumers bore much of the cost of protecting dairy products because of the relatively high income elasticity for these products. However, consumers benefited from the negative protection of wheat as well as from an explicit consumer subsidy on wheat that maintained flour prices constant from 1973 to 1981 and resulted in a nearly 50% drop in the real price of bread (Figure 2).

(c) *Price policy for agricultural inputs*

Most agricultural inputs were imported duty free or at very low duties of 3–10%. Hence, overvaluation of the exchange rate throughout the period tended to make agricultural inputs cheap. Real fertilizer prices, for example, declined continuously from 1975 to 1983. Costs of mechanization were also subsidized through subsidized diesel prices and subsidies by the Ministry of Agriculture for machinery hire services. These policy-induced effects on input prices benefited all enterprises, depending on the relative intensity with which specific inputs were used in each enterprise.

Associated with the petroleum boom was a rapid increase in credit at low interest rates for all sectors of the economy. Most of this credit was provided by the state-owned Banco Nacional de Fomento (BNF), which charged interest rates below the inflation rate. By 1983, differences in the two rates had become quite large. The BNF charged 13% interest plus some administrative costs for short-term agricultural loans, compared to an inflation rate exceeding 50%.

Cheap credit policies had very different effects on crop and livestock enterprises. Most official credit channeled through the BNF and private banks to farmers in the Sierra was received by dairy farmers to improve livestock and pastures. One survey found that all large dairy farmers used bank credit and that credit covered an average of two-thirds of investment costs (Barskey and Cosse, 1981). Credit to livestock enterprises issued by the BNF in Cayambe quadrupled from 1970 to 1977 in real terms, but credit for wheat production declined steadily from 1974. By 1980, funds from official credit institutions were used in planting only 7% of the wheat area.

5. ESTIMATES OF COMPARATIVE ADVANTAGE AND AGGREGATE POLICY INCENTIVES

(a) *Estimates of social profitability*

Social profitabilities for wheat and dairying were calculated using economic prices, which removed the policy distortions described earlier.[10] These calculations also provided estimates of the effects of individual policies as well as the aggregate effects of all policy interventions for each enterprise. The 1983 border prices for tradable inputs were based on long-run trend prices in world markets to remove the effects of short-term price fluctuations.[11] They were converted at the shadow exchange rate and valued at the consumption point using unsubsidized transport costs (see Byerlee, 1985 for full details). All capital expenses were based on a real interest rate of 10% (most estimates indicate that the opportunity cost of capital in a country at Ecuador's stage of development is at least this amount). Labor was valued at the actual wage rate paid to workers.

Table 6 summarizes farmer prices and estimated economic prices free of policy distortions. In most cases, farmers received and paid prices lower than the economic price because of the overvalued exchange rate. Larger differences occur due to subsidies on diesel fuel, bank credit, and government tractor hire services.

At recommended levels of technology, wheat was the most socially profitable enterprise, followed by intensive dairying. Extensive dairying was the least profitable use of land (Table 7). These results almost completely reverse the enterprise rankings based on private profitability, in which wheat was the least profitable enterprise and intensive dairying gave the second highest profits after potatoes.

The difference between private and social profitability for each enterprise is a measure of net policy effects on that enterprise (Table 8). The aggregate effect of policy interventions was to tax wheat producers 22% (net) of the value of production and to subsidize intensive dairying by 19%. Effects of individual policies are also shown in Table 8. For wheat, the overvaluation of the exchange rate and its influence on output prices was the dominant policy effect. For dairying, subsidized credit had the largest effect on incentives.

At the farmers' level of technology, wheat gave somewhat higher social returns than intensive dairying (Table 9). However, returns in extensive dairying (on an annual basis) were slightly higher than in wheat. For wheat to compete with extensive dairying, small improvements in wheat productivity are needed: social profitabilities of the two enterprises become equal at a wheat yield of only 1.6 t/ha, compared to farmers' current yields of 1.5 t/ha.

On the other hand, at the recommended level of technology for wheat (2.5 t/ha), milk yields in extensive dairying need to increase by 50% with no change in costs to compete with wheat. This increase is unlikely given the lack of improved

Table 6. *Economic prices used for social profitability analysis compared to actual farm prices*

	Farm price June, 1983	Economic price 1983	Farm price as percentage of economic price
Products			
Wheat (S/kg)	11.1	18.3	60
Milk (S/l)	14.0	16.0	87
Inputs			
Seed (wheat) (S/kg)	11.0	18.3	60
Diesel (S/l)	3.4	20.8	16
Urea (S/50 kg)	660	1,020	65
2–4, D (S/l)	250	445	56
Tractor rental (S/hr)	220*	800	28
Real interest on bank credit (%/yr)	Negative	10	<0
Labor (S/day)	135	135	100
Capital goods			
Tractor (75 HP) ($Sx10^{-3}$)	1,100	1,691	65
Combine harvester ($Sx10^{-3}$)	3,668	5,000	68
Value of dairy herd (S/adult animal equivalent)	40,000	40,000	100

*Based on price of government tractor hire services.

Table 7. *Estimated private and social profitability of competing enterprises using recommended levels of technology, Ecuadorian Sierra, 1983*

	Private returns to land		Social returns to land	
	(S/ha)	(Rank)	(S/ha)	(Rank)
Wheat	13,360	3	23,330	1
Intensive dairying	26,550*	1	18,850*	2
Extensive dairying	15,540	2	12,830	3

*Expressed per six-month cycle.

Table 8. *Summary of policy effects by enterprise, Ecuadorian Sierra, 1983*

	Policy effect*					
	Price of output in relation to world price	Subsidy on diesel and mechanization services	Import of inputs at official exchange rate	Subsidy on credit	Net policy effect	Effective subsidy coefficient
	(Sucres/ha)	(Sucres/ha)	(Sucres/ha)	(Sucres/ha)	(Sucres/ha)	(%)
Wheat	−17,300	4,590	1,990	0	−10,720	−22
Intensive dairying†	−4,690	3,160	1,920	7,300	7,700	19
Extensive dairying	−2,490	0	701	4,500	2,710	11

*Measures of policy effects were defined in Table 1.
†Calculated for a six-month cycle.

technology for the extensive dairy sector. Hence the results of social profitability are not very sensitive to assumptions about technological levels and the potential for improving productivity in wheat and dairying.[12]

Table 9 also shows that wheat gives the largest increase in returns from use of improved technology. The implication is that if the use of improved technology for wheat and dairying requires the same investment in research and extension services per hectare, then allocation of research and extension resources to wheat will provide substantially higher payoffs to society, providing farmers are given appropriate policy incentives to grow wheat.

Table 9. *Comparison of the social profitability of wheat and dairying under alternative technological assumptions, Ecuadorian Sierra, 1983*

	Social returns to land (S/ha)
Current farmer technology	
Wheat (yield 1.5 t/ha)	10,550
Intensive dairying (milk yield 3,000 l/ha)*	8,450
Extensive dairying (milk yield 1,300 l/ha)	12,830
Improved technology†	
Wheat (yield 2.5 t/ha)	23,330
Intensive dairying (milk yield 4,900 l/ha)*	18,850

*Calculated for six-month cycle.
†For wheat, based on results of on-farm experiments; for dairy production, based on productivity levels of the best farmers.

Coefficients of Resource Use Intensity were also calculated to show the value of foreign exchange, labor, and capital needed to produce one unit of output valued at economic prices (Table 10). These coefficients are indicators of the potential sensitivity of the social profitability rankings to changes in the prices of these resources. All enterprises except extensive dairying had similar levels of foreign exchange intensity; in fact, the comparative advantage ranking was unaffected for exchange rates ranging from S65/US$1.00 to S95/US$1.00. The coefficients indicate that for each US$1.00 saved in foreign exchange by domestic production of wheat and milk, US$0.31 and US$0.24, respectively, were spent importing inputs and equipment used in their production.

Despite the clear comparative advantage of wheat, negative price incentives have retarded the use of improved technology in its production. The most important factor limiting productivity in wheat is that fertilizer is not used. Extensive on-farm experimentation from 1977 to 1983 in the study area showed that yield increases of over 1 t/ha can be expected from using the appropriate levels and balance of nutrients. At market prices prevailing in 1983, this improved technology provided farmers an expected marginal return on fertilizer expenditures of 65% per season. This return is low compared to potatoes, for which returns to fertilizer use were estimated to exceed 500% (in fact, fertilizer was widely used in potato production). Using economic prices, the marginal return to fertilizer expenditures in wheat increases to 175%. Although that return is still lower than returns in potatoes, appropriate price policies would substantially increase the incentive for adopting fertilizer in wheat production. It would seem that policy disincentives for wheat

Table 10. *Coefficients of resource use intensity showing the costs of foreign exchange, labor, and capital to produce one unit in value of output at improved levels of technology**

	Foreign exchange cost per unit value of output	Labor cost per unit value of output ($\times 10^3$)	Capital cost per unit value of output† ($\times 10^3$)
Wheat	0.31	36	57
Barley	0.37	46	72
Potatoes	0.35	157	41
Intensive dairying	0.24	54	193
Extensive dairying	0.10	62	270

*All values calculated at economic prices.
†Excludes capital invested in land.

production explain both the decline in area as well as stagnant yields.

6. CONCLUSIONS

The macroeconomic environment, especially the policy decision to maintain a fixed exchange rate during the Ecuadorian oil boom of the 1970s, led to a general decline in real prices in the agricultural sector, particularly for tradable commodities (see also Keeler, Scobie, and Greene, 1988). However, in the Ecuadorian Sierra during that decade a range of policies converged to favor the dairy industry over wheat and other cereals. These policies, primarily manifested through differential effects of tariffs, import controls, and credit and fuel subsidies, dramatically altered the relative profitability of wheat and dairying. They led to rapid expansion of area devoted to pastures and increased productivity in milk production at the expense of declining area and stagnant productivity in wheat. Stripping away these policy distortions indicates that these changes have resulted in inefficiency in resource use in the Sierra. These same distortions may also have heightened inequalities within the agricultural sector between large commercial farmers who specialized in dairying, the subsidized enterprise, and small farmers who were more involved in wheat production, which was substantially taxed (see also Commander and Peek, 1986).

Consumers have also paid some of the costs of the policy distortions. Low wheat prices benefited urban consumers but these same consumers paid much of the subsidy on the dairy industry by paying high prices for butter and cheese.

The complex effects of these policy interventions were probably not widely understood by policy makers in the Ministry of Agriculture. Direct interventions such as the allocation of credit to the dairy industry are not difficult to trace and usually have specific objectives related to the political economy of a particular commodity. However, Ministry officials appeared to have little appreciation of the effects on the agricultural sector of macroeconomic policies, especially exchange rate manipulation and the subsidized cost of diesel fuel. It also seems that, following the Hayami and Ruttan (1985) induced-innovation hypothesis, research resource allocation within the agricultural sector reflected the signals of market prices rather than economic prices. Thus the pressure to reduce the budget for wheat research was in fact contrary to Ecuador's potential comparative advantage in producing wheat.

Definite policy prescriptions require more analysis, especially from other areas of the Sierra, but the results of this study suggest that correcting only one policy distortion — setting the producer price of wheat equal to the import equivalent price at the shadow exchange rate — would significantly improve resource allocation. At this price wheat would be equal in private profitability to intensive dairying and substantially higher than extensive dairying, the least economically efficient industry. The cost of this option would be relatively low because wheat could still be imported at the official exchange rate to maintain low consumer prices.[13]

NOTES

1. It is assumed in this study that the policies analyzed were not implemented to offset market failures. In the particular industries under study competitive forces appear to operate.

2. For more discussion on the different levels of technology used by farmers in the area, see Byerlee (1985).

3. In the case of wheat, five years' results of on-farm experiments in the area were available (see Moscardi *et al.*, 1983). The major difference between farmer and recommended technology was the change in fertilizer levels and nutrient composition from 15–45–15 kg/ha of N, P_2O_5, and K_2O, respectively, to 80–80–0 kg/ha, leading to close to 1 t/ha increase in yields.

4. In both private and social profitability analysis, large farmer technology dominated small farmer technology. In addition, in the study area the bulk of the wheat area comprised large farms, many of which were operated as cooperatives that were established after the land reform in the 1970s. At recommended levels of technology for wheat (based largely on the use of a balanced dose of fertilizer), there is little difference in profitability between small and large farmers.

5. The area under potatoes was limited by high capital and labor requirements as well as significant market risk.

6. For a complete discussion of exchange rate policy and effects, see Keeler, Scobie, and Greene (1988).

7. These are projected effects of income growth. Actual demand effects were modified by price effects since relative prices of food commodities changed considerably in the 1970s as discussed later.

8. Because dairy products have a relatively high

value per unit of volume the fuel subsidy had a negligible effect on the calculated NPCs.

9. These NPCs were based on guaranteed prices and understate the differential in price incentives between milk and wheat producers. Because a substantial amount of milk was diverted into manufacturing cheese and butter, milk producers received about 15% above the guaranteed price. On the other hand, farmers often received below the guaranteed price for wheat as millers with ready access to reliable supplies of imported, uniform quality wheat were reluctant to buy local wheat.

10. Social profitability was also calculated for the other crops (potatoes, soft maize, and barley) (Byerlee, 1985). However, since potatoes and soft maize are essentially nontradables and the main focus of this paper is on the competition between wheat and dairying, results are not reported here.

11. For example, in the case of wheat this was estimated from the time trend regression on the US FOB price, $\text{Log}_e(\text{Price}) = 3.611 + 0.0485\ T$ for the period 1953–83. This gave a long-run trend price for wheat of $US170/t FOB Gulf ports (No. 2 Hard Red Winter Wheat) or $US210/t landed in Guayaquil.

12. Sensitivity analysis was also conducted with respect to world prices for dairy products assuming that current large subsidies on dairy exports by major exporting countries are reduced. With a 20% higher import price of dry milk, intensive dairying is slightly more profitable than wheat but there is still a large advantage of wheat over extensive dairying.

13. Since imported wheat will account for at least 90% of consumption in the short term, a small tax on wheat imported at the official exchange rate could be used to support the producer price of wheat at its import equivalent price at the shadow exchange rate.

REFERENCES

Archetti, E. P., "Estructura agraria y diferenciación campesina en la Sierra Ecuatoriana," *Estudios Rurales Latinoamericanos*, Vol. 9 (1986), pp. 17–42.

Barskey, O., and G. Cosse, "Tecnología y cambio social: Las haciendas lecheras de Ecuador," Mimeo (Quito, Ecuador: Facultad Latinamericana de Ciencias Sociales, 1981).

Barskey, O., and I. Llovet, *Pequeña Producción y Acumulación de Capital: Los Productores de Papa de Carchi, Ecuador*, Publicación Miscelanea No. 369 (Quito, Ecuador: Protaal, 1982).

Byerlee, D., *Comparative Advantage and Policy Incentives for Wheat Production in Ecuador*, CIMMYT Economics Working Paper 01/85 (Mexico: CIMMYT, 1985).

Commander, S., and P. Peek, "Oil exports, agrarian change, and the rural labor process: The Ecuadorian Sierra in the 1970s," *World Development*, Vol. 14, No. 1 (1986), pp. 79–96.

Hayami, Y., and V. W. Ruttan, *Agricultural Development: An International Perspective* (Baltimore, MD: Johns Hopkins University Press, 1985).

Keeler, A. G., G. M. Scobie, and D. D. Greene, *Exchange Rates and Foreign Trade Policies in Ecuador: 1960–85*, Working Paper (Raleigh, NC: Sigma One Corporation, 1988).

Moscardi, E., *et al.*, *Creating an On-farm Research Program in Ecuador; The Case of INIAP's Production Research Program*, CIMMYT Economics Working Paper 01/83 (Mexico: CIMMYT, 1983).

Nelson Flores, I., *Evaluación Económica de Haciendas Lecheras Localizadas en el Canton Mejia de la Provincia de Pichincha*, Publicación Miscelanea No. 19 (Quito, Ecuador: Departmento de Economía Agrícola, Instituto Nacional de Investigaciónes Agropecuarias, 1974).

Ortiz Crespo, G., *Estudio Introductorio, Libro del Sesquicentenario, Parte III, Economía, Ecuador, 1830–1980* (Quito, Ecuador: Corporación Editora Nacional, 1983).

Park, W. L., "Pricing milk in Ecuador: The impact of transport margins," *Food Policy*, Vol. 10, No. 4 (November 1985), pp. 374–377.

Pearson, S., "Methods of analysis," in J. S. Hillman *et al.*, *Comparative Advantage and Policy Choices in Portuguese Agriculture: Phase II Report* (Tucson, AZ and Stanford, CA: University of Arizona and Stanford University, 1982).

Ruff, S., *Agricultural Progress in Ecuador, 1970–82*, Foreign Agricultural Economic Report No. 208 (Washington, DC: USDA Economic Research Service, 1984).

Scobie, G., and V. Jardine, "Macro-economic policy and agriculture in Ecuador: A case of Dutch health?" Paper presented at the 20th International Conference of Agricultural Economists (Buenos Aires, Argentina: August, 1988).