Policy, Research, and External Affairs

WORKING PAPERS

Women in Development

Population and Human Resources
Department
The World Bank
August 1990
WPS 469

Modeling Economic Behavior in Peru's Informal Urban Retail Sector

J. Barry Smith
and
Morton Stelcner

Small family businesses that operate outside the formal system comprise a large part of the economy in developing countries and more than half the Peruvian street vendors are women. This model of informal activity in Peru's urban areas elicits policy recommendations to improve productivity (especially women's) in the informal sector.

Policy, Research, and External Affairs

WORKING PAPERS

Women in Development

WPS 469

This paper — a product of the Women in Development Division, Population and Human Resources Department — is part of a larger effort in PRE to determine if and how women's productivity (and thus family welfare) are improved when women are given more access to education, extension, training, credit, health care, and other public resources. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Maria Abundo, room S9-123, extension 36820 (87 pages with diagrams and tables).

The informal sector is a collection of loosely organized, small-scale competitive family businesses that rely little on nonfamily hired labor, use labor-intensive technologies, and operate largely outside of the legal, bureaucratic, and regulatory framework in terms of licenses, taxes, and contractual obligations.

In Lima, Peru, the informal sector makes up half the labor force, accounts for 61 percent of the hours worked, and generates an astounding 39 percent of GDP. More than half the street vendors are women.

In the informal sector, the free play of market forces determines returns to productive factors, especially labor. Informal enterprises are concentrated in low-income areas of urban centers, but rural households in Kenya and Peru, among other countries, have joined.

The informal sector is an important — if not the sole — income opportunity for growing numbers of the poor. International aid agencies have explored policies to make informal businesses more profitable. But this surge of interest is not based on much empirical evidence about what determines the firms' performance. Nor is the value of women's entrepreneurial activities reflected in the national accounts.

Smith and Stelcner analyze Peru's urban informal sector — particulary women's role in it — based on a theoretical model of informal retail trade (the dominant nonfarm family enterprises), using data from the Peru Living Standards Survey (PLSS).

They address these questions: What factors explain differences in the performance of retail businesses? If these can be identified, what types of policy initiatives might improve the performance of firms, especially those run by women? Among their recommendations:

- Channeling credit to small businesses.

- Promoting cooperatives and self-help associations, which provide credit, facilitate bulk purchases, and establish markets for entrepreneurs.

- Providing technical assistance, such as short-term instruction in basic management.

- Making it easier and cheaper to get business licenses.

- Provide or facilitate cooperative childcare centers, facilities for preparing food, and neighborhood facilities for basic health care to reduce the heavy workload typical for women.

Table of Contents

J. Barry Smith is a member of the Department of Economics, York University, Toronto, Ontario and Morton Stelcner is in the Department of Economics, Concordia University, Montreal, Quebec.

The authors thank the following individuals: Jorge Castillo, Shahid Khandker, Valerie Kozel, and Marcia Schafgans of the World Bank; Richard Laferrière, Department of Economics, Concordia University; Georges Monette, Department of Mathematics, York University; Jeffrey Racine, Department of Economics, York University; Gwenn B. Hughes, Policy and Strategic Analysis Branch, Labour Canada, Ottawa, and Gail A. Spence, Canadian Pacific Forest Products Limited, Montreal. The authors also benefited from the opportunity to present an earlier version of the paper at a seminar sponsored by the Women in Development Division. Jeffrey Racine performed the nonparametric analysis and wrote Appendix A. The research was funded by the Women in Development Division, the World Bank.

Modeling Economic Behavior in the Informal Urban Retail Sector of Peru

J. Barry Smith and Morton Stelcner

1. Introduction

Few topics in the literature on development economics have inspired as much interest, controversy, and rhetoric as the informal sector in developing countries.[1] Here the term is intended as a shorthand expression to describe the collection of loosely organized (but not necessarily fly-by-night) small-scale competitive family businesses. Such businesses rely little on nonfamily hired labor. Their technologies are labor intensive and they operate largely outside the legal, bureaucratic, and regulatory framework regarding such matters as licenses, taxes, and contractual obligations. An important characteristic of the informal sector is that the free play of market forces generally determines returns to productive factors, especially labor. The enterprises are usually concentrated in low-income areas of large metropolitan centers, but it is not uncommon to find rural households, for example in Kenya and Peru, that have joined the informal sector.[2]

There appears to be a consensus that the informal economy is a sizable and growing component of developing economies. It accounts for a substantial fraction

[1] For more recent literature see Bromley (1978), Cornia (1987), Hallak and Caillods (1982), Hart (1987), House (1984), IDB (1987a), Mattera (1985), Moser and Marsie-Hazen (1984), Sethuraman (1981), Stewart (1987), and Tokman (1978).

[2] For a discussion see Stelcner and Moock (1988), Moock, Musgrove, and Stelcner (1989), and Freeman and Norcliffe (1985).

of the labor force, especially in urban areas, and provides an important -- if not the sole -- income opportunity for growing numbers of the poor. But the debate about its role in economic development continues. There is considerable disagreement about whether measures should be taken to promote informal activities as an impetus to economic growth and a strategy for improving the earnings of low-income households.

The place of the informal sector in development is all the more important because of the severe economic crisis in most third world economies. As Cornia (1987) discusses, households faced with sharply reduced employment and income prospects in the formal (or modern) sectors -- manufacturing, services, mining, and government -- tend to seek employment and income opportunities in the informal economy. The first to shift are those who have lost jobs in the formal sector. Next, employed formal sector workers, especially government employees, resort to moonlighting activities, most of which are informal. As household incomes decline, married women and children who previously did not work in the market are drawn into informal market activities, and soon new entrants to the labor force begin to find jobs in the informal rather than the formal sector.[3]

The rapid growth of the informal sector has led international aid agencies and governments to explore policies to improve the profitability of such businesses. This surge of interest, however, is not based on much empirical evidence about the underlying determinants of the performance of the firms.

Informals perform a remarkable array of activities, ranging from vending foodstuffs and prepared foods to consumer goods and services, including

---

[3] Several recent studies have identified these general patterns. See Cornia (1987), IDB (1987b), PREALC (1985), van der Gaag, Stelcner and Vijverberg (1989), and Tokman (1986).

carpentry, tailoring, barbering, shoe-repair, domestic work, vehicle and tool repairs, and transport. In addition, small-scale entrepreneurs manufa ce textiles, garments, footwear, household utensils, musical instruments, metal products, furniture and wood products, and leather goods. They process foods and beverages, and recycle junk. Some firms are also involved in such illicit ventures as smuggling and processing alcohol and cocaine.

This research analyzes the informal sector in Peru, particularly the role of women, based on a theoretical model of informal retail trade that uses data from the Peru Living Standards Survey (PLSS). Retailing is the dominant nonfarm family enterprise. The central questions are: What factors explain differences in the performance of retail businesses? Assuming that these considerations can be identified, what types of policy initiatives might improve the performance of firms, particularly those run by women? The analysis is confined to urban areas where most of these businesses are located.[4]

[4] We attempted to provide an analysis of nonfarm enterprises in both urban and rural areas. But the limited size of the sample in rural areas precluded the estimation of a model that we were confident of using. The results for rural areas are in appendix [illegible].

2. Some Stylized Facts on the Informal Sector

2.1 Magnitudes and Other Characteristics

Informal economic activity is a mainstay of the Peruvian economy. Its sustained growth stands in marked contrast to formal activity, which has deteriorated in the last decade at an alarmingly rapid rate. There is extensive evidence that a high proportion of the labor force, especially the female component, is in informal activities. As Glewwe and de Tray (1989) and Suarez-Berenguela (1987) discuss, the majority of the bottom socioeconomic strata in urban areas earns a livelihood from self-employment in the informal sector.

Peru's shadow economy has recently attracted worldwide attention[5] as a result of the recent publication of El Otro Sendero: La Revolución Informal[6] by Hernando de Soto, a businessman and president of the Instituto Libertad y Democracia (ILD) in Lima. He concludes that the informal sector is the dominant and most dynamic part of the economy, and believes that removing the burdensome obstacles to legitimacy (such as bureaucratic red tape) would considerably improve Peru's economic malaise.

Several other recent studies corroborate de Soto's view that a sizable portion, perhaps a majority, of the labor force is in the informal sector.[7] Surveys by the ILD in 1985 and 1986 show that the informal sector in Lima makes up almost half the labor force, accounts for 61 percent of the hours worked and

---

[5] See The Economist, February 18 and September 23, 1989; and Leaders, March 1989 (12) 1.

[6] The English translation is The Other Path: The Invisible Revolution in the Third World. (See de Soto 1989).

[7] See Althaus and Morelli (1980), Kafka (1984), Litan and others (1987), Stelcner and Moock (1988), Moock, Musgrove, and Stelcner (1989), Strassmann (1987), Suarez-Berenguela (1987), Vargas Llosa (1987), Webb (1977), and World Bank (1987).

generates an astounding 39 percent of GDP (1984). For such sectors as commerce and personal services this share exceeds 60 percent. Litan and others (1987) report that the official national accounts estimate of the informal sector's contribution to GDP in 1984 resulted in an understatement of total GDP of 23 percent. Perhaps even more striking is the estimate that 439,000 Lima residents depend on the underground commercial economy, and almost three fourths (314,000) of these individuals depend on street sales. According to de Soto, these activities generated about $25 million a month in gross sales in 1985 and an average net per capita profit of $58 a month, about 40 percent more than the legal minimum wage. The 314,000 street merchants include 91,455 street vendors, are 42 percent of the Lima work force involved in commerce.

The ILD surveys show that women make up 54 percent of the street vendors. Eighty-six percent of the street merchants occupy curbside sites, while the remaining 14 percent rove the streets. Business is also conducted in (illegal) cooperative markets -- collections of kiosks, stalls and booths. Of the 331 markets in Lima, 274 were put up illegally; only 57 were built by the government. It is estimated that $41 million has been invested in these illegal markets, which employ about 125,000 people (including so 40,000 vendors). More than 80 percent of the street vendors and 64 percent of the informal markets are found in low-income districts.

According to recent studies that used the Peru Living Standards Survey[8], half of the 5,100 households surveyed owned at least one nonagricultural family enterprise. Of the 27,000 individuals in the survey, 13,600 were in the labor force and 97 percent were employed. More than 4,500 worked in nonfarm family

[8] See Stelcner and Moock (1988), and Moock, Musgrove, and Stelcner (1989).

businesses, and 3,100 worked in family enterprises as their main occupation. About 6,200 worked on family farms.

Metropolitan Lima accounted for 34 percent of nonfarm family businesses, other urban areas for 44 percent, and rural areas only 22 percent. Of course, a large fraction of rural households also operate farms. These proportions correspond closely to the distribution of family workers and households across regions. The average number of enterprises per household is 1.25.

These family businesses are dominated by retail trade, manufacturing (especially textiles), and personal services (mainly in urban areas). Retail trade encompasses small shops, inns and cafes, kiosks, stalls, and street vending. Nontextile manufacturing includes food, beverages, pottery, furniture, toys,novelties, and musical instruments. The textile sector includes spinning, weaving, and tailoring. Personal services range from laundries and hairdresser and barbers to entertainment, auto and electrical repairs, and cleaning services. Most businesses rely on just one or two family workers; the use of hired labor is negligible.

Many firms do not own any capital or inventory and often have no operating expenses. In the retail sector selling is often on consignment or commission. Large factories, wholesalers, and stores in the formal sector often provide the goods and perhaps the cart, stall, or kiosk. The goods are sold either on straight commission, or on consignment: the sellers pay only for what they sell and return the unsold goods. Factories often subcontract textile, clothing, leather and footwear manufacturing to family enterprises, which they provide with materials and equipment. In the labor-intensive personal services sector, little use is made of capital equipment. Thus it is not surprising that many family businesses in the dominant sectors reported little or no capital, inventories, or operating expenses.

How much credit do informals use and obtain? The Peru Living Standards Survey provided information on the current debt position of each household, and on the source and terms of loans obtained in the past year.

Only 10 percent of the households that operated businesses reported that they received loans or were in debt. This is not surprising for several reasons. First, the PLSS was conducted when inflation rates were extremely high (June 1985-July 1986). (During the first half of 1985 the annual inflation was 200 percent, and in the first half of 1986 monthly inflation was 4 to 5 percent. Such high rates of inflation are unlikely to foster a willingness to lend, except at interest rates so high that few households would choose to borrow. Second, given a sensitivity to questions about indebtedness, the Peru Living Standards Survey probably underestimated the debt among respondents. (To preserve good will, questions on debt and credit were last in a long questionnaire). Third, given the uncertain legal position of family businesses, their ability to obtain credit from formal lending institutions is very restricted at best. As Carbonetto (1984), Mescher (1985), and Kafka (1984) document, only a minute fraction of informal sector firms in Lima borrow from financial intermediaries in the formal sector. Households that need to borrow must depend on loan sharks and pawnbrokers, or resort to a "pandeiro". This is a revolving fund to which members make a weekly contribution. A lottery determines the winner of the week's contributions.[9]

[9] See Mescher(1985), World Bank (1989).

In Lima, retail trade, personal services, and manufacturing account for more than 80 percent of the businesses and almost 85 percent of the family workers (Table 1). The single most important activity is retail trade. The pattern is the same in the rest of Peru. In other urban areas the proportions are 86 percent (retail trade, 52 percent) and 90 percent. In rural areas 80 percent of entrepreneurial families and workers are in retail trade (43 percent) or manufacturing, particularly textiles. These are typical informal sector endeavors in most developing countries. What distinguishes Peru from other countries is the unusually large proportion of women and households in these activities.

2.2 The Role of Women

The Peru Living Standards Survey shows that women dominate the informal economy. Schafgans (1989) notes that women make up about 45 percent of the labor force. The vast majority work in family-owned firms and farms. Table 2 shows that 82 percent of the 5,952 employed women worked in family-owned nonfarm businesses (28 percent) or on family farms (54 percent). The remaining 18 percent were wage earners, mostly in urban areas. In Lima 45 percent of employed women were wage earners in contrast to 19 percent in other urban areas. In rural areas only 5 percent of employed women worked as salaried employees, usually as school-teachers and clerks in the public sector. There is practically no labor market for women in rural areas. In Lima, 38 percent of the women were employed in nonfarm businesses and 17 percent in agricultural activities; in other urban areas the corresponding proportions were 44 and 37 percent, and in rural areas 11 and 84 percent.

Table 1. Percent Distribution of Informal Family Businesses by Sector of Activity

	Metro Lima	Other Urban Areas	All Urban Areas	Rural Areas	Peru
No. of Observations	1045	1387	2432	692	3124
Retail Trade	40.7	51.5	46.8	43.1	46.0
Personal Services	19.8	12.4	15.6	4.5	13.1
Textile Manufacturing	10.9	12.2	11.6	26.4	14.9
Other Manufacturing	10.4	9.7	10.0	11.9	10.4
Subtotal	**81.8**	**85.8**	**84.0**	**85.9**	**84.4**
Other Sectors	**18.2**	**14.2**	**16.0**	**14.1**	**15.6**

Note: Other Manufacturing includes food, beverages, furniture production and miscellaneous items.
Other Sectors include construction, transport, wholesale trade, mining, fishing and hunting.

Source: Peru Living Standards Survey.

TABLE 2. Percent Distribution of Employed Labor Force by Type of Employment

	Metro Lima		Other Urban Areas		All Urban Areas		Rural Areas		Peru	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
No. of Observations	1237	1747	1978	2450	3215	4197	2737	3041	5952	7238
NonFarm Sector	38.2	31.5	44.1	32.5	41.9	32.1	10.6	5.3	27.5	20.8
Farm Sector	16.5	3.4	37.0	25.1	29.0	16.1	84.0	77.0	54.4	41.7
Wage Sector	45.3	65.1	18.9	42.4	29.1	51.8	5.3	17.7	18.1	37.5

Note: The nonfarm and farm sectors refer to self-employment; wage sector refers to hired labor.

Source: Peru Living Standards Survey.

Of the 7,238 employed men surveyed, 21 percent worked in nonfarm enterprises and 42 percent worked on family farms, while 38 percent worked as wage employees (65 percent in Lima. 42 percent in other urban areas, and 18 percent in rural areas). In Lima about 32 percent of employed men worked in family businesses and 3 percent on farms, while in other urban areas the proportions were 33 and 25 percent, respectively. In rural areas only 5 percent of men worked in nonfarm family businesses; 77 percent worked on family farms.

In the retail food and textile sectors women account for three-fourths of the family workers. In retail nonfood and food processing sectors they make up 60 to 70 percent of the work force, and account for about half the workers in urban personal services. The remaining family businesses -- transportation, construction, wood and chemical manufacturing, wholesale trade, hunting and fishing, and professional services -- are dominated by men and employ only a small fraction of women. There appears to be a clear division of labor between men and women. The proportion of women employed in the formal sector is much smaller than that of men and the informal sector activities that women pursue are considerably different from those of men.

The role of women in family enterprises is also highlighted by the large proportion of family businesses in the dominant three sectors that employ exclusively women and children under 20. In urban and rural areas about half the family retail businesses rely only on women and children. About 40 percent of that provide services firms employ only women and children. In textiles, which are largely home-based, over 66 percent of the rural concerns employ only women and children. In Lima the proportion rises to 70 percent and in other urban areas to 75 percent. These data suggest that women not only make up a high proportion of family workers but also operate the family businesses.

Despite their importance in these businesses, the value of women's entrepreneurial activities is not adequately reflected -- if at all -- in the national accounts. There have been very few attempts to assess their contribution to the economy or to analyze the relative performance of men and women in the informal economy. This is particularly true in Peru and other Latin American countries where such work has gone largely unnoticed, with the possible exception of domestic work.

Moreover, official Latin America data[10] do not give accurate information about women's economic activities. Most of the empirical economic research on family businesses has focused on agricultural activities or on the activities of self-employed urban men. Agricultural research tends to ignore informal nonfarm economic activities in rural areas. And most of the research on the self-employed analyzes individuals rather than the enterprise, ignoring the contributions to income of capital, nonlabor inputs, and the labor of women and children. These last are typically excluded because most surveys report them as unpaid family workers, while men are usually reported as paid family workers (Chiswick 1983).[11]

This analysis focuses on the family business rather than the self-employed individual, thereby incorporating enterprise characteristics -- capital, location, nonlabor inputs -- and the labor of all family workers.[12]

---

[10] See Recchine de Lates and Wainerman 1986; Bunster and Chaney 1985; Babb 1984.

[11] Often it is not clear whether these self-employed earnings refer to the value of gross sales or to the value of net production, that is, sales less cost of materials and other inputs.

[12] For related approaches see Blau (1985), Chiswick (1983), Strassmann (1987), Vijverberg (1988), and Teilhet-Waldorf and Waldorf (1983).

3. **Model Formulation and Concepts**

The analysis of the model of the revenue process of retail enterprises includes a theoretical characterization of revenue generation by retailers as well as a basis for estimating economic magnitudes (such as productivity). The model incorporates three features of sales revenue -- price, potential customers, and the process by which a potential customer becomes a purchaser, at a given price.

The traditional economic model of production is extended to explain the production process of firms that expend resources in selling as well as in producing goods or services. For example, consider a street vendor who sells pencils at a given price at a busy intersection. An important consideration involves measuring the vendor's output. To argue that output can be measured in terms of the number or constant dollar value of transactions (in this case, pencils sold) is akin to measuring output by the value of inputs, and misses a vital feature of the retailing process. That is, in every attempt (whether successful or not) to convince a passerby to purchase a pencil, the vendor is also making a sales effort, that includes information about the product and its availability. To measure output by the volume or value of transactions measures only that part of the vendor's activity that is successful.

In our model we argue that an enterprise in the retail sector effectively 'produces' the probability that a contacted customer will make a purchase. We argue further that the firm can adjust its inputs (including labor, capital, materials, and inventory) to change the likelihood that it will make a sale. Changing inputs may range from increasing inventories to providing more information to customers.

The model is not explicitly one of profit maximization and not necessarily one where optimization leads to a dual relationship between cost and production. The data (particularly on prices) are not sufficient to estimate such a model. More important, it is not clear whether the textbook model of cost-efficient production and profit maximization is a useful hypothesis. It may be more reasonable to assume simply that firms make efficient use of their inputs and then to test whether observed decisions are consistent with profit maximization. Since our goal is to provide an empirical model of production for retail firms, in our discussion of the theoretical model we will also refer to problems and limitations in the applied work.

3.1 Assumptions

Assume that potential shoppers arrive randomly at the location of a vendor. Thus the contacts between buyers and sellers is a random variable. The average number of such contacts will depend upon the characteristics of the firm, including its location and reputation.[13] There is no guarantee that a shopper arriving at an enterprise will decide to make a purchase. Of two seemingly identical shoppers, one may decide to buy while the other does not, independently of the characteristics of the enterprise. The fraction of shoppers that makes a purchase is thus a random variable.

We assume that at each point in time and for a given price and type of good, a customer has a random yet rationally determined threshold response level to the vendor's sales effort. Suppose shopper j has threshold level t_j. The decision by the customer whether or not to make the purchase involves a comparison of t_j with the variable T_i defined as the index of sales effort

[13] No information is available concerning repeat buyers or customers who purchase more than one unit of a good.

produced by firm i. If $T_i > t_j$, then the arriving customer will buy from firm i. If customers have their threshold levels t_j distributed according to the same (distribution) function F, then a firm with sales effort T_i will make a sale to a randomly arriving customer with probability $F(T_i)$. This probability, $F(T_i)$, can also be thought of as the fraction of arriving customers that buy from the firm. Part of the firms' decision making involves setting the level of T_i.

The model described above is similar to stochastic choice models that have lately become quite popular in labor economics. By analogy, the decision to buy is like the decision to enter the labor force and the condition that $t_j < T_i$ is similar to the requirement that the reservation wage at zero work is less than the market wage.

The enterprise can change its operating characteristics to affect the fraction of shoppers that makes a purchase. For example, a business can increase its inventory or stay open longer. Such factors are considered productive if increasing them raises the fraction of potential consumers who make purchases or, equivalently, increases the probability that a given shopper will make a purchase. Since the fraction of shoppers who buy is bounded from above by unity, in the limit for large quantities of factors there must be zero returns at the margin to increasing the level of productive factors. Similarly, while enterprises may adopt different mixes of factors (perhaps due to financing restrictions), labor is a common feature; no retail firm can operate without labor. The fraction of shoppers making purchases will approach zero as the amount of labor input approaches zero. This need not be true, however, for such inputs as capital (for example, a cart or stall) or inventory. Without these factors a customer can still make a purchase. The model is not constrained ex ante to require profit maximizing decisions on the part of firms. We do, however, examine whether the properties of the estimated model are consistent with profit maximization.

In applied work, neither the total number of units sold nor the selling price per unit are generally known. Data sets typically do not contain this information. Similarly, information on the number of customer contacts and the fraction of shoppers who buy is not available. At most, information on revenues, costs, and other characteristics of factors employed by the firm will be available in cross-section or time series data sets. With cross-section data the absence of separate information on price and quantity may cause fewer problems than in a time series setting where constancy of price is difficult to justify as a working assumption.

3.2 Specific Aspects of the Model

The expected price per unit received by an enterprise is defined as p^E. It is assumed that agents treat p^E as independent of the decisions of individual enterprises and of customers.

The expected number of shoppers arriving at enterprise i is defined as $N^E(X^i)$. N^E is assumed to depend upon (a vector of) characteristics of firm i, X^i, one element of which, for example, would be location. Differences in the expected number of arrivals at firm i versus firm j are assumed to depend only on differences in the characteristics of vectors x_i and x_j. Because the total number of arrivals is subject to random effects, firm i will not in general observe arrivals equal to $N^E(X^i)$. In the applied work of subsequent sections it is assumed that the expected number of arrivals to firm i can be expressed as:

$$N^E(X^i) = \exp[a_0 + \sum_{j=1}^{n_N} a_j x_j^i] \qquad (1)$$

Thus,

$$\ln N^E(X^i) = a_0 + \sum_{j=1}^{n_N} a_j x_j^i \qquad (2)$$

where x^i_j is a measure of the j^{th} characteristic in firm i. The specification of $N^E(X^i)$ is seen to be linear in its logarithm and introduces the ex ante restriction that the number of arrivals is nonnegative.

The fraction of shoppers that make a purchase or, equivalently, the probability that firm i makes a sale to a randomly arriving customer, is given by $F(T(Z^i))$. F depends upon a vector of firm i's characteristics, Z^i, which includes labor, materials/expenses, capital, and inventories.

In keeping with the discussion of the previous section, F can be written as a function of T_i where T_i is an index of sales effort and output produced by firm i and given by:

$$T_i = T(Z^i) \tag{3}$$

F will be a nondecreasing function of T_i, bounded from below by 0 and from above by 1. Indeed, F is just the cumulative distribution function for the random variable t representing individual consumer purchasing thresholds. A drawing of t for a given customer j (t_j) shows the level of (an index of) sales effort needed to guarantee that individual j will make a purchase.

By adopting the above characterization of retailing, we obtain a model whereby something can be produced (sales effort or the probability of a purchase) with no guarantee that any consumer will make a purchase or that a firm will be observed to make a transaction. This will occur when the level of (the index of) sales effort produced by a given firm falls short of the threshold level necessary to convince the customer to buy. In the applied research it is assumed that the cumulative distribution function, F, is given by the logistic function.[14] :

$$F(T_i) = \frac{1}{1 + \exp[-T_i]} \tag{4}$$

From (3) it will be recalled that the index T_i is a function of a vector of characteristics Z^i of firm i. This function must reflect the fact that labor is indispensable to the activity but that other factors are not. If we define z^i_1 as the labor component of Z^i, the indispensability of labor can be introduced by requiring T_i to be an increasing function of the logarithm of z^i_1. Introducing the remaining factors affecting T_i in a linear fashion leads to the specification:

$$T_i = b_0 + b_1 \ln z^i_1 + \sum_{j=2}^{n_F} b_j z^i_j \tag{5}$$

where n_F is the number of factors used in the production of T_i. Given that $b_1 > 0$, labor will be an indispensable factor with a positive marginal product in terms of increasing the index T_i. As labor becomes small, T_i decreases without bound and $F(T_i)$ approaches zero. Any other factor z^i_j will be productive as long as $b_j > 0$. The parameter b_0 is the value of the index when labor is equal to one unit and all other factors are zero.It is reasonable to expect b_0 to be negative and large enough in absolute value such that $\exp[-b_0]$ is large and $F(T_i)$, the average frequency of sales, is small when almost no factors are allocated to sales.

As a final point, it is possible to extend the production analogy to consider isoquants which, in this case, are isoprobability contours of F. Since

---

[14] This specification of a logistic probability distribution function has proved valuable in other areas of applied economic research and it has the added benefit that it leads to applied models that are somewhat easier to estimate than those based upon the cumulative normal distribution function.

F is a monotone increasing transformation of T_i, isoquants of T_i will coincide with isoquants of F. These isoquants will be straight lines for pairs of inputs, excluding labor. Alternatively, for pairs of inputs one of which is labor measured on the vertical axis, the isoquants are horizontally parallel and intersect the vertical axis. Production processes such as this are called quasi-linear.

3.3 The Revenue Function of the Firm

The discussion contained in the foregoing sections leads to the specification of a revenue function for a representative firm in the retail sector. This function is comprised of both a deterministic and a stochastic component. The expected revenue of firm i, ${R^E}_i$, is given by the product of the expected price and the expected number of buyers. The latter quantity is itself given by the product of the expected number of arriving customers and the fraction of customers who make purchases. In terms of the notation introduced above,

$$R_i^E = p^E N^E(X^i)F(T(Z^i)) \tag{6}$$

We assume that the stochastic influence on revenues enters multiplicatively. Thus observed revenues of firm i, R_i, are given by:

$$R_i = R_i^E \exp[v_i] \tag{7}$$

where v_i is a random variable incorporating uncertainties in the price level and the unforecastable factors affecting the number of customer contacts with the firm. We assume that v_i is such that $E[\exp[v_i]] = 1$. Our applied work will involve estimating the revenue function in logarithmic form. In terms of the specification of N^E and $F(T_i)$ in previous sections, the estimating equation will be of the form:

$$\ln R_i = \ln p^E + a_0 + \sum_{j=1}^{n_N} a_j x_j^i - \ln(1 + \exp[-(b_0 + b_1 \ln z_1^i + \sum_{j=2}^{n_F} b_j z_j^i)]) + v_i \tag{8}$$

A nonlinear least squares algorithm is used to obtain point estimates of the parameters of the model. Since independent information on average price is not available, the coefficient estimate of a_0 will not identify the parameter a_0.

3.4 Marginal Revenue Products and Profit Maximization

The derivative of the expected revenue function with respect to a right-hand side variable (such as labor or capital) can be interpreted as the expected marginal revenue product of the variable. In cases where the unit price of the factor is known, the expected marginal revenue product can be compared with this magnitude to partially assess the efficiency of the firm. For example, if a firm is maximizing expected profits, the factor price and the marginal revenue product should, on average, coincide. In cases where data on factor prices are not available (a common occurrence in the informal sector), the derivative of the expected revenue function can be considered the shadow price of the factor. This shadow price is the amount of money that would be paid to the factor if the existing situation represented profit-maximizing behavior. In both situations the results lead to interesting insights for policy analysis.

The model is quite flexible with respect to possible relationships between revenue and such productive factors as labor, capital, and expenses. The fact that $F(T_i)$ is strictly bounded from above and below introduces some features into the relationship between factors that often do not arise in standard models of production. To highlight some of these properties, we present the following example of an expected revenue function.

Suppose that a simplified expected revenue function with two factors (x and y) is given by:

$$R = 1/(1 + \exp[a - x - y]),\ a \geq 0 \qquad (9)$$

where R is (expected) revenue, price and customer effects are fixed (in this example) and (a, -1, -1) are the estimated coefficients of the model. The (expected) marginal revenue product of factor x, R_x, is the derivative of the right hand side of (9) with respect to x and is given by:

$$R_x = R - R^2 \qquad (10)$$

The marginal revenue product of x will be positive as long as the right hand side of (10) is positive. Given the definition of R in (9), this will always be the case because $R < 1$.

The response of the marginal revenue product function to changes, ceteris paribus, in x and y is important for determining the suitability of any profit maximization hypothesis and for determining the relationships between productive factors. The slope of the marginal revenue product function is given by the derivative of the right hand side of (10) with respect to x. Denoting this slope by R_{xx}, differentiation yields:

$$R_{xx} = R_x(1 - 2R) \qquad (11)$$

Eventually, the marginal revenue product curve will slope downwards as R becomes larger than .5. There may be a range of x values where the marginal revenue product curve is upward sloping. This would be the case, for example, if when $x = 0$, the value of the expression $(a - y)$ exceeds 0 (and hence, $R < .5$ when $x = 0$). Thus the slope of the marginal revenue product curve for x depends in part on the quantity of the other productive factors. Within a profit maximization setting, the marginal revenue product curves must be downward sloping if the optimality conditions are to be satisfied.

It was noted above that the levels of other factors affect the slope of the marginal revenue product curve for a given factor. The position of the marginal revenue product curve for a given factor is influenced by the quantities of the other factors as well. This effect can be illustrated by considering the change in the marginal revenue product of x as y changes. Denoting this effect by R_{xy}, the right hand side of (10) can be differentiated with respect to y to obtain:

$$R_{xy} = R_y(1 - 2R) = (R - R^2)(1 - 2R) \tag{12}$$

where R_y is the marginal revenue product of y. Thus in this simple example, as long as $R < .5$, increasing y makes x more productive. Eventually, though, as y becomes increasingly large, more of the factor y will exert a negative effect on the (marginal) productivity of x. The explanation lies in the fact that the probability of making a sale (in this case $1/(1 + \exp[1 - x - y])$) is bounded from above by 1. The only way this condition can be met for increasing values of y and fixed x is if both factors are made less productive. If this were not to happen then x could be increased over a feasible range of values and the probability could be made greater than 1.

4. Description of the Data and Variables

The theoretical model is applied to data from the Peru Living Standards Survey (PLSS). The survey results provide information on a variety of topics: household composition, demographics, housing conditions, health, education, migration, labor force activities, housework, farm and nonfarm businesses, and household expenditures (see Grootaert and Arriagada 1986; INE 1988).

The survey modules on nonfarm family businesses, labor force behavior, and the personal characteristics of household members are particularly useful. For each family enterprise the PLSS gives the labor inputs of family workers, the value of output sold or consumed by the household, expenditures on purchased inputs, and the value of assets. The survey does not contain information on physical units and prices of output and nonlabor inputs -- only total values. The survey shows how long each business has been open, the type of output, how many months it operated in the past year, and whether the business is in the home, at other fixed premises, or has no fixed premises. The information covers 3,360 businesses: 1,178 in metro Lima, 1,480 in other urban areas, and 702 in rural areas. The most popular activity is retail trade: 425 firms in Lima, 714 in other urban areas, and 298 in rural areas. In the analysis of the retail sector we excluded 51 observations urban because i) only children under 15 were employed (five in Lima, four in other urban areas, seven in rural areas), ii) no sales revenue was reported (nine in Lima, eight in other urban areas, three in rural areas), and iii) values of capital or expenses were more than 100,000 intis (six in Lima and nine in other urban areas). This reduced the sample to 1,386 firms: 405 in Lima, 693 in other urban areas, and 288 in rural areas.

A novel feature of this study is that it explicitly addresses the predominate role of women in the retail sector by distinguishing among three types of businesses: 1) female-only firms (possibly with children), 2) male-only firms (perhaps with children), and 3) mixed firms. Most retail firms employ only one or two family workers and do not use hired laborers. (See Table 3)

We use the following variables in the empirical analysis. The dependent variable is the logarithm of monthly gross revenues, which is the value of output. The set of regressors can be grouped into two categories -- those that describe customer arrivals and those that affect the probability of a purchase. The former group includes the age of the enterprise in years, which can be interpreted as a reflection of the reputation of the firm and perhaps as a predictor of learning by doing in attracting clients. Also included is the place of operation as a proxy for ease of access by customers. Two dummy variables -- 'in the home' and 'at a fixed location' (a kiosk or stall) -- incorporate the site information. Itinerant operations with no fixed location (such as peddling and street hawking) are excluded.

The following variables are deemed to affect the probability of a purchase. First, the value of capital, which includes land, buildings, furniture, tools, machinery, equipment and vehicles. Second, the value of inventory stocks and third, monthly operating expenses which measure the cost of goods purchased for resale, raw materials, and such items as repairs, utilities, and fuel. The timeframe of this variable corresponds to that of the dependent variable. The fourth variable is labor input, measured by the logarithm of monthly hours devoted by all family workers in the enterprise. The annual hours of farming labor are divided by the months of operation. Other aspects of managerial or sales skills are described by two proxies: 1) total work experience (in years) of the most experienced adult family worker in the firm and 2) the level of educational attainment of the most educated adult family worker in the firm. Work experience is entered with linear and quadratic (scaled by 100) terms. The effects of educational attainment are entered in two alternative ways. First, we use three dummy variables - primary school completed, secondary school completed, and postsecondary school completed; the excluded category is less than primary schooling. Second, we use three splines - years of primary school (zero to five), secondary school (six to ten) and postsecondary school (more than 10 years). Finally, the effects of vocational training are reflected by a dummy variable that takes a value of unity if any adult family worker in the enterprise had vocational training, or a value of zero otherwise.

TABLE 3. Descriptive Statistics of Urban Retail Sector

Type of Firm		METRO LIMA Female	METRO LIMA Male	METRO LIMA Mixed	METRO LIMA Total	OTHER URBAN AREAS Female	OTHER URBAN AREAS Male	OTHER URBAN AREAS Mixed	OTHER URBAN AREAS Total	ALL URBAN AREAS Female	ALL URBAN AREAS Male	ALL URBAN AREAS Mixed	ALL URBAN AREAS Total
Number of Firms		203	98	104	405	375	132	188	693	576	230	292	1098
PLACE OF OPERATION	%												
Home		25.1	8.2	24.0	20.7	37.5	18.2	34.6	33.0	33.2	13.9	30.8	28.5
Fixed location		21.2	18.4	37.5	24.7	25.5	25.8	31.9	27.3	24.0	22.6	33.9	26.3
Itinerant (Streets)		5[illegible].7	73.5	38.5	54.6	37.0	56.1	33.5	39.7	42.9	63.5	35.3	45.2
MONTHS OPERATED DURING YEAR		8.8	9.2	10.0	9.2	9.7	9.6	10.1	9.8	9.4	9.4	10.1	9.6
		(3.9)	(3.8)	(3.0)	(3.7)	(3.6)	(3.8)	(2.9)	(3.4)	(3.7)	(3.8)	(3.0)	(3.6)
1 - 6 months	%	28.1	27.6	14.4	24.4	22.0	22.7	11.2	19.2	24.1	24.8	12.3	21.1
6 - 9 months		16.3	9.2	17.3	14.8	9.1	8.3	18.1	11.4	11.6	8.7	17.8	12.7
9 -12 months		55.7	63.3	68.3	60.7	68.9	68.9	70.7	69.4	64.2	66.5	69.9	66.2
AGE OF FIRM (Years)		6.0	7.8	8.8	7.1	7.7	9.3	10.8	8.9	7.1	8.7	10.1	8.2
		(8.8)	(10.1)	(9.1)	(9.3)	(9.8)	(11.5)	(11.8)	(10.8)	(9.5)	(10.9)	(10.9)	(10.3)
Less than 4 months	%	12.3	8.2	4.8	9.4	9.4	9.8	4.3	8.1	10.4	9.1	4.5	8.6
4 months - 1 year		14.3	13.3	9.6	12.8	8.8	7.6	3.2	7.1	10.8	10.0	5.5	9.2
1 - 3 years		27.1	24.5	19.2	24.4	23.1	18.2	14.4	19.8	24.5	20.9	16.1	21.5
3 - 5 years		14.3	17.3	15.4	15.3	14.5	14.4	15.4	14.7	14.4	15.7	15.4	14.9
5 - 10 years		11.8	7.1	17.3	12.1	16.9	17.4	22.9	18.6	15.1	13.0	20.9	16.2
Over 10 years		20.2	29.6	33.7	25.9	27.3	32.6	39.9	31.7	24.8	31.3	37.7	29.6
MONTHLY REVENUES	$	2731	4328	8300	4548	1889	5961	4801	3455	2186	5266	6048	3858
		(5489)	(6110)	(12138)	(8178)	(4262)	(21147)	(6337)	(10406)	(4743)	(16501)	(8968)	(9655)
$ 1 - 500 Revenues	%	24.6	20.4	2.9	18.0	32.7	28.0	12.2	26.3	29.9	24.8	8.9	23.2
500 - 1000		19.7	16.3	9.6	16.3	19.8	12.9	12.2	16.5	19.8	14.3	11.3	16.4
1000 - 2000		21.2	14.3	11.5	17.0	22.5	12.9	14.9	18.6	22.0	13.5	13.7	18.0
2000 - 4000		17.7	20.4	25.0	20.2	15.5	18.9	25.0	18.8	16.3	19.6	25.0	19.3
More than 4000		16.7	28.6	51.0	28.4	9.4	27.3	35.6	19.9	12.0	27.8	41.1	23.0
Log of Revenues	$	7.0791	7.4453	8.3448	7.4927	6.7389	7.2857	7.7911	7.1285	6.8588	7.3537	7.9883	7.2629
		(1.2895)	(1.5110)	(1.1663)	(1.4142)	(1.2733)	(1.6530)	(1.2595)	(1.4224)	(1.2882)	(1.5926)	(1.2536)	(1.4296)
MONTHLY EXPENSES	$	1874	2491	5633	2988	1294	3399	4376	2531	1498	3012	4824	2700
		(3394)	(4177)	(8076)	(5391)	(3552)	(8032)	(8927)	(6513)	(3505)	(6671)	(8640)	(6125)
Spline 2 Expenses > 830	$	1331	1945	4919	2401	819	2883	3696	1993	1000	2483	4132	2143
		(3265)	(4029)	(8000)	(5273)	(3455)	(7910)	(8860)	(6415)	(3395)	(6548)	(8570)	(6020)
Spline 3 Expenses > 2000	$	960	1489	4133	1903	550	2343	3013	1560	695	1979	3412	1686
		(2977)	(3715)	(7780)	(4994)	(3276)	(7699)	(8676)	(6211)	(3177)	(6320)	(8372)	(5792)
$ 0 Expenses	%	1.5	5.1	1.0	2.2	2.7	9.1	0.5	3.3	2.3	7.4	0.7	2.9
1 - 500		42.4	38.8	15.4	34.6	48.8	32.6	20.2	38.0	46.5	35.2	18.5	36.7
500 - 1000		18.2	9.2	11.5	14.3	19.8	7.6	11.7	15.3	19.3	8.3	11.6	14.9
1000 - 2000		14.8	19.4	11.5	15.1	13.1	13.6	23.9	16.2	13.7	16.1	19.5	15.8
2000 - 4000		10.3	10.2	25.0	14.1	9.1	19.7	18.6	13.7	9.5	15.7	20.9	13.8
Over 4000		12.8	17.3	35.6	19.8	6.4	17.4	25.0	13.6	8.7	17.4	28.8	15.8
$ 0 - 830	%	57.6	51.0	23.1	47.2	66.8	47.0	28.7	52.7	63.5	48.7	26.7	50.6
Over 830		42.4	49.0	76.9	52.8	33.2	53.0	71.3	47.3	36.5	51.3	73.3	49.4
Over 2000		23.2	27.6	60.6	33.8	15.5	37.1	43.6	27.3	18.2	33.0	49.7	29.7

Notes: All monetary values in the table are in June 1985 Intis. The exchange rate was $1.00 US = 11 Intis. Standard deviations are in parentheses.

	METRO LIMA				OTHER URBAN AREAS				ALL URBAN AREAS			
Type of Firm	**Female**	**Male**	**Mixed**	**Total**	**Female**	**Male**	**Mixed**	**Total**	**Female**	**Male**	**Mixed**	**Total**
Number of Firms	**203**	**98**	**104**	**405**	**375**	**132**	**188**	**693**	**576**	**230**	**292**	**1098**
TOTAL CAPITAL $	2191	8603	10523	5882	3264	8175	9195	5808	2886	8358	9668	5836
	(7733)	(21303)	(18407)	(15474)	(8173)	(19969)	(13732)	(13040)	8030	20504	15541	13980
Spline 2 Total Capital $	1693	8110	9683	5298	2715	7555	8327	5159	2355	7792	8810	5210
> 1000	(7610)	(21103)	(18320)	(15325)	(8011)	(19819)	(13649)	(12893)	7880	20333	15457	13833
$ 0 Total Capital %	15.3	23.5	0.0	13.3	6.4	12.1	2.1	6.3	9.5	17.0	1.4	8.9
1 - 250	26.1	20.4	10.6	20.7	29.8	19.7	7.4	21.8	28.5	20.0	8.6	21.4
250 - 500	13.8	11.2	6.7	11.4	14.5	9.8	4.3	10.8	14.2	10.4	5.1	11.0
500 - 2000	24.1	17.3	22.1	22.0	19.8	14.4	17.0	18.0	21.4	15.7	18.8	19.5
2000 - 4000	10.8	5.1	15.4	10.6	11.3	13.6	20.2	14.1	11.1	10.0	18.5	12.8
4000 - 12000	5.9	8.2	21.2	10.4	10.7	13.6	26.1	15.4	9.0	11.3	24.3	13.6
Over 12000	3.9	14.3	24.0	11.6	7.5	16.7	22.9	13.4	6.3	15.7	23.3	12.8
$ 0 - 1000 %	65.5	64.3	27.9	55.6	60.6	47.0	20.2	47.0	62.3	54.3	22.9	50.2
Over 1000	34.5	35.7	72.1	44.4	39.4	53.0	79.8	53.0	37.7	45.7	77.1	49.8
TOTAL CAPITAL EXCL. STOCK $	1559	5750	7050	3983	2004	4459	5044	3296	1847	5009	5759	3550
	(5386)	(17125)	(14833)	(12130)	(5657)	(13907)	(10553)	(9268)	(5563)	(15338)	(12262)	(10416)
STOCK (Inventory) $	632	2853	3473	1899	1260	3716	4151	2512	1039	3349	3910	2286
	(2874)	(8422)	(6634)	(5835)	(3913)	(10140)	(7048)	(6555)	(3592)	(9436)	(6899)	(6303)
MONTHLY PROFITS $	858	1838	2667	1560	595	2562	425	924	688	2253	1224	1158
	(3475)	(4172)	(7519)	(5021)	(2198)	(19426)	(8850)	(9790)	(2717)	(14946)	(8456)	(8357)
Profits > 0 %	84.7	88.8	84.6	85.7	79.1	80.3	73.4	77.8	81.1	83.9	77.4	80.7
FAMILY WORKERS	1.4	1.2	2.8	1.7	1.5	1.3	2.7	1.8	1.5	1.3	2.8	1.8
	(0.9)	(0.6)	(1.3)	(1.1)	(0.9)	(0.6)	(1.0)	(1.1)	(0.9)	(0.6)	([illegible].1)	(1.1)
1 worker %	72.9	85.7	0.0	57.3	68.1	75.0	0.0	50.9	69.8	79.6	0.0	53.3
2 workers	16.7	9.2	57.7	25.4	19.6	18.2	56.9	29.4	18.6	14.3	57.2	28.0
3 workers	5.4	4.1	23.1	9.6	7.0	6.1	23.9	11.4	6.4	5.2	23.6	10.7
4 or more workers	4.9	1.0	19.2	7.7	5.4	0.8	19.1	8.2	5.2	0.9	19.2	8.0
Adult Male Workers Only %	0.0	92.9	0.0	22.5	0.0	81.8	0.0	15.6	0.0	86.5	0.0	18.1
Male Workers Only	0.0	96.9	0.0	23.5	0.0	94.7	0.0	18.0	0.0	95.7	0.0	20.0
Adult Female Workers Only	76.4	0.0	0.0	38.3	73.5	0.0	0.0	39.5	74.5	0.0	0.0	39.1
Female Workers Only	89.2	0.0	0.0	44.7	88.2	0.0	0.0	47.5	88.5	0.0	0.0	46.4
Adult Workers Only	76.4	92.9	70.2	78.8	73.5	81.8	69.1	73.9	74.5	86.5	69.5	75.7
MONTHLY HOURS OF LABOR	200.3	227.6	499.5	283.7	210.1	227.6	459.0	281.0	206.7	227.6	473.4	282.0
	(172.0)	(186.5)	(289.1)	(246.4)	(162.7)	(172.3)	(259.2)	(223.3)	(166.0)	(178.1)	(270.4)	(232.0)
1 - 100 Hours %	32.5	25.5	1.0	22.7	28.4	25.8	2.7	20.9	29.9	25.7	2.1	21.6
100 - 200 Hours	28.1	23.5	9.6	22.2	27.3	19.7	12.8	21.9	27.6	21.3	11.6	22.0
200 - 300 Hours	15.8	20.4	17.3	17.3	20.6	25.0	12.8	19.3	18.9	23.0	14.4	18.6
300 - 400 Hours	11.8	19.4	16.3	14.8	11.5	18.2	15.4	13.9	11.6	18.7	15.8	14.2
400 - 500 Hours	4.9	7.1	12.5	7.4	5.9	5.3	17.6	8.9	5.6	6.1	15.8	8.4
Over 500 Hours	6.9	4.1	43.3	15.6	6.2	6.1	38.8	15.0	6.4	5.2	40.4	15.2
Log Monthly Hours	4.8406	5.0002	6.0544	5.1909	4.9867	5.0871	5.9532	5.2680	4.9352	5.0501	5.9893	5.2396
	(1.1192)	(1.1016)	(0.5902)	(1.1265)	(0.9735)	(0.9464)	(0.6361)	(0.9822)	(1.0286)	(1.0140)	(0.6210)	(1.0379)
Adult Male/Total Hours %	0.0	95.8	48.3	35.6	0.0	91.6	46.3	30.0	0.0	93.4	47.0	32.1
Adult Female/Total Hours %	91.6	0.0	46.9	58.0	89.8	0.0	46.3	60.9	90.5	0.0	46.5	59.8
Child Hours/Total Hours %	8.4	4.2	4.8	6.4	10.2	8.4	7.4	9.1	9.5	6.6	6.5	8.1

TABLE 3. (Contd)

	METRO LIMA				OTHER URBAN AREAS				ALL URBAN AREAS			
Type of Firm	Female	Male	Mixed	Total	Female	Male	Mixed	Total	Female	Male	Mixed	Total
Number of Firms	203	98	104	405	375	132	188	693	576	230	292	1098
EDUCATION (Most Educated Worker)												
Years of Schooling	6.2	7.6	9.1	7.3	5.7	7.2	8.6	6.8	5.9	7.3	8.8	6.9
	(3.8)	(3.6)	(3.3)	(3.8)	(4.0)	(3.9)	(3.6)	(4.1)	(4.0)	(3.8)	3.5	4.0
Spline 0 - 5 years of school	4.0	4.5	4.9	4.4	3.7	4.3	4.7	4.1	3.8	4.4	4.8	4.2
	(1.7)	(1.1)	(0.5)	(1.4)	(1.8)	(1.4)	(0.8)	(1.6)	(1.8)	(1.3)	(0.7)	(1.5)
Spline 6 -10 years of school	1.9	2.6	3.5	2.5	1.6	2.3	3.2	2.2	1.7	2.4	3.3	2.3
	(2.2)	(2.3)	(2.1)	(2.3)	(2.2)	(2.3)	(2.2)	(2.3)	(2.2)	(2.3)	(2.2)	(2.3)
Spline 10 + years of school	0.2	0.5	0.7	0.4	0.3	0.5	0.7	0.5	0.3	0.5	0.7	0.4
	(1.0)	(1.3)	(1.6)	(1.3)	(1.1)	(1.3)	(1.5)	(1.3)	(1.1)	(1.3)	(1.6)	(1.3)
Highest Education Level Completed												
None %	8.9	2.0	0.0	4.9	12.3	3.8	0.5	7.5	11.1	3.0	0.3	6.6
Primary	42.9	37.8	23.1	36.5	47.7	39.4	28.7	41.0	46.0	38.7	26.7	39.3
Secondary	40.9	44.9	57.7	46.2	31.1	40.9	47.9	37.5	34.5	42.6	51.4	40.7
Post-secondary	7.4	15.3	19.2	12.3	8.8	15.9	22.9	14.0	8.3	15.7	21.6	13.4
% OF FAMILY WORKERS WHO:												
Attended Public Schools	77.6	85.9	80.7	80.4	79.8	87.6	86.5	83.1	79.0	86.9	84.4	82.1
Have Vocational Training	32.8	27.7	34.8	32.1	22.6	13.5	17.8	19.6	26.2	19.6	23.9	24.2
AT LEAST 1 FAMILY WORKER HAS VOCATIONAL TRAINING %	39.4	28.6	60.6	42.2	27.9	15.2	37.8	28.1	31.9	20.9	45.9	33.3
AGE OF OLDEST WORKER (Years)	39.1	40.7	44.0	40.7	41.8	42.2	44.1	42.5	40.9	41.5	44.0	41.8
	(11.8)	(15.4)	(11.8)	(12.9)	(13.2)	(15.8)	(12.6)	(13.6)	(12.8)	(15.6)	(12.3)	(13.4)
JOB EXPERIENCE (MOST EXPERIENCED WORKER)												
Years	9.7	14.8	18.6	13.2	15.1	19.4	21.2	17.6	13.2	17.4	20.3	16.0
	(9.9)	(13.3)	(11.3)	(11.8)	(14.2)	(14.8)	(12.7)	(14.1)	(13.1)	(14.3)	(12.3)	(13.5)
Years squared/100	1.9	4.0	4.7	3.1	4.3	5.9	6.1	5.1	3.5	5.1	5.6	4.4
	(3.3)	(6.3)	(5.2)	(4.8)	(6.9)	(7.3)	(7.2)	(7.1)	(6.0)	(6.9)	(6.6)	(6.4)

5. **The Empirical Model**

This section reports the specification and estimation of the revenue model for the informal retail sector. In contrast to popular approaches to estimating the properties of production technologies, we introduce no assumptions about the optimizing behavior of agents. One reason for this is that there are seldom well-developed markets for the factors employed by these firms and thus no way to construct independent measures of the opportunity cost necessary for optimizing models.

Our work uses the revenue function specified in equation (8). Ultimately, though, the statistical process of specification, estimation, diagnostic analysis, and nonlinearity analysis that we employ is iterative. In our case there were iterations with respect to both model specification and inclusion/exclusion of data points in the sample reflecting the inflow of information from the battery of diagnostic tests to which the model and data were subjected. Since our model is nonlinear in some parameters it was necessary to estimate the extent of this nonlinearity to determine whether the local diagnostic analysis, based on a version of the model linearized about the least squares optimum and other measures of goodness of fit and precision, retained their traditional meaning. It is known, for example, that as the measured degree of model/parameter nonlinearity increases,traditional confidence ellipsoids may become distorted, with the result that traditional measures of (joint) significance of parameters lose their validity.

We describe below the iterations of testing and diagnostic analysis that separate the initial model from the final model for which parameter estimates are reported. The approach led to a model that is extremely robust, provides an excellent fit of the data, and is very close to the initial model in both specification and sample. Two versions of the final model are reported: the difference between the two lies in the measurement of education -- dummy or splined variables. Finally, as a further test of validity, we analyzed the data using nonparametric techniques (see Appendix B). The results are discussed below.

5.1 Initial Specification

The initial model was given by:

$$\ln R_i = a_0 + a_1\text{LOCTION\_HOME} + a_2\text{LOCATION\_FIXED} + a_3\text{FIRM\_AGE} - \ln(1 + e^{-T_i}) + V_i \qquad (13)$$

where:

$$T_i = b_0 + b_1\text{EXPENSES} + b_2\text{CAPITAL} + b_3\text{STOCK} + b_4\ln(\text{LABOR}) + b_5\text{TRAINING} + b_6\text{SCHOOL\_PRIMARY} + b_7\text{SCHOOL\_SECONDARY} + b_8\text{SCHOOL\_POSTSEC} + b_9\text{EXPERIENCE} + b_{10}\text{EXPERIENCE}^2 \qquad (14)$$

The model was fitted to three subsamples of the data: Lima, other urban areas, and rural areas. All the first round point estimates of the parameters (obtained by a nonlinear least squares Gauss-Newton algorithm) had the correct signs and between 50 and 60 percent of the variance in the logarithm of revenues was explained.

5.2 Preliminary Tests for Aggregation and Pooling

The initial results showed similar patterns in the estimated parameters of the Lima and other urban areas models. Some parameters from the rural model were similar to their counterparts for Lima and for other urban areas. These results led to the hypothesis that an aggregate model based on a pooled sample could be estimated. At the same time it was necessary to determine whether we were justified in pooling data among female, male, and mixed enterprises. This question was particularly important given that one of our goals was to estimate women's productivity. Finally, regardless of the outcome of these initial hypothesis tests, all the tests would have to be redone since the model specification and the data set might change as a result of information obtained from the diagnostic analysis (see below). All hypotheses were tested using the sample likelihood ratio statistic compared with its 1 percent critical value.

Table 4 gives the test results.[15] We could not reject the hypothesis of equality of parameters or structure in Lima and other urban areas. All pooling that included rural data, however, was rejected. That is, the structure of rural firms was found to be different from that of urban firms. Finally, we could not reject the hypothesis of equal parameters in the three classes of enterprises: male, female, and mixed.[16] For these reasons our urban model is estimated on a sample pooled with respect to enterprise and location (Lima and other urban areas). Tables B1 - B3 in appendix B give the results for the rural model.

Table 4. Summary Tests of Pooling Structure

HYPOTHESIS	TEST STATISTIC	CRITICAL VALUE	DECISION
1. Lima, Other Urban Areas and Rural Areas can be aggregated.	83.040	56.123	REJECT
2. Lima and Other Urban Areas can be aggregated.	25.041	33.409	DO NOT REJECT
3. For Lima and Other Urban Areas, Female, Male and Mixed Firms can be aggregated.	52.800	56.123	DO NOT REJECT

Note: Tests are based on likelihood ratio statistics.

[15] The results correspond to the final estimated model where education is represented by dummy variables. The pattern of results is similar to that obtained with the initial version of the model.

[16] This hypothesis was tested on the pooled Lima and other urban areas samples.

5.3 Diagnostic Analysis

Our analysis involved assessing the sensitivity of parameter estimates to what we term "data problems." Although the PLSS is an unusually clean data set, where much effort was devoted to correcting anomalies, it is still open to a variety of impurities due to, inter alia, measurement errors, data entry, and inaccurate reporting by respondents and enumerators. Advances in statistical research have made it possible to implement a set of data diagnostic tests to reveal statistical problems arising from imperfect data or highly influential sets of observations. These tests provide another useful way to assess the reliability of a given model.[17]

The diagnostic techniques involve searching the data for single observations or sets of observations that differ significantly from the 'average' data point and may have an excessive influence on the regression results. Parameter estimates that are highly dependent on the properties of small subsamples of the data should be treated with caution. For this reason the isolation and careful study of influential observations is an important task in applied modeling. The theory behind these tests for linear models has been developed extensively in the statistics literature. For our nonlinear model, the tests were performed on a version of the model linearized about the nonlinear least squares optimum.

Two possible sources of influential observations are high leverage points and outliers. A high leverage point is an observation for which the vector of independent variables is "far" from the rest of the data. In the leverage analysis, the data were searched for points that were farthest from the center

---

[17] For an excellent discussion of these issues, see Belsley, Kuh, and Welsch (1980), and Chatterjee and Hadi (1988).

of the remaining data. Since leverage points need not be influential points, these observations were iteratively dropped and the model reestimated to see if the points were particularly influential in determining the overall fit. The second test involved plotting residuals against leverage values to identify outliers, that is, those observations where the residuals were large. We isolated observations where the fitted values of the model were farthest from the actual values of the dependent variables. These observations were removed from the data set and the model was reestimated to evaluate their influence on the regression results. This process was repeated several times because the removal of any one high leverage point can, and generally does, cause a change in the set of high leverage points.

Finally, we examined the plots of the studentized residuals against the independent variables and against the fitted values of the dependent variable. The first set of plots was studied for patterns (for example, positive residuals for large values of the variables) that might indicate that the specification was not robust. The second plots provided information about possible nonlinear relationships in the residuals.

Ultimately the analysis showed that 15 data points were influential. That is, their removal from the sample led to significant changes in the parameter estimates for capital, stock, and expenses. All the influential observations we isolated had extremely large values for capital, stock, or expenses (more than 100,000 intis). We chose not to include these 15 data points in the estimation of subsequent models.

In studying the stability of the estimated parameters, we were particularly concerned about their sensitivity to restrictions on the capital, stock, and expenses variables. Our analysis involved setting critical values for these variables and dropping observations in excess of these values. When we reestimated the model for successively smaller critical values, we found that the parameters associated with capital, stock, and expenses were quite sensitive to these restrictions, but that other parameters were stable. The parameter estimates for capital, stock, and expenses tended to increase as the independent variables were restricted.

These results suggest that a model with constant coefficients for capital, stock, and expenses might not be appropriate. The coefficients should be given the flexibility to decrease as the variables increase.[18] The economic interpretation of these results was that there were variable returns to these factors beyond what the original specification of the model could encompass.

We reestimated the model with piecewise linear splines for capital, stock, and expenses. Because the nonlinear nature of the model combined with the large sample size made estimation somewhat expensive, we undertook only limited experimentation on determining the knots of the splines. Up to three segments appeared necessary to remove a large amount of the instability of the coefficients.

The parameter instability that remained appeared to involve a trade-off in the values of the parameters of the stock the capital variables similar to a multicollinearity problem. Independent of the choice of knot points, the spline coefficients for the stock variables were never significant and typically had t-statistics less than 0.5. The estimated coefficients were of the wrong sign as well. But if the added spline variables for stock were removed, an unstable

[18] We also estimated the model with quadratic terms for capital, stock, and expenses, but the parameter instability remained. Box-Cox transformations were not possible because these variables often had values of zero.

but statistically significant coefficient of the correct sign arose for the remaining stock variable.

We resolved this problem by aggregating the stock and capital variables into a single variable called total capital. We reasoned that statistical testing based on the likelihood ratio test provided no clear evidence against the aggregation decision. Whether or not the test rejected or did not reject aggregation depended on the number of spline variables introduced. In no case was aggregation as strongly rejected as the competing hypothesis that the stock variable should simply be dropped from the model. Second, the model with capital and stock aggregated was characterized by stable and significant parameter estimates of the correct sign. Third, prior to aggregation the nonlinearity tests (see below) indicated that the model was highly nonlinear in terms of the curvature properties of the estimated revenue function. After aggregation this problem disappeared.

5.4 Analysis of Nonlinearity

The diagnostic analysis is based on the assumption that the underlying regression model is linear in the parameters. Other statistics, such as confidence intervals about the point estimates of the parameters, assume that the model is linear. This linearity assumption is violated in the strict sense, but that there will be a linearized version of the model around the nonlinear least squares optimum. The important question to raise is whether the linearized version of the nonlinear model is accurate over a sufficiently large range of the parameter space so as to include confidence intervals measured in the standard way. Alternatively, the model may be so nonlinear that the linear approximation model becomes unacceptably inaccurate within the range of the traditionally (linearly) measured confidence intervals.

Current research in the statistics literature has been aimed at resolving such questions using differential geometry. This branch of mathematics has well-developed notions and measures of curvature and nonlinearity. Nonlinearity of statistical models has been reduced, in part, to the study of the radius (of curvature) of the largest approximating ball "covered" by the estimated model. Intuitively, the larger the radius of curvature, the better will be the local linear approximation to the model and the more confident one can feel about results based on the linearized model. The total curvature of a model can be decomposed to three parts: one representing the intrinsic curvature of the model (and about which nothing can be done short of respecification) and the other two representing parameter effects curvature (which can, to some degree, be mitigated by reparametrization of the model without distorting the specification). Statistical tests of the extent of curvature relative to the distance of the estimated model from the dependent variable can be performed and the significance of deviations from linearity can be assessed (see Bates and Watts 1980).

Table 5 shows the nonlinearity analysis arising from the last diagnostic iteration. All the parameters of the model fell within acceptable limits for nonlinearity. Those parameters for which the curvature measures were greatest were associated with the spline variables for capital and expenses. These results confirm our finding that it was inappropriate to specify constant coefficients for the aggregate expenses and capital variables. They also suggest that the spline approach leads to a model with a sufficiently accurate linear approximation around the nonlinear least squares optimum. The nonlinearity analysis increased our confidence in the quality of the estimated model and in the validity of applying traditional statistical tests to the model.

TABLE 5. ANALYSIS OF NONLINEARITY

Parameter Considered	Total	Intrinsic	Geodesic	Acceleration
		Curvature Type		
CONSTANT2 (b_0)	.036	.020	.014	.027
EXPENSES_1	.286	.119	.180	.187
EXPENSES_2	.385	.172	.216	.269
EXPENSES_3	.551	.271	.247	.411
CAPITAL_1	.311	.199	.088	.223
CAPITAL_2	.327	.211	.080	.236
LABOR	.023	.006	.015	.016
SCHOOL_PRIMARY	.022	.013	.010	.015
SCHOOL_SECONDARY	.034	.017	.015	.025
SCHOOL_POSTSEC	.065	.041	.019	.047
TRAINING	.018	.003	.012	.012
EXPERIENCE	.030	.018	.015	.019
EXPERIENCE^2	.041	.030	.016	.023

Notes:

1. Curvature numbers should be compared to: $lambda_c = F(17,1081;\alpha)^{-.5}$. When $\alpha = .05$, $lambda_c = .778$; when $\alpha = .01$, $lambda_c = .705$.

2. Curvature values greater than $lambda_c$ imply that standard confidence ellipsoids are significantly inaccurate.

5.5 Distribution of the Errors

The specified form of the (logarithmic) model in (13) contains the representative error term v_i. The error term is unobserved but the regression residuals (that is, the differences between the dependent variable, $\ln R_i$, and its fitted value, $\ln \hat{R}_i$) provide information about the distribution of the error terms. Using the standard Shapiro-Wilk test (based upon order-statistics), we could not reject the hypothesis that the residuals were normally distributed.[19] This in turn suggests that the multiplicative error term for total revenues given by $\exp[v_i]$ in equation (7) is lognormally distributed.

There are two implications of these distribution results. First, because the error term appears to be normally distributed in the logarithmic model, the least squares parameter estimates are also maximum likelihood estimates.

The second point is technical but important for the simulation analysis. In some of the simulation work it is necessary to construct an estimate of R^E_i (the expected value of revenue for the i^{th} firm). Given that the model is estimated with the logarithm of revenues as the dependent variable: $\ln R_i = h(x_i) + v_i$, then, because the v_i appear to be normally distributed, the appropriate estimate for R^E_i is given by:

$$\hat{R}^E_i = \exp[\hat{h}(x_i)]\exp[\hat{\sigma}^2/2]$$

where $\hat{\sigma}^2$ is the estimated variance of v_i. The second exponential term is a scaling factor arising in the transition from a normally distributed random variable to one that is lognormally distributed. In the empirical work we found that $\hat{\sigma}^2$ was about equal to 0.773 and thus that the scaling factor was about 1.47. If this scaling factor were ignored, the estimate of expected revenue would be biased downward by approximately 47 percent.

---

[19] An examination of the normal probability plot of the residuals as well as the shape of the plotted density function for the residuals confirms this finding.

6. Empirical Findings and Interpretation

We first present regression results for the final models for urban areas and comment on some (ex post) tests for aggregation and pooling. Second, we discuss the factor productivity of labor, expenses, and capital, and explain the distributions of productivity overall and by type of enterprise. Finally, we report some simulation experiments in which we provide loans to selected groups of firms. We use information from the estimated revenue model is to assess the firms' ability to repay these loans. We also consider simulations that change the level of schooling and the number of labor hours available to the firm.

The exact form of the final regression model is given by:

$$\ln R_i = a_0 + a_1 \text{LOCATION\_HOME} + a_2 \text{LOCATION\_FIXED} + a_3 \text{FIRM\_AGE} - \ln(1 + e^{-T_i}) + v_i \qquad (15)$$

where:

$$\begin{aligned} T_i = {} & b_0 + b_1 \text{EXPENSES\_1} + b_2 \text{EXPENSES\_2} + b_3 \text{EXPENSES\_3} + b_4 \text{CAPITAL\_1} \\ & + b_5 \text{CAPITAL\_2} + b_6 \ln(\text{LABOR}) + b_7 \text{TRAINING} + b_8 \text{SCHOOL\_PRIMARY} \\ & + b_9 \text{SCHOOL\_SECONDARY} + b_{10} \text{SCHOOL\_POSTSEC} + b_{11} \text{EXPERIENCE} \\ & + b_{12} \text{EXPERIENCE}^2 \end{aligned} \qquad (16)$$

The introduction of spline variables increased the number of expenses variables to three and the number of capital variables to two. The capital variable now includes the values of both physical capital and stock. Finally, we consider two versions of the model: one where the schooling variables are measured as splines, and the other where binary variables are used to distinguish levels of schooling.

Tables 6 and 7 present the regression results. The t-statistics suggest that most of the parameters are significantly different from 0 at the 1 percent level. In addition, each model explains about 60 percent of the variation in the dependent variable. This is high by cross-section standards.

TABLE 6. REGRESSION RESULTS - ALL FIRMS (Binary Schooling Variables)

CONSTANT1(a_0)	9.703
	(57.818)
LOCATION_HOME	-0.360
	(-5.180)
LOCATION_FIXED	-0.033
	(-0.449)
FIRM_AGE	0.006
	(2.079)
CONSTANT2(b_0)	-5.289
	(-21.478)
EXPENSES_1	1419.004
	(10.044)
EXPENSES_2	-1102.338
	(-4.926)
EXPENSES_3	-82.269
	(-0.654)
CAPITAL_1	474.017
	(5.269)
CAPITAL_2	-456.014
	(-5.013)
LABOR	0.215
	(6.494)
SCHOOL_PRIMARY*	0.194
	(1.696)
SCHOOL_SECONDARY	0.356
	(2.759)
SCHOOL_POSTSEC	0.402
	(2.659)
TRAINING	0.113
	(1.521)
EXPERIENCE	0.022
	(3.025)
$EXPERIENCE^2/100$	-0.058
	(-4.049)
LLF	-1419.360
SSR	852.963
Adjusted R-squared	0.61614
Mean Dependent Variable	7.26285
St. Dev.	1.42960

Notes: t-statistics are in parentheses.

* Excluded category is less than primary schooling completed.

TABLE 7. REGRESSION RESULTS (Spline Schooling Variables)

Type of Firm	Total	Female	Male	Mixed
Number of Firms	1098	576	230	292
CONSTANT1(a_0)	9.720	10.035	9.406	9.835
	(57.079)	(22.131)	(32.539)	(40.607)
LOCATION_HOME	-0.363	-0.302	-0.464	-0.431
	(-5.224)	(-3.329)	(-2.072)	(-3.292)
LOCATION_FIXED	-0.030	-0.074	0.176	-0.147
	(-0.419)	(-0.737)	(0.929)	(-1.123)
FIRM_AGE	0.006	0.014	0.003	-0.007
	(2.003)	(3.179)	(0.439)	(-0.136)
CONSTANT2(b_0)	-5.281	-5.338	-5.806	-5.839
	(-22.362)	(-10.989)	(-9.556)	(-7.458)
EXPENSES_1	1422.047	1498.644	1861.097	823.518
	(10.108)	(8.858)	(4.515)	(2.545)
EXPENSES_2	-1105.146	-1072.956	-1987.134	-354.705
	(-4.962)	(-4.022)	(-2.893)	(-0.736)
EXPENSES_3	-88.862	-263.425	505.992	-233.278
	(-0.713)	(-1.745)	(1.262)	(-0.991)
CAPITAL_1	468.985	303.434	522.262	844.269
	(5.243)	(2.691)	(2.225)	(3.963)
CAPITAL_2	-451.513	-269.499	-500.477	-837.998
	(-4.992)	(-2.332)	(-2.106)	(-3.912)
LABOR	0.210	0.160	0.323	0.282
	(6.361)	(3.977)	(3.911)	(2.598)
SCHOOL_PRIMARY	0.046	0.051	0.053	0.016
	(2.007)	(2.015)	(0.719)	(0.165)
SCHOOL_SECONDARY	0.041	0.007	0.093	0.087
	(2.258)	(0.309)	(1.867)	(2.231)
SCHOOL_POSTSEC	-0.005	0.036	-0.109	-0.010
	(-0.157)	(0.848)	(-1.376)	(-0.215)
TRAINING	0.080	0.057	0.200	0.227
	(1.078)	(0.615)	(0.844)	(1.580)
EXPERIENCE	0.022	0.014	0.032	0.041
	(3.096)	(1.587)	(1.484)	(2.565)
$EXPERIENCE^2/100$	-0.058	-0.048	-0.065	-0.085
	(-4.058)	(-2.640)	(-1.516)	(-2.914)
LLF	-1416.23	-710.608	-320.041	-356.472
SSR	848.114	397.669	217.710	196.461
Adjusted R-squared	0.61614	0.57135	0.59712	0.54541
Mean Dependent Variable	7.26285	6.85879	7.35373	7.98832
St. Dev.	1.42960	1.28823	1.59263	1.25358

Notes: t-statistics are in parentheses.

The pattern of signs and relative magnitudes of the estimated parameters is quite reasonable. All levels of schooling and vocational training have positive impacts on revenues in the binary variable model. The results suggest there are diminishing benefits at the margin for postsecondary schooling. The spline model tells an identical story. The fact that the third spline coefficient is not significantly different from zero suggests that there is no important difference (in terms of revenues) between secondary and postsecondary education.

As the sign of the linear term suggests, there are positive returns to work experience. While these returns may initially increase, they ultimately diminish. The fact that the quadratic term is negative implies that diminishing returns set in more quickly. There appears to be a distinct disadvantage to operating a business from the home as opposed to being itinerant. Finally, the older the firm, the greater are the estimated revenues.

Labor, expenses, and capital variables continue the reasonable pattern of results. The labor parameter has the correct sign and is highly significant. With respect to the expenses parameters, their pattern and relative sizes are sensible. The two spline knots for expenses were at 830 and 2,000 intis respectively. Thus a firm with less than 830 intis in expenses will have an expenses coefficient of 1419.004. This drops to 316.666 for a firm with between 830 and 2,000 intis of expenses, and to 234.397 for a firm with more than 2,000 intis of expenses. The fact that the coefficients decline, however, does not guarantee that there is everywhere diminishing marginal productivity for expenses. Eventually though, the marginal products will decline. The same is true for capital. Here the spline knot is at 1,000 intis. Thus, a firm with less than 1,000 intis in stock and capital has a coefficient of 474.017 for aggregate capital, and when the firm has aggregate capital in excess of 1,000 intis, the coefficient is 18.003. There will eventually be diminishing returns to this factor for all firms. Some firms in the sample, though, may be operating in a range of increasing marginal productivity for capital.

The (ex post) tests for aggregation and pooling are identical to the ex ante results. The hypothesis of equal structures in Lima and OUAs could not be rejected. Similarly, the hypothesis that male, female, and mixed enterprises have similar structures could not be rejected for all urban areas.[20] An important implication of the last test is that productivity does not differ by type of firm. A female firm with the same factor endowments and other characteristics as a male or mixed firm will have the same revenues, on average, as other businesses.

6.1 Factor Productivities

The estimated revenue function provides some insights into the behavior of factor productivity, particularly the marginal revenue products of factors. The derivative of the revenue function with respect to a right-hand side variable is the marginal revenue product of that variable. These derivatives will differ from observation to observation and thus we can determine their distribution separately for all firms, female-only firms, male-only firms, and mixed firms. The derivatives are the product of the (unknown) price and the marginal product of the factor. Despite the fact that the marginal products of these factors remain unobservable, some interesting related results can be obtained for the expected marginal revenue products.

The marginal revenue products can be thought of as shadow input prices. A profit maximizing firm in a competitive setting would attempt to equate the

---

[20] In all cases rural firms had significantly different structures. (See Table 4).

marginal cost of factors (prices) with corresponding marginal revenue products. The shadow price for a factor is deduced from the marginal revenue product as the amount the firm would be paying to the factor if the firm were being observed at a profit-maximizing equilibrium.[21]

For labor, expenses, and capital we can make some conjectures about the size of the marginal revenue products. For example, one might expect the marginal revenue product of labor in the informal sector to be less than the wage in the formal sector. With respect to expenses, we might expect the shadow price to be close to unity. Except for that part of current expenses going to purchase stock,[22] we would not expect any firm to spend one more inti on expenses unless it also expected to recoup it in revenues.

For aggregate capital the case is less clear. It is difficult to deduce dynamic effects from a static model. Nonetheless the marginal revenue product of capital, for example, can be thought of as the rate of return to having one more unit (inti) of, say, stock in the firm. This is over and above the price that a firm will get when it sells the unit currently in stock. Table 8 shows the measured marginal revenue products.

---

[21] A further restriction for these results to hold is that the marginal revenue product curve is downward sloping at the profit maximizing equilibrium. If this condition is violated then the firm is not maximizing profits.

[22] Unsold goods purchased with current expense money enter the inventories of firms. Our data set does not contain any information about inventory policies.

TABLE 8. DISTRIBUTION OF MARGINAL REVENUE PRODUCTS OF LABOR (L), EXPENSES (E) AND CAPITAL (K)

TYPE OF FIRM	TOTAL			FEMALE			MALE			MIXED		
DECILE	L	E	K	L	E	K	L	E	K	L	E	K
1	.054	.490	.021	.057	.468	.019	.057	.492	.019	.049	.601	.096
2	.087	.638	.038	.088	.584	.037	.093	.629	.038	.079	.763	.037
3	.115	.751	.057	.116	.695	.062	.138	.713	.066	.101	.884	.050
4	.147	.860	.078	.150	.814	.132	.110	.817	.094	.125	.985	.060
5	.190	.992	.116	.200	.925	.232	.375	.957	.178	.147	1.091	.069
6	.245	1.127	.253	.263	1.067	.315	.321	1.067	.266	.185	1.204	.082
7	.322	1.300	.391	.360	1.266	.438	.415	1.225	.404	.226	1.352	.100
8	.456	1.536	.590	.498	1.494	.603	.645	1.470	.848	.306	1.614	.398
9	.916	1.945	1.069	1.188	1.882	1.010	1.601	1.765	1.367	.431	1.418	1.183
10	67.053	7.247	3.550	67.053	4.542	3.202	7.835	7.247	3.550	6.980	6.396	3.363
MEAN	.535	1.170	.385	.646	1.096	.385	.632	1.154	.467	.249	1.327	.322
ST DEV	2.253	.801	.568	3.000	.642	.488	1.152	.927	.676	.497	.944	.614
OBS	1098	1098	1098	576	576	576	230	230	230	292	292	292

A feeling for the results can be obtained by considering the row of means. For the total sample of firms, the mean marginal revenue product for expenses is 1.170 intis and is slightly in excess of the value of one inti suggested above.[23] The mean rate of return to capital is 38.5 percent and the shadow wage for one hour of labor is .535 inti. Before considering comparative returns in different types of enterprises, it is useful to determine the extent to which the mean values are informative. Table 8 also shows the cumulative distribution (by decile) of the marginal revenue products for each factor and by each type

[23] As discussed earlier, these estimates are unbiased with respect to the expected revenue component.

of enterprise. It is clear that all of the distributions are highly skewed and that the mean value is typically not encountered until the seventh or eighth decile. Thus for policy purposes the mean is not an informative statistic. Moreover, before policy questions can be answered, it is necessary to determine which firms are in the tails of the distributions (high versus low returns at the margin), their characteristics, and the extent to which having a high (or low) return for one variable coincides with a high (low) return for another variable.

We analyzed the distribution of the marginal revenue products of capital, expenses, and labor for the four sample groups: (1) all firms, (2) female-only firms,(3) male-only firms, and (4) mixed firms. We also examined the relationship of the marginal revenue products of factors by firm to the levels of all productive factors. The results are presented in a set of 12 diagrams labelled C1, C2, C3, C4; E1, E2, E3, E4; and L1, L2, L3, L4. The letter refers the productive factor -- capital, expenses, and labor; the number refers to the relevant subgroup of firms above. Thus Diagram L2 shows the marginal revenue product of labor for women-only firms.

In a representative diagram the information is: In diagram C1, the relevant sample is all firms, ordered from largest to smallest according to the size of the estimated marginal revenue product of the relevant factor (in this case, capital). Thus the firm with the largest marginal revenue product of capital becomes the first firm and the firm with the smallest marginal revenue product becomes the 1,098 firm. The marginal revenue product of capital is measured on the left-hand vertical axis and, by construction, the plotted values of the marginal revenue product of capital will decrease as higher-numbered firms are encountered. The median firm is the \$549th and for this firm the marginal

DIAGRAM C1
MARGINAL REVENUE PRODUCT OF CAPITAL
SAMPLE VALUES: ALL ENTERPRISES

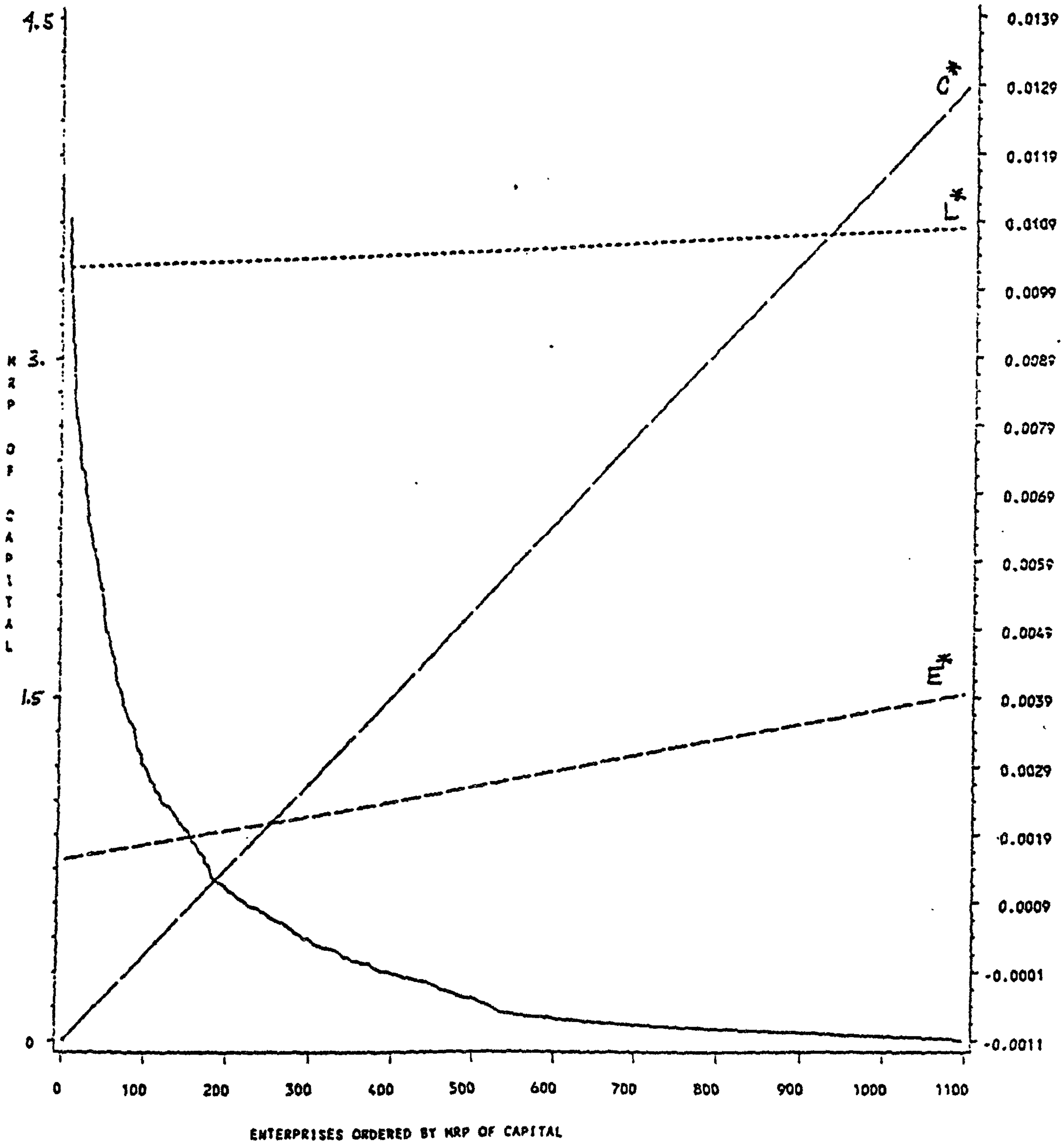


DIAGRAM C2
MARGINAL REVENUE PRODUCT OF CAPITAL
SAMPLE VALUES: FEMALE ENTERPRISES

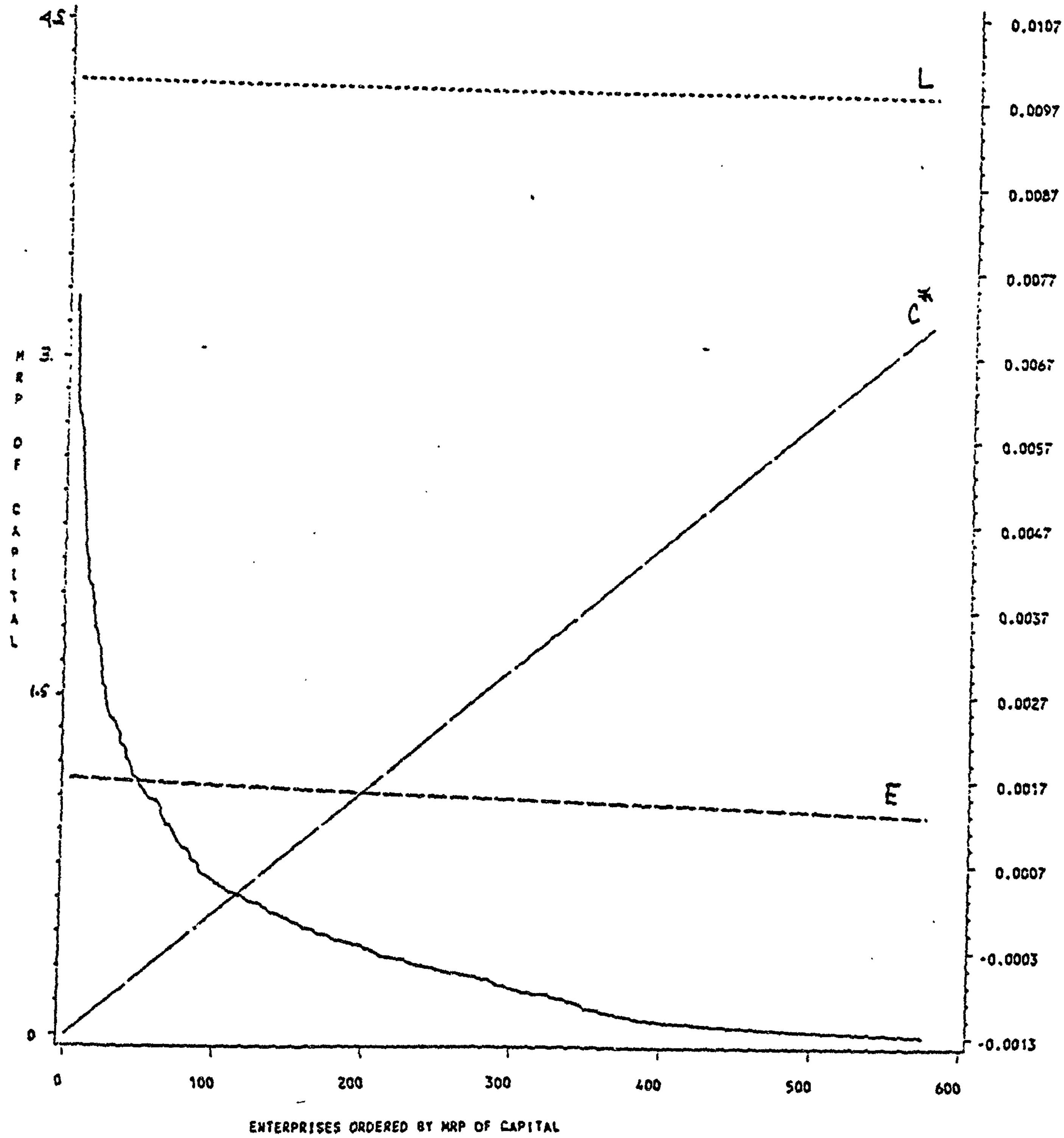


DIAGRAM C3
MARGINAL REVENUE PRODUCT OF CAPITAL
SAMPLE VALUES: MALE ENTERPRISES

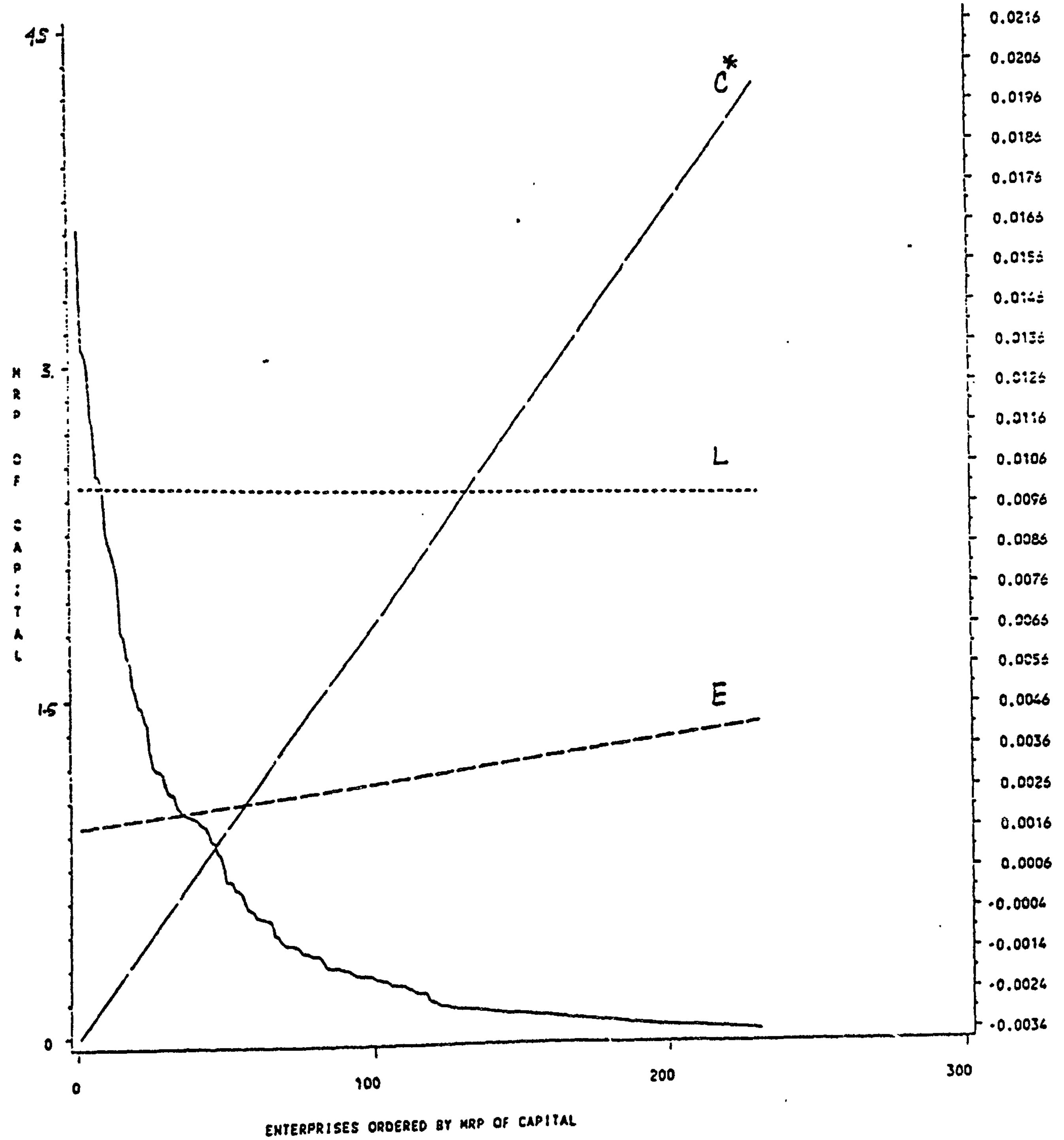


DIAGRAM C4
MARGINAL REVENUE PRODUCT OF CAPITAL
SAMPLE VALUES: MIXED ENTERPRISES

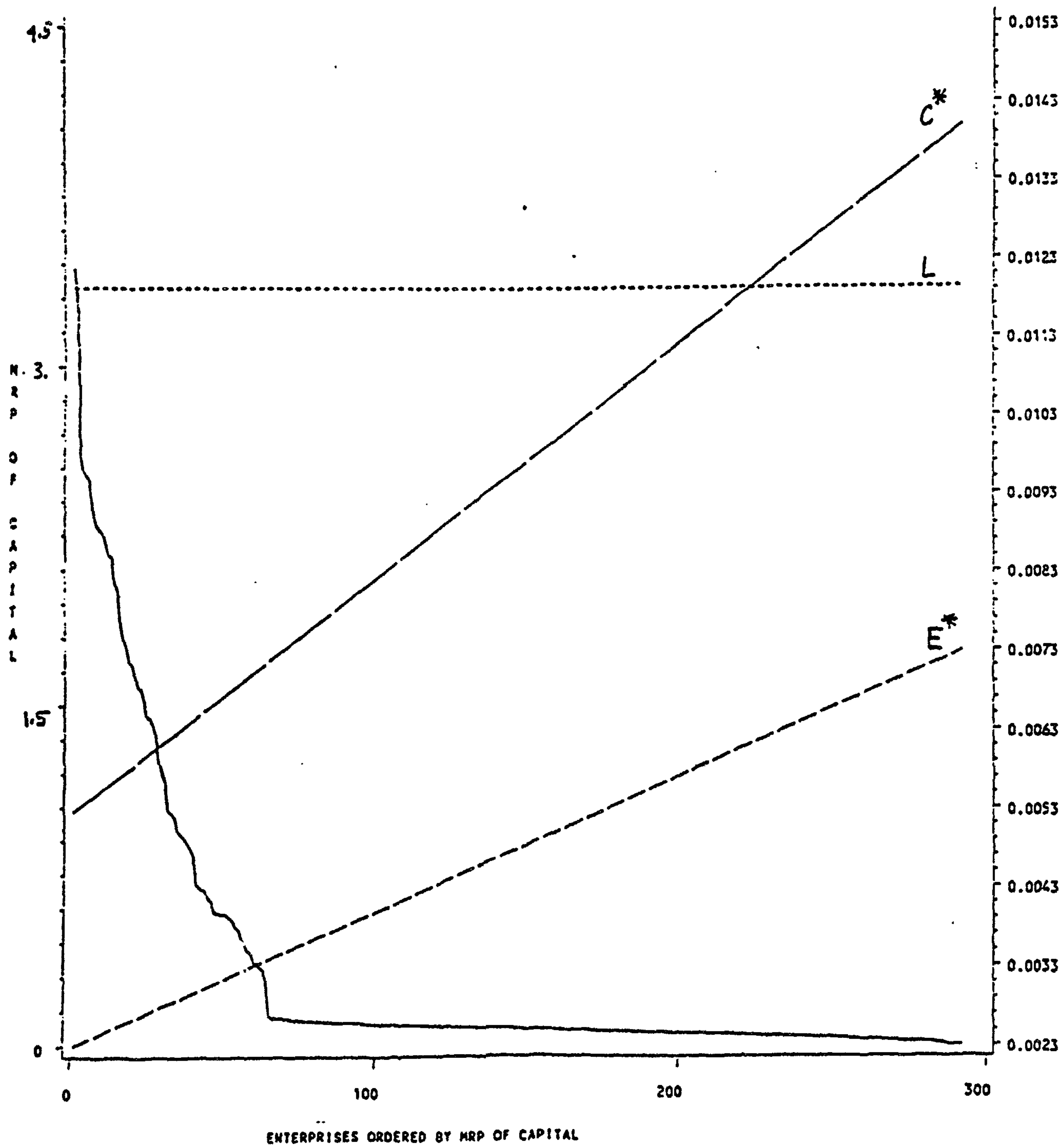


DIAGRAM E1

MARGINAL REVENUE PRODUCT OF EXPENSES

SAMPLE VALUES: ALL ENTERPRISES

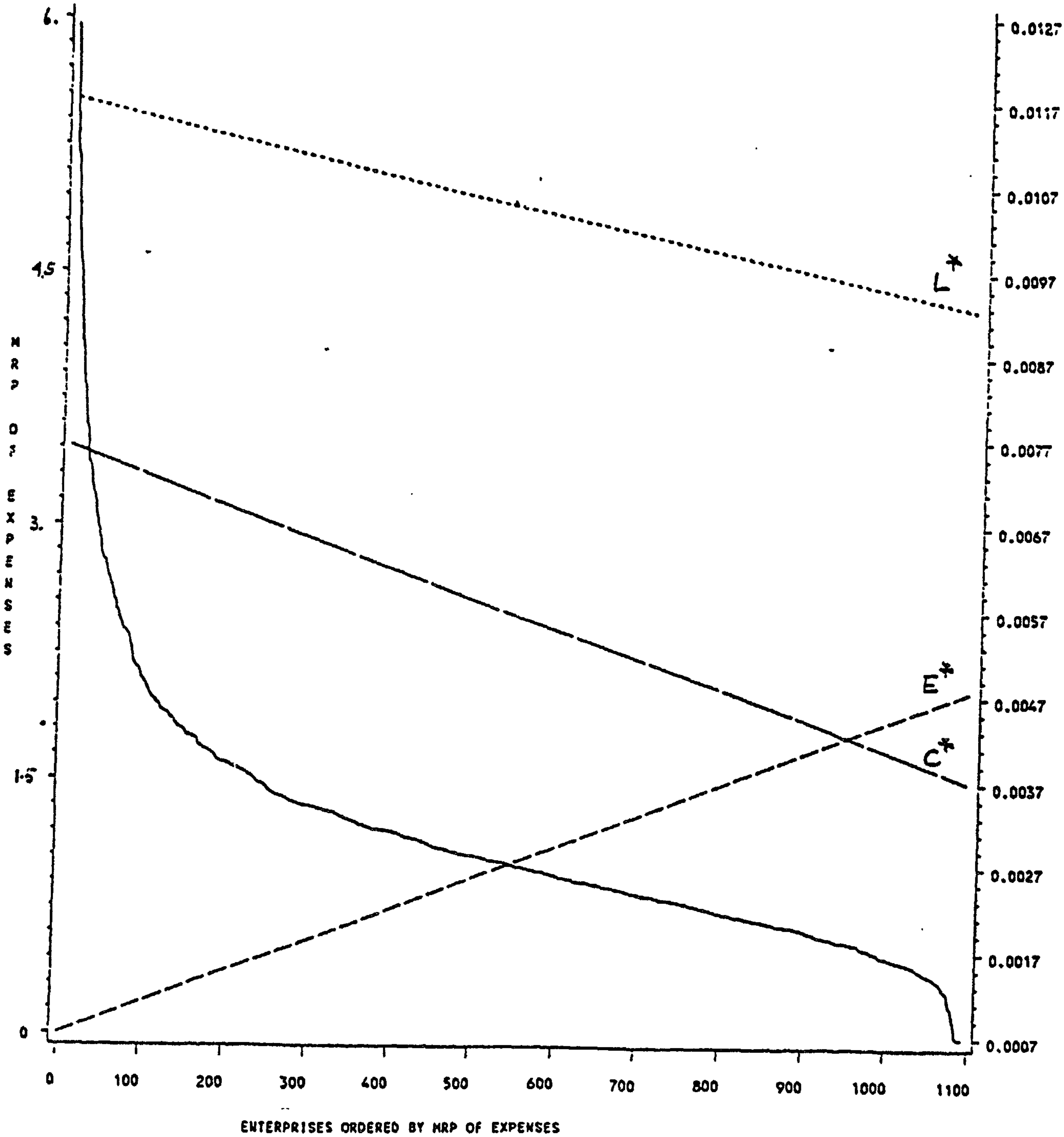


DIAGRAM E2

MARGINAL REVENUE PRODUCT OF EXPENSES

SAMPLE VALUES: FEMALE ENTERPRISES

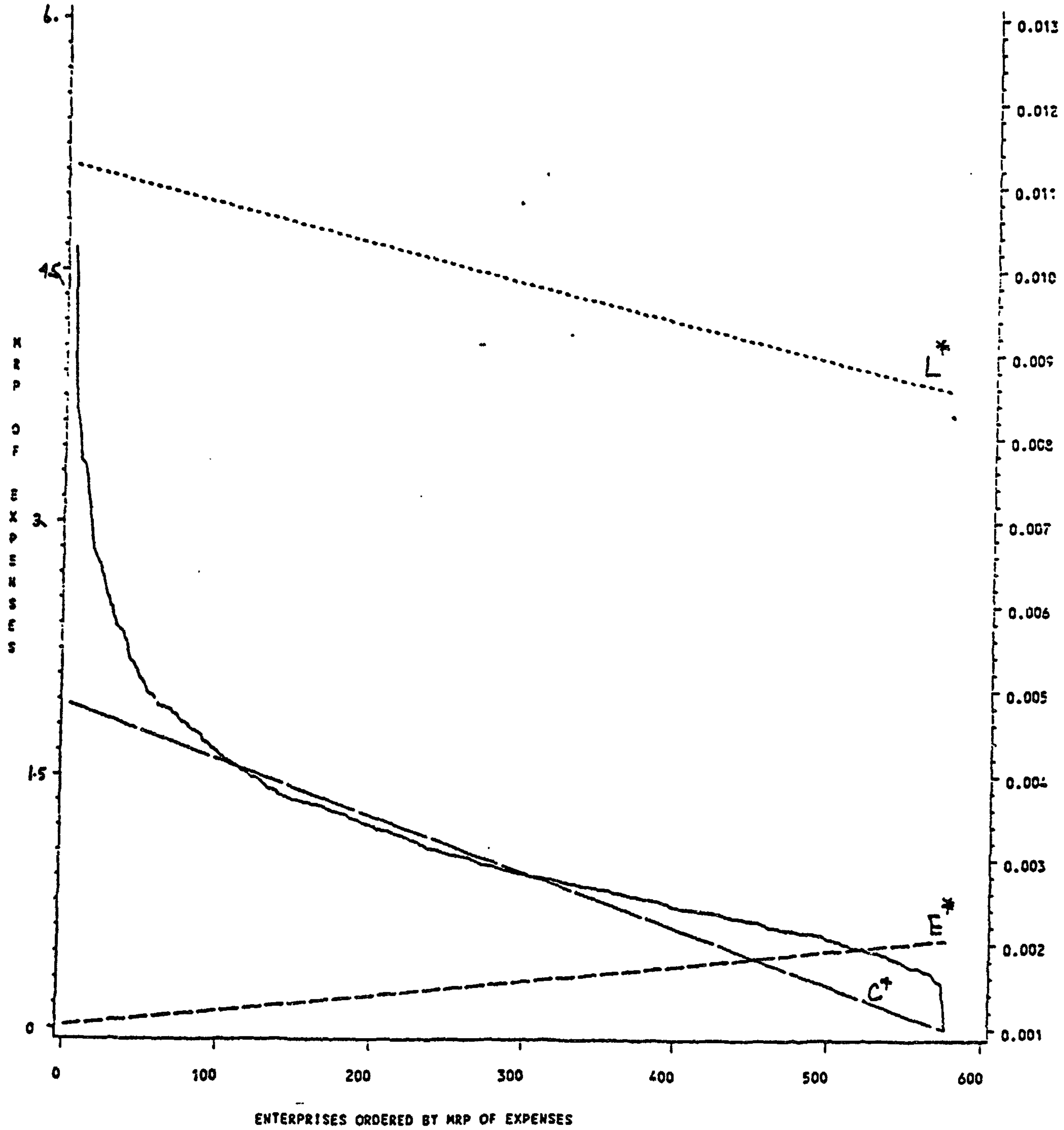


DIAGRAM E3

MARGINAL REVENUE PRODUCT OF EXPENSES
SAMPLE VALUES: MALE ENTERPRISES

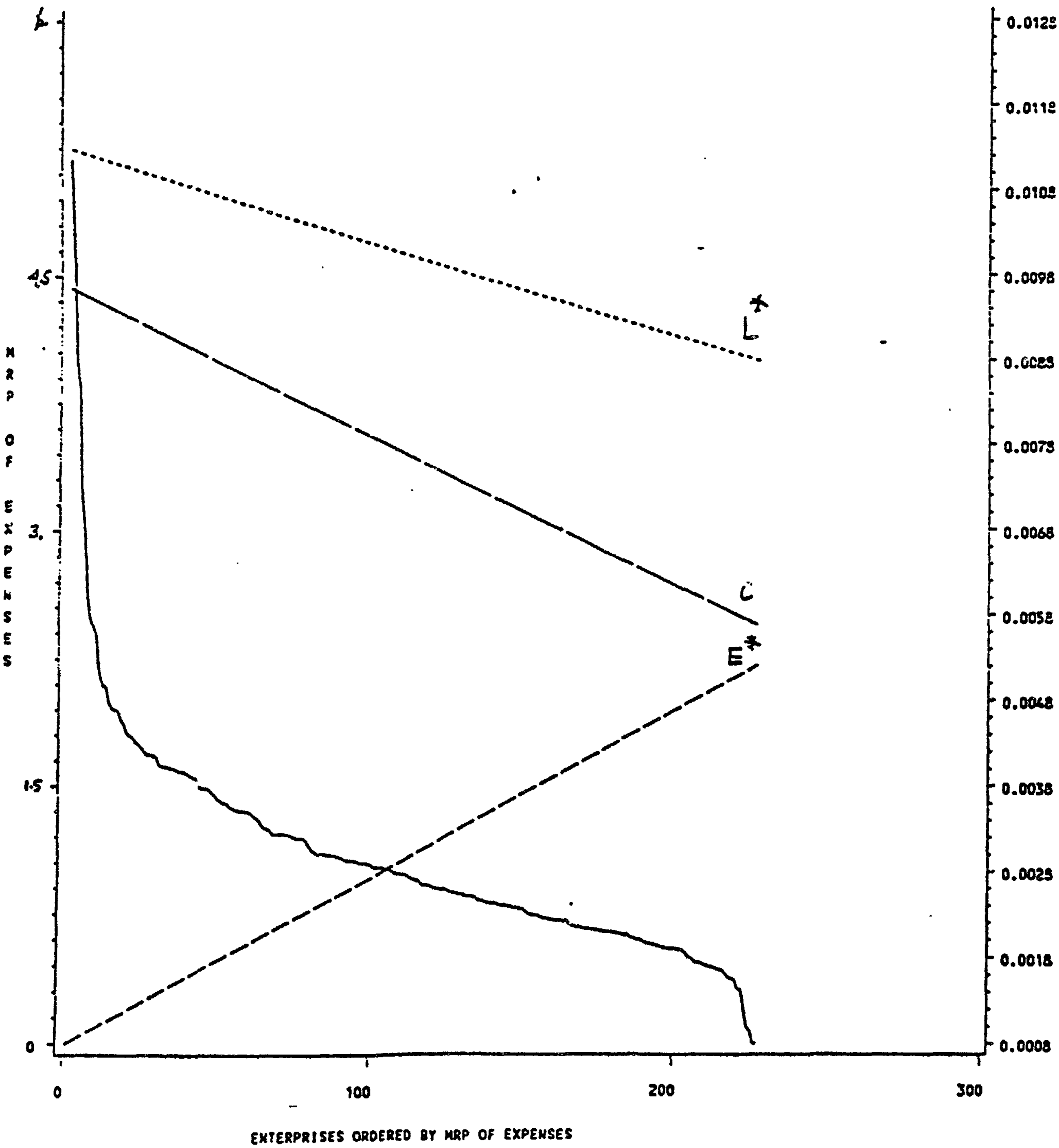


DIAGRAM E4
MARGINAL REVENUE PRODUCT OF EXPENSES
SAMPLE VALUES: MIXED ENTERPRISES

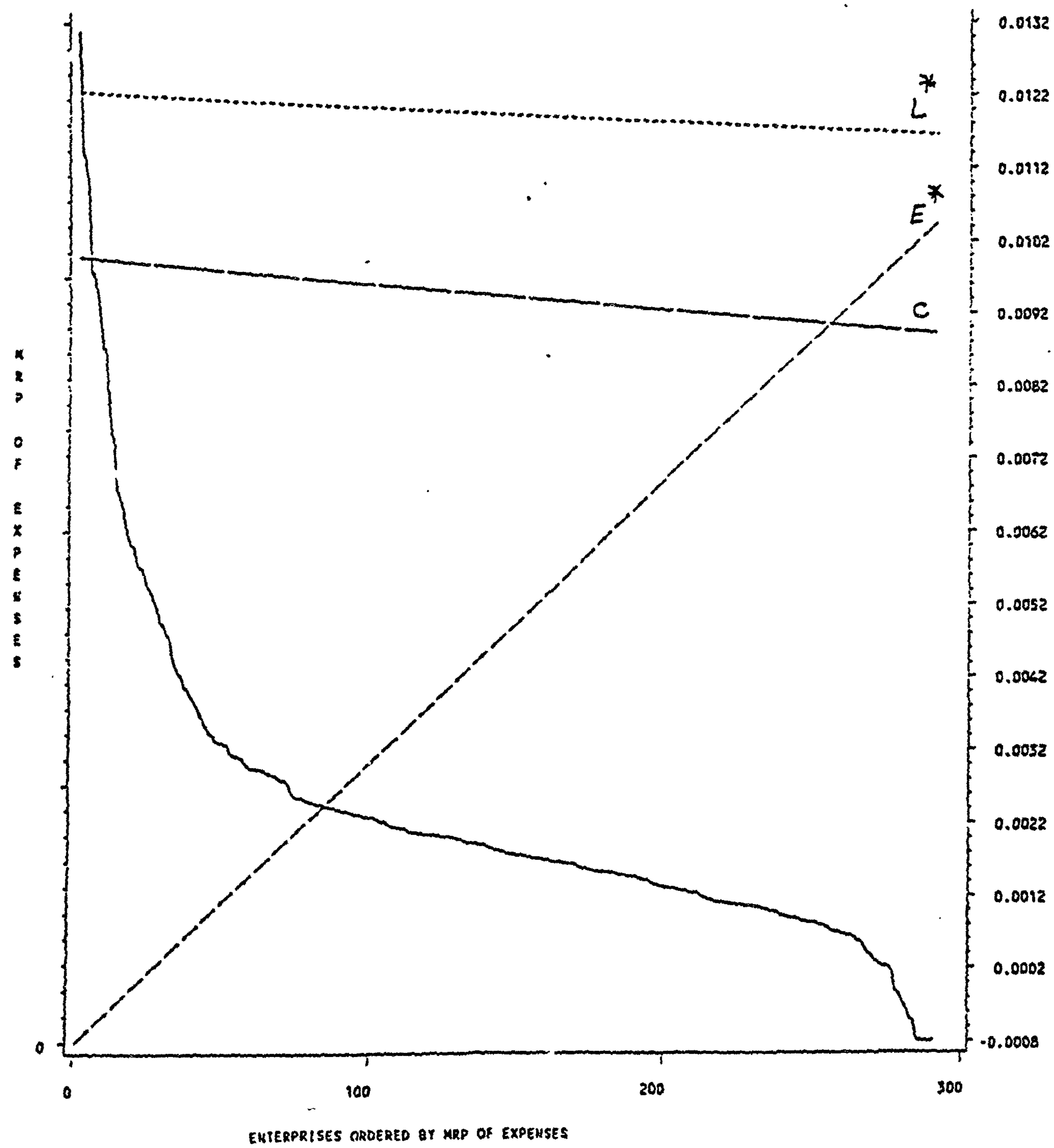


DIAGRAM L1

MARGINAL REVENUE PRODUCT OF LABOUR

SAMPLE VALUES: ALL ENTERPRISES

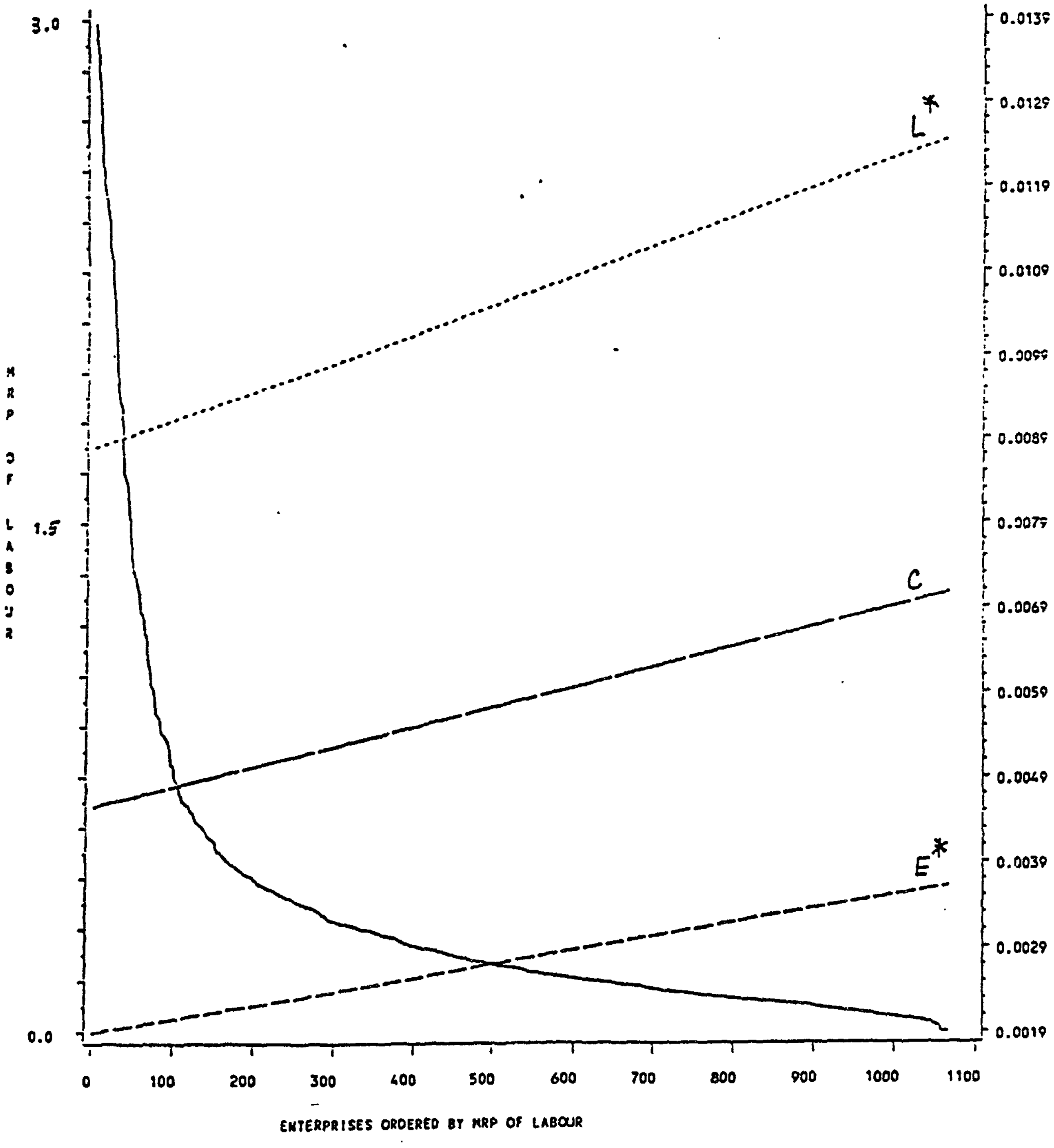


DIAGRAM L2

MARGINAL REVENUE PRODUCT OF LABOUR SAMPLE VALUES: FEMALE ENTERPRISES

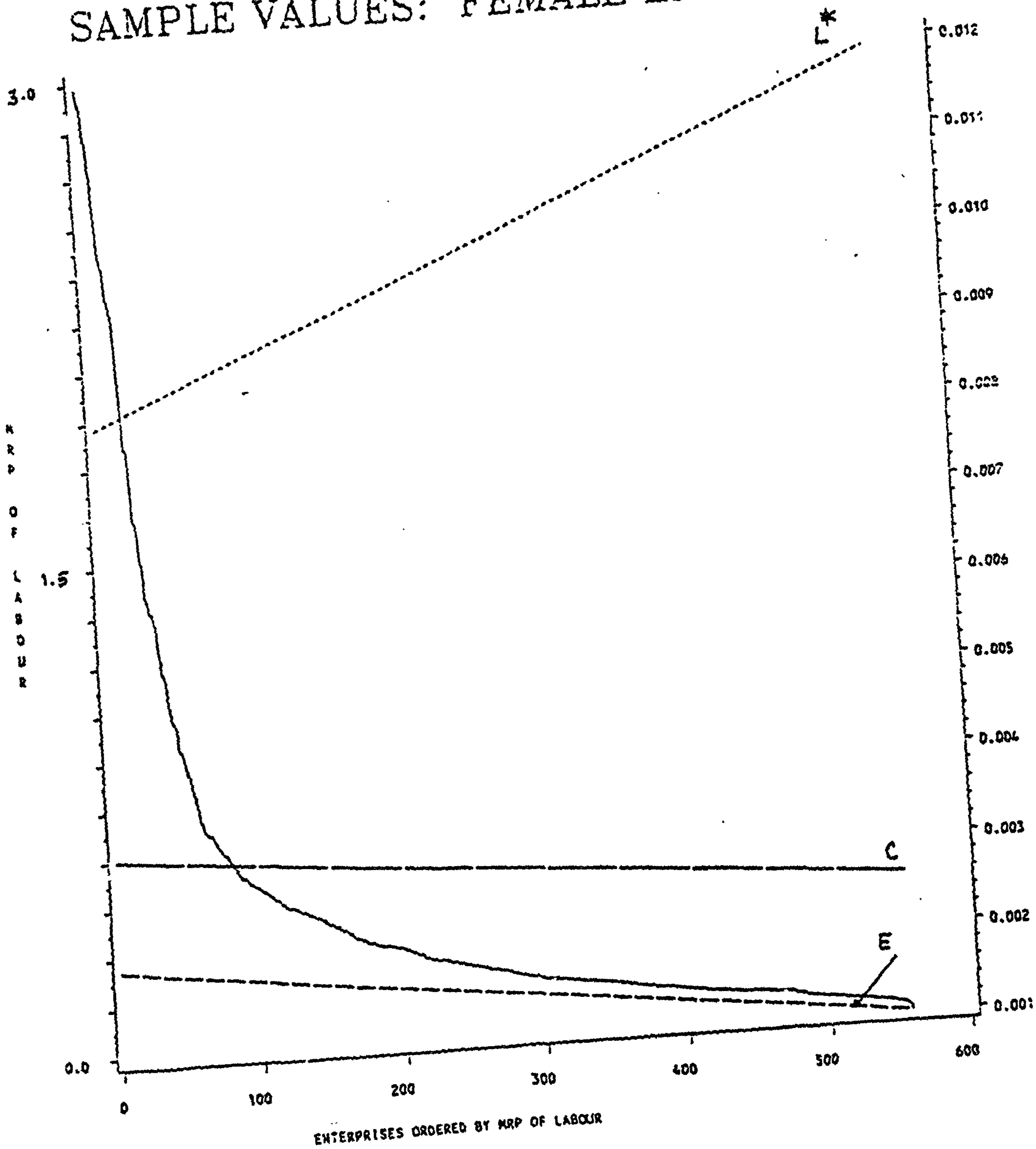


DIAGRAM L3

MARGINAL REVENUE PRODUCT OF LABOUR

SAMPLE VALUES: MALE ENTERPRISES

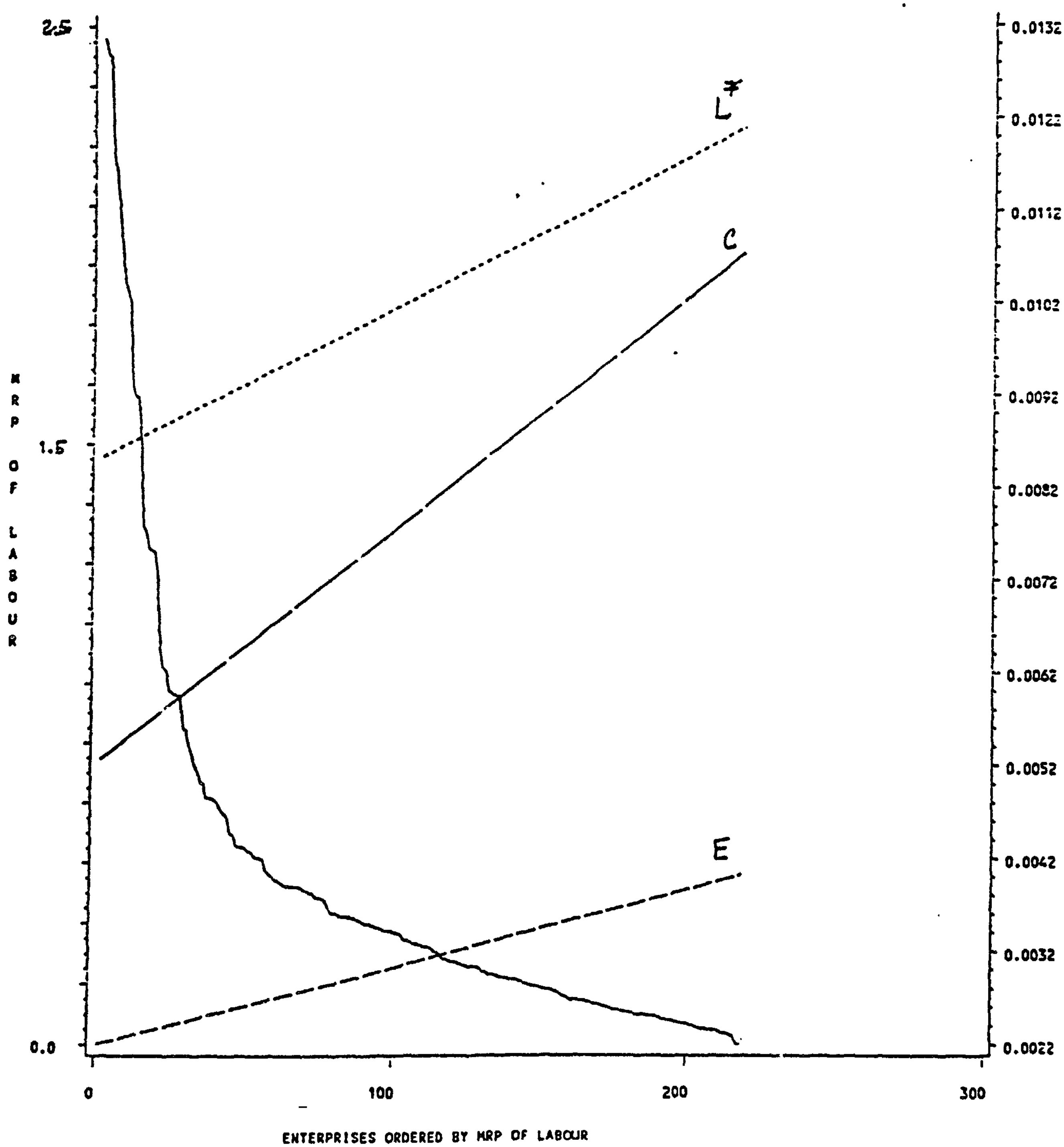
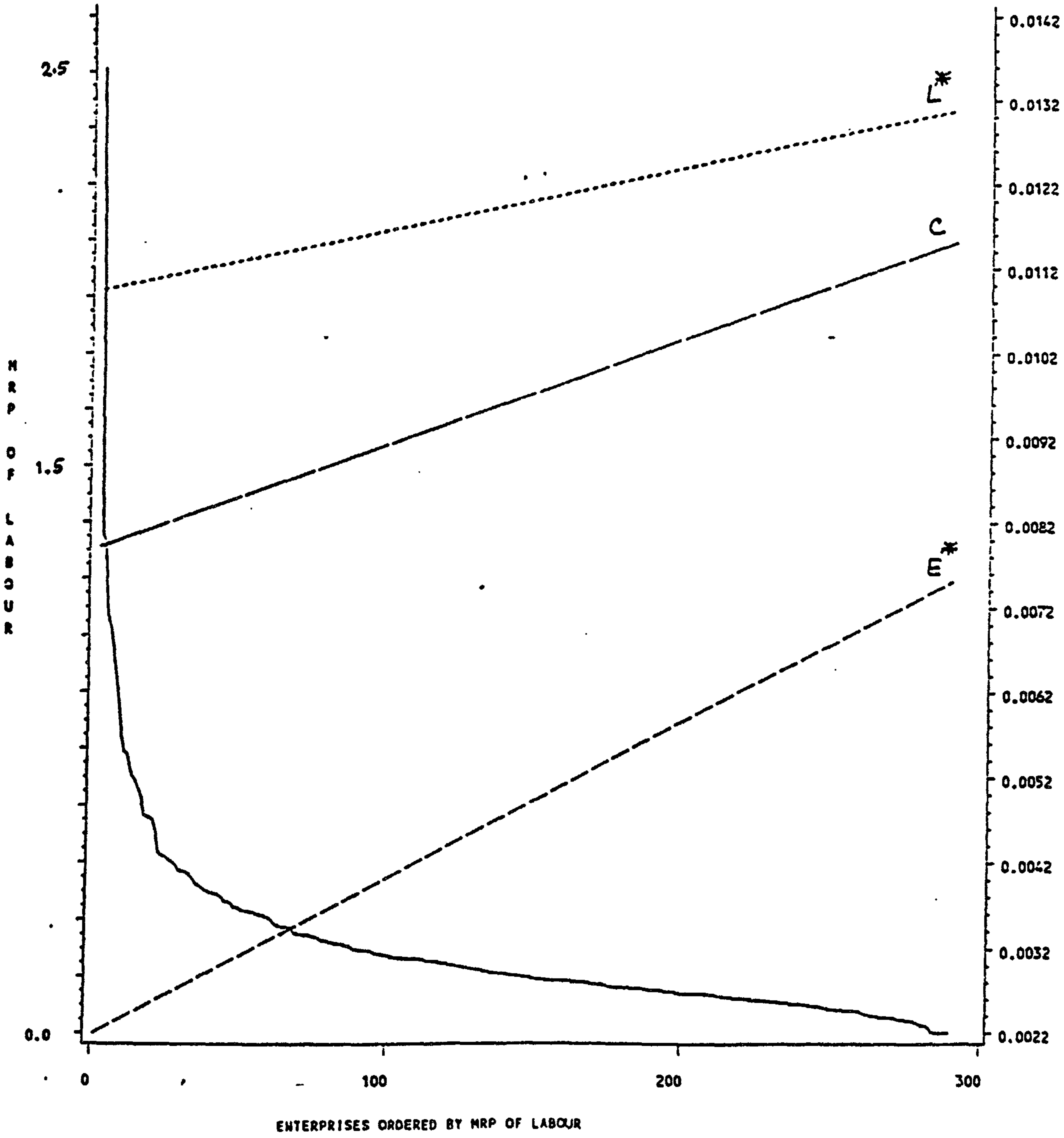


DIAGRAM L4
MARGINAL REVENUE PRODUCT OF LABOUR
SAMPLE VALUES: MIXED ENTERPRISES



revenue product is about .15 inti. Notice how quickly the marginal revenue product of capital by firm declines as we consider the first 200 firms.

Next consider the relationship of the marginal revenue products to the levels of the productive factors. Capital, expenses, and labor variables are all measured on the right-hand vertical axis. The variables were scaled to all fit on these axes. The lines C, E and L represent the least squares regression lines of the capital, expenses, and labor variables (respectively) of firm i on the rank (1 to 1,098) of firm i. The rank of a firm continues to be determined by the size of its marginal revenue product. An asterisk in the label of a regression line indicates that the slope of the regression line is significantly different from zero.

These regression lines provide a considerable amount of additional information that explains the distributions of the marginal revenue products. In diagram C1 we see that firms with high marginal revenue products of capital also had significantly lower endowments of capital. They also tended to have significantly lower quantities of expenses and labor. Extending the analysis to capital input for female enterprises (diagram C2), we see that firms with high marginal revenue products of capital had significantly lower endowments of capital. There is, however, no significant relationship between the distribution of the marginal revenue products and either expenses or labor.

Two patterns can be isolated in the marginal revenue product diagrams. First, for all groups of firms and for all productive factors there is a significant relationship between the marginal revenue product of a factor and the amount of the factor. Firms with smaller amounts of a given factor tend to have higher marginal revenue products for the factor. Second, in about 75 percent of the cases where a significant relationship exists, there is an inverse relationship between the marginal revenue product of one factor and the quantities of the other factors. This suggests that small firms are the most productive in terms of measured marginal revenue products.

These results have important implications for the competitive structure of the informal urban retail sector. The sector's rapid growth may well signal a greater degree of competitiveness in retail trade, and large incumbent firms may be feeling the pressure of both inefficient size and falling (real) prices. Leaner and more aggressive small firms appear to be making significant inroads. Some supporting evidence for this view comes from examining the location structure of firms in the upper and lower 20 percent tails. Firms with low returns to labor and capital are much more likely to operate out of homes and fixed locations while those with high returns are mobile. For the capital variable, firms in the upper tail are twice as likely to be mobile as firms in the lower tail. And female-only firms tend to have lower capital, labor, and expenses than male-only and mixed firms. It appears that women are good candidates for the high rates of return obtained by smaller firms. It may be, however, that these returns at the margin can be further increased. Female firms may be operating where marginal revenue product curves have a positive slope. In this case growth would tend to make these firms even more productive.

6.2 Nonparametric Evidence

These estimates are based on parametric methods. The results below are based on a nonparametric approach (described in appendix B). That estimates marginal revenue products and revenue without having to specify (parametric) model. In the nonparametric analysis all the variables appearing in the parametric model were included except dummy variables. Since the nonparametric technique is robust to data transformations, the capital and expenses variables were not transformed as splines. Graphs B1 to B6 show that the order of magnitude and the direction of the estimates from the two approaches are consistent. These results support the validity of the parametric specification.

Diagrams B1 and B2 show plots of the fitted values of the dependent variable against the sample values. The parametric model (B1) on average does not over- or underestimate. The nonparametric model (B2) tends to overestimate for smaller values of the dependent variable and underestimate for larger values. At first the cloud of points lies mostly on the 45-degree line initially and then drops below it. The mean value of the dependent variable is about 7.2.

A plot of the residuals from the two models (B3) shows that they to move in the same direction. The residuals are plotted as pairs for the same enterprise. Positive (negative) errors in the parametric model coincided with positive (negative) errors in the nonparametric model. This suggests that the approaches estimated similar relationships.

Diagrams B4, B5, and B6 show plots, by enterprise, of marginal revenue products from the two model. Using the 45-degree line as a reference point, the marginal revenue product of expenses tends to be higher in the parametric model, while those of labor tend to be lower. The marginal revenue product for capital in the nonparametric model is initially greater and then smaller than those in the parametric model.

These findings come from a first application of the nonparametric technique. Nonetheless we conclude that the directions and orders of magnitudes of the parametric model estimates are supported.

DIAGRAM B1
PARAMETRIC FIT

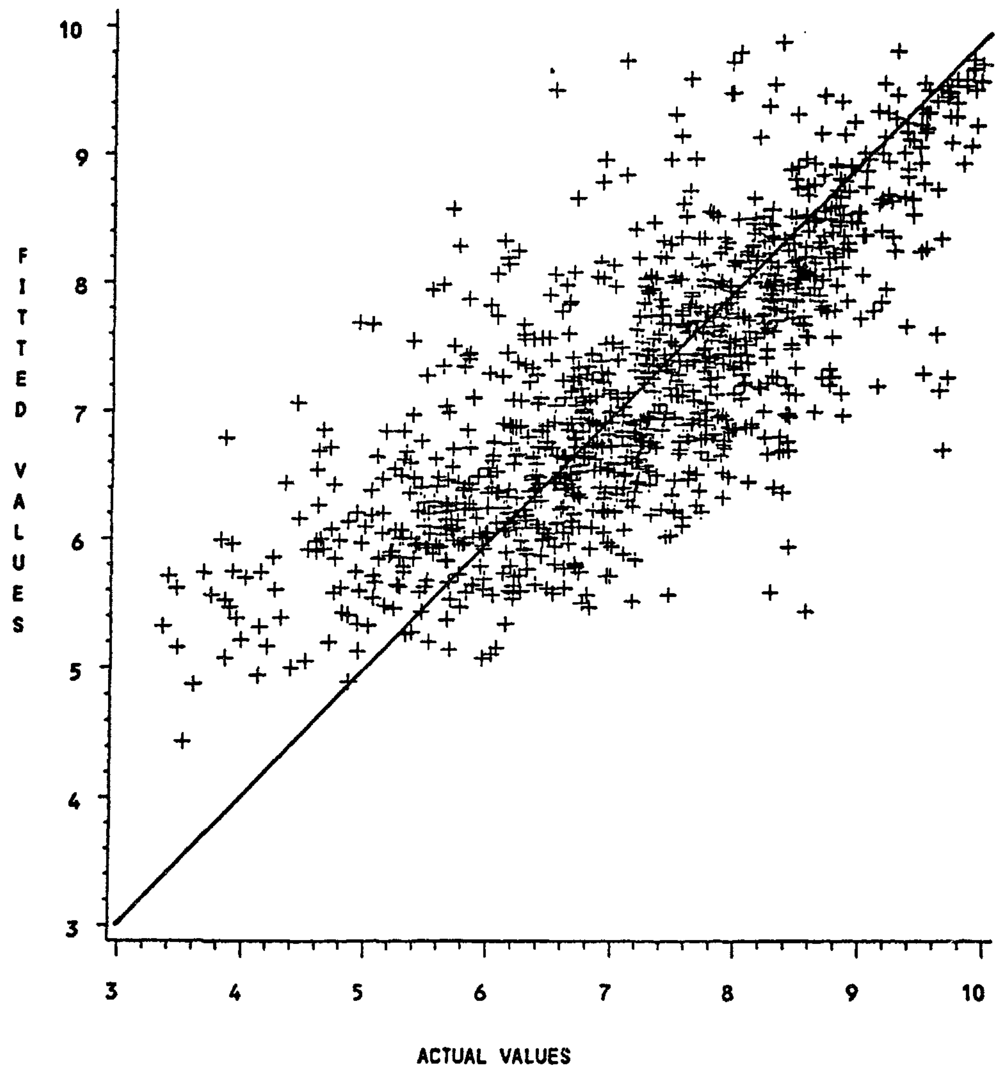


DIAGRAM B2
NONPARAMETRIC FIT

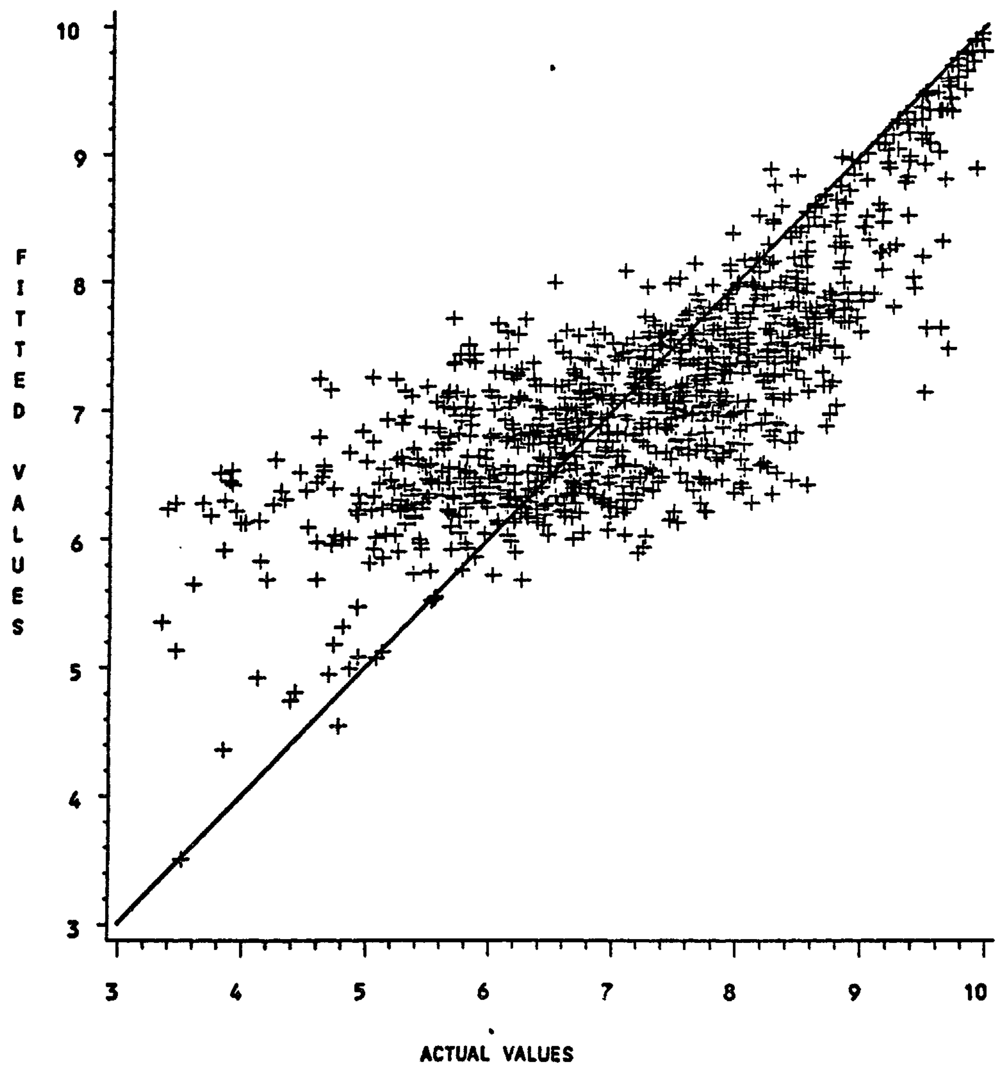


DIAGRAM B3
COMPARISON OF MODELS
RESIDUALS

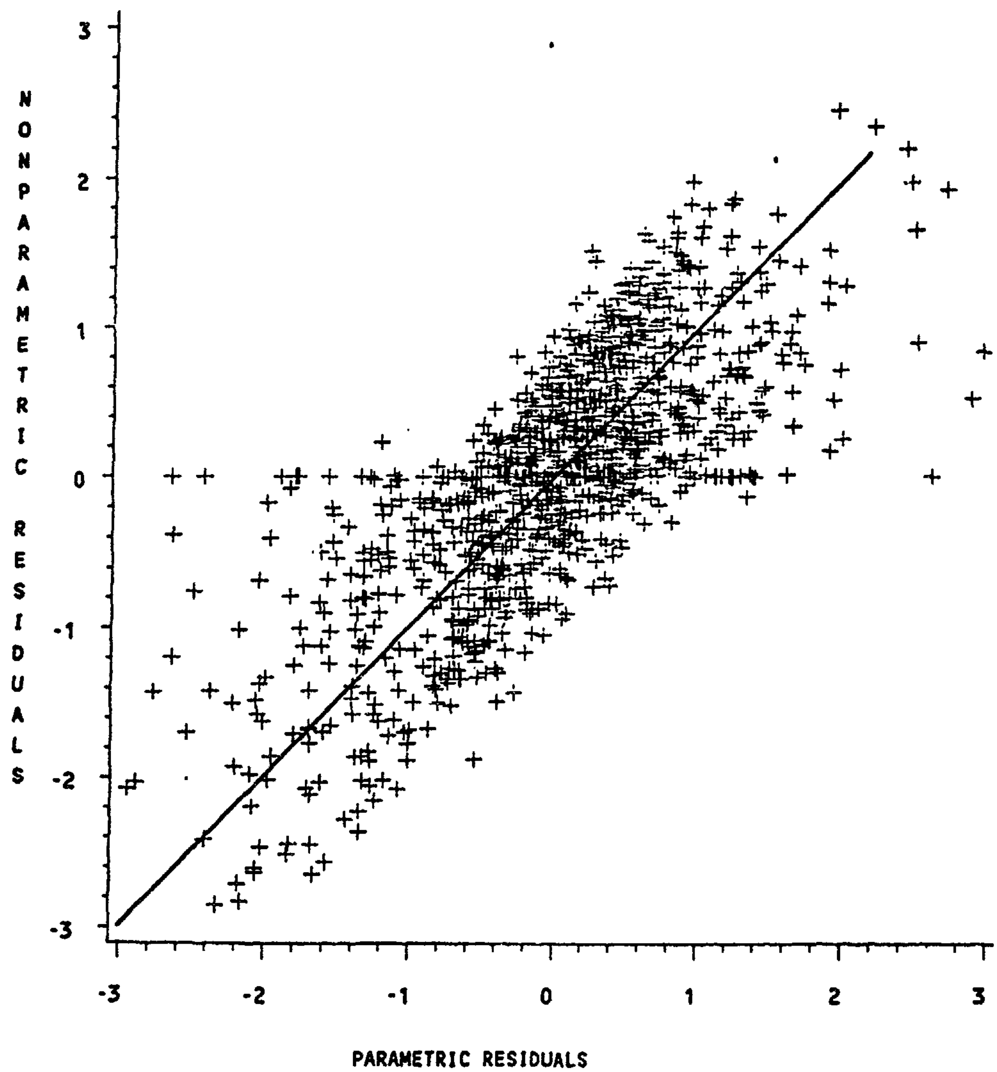


DIAGRAM B4
COMPARISON OF MODELS
EXPENSE MARGINAL PRODUCTS

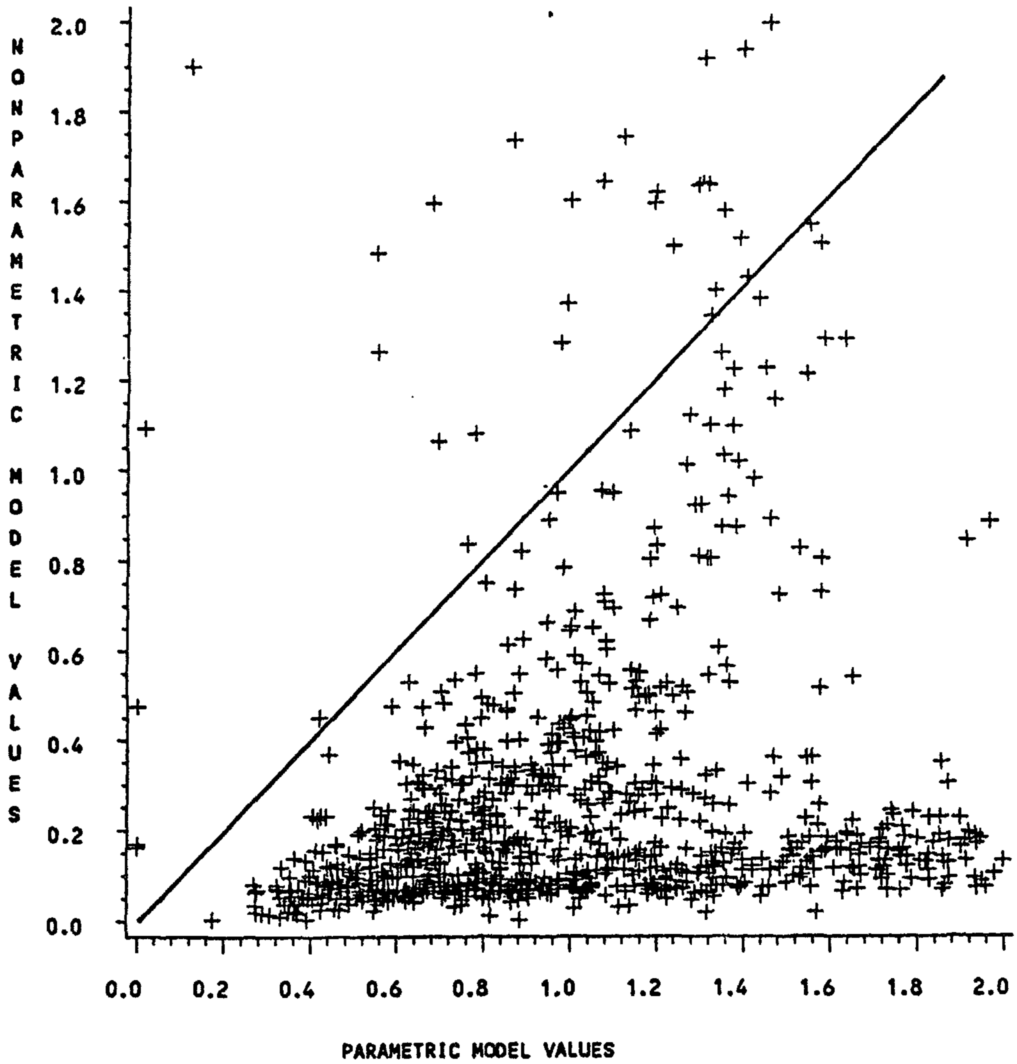


DIAGRAM B5
COMPARISON OF MODELS
LABOUR MARGINAL PRODUCTS

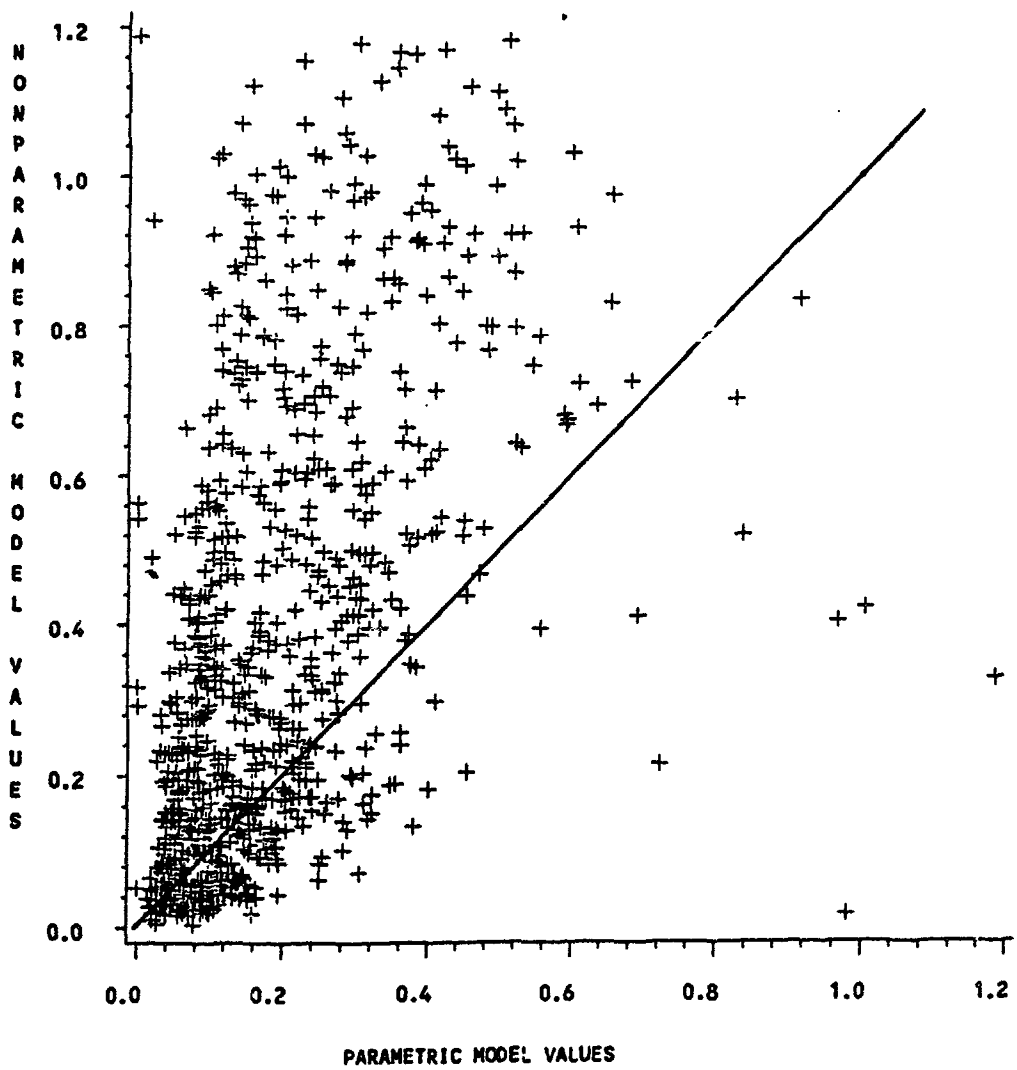
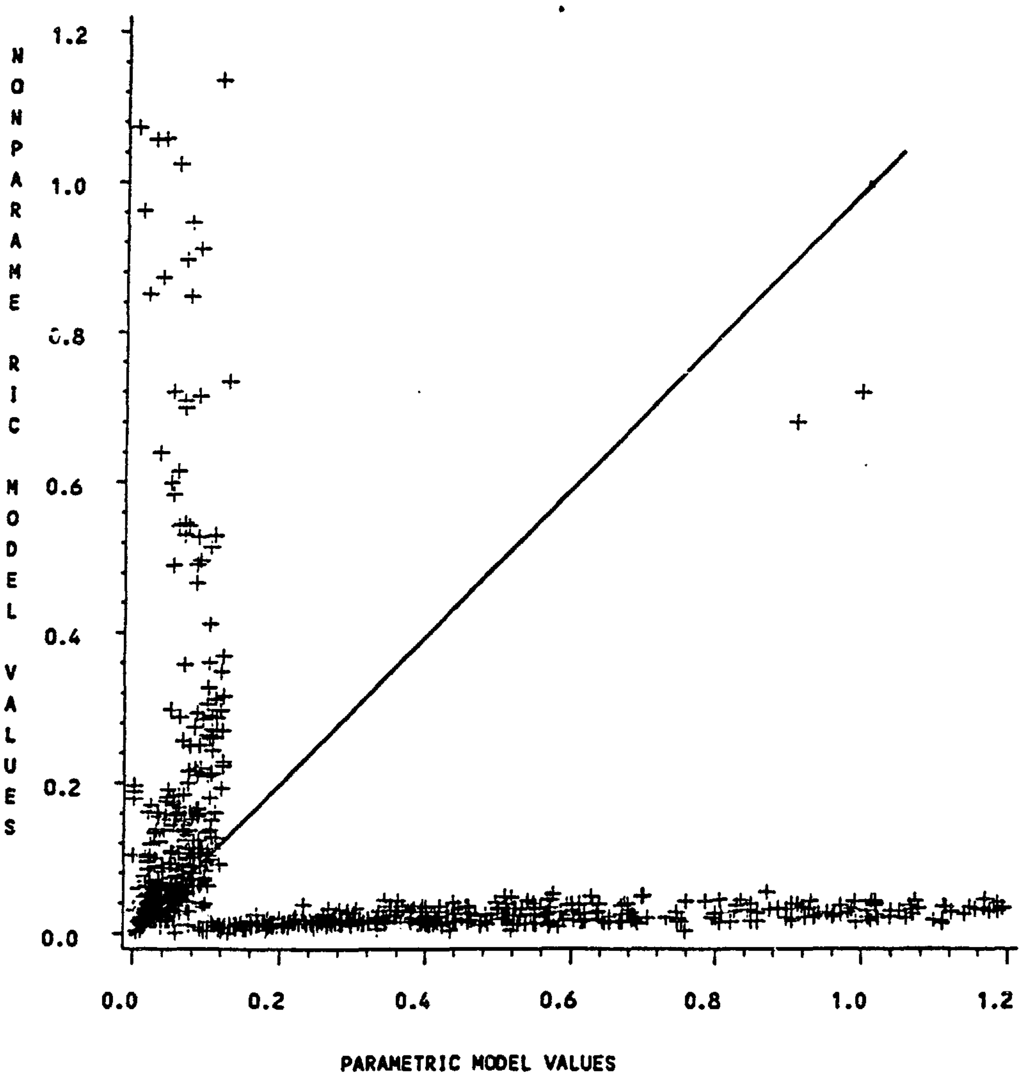


DIAGRAM B6
COMPARISON OF MODELS
CAPITAL MARGINAL PRODUCTS



6.3 Simulation Experiments

The estimated revenue model can address a variety of other questions. For example, it can assess the impact of policies that affect the amount, quality, and distribution of productive factors such as loans (either unrestricted or factor-specific) to a given subgroup. Evaluating such a credit policy would involve estimating the effects on expected revenues and determining the payback period for the loan. Policymakers can also assess the revenue impact of social policies that raise education levels or allow family members to substitute work in the family business for housework (perhaps through child care programs).

Table 9 shows the effects on expected revenues, averaged over firms, of seven different policy experiments. The first four experiments are 'simple' in that only one underlying variable is changed. The other four experiments are 'compound' in that more than one variable changes. For example, in the first experiment, the most educated individual in the firm is given two more years of schooling if the number of years of schooling is less than nine. The group of firms receiving this education changes from all firms, to the bottom 50 percent (in terms of education), and then to the bottom 25 percent (in terms of education) and finally, for comparison purposes, to the top 25 percent. Within each group, the effects on all, female firms, male firms, and mixed firms are calculated separately. The effect of formal schooling on revenues is 100 to 200 intis a month.

The second simulation increases the amount of labor by 100 hours a month. This could be accomplished by policies that reduce the costs of noncompliance, encourage bulk purchasing by cooperatives, and offer training in management. The time devoted to business activities by women could be increased by providing

Table 9. SIMULATION RESULTS - EFFECTS ON REVENUES

INCREASE IN BY	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Years of Schooling		2		.		.		.		.		.		2
Monthly Hours		.		100		.		.		.		100		100
Expenses $		.		.		1000		.		500		500		500
Total Capital $		.		.		.		1000		500		500		500
	Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$
Given to All Firms														
All Enterprises	1098	103	1098	187	1098	1079	1098	314	1098	843	1098	1100	1098	1245
Female Enterprises	576	97	576	182	576	988	576	323	576	828	576	1101	576	1250
Male Enterprises	230	112	230	237	230	1136	230	399	230	907	230	1255	230	1377
Mixed Enterprises	292	109	292	157	292	1213	292	231	292	820	292	1001	292	1130
Given to Bottom 50 % of Firms														
All Enterprises	528	157	546	239	549	1279	549	578	755	872	845	1001	926	1039
Female Enterprises	343	126	366	218	361	1102	358	495	471	810	514	977	538	1057
Male Enterprises	100	175	127	299	111	1394	125	690	165	908	195	1030	209	1074
Mixed Enterprises	85	260	53	243	77	1944	66	816	119	1070	136	1052	179	943
Given to Bottom 25 % of Firms														
All Enterprises	242	144	274	284	274	1409	274	641	446	669	541	737	637	695
Female Enterprises	180	119	197	257	163	1176	182	588	281	567	347	650	411	615
Male Enterprises	40	199	67	363	71	1449	72	671	109	729	131	843	145	832
Mixed Enterprises	22	248	10	267	40	2285	20	1011	56	1068	63	998	81	853
Given to Top 25 % of Firms														
All Enterprises	146	42	274	115	274	978	274	58	421	334	522	330	577	309
Female Enterprises	47	32	75	104	81	973	82	49	138	296	181	270	210	239
Male Enterprises	36	40	27	114	61	988	59	58	96	328	108	321	121	299
Mixed Enterprises	63	50	172	120	132	975	133	64	187	364	233	382	246	374

Notes: The bottom 50% refers to those firms that have less than the median value of the variables) of interest for all firms. For example, if $1000 of expenses is provided, then only those firms with less than the median value of expenses ($806) receive the $1000. The same applies to the bottom 25% and the top 25%. The median and quartile values are:

	Median	Bottom 25%	Top 25%
Years of Schooling	7.0	4.0	10.0
Monthly Hours	234.0	113.6	386.3
Expenses $	805.6	247.2	2478.3
Total Capital $	967.7	170.5	4337.8

cooperative child care and facilities for meals. This experiment suggests that revenues will increase by a respectable 200 to 300 intis a month, especially among firms in the bottom 50 and 25 percent (in terms of labor).

The third simulation lends 1,000 intis to selected firms for operating expenses. The results are impressive. If all firms receive the loan, on average they will be able to repay the loan, retaining 79 intis as net profit for the month. Alternatively, because they are more productive, when only the lowest quartile (in terms of expenses) receive the loans, the average net profit is 409 intis. The small number (40 firms) of mixed enterprises in this quartile would be the most successful, with an average net profit of 1,285 intis for the month, compared to 176 intis for the 163 female businesses, and 449 intis for the 71 male firms.

When interpreting the fourth experiment, (each firm receives 1,000 intis for capital expansion), the fact that the average return is less than 1,000 intis does not mean the policies are not successful. The funds would be used to acquire capital that would not completely depreciate in a month. In fact, the ratio of 1,000 intis to the average monthly increase in revenues is the average payback period for the loan in months assuming zero economic depreciation. For example, all enterprises would take just over three months (1,000/314) on average to repay the loan. It should be noted, however, that firms with low capital endowments, mostly female firms, tend to perform better than those with high endowments. Two-thirds of the firms in the lowest quartile are female businesses, with an estimated payback period of less than two months (1,000/588). The payback period for firms in the top quartile is about 18 months (1,000/58).

The remaining 'compound' experiments (five, six, and seven) largely confirm the 'simple' ones. The effects on predicted revenues of firms with lower endowments of expenses, capital, and labor are generally higher than three of better-endowed firms.

Finally, in comparing the simulated increases in revenues it is important to examine more than just the average increases. There are distributions associated with these point estimates. Standard statistical testing shows few significant differences among the three types of firms, but this was not the case among firms in different quartiles.

The simulation results in Table 9 are quite similar to those obtained in the analysis of factor productivity discussed earlier. These results are very helpful in terms of quantifying the effects of policies for the informal sector. It appears a policy of loans to poorly endowed firms, most of which are female businesses, could offer significant social gains.

7. **Policy Implications**

The extent to which estimated productivity differs among male, female, and mixed firms appears to be due more to the distribution of factors across enterprises than to any inherent advantage or disadvantage in the type of firm. On average, the productivity of female firms is neither better nor worse than that of male or mixed firms with the same factor endowments (capital, expenses, and labor). The influence of these endowments, however, affects productivity more than the gender or education of the entrepreneurs. Firms with smaller endowments tended to have higher factor productivity. Thus the process of retailing is the same among firms, but the endowment effect makes them different. Put another way, firms with less capital, expenses, or labor usually have higher returns at the margin but typically lower revenues. As seen in Table 3 or Table 9, a high proportion of female firms, but a much smaller proportion of male and mixed firms, have low amounts of capital, expenses, and labor. In our sample about a fourth of the businesses had little or no capital and a third carried no inventories -- most of these were female firms. The empirical analysis suggests that proactive policies would increase substantially the productivity of small businesses. Providing assistance to small businesses makes good economic sense -- particularly if directed to those with low factor endowments.

The ultimate objective of policy measures is to alleviate poverty and improve household welfare. Improving productivity in the informal sector helps to achieve this goal. While we do not elaborate on implementation, two directions will be effective. First enterprise-specific policies that directly affect productivity, and second, set of policies aimed at women that address the competing demands on their time.

7.1 Enterprise-Specific Policies

Governments and international donors have primarily assisted small businesses by providing low-cost credit to firms that do not have access to formal financial markets. Loans are small -- usually less than $500 -- but there are many beneficiaries. Results are good and the repayment rate is often more than 90 percent. Our estimates of productivity confirm that channeling credit to small businesses is effective in raising productivity. Examples of different credit programs include the Grameen Bank in Bangladesh, the Self-Employed Women's Association in India, the Banco Popular in Costa Rica, the Badan Kredit Kecamatan in Indonesia, the Northeast Union of Assistance to Small Businesses in Brazil, the Institute for the Development of the Informal Sector in Peru, Fondo de Fomento para la Pequena Industria y la Artesania in Ecuador, and the Small Projects Program of the Inter-American Development Bank.[24]

Another way to help small businesses is by promoting cooperatives and self-help associations. In addition to providing credit these organizations can

[24] See Cornia (1987), Everett and Savara (1986), Herz (1989), Hossain (1987), IDB (1988), Tendler (1983), United Nations (1985), and World Bank (1989).

make bulk purchases from wholesalers, provide storage facilities for perishable or nonperishable commodities, and establish markets for entrepreneurs (see Bunster and Chaney 1985, de Soto 1989).

Technical assistance programs are a third option, offering short-term instruction in basic management, including keeping records, marketing, purchasing, and dealing with municipal authorities and other formal sector institutions. Inter-American Development Bank (1988) notes that instruction can be provided informally at neighborhood markets or at the business site.

Most family businesses in Peru are clandestine operations that generally avoid complying with regulations. The performance of these businesses could be improved by reducing the costs of non compliance. This would mean eliminating various forms of harassment by local authorities, and simplifying the process of conforming to the laws (for example, by making it easier and less costly to obtain a business license).[25]

7.2 Women-Specific Policies

Although enterprise-specific policies can improve the productivity, they may have undesirable side-effects in those instances where women operate or work in the business. Most of these women also have household responsibilities and children, and inevitably these obligations entail conflicting demands.

Enterprise-specific policies may inadvertently encourage women to devote more time to the firm, leaving them with less time for activities related to health, nutrition, education, and child care. Hence these policies may have negative effects on household welfare in general and child welfare in particular (Cornia 1987, Jolly and Cornia 1984).

[25] For discussions see Bunster and Chaney (1985), de Soto (1989), Mescher (1985), Tinker (1987), and World Bank (1987).

These negative effects can be mitigated by a complementary set of women-specific policies directed toward reducing the workload associated with home activities. These may enhance the firm's productivity by allowing women to devote more time to the business. Cornia (1987) discusses such programs in Latin America. Cooperative child care centers ("clubes de madres"), facilities for the preparation of food ("comodores populares"), and neighborhood facilities for basic health care will improve the firm's productivity.

This study suggests that proactive policies and projects to help small firms will result in social gains, contribute to the alleviation of economic hardship, and enable disadvantaged -- especially women -- to become effective agents in the development process.

Appendix A: Nonparametric Analysis

A nonparametric approach provides an alternative to the parametric model presented in the paper. The specification of functional forms is not required in nonparametric modeling, while in parametric modeling a functional form is explicitly defined. Also, under certain regularity conditions, the nonparametric estimates are consistent. This contrasts with the least squares approach where any misspecification of the functional form, however minor, will lead to inconsistent parameter estimates. It is not possible to say that nonparametric methods are more or less powerful than parametric methods -- the technique may provide a different explanation of the data. When parametric and nonparametric models provide similar results, it is reasonable to hold a stronger belief in the validity of the parametric specification.

Nonparametric Modeling

Consider the model:

$$Y_i = g(X_i) + u_i \quad i = 1,\ldots,n \tag{17}$$

where Y_i is the i^{th} observation of the dependent variable **Y** and X_i is the i^{th} row of the matrix of explanatory variables, **X**. There are **k** explanatory variables and **n** observations on each dependent and independent variable. The unobserved error term for the i^{th} observation is u_i.

The parametric approach to estimating this model involves specifying a functional form for **g()** and then applying a least squares or maximum likelihood algorithm to obtain point estimates of the parameters. The results of such an approach were presented in the paper.

The nonparametric approach to estimat..ng (17) starts with the observation that the model could be written equivalently as:

$$
\begin{aligned}
Y_i &= g(X_i) + u_i \\
&= E(Y_i|X_i) + u_i
\end{aligned}
\tag{18}
$$

where $g(X_i) \equiv E(Y_i|X_i)$ is the expectation of Y_i conditional upon X_i. This is also called the conditional mean of Y_i. The researcher estimates the model in (17) or (18) and its properties by estimating the conditional mean and how the conditional mean depends upon the conditioning vari:bles. Techniques exist for estimating the conditional mean without specifying a particular functional form for g(). Of course, different distribution and regularity assumptions are introduced. In particular, the independent variables (drawings from which form the conditioning matrix X) are typically assumed, but not required, to be jointly distributed random variables. As well, continuity and differentiability assumptions are often implicit in the estimation of the conditional mean function.

The following is a brief description of the nonparametric approach. The reader is referred to Ullah (1988) for a more complete discussion of the development and use of nonparametric techniques in economics.

Defining Conditional Means and Their Properties

Suppose that the vector of random variables (Y, X) has a joint density function given formally by:

$$
f(y,x) = \frac{dProb[(Y,X) < (y,x)]}{d(y,x)} \tag{19}
$$

The marginal density function for X is defined by:

$$
f_1(x) = \int f(y,x)dy \tag{20}
$$

Finally, the conditional density function of Y given X is defined by:

$$f(y|x) = \frac{f(y,x)}{f_1(x)} \tag{21}$$

Using these definitions, the conditional mean introduced in (18) is given by :

$$E(y|x) = \int y f(y|x) dy$$

$$= \int y \frac{f(y,x)}{f_1(x)} dy \tag{22}$$

In a similar fashion, the vector of changes or responses of the conditional mean to a change in the vector of realizations of X_i is given by:

$$\frac{dE(Y|X)}{dx_i} = \frac{d}{dx_i} \int y \frac{f(y,x_i)}{f_1(x_i)} dy \tag{23}$$

The parametric analogue of the vector of derivatives of the conditional mean with respect to the realizations of the explanatory variables is the vector of derivatives of the dependent variable with respect to the independent variables. In terms of our revenue model, they are the marginal revenue products of the factors.

Estimating Conditional Means and Derivatives

Equations (22) and (23) show that the only information required to estimate the conditional means and the derivatives is the joint density function $f(y,x)$. Once this is available, the marginal density can be computed (as in (20)) and all the right hand side of (22) is known. As (21) shows, the derivative on the right hand side of (23) can be computed and the integral can then be evaluated.

There are many ways to estimate a multivariate density function. For example it is possible to generalize the one-dimensional technique for obtaining histograms. However, the resulting density estimate will not be differentiable. More popular techniques involve kernel estimators. Formally, the estimate of the multivariate density $f(w) = f(y,x)$, where $W_i = (Y_i, X_i)$ is given by:

$$\hat{f}(w) = (1/nh^q)\sum_{i=1}^{n} K((W_i - w)/h) \tag{24}$$

where: **h** is the window width, n is the number of observations, **q** is the number of elements in any W_i (equal to the number of explanatory variables, **k**, plus one for the dependent variable) and K() is the kernel function. The kernel function is typically taken from the set of many times differentiable multivariate density functions. One popular kernel function is the multivariate normal or Gaussian density. Note, however, that the choice of a Gaussian kernel in no way restricts the estimated density. Indeed, it would appear that density estimates are much less sensitive to the kernel function than they are to the window width, **h**. The choice of the window width determines, in part, the degree of smoothing of the density estimate. Recent work by Racine (1989) has examined the optimal window width, **h**, in the sense of integrated mean square error. The results for the Peru Living Standards Survey data make use of this optimal window width and a Gaussian kernel.

Appendix B: The Rural Model

We have attempted to fit the revenue model to the rural data.[26] The results show definite similarities to the results arising in the urban data, but we are somewhat less confident that the rural results are robust.

Table B2 shows the parameter estimates for the model.[27] It is apparent that the pattern of signs for those parameters estimated with some precision (that is, those with t-statistics more than 2) is similar to that in the urban data. For example, labor, capital and expenses (materials) have positive marginal products everywhere. But only 7 of 17 parameters are estimated with precision as opposed to 13 of 17 in the urban data. The model explains 59 percent of the variation in the dependent variable. This compares well with the corresponding 61 percent for the urban model.

We computed values for the marginal revenue products of labor, capital, and expenses for every observation in the sample of 288 rural businesses. Table B3 gives the means, standard deviations, and decile values for the distributions of these derivatives in the sample. These values can be compared with corresponding results for the urban model presented in Table 4. In general, the marginal revenue products for rural firms are lower than those for urban firms; the rural values for labor and expenses are about 80 percent of the urban levels, and the rural values for capital are almost the same as the urban levels. The troubling statistical feature of the rural model is that many of the data points may be highly influential. Of the 288 observations, 56 data points (20 percent

---

[26] Table B1 contains information on the variables entering the rural model; the format of is identical to that of urban areas.

[27] We present results for the case where dummy variables are used to distinguish schooling levels.

of the sample) need detailed examination. Our concern arises from two sources: the data have high measured leverage, and the regression residuals are large in absolute value. The sheer number of these points combined with the costs of reestimating the nonlinear model to examine the importance of these points individually and in groups led us to concentrate our efforts instead on the urban model.

We do not argue that the estimates of the rural model are wrong. Indeed, as noted above, the pattern of results and other similarities with the urban results provide strong indirect evidence of their quality. We note, however, that the diagnostic evidence in support of the rural model is not as strong as that for the urban model.

TABLE B1. Descriptive Statistics of Rural Retail Sector

Type of Firm / Number of Firms		Female 151	Male 90	Mixed 47	Total 288
		%	%	%	%
PLACE OF OPERATION	%				
Home		31.8	28.9	25.5	29.9
Fixed Location		19.2	5.6	25.5	16.0
Itinerant (Streets)		49.0	65.6	48.9	54.2
MONTHS OPERATED DURING YEAR		9.5	8.1	9.7	9.1
		(3.7)	(4.2)	(3.4)	(3.9)
1 - 6 months	%	23.2	40.0	21.3	28.1
6 - 9 months		11.3	7.8	8.5	9.7
9 -12 months		65.6	52.2	70.2	62.2
AGE OF FIRM (Years)		8.6	9.5	12.4	9.5
		(11.2)	(13.7)	(15.1)	(12.7)
Less than 4 months	%	7.9	7.8	2.1	6.9
4 months - 1 year		5.3	7.8	6.4	6.3
1 - 3 years		25.8	18.9	14.9	21.9
3 - 5 years		12.6	18.9	8.5	13 9
5 - 10 years		19.2	22.2	25.5	21.2
Over 10 years		29.1	24.4	42.6	29.9
MONTHLY REVENUES	$	1047	1574	1902	1351
		(2233)	(2642)	(2541)	(2433)
$ 1 - 500 Revenues	%	59.6	47.8	38.3	52.4
500 - 1000		17.9	14.4	14.9	16.3
1000 - 2000		10.6	15.6	14.9	12.8
2000 - 4000		6.6	11.1	19.1	10.1
More than 4000		5.3	11.1	12.8	8.3
Log of Revenues	$	5.9191	6.3073	6.7357	6.1737
		(1.4161)	(1.5782)	(1.3940)	(1.4911)
MONTHLY EXPENSES	$	774	1731	1455	1184
		(1849)	(3015)	(2126)	(2350)
Spline 2 Expenses > 830	$	432	1239	1000	77[illegible]
		(1702)	(2849)	(1906)	(2180)
Spline 3 Expenses > 2000	$	285	893	627	531
		(1480)	(2527)	(1530)	(1891)
$ 0 Expenses	%	8.6	12.2	10.6	10.1
1 - 500		59.6	33.3	44.7	49.0
500 - 1000		14.6	15.6	6.4	13.5
1000 - 2000		9.9	16.7	12.8	12.5
2000 - 4000		3.3	11.1	12.8	7.3
Over 4000		4.0	11.1	12.8	7.6
$ 0 - 830	%	80.8	56.7	59.6	69.8
Over 830		19.2	43.3	40.4	30.2
Over 2000		7.3	22.2	25.5	14.9

Notes: All monetary values in the table are in June 1985 intis. The exchange rate was $1.00 US = 11 intis. Standard deviations are in parentheses.

TABLE B1. (Cont.)

Type of Firm Number of Firms		Female 151	Male 90	Mixed 47	Total 288
TOTAL CAPITAL	$	1695 (4016)	1990 (5362)	6079 (15081)	2503 (7504)
Spline 2 Total Capital > 1000	$	1313 (3783)	1561 (5173)	5501 (14916)	2074 (7331)
$ 0 Total Capital	%	13.9	17.8	14.9	15.3
1 - 250		44.4	33.3	23.4	37.5
250 - 500		7.3	12.2	6.4	8.7
500 - 2000		15.9	11.1	21.3	15.3
2000 - 4000		7.9	14.4	8.5	10.1
4000 - 12000		5.3	7.8	12.8	7.3
Over 12000		5.3	3.3	12.8	5.9
$ 0 - 1000		74.8	70.0	53.2	69.8
Over 1000		25.2	30.0	46.8	30.2
TOTAL CAPITAL EXCL. STOCK	$	1033 (3181)	741 (2070)	4500 (14217)	1508 (6386)
STOCK (Inventory)	$	662 (1533)	1249 (4495)	1579 (2602)	995 (2952)
MONTHLY PROFITS	$	272 (1001)	157 (2285)	447 (1984)	167 (1681)
Profits > 0	%	76.2	67.8	74.5	73.3
FAMILY WORKERS		1.3 (0.6)	1.1 (0.3)	2.8 (1.3)	1.4 (0.9)
1 worker	%	80.1	92.2	0.0	70.8
2 workers		15.2	6.7	63.8	20.5
3 workers		4.0	1.1	17.0	5.2
4 or more workers		0.7	0.0	19.1	3.5
Adult Male Workers Only	%	0.0	91.1	0.0	28.5
Male Workers Only		0.0	95.6	0.0	29.9
Adult Female Workers Only		80.8	0.0	0.0	42.4
Female Workers Only		95.4	0.0	0.0	50.0
Adult Workers Only		80.8	91.1	70.2	82.3
MONTHLY HOURS OF LABOUR		141.7 (135.7)	122.3 (116.4)	356.8 (314.2)	170.7 (191.0)
1 - 100 Hours	%	49.0	54.4	17.0	45.5
100 - 200 Hours		27.8	22.2	17.0	24.3
200 - 300 Hours		12.6	15.6	19.1	14.6
300 - 400 Hours		4.6	5.6	17.0	6.9
400 - 500 Hours		3.3	0.0	6.4	2.8
Over 500 Hours		2.6	2.2	23.4	5.9
Log Monthly Hours		4.5265 (0.9902)	4.3565 (.0399)	5.5194 (0.9029)	4.6354 (1.0663)
Adult Male/Total Hours	%	0.0	94.3	45.9	37.0
Adult Female/Total Hours	%	90.7	0.0	46.0	55.1
Child Hours/Total Hours	%	9.3	5.7	8.1	8.0
EDUCATION (Most Educated Worker)					
Years of Schooling		3.1 (3.2)	3.8 (2.5)	5.3 (3.0)	3.7 (3.1)
Spline 0 - 5 years of school		2.5 (2.2)	3.3 (1.7)	4.0 (1.6)	3.0 (2.0)
Spline 6 -10 years of school		0.6 (1.7)	0.5 (1.2)	1.3 (1.9)	0.7 (1.6)
Highest Education Level Completed					
None	%	34.4	6.7	6.4	21.2
Primary		47.7	73.3	57.4	57.3
Secondary		17.9	20.0	36.2	21.5
% OF FAMILY WORKERS WHO:					
Attended Public Schools		57.8	87.2	71.9	69.3
Have Vocational Training		7.4	8.9	7.1	7.8
AT LEAST 1 FAMILY WORKER HAS VOCATIONAL TRAINING		9.9	8.9	12.8	10.1
AGE OF OLDEST WORKER (Years)		0.8 13.7	39.5 14.5	44.0 13.1	40.6 13.9
JOB EXPERIENCE (MOST EXPERIENCED WORKER)					
Years		18.4 (14.3)	24.0 (15.7)	25.2 (12.6)	21.2 (14.8)
Years squared/100		5.4 (7.2)	8.2 (9.7)	7.9 (7.0)	6.7 (8.1)

TABLE B2: REGRESSION RESULTS RURAL AREAS - ALL FIRMS (Binary Schooling Variables)

CONSTANT1(a_0)	9.486 (7.993)
LOCATION_HOME	-0.191 (-1.197)
LOCATION_FIXED	-0.112 (-0.600)
FIRM_AGE	-0.002 (0.291)
CONSTANT2(b_0)	-5.361 (-4.620)
EXPENSES_1	2068.170 (7.318)
EXPENSES_2	-1450.507 (-3.029)
EXPENSES_3	-522.151 (-1.714)
CAPITAL_1	673.694 (3.265)
CAPITAL_2	-657.124 (-3.135)
LABOR	0.168 (2.633)
SCHOOL_PRIMARY	0.181 (1.141)
SCHOOL_SECONDARY	0.212 (0.973)
SCHOOL_POSTSEC	----- -----
TRAINING	0.247 (1.093)
EXPERIENCE	0.033 (0.277)
EXPERIENCE^2/100	-0.023 (-1.045)
LLF	-386.738
SSR	247.340
Adjusted R-squared	0.59000
Mean Dependent Variable	6.17370
St. Dev.	1.49111

Notes: t-statistics are in parentheses.

TABLE B3. DISTRIBUTION OF MARGINAL REVENUE PRODUCTS OF LABOR, EXPENSES, AND CAPITAL - RURAL AREAS

DECILE	LABOR	EXPENSES	CAPITAL
1	.028	.302	.016
2	.051	.386	.046
3	.070	.468	.074
4	.103	.596	.130
5	.131	.777	.167
6	.179	.953	.221
7	.251	1.097	.310
8	.390	1.379	.499
9	.896	1.776	1.101
10	16.085	5.007	3.358
MEAN	.427	.964	.379
ST DEV	1.183	.747	.556
OBS	288	288	288

Bibliography

Althaus, Jaime, and Jorge Morelli (1980). Approximaciones a La Composicion y Evolucion del Empleo Informal en El Peru. Lima: Pontificia Universidad Catolica del Peru, Mimeo.

Babb, Florence E. (1984). "Women in the Marketplace: Petty Commerce in Peru." Review of Radical Political Economics 16(1): 45-59.

Bates, D.M., and D.G. Watts (1980). "Relative Curvature Measures of Nonlinearity (with discussion)." Journal of the Royal Statistical Society B 42: 1-25.

Belsey, David A., Edwin Kuh, and Roy E. Welsch (1980). Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. New York: Wiley.

Bromley, Ray (1978). "The Urban Informal Sector: Why is It Worth Discussing?" World Development 6, 9/10, 1033-1039.

Buvinic Mayra, Margaret A. Lycette, and William Paul McGreevey (1983). Women and Poverty in the Third World. Baltimore: The Johns Hopkins University Press.

Bunster, Ximena, and Elsa Chaney (1985). Sellers and Servants: Working Women in Lima. New York: Praeger Press.

Chatterjee, Samprit, and Ali S. Hadi (1988). Sensitivity Analysis in Linear Regression. New York: Wiley.

Chiswick, Carmel U. (1983). "Analysis of Earnings from Household Enterprises: Methodology and Application to Thailand." Review of Economics and Statistics LXV: No. 4, November, 656-662.

Cornia, Giovanni A., Richard Jolly, and Frances Stewart, eds. (1987). Adjustment with a Human Face: Protecting the Vulnerable and Promoting Growth. Oxford: Clarendon Press.

Cornia, Giovanni A. (1987). "Adjustment at the Household Level: Potentials and Limitations of Survival Strategies." In Giovanni A. Cornia, Richard Jolly, and Frances Stewart, eds. Adjustment with a Human Face: Protecting the Vulnerable and Promoting Growth. Oxford: Clarendon Press.

de Soto, Hernando (1988). The Other Path: The Invisible Revolution in the Third World. New York: Harper and Row. (First published in Spanish in 1986 as El Otro Sendero: La Revolucion Informal. Lima: Editorial El Barranco.)

Freeman, Donald B., and Glen B. Norcliffe (1985). Rural Enterprise in Kenya: Development and Spatial Organization of the Nonfarm Sector. Chicago: University of Chicago, Department of Geography, Research Paper No. 214.

Glewwe, Paul, and Dennis de Tray (1989). The Poor in Latin America During Adjustment: A Case Study of Peru. Washington, D.C: The World Bank, Population and Human Resources Department, Welfare and Human Resources Division, Living Standards Measurement Study Working Paper No. 24.

Grootaert, Christiaan, and Ana-Maria Arriagada (1986). The Peru Living Standards Survey: An Annotated Questionnaire. Washington, D.C: The World Bank, Development Research Department, Living Standards Measurement Study Working Paper Number 24.

Hallak, Jacques, and Francoise Caillods (1981). Education, Training and the Traditional Sector. Paris: UNESCO.

Hart, Keith J. (1987). "Informal Economy." In John Eatwell, Murray Milgate, and Peter Newman, eds. The New Palgrave: A Dictionary of Economics. London: The MacMillan Press, 845-46.

Hart, Keith J. (1973). "Informal Income Opportunities and Urban Employment in Ghana." Journal of Modern African Studies 11: No. 1, 61-89.

Herz, Barbara (1989). "Bringing Women into the Economic Mainstream" Finance & Development 32: No. 4, December, 22-25.

House, William J. (1984). "Nairobi's Informal Sector: Dynamic Entrepreneurs or Surplus Labor?" Economic Development and Cultural Change 32: No. 2, 277-302.

Instituto Nacional de Estadistica, INE (1988). Encuesta Nacional de Hogares Sobre Medicion de Niveles de Vida Enniv (1985-86): Analisis de Resultados. Lima: INE.

Inter-American Development Bank, IDB, (1988). Ten Years of Small Projects: Bringing the Margin into the Mainstream. Washington, D.C: IDB.

Inter-American Development Bank, IDB, (1988). Annual Report, 1988. Washington, D.C: IDB.

Inter-American Development Bank, IDB, (1987a). Bibliography on the Urban Informal Sector. Washington, D.C: Plans and Programs Department, Social Policies Division, IDB.

Inter-American Development Bank, IDB, (1987b). Economic and Social Progress in Latin America: 1987 Report. Washington, D.C: IDB.

International Labour Office (1972). Employment Incomes and Equality: A Strategy for Increasing Productive Employment in Kenya. Geneva: ILO.

Kafka, Folke (1984). El Sector Informal Urbano en la Economia Peruana. Lima: Centro de Investigacion, Universidad del Pacifico.

Litan, Robert, Luis Morales-Bayro, and Jorge Fernandez-Baca (1986)."Internal Structural Reforms in Peru: A Promising Road out of the Debt Crisis." Journal of Economic Growth 1: No. 2, 28-36.

Mazumdar, Dipak (1976). "The Urban Informal Sector." World Development 4: No. 8, 655-679.

Mescher, Micheline (1985). The Urban Informal Sector in Latin America: Case Studies of Peru and Brazil. Alexandria, Va.: Mescher Associates.

Mattera, Philip (1985). Off the Books: The Rise of the Underground Economy. New York: St. Martin's Press.

Moock, Peter, Philip Musgrove, and Morton Stelcner, (1989). Education and Earnings in Peru's Informal Nonfarm Family Enterprises. Washington, D.C.: Population and Human Resources Department, Education and Employment Division, Policy, Planning and Research Complex, WPS 236.

Moser, Caroline O., and Judith Marsie-Hazen (1984). A Survey of Empirical Studies in Industrial and Manufacturing Activities in the Informal sector in Developing Countries. New York: UNIDO.

OECD - Organisation for Economic Co-operation and Development (1989). Development Co-operation in the 1990s: Efforts and Policies of the Members of the Development Assistance Committee: Paris, OECD.

PREALC - program regional de empleo en America Latina y el Caribe (1985). Mas Alla de la Crisis. Santiago, Chile: PREALC.

Racine, Jeffrey S. (1989). A Semiparametric Approach to the Estimation of Systems of Equations Models in the Presence of Heteroskedasticity of Unknown Form. Toronto: Department of Economics, York University Working Paper 89-13.

Reichmuth, Markus (1978). Dualism in Peru: An Investigation into the Inter-relationships between Lima's Informal Clothing Industry and the Formal Sector. Oxford: B. Litt. thesis, Oxford University.

Ross, W.H. (1987). "The Geometry of Case Deletion and the Assessment of Influence in Nonlinear Regression." Canadian Journal of Statistics 15: 91-103.

Schafgans, Marcia (1989). The Status of Women in the Economy of Peru: A Descriptive Analysis. Washington D.C: The World Bank, Population and Human Resources Department, Women in Development Division, (unpublished manuscript).

Sethuraman S.V. ed. (1981). The Urban Informal Sector in Developing Countries: Employment, Poverty and Environment. Geneva: ILO.

Stewart, Frances (1987). "Supporting Productive Employment Among Vulnerable Groups." In Giovanni Andrea Cornia, Richard Jolly, and Frances Stewart, eds. Adjustment with a Human Face: Protecting the Vulnerable and Promoting Growth. Oxford: Oxford University Press.

Strassmann, Paul, W. (1987). "Home-based Enterprises in Cities of Developing Countries." Economic Development and Cultural Change 36: No. 1, 121- 144.

Stelcner, Morton, and Peter Moock (1988). Nonagricultural Family Enterprises in Peru: The Role of the Informal Sector in a Developing Economy. Washington, D.C: The World Bank, Population and Human Resources Department, Welfare and Human Resources Division, (unpublished manuscript).

Suarez-Berenguela, Ruben M. (1987). Peru Informal Sector, Labor Markets, and Returns to Education. Washington, D.C: The World Bank,Development Research Department, Living Standards Measurement Study, No. 41.

Tendler, Judith (1983). Ventures in the Informal Sector and How They Worked Out in Brazil. AID Evaluation Special Study No. 12. Washington, D.C.: Agency for International Development.

Tinker, Irene (1987). "Street Foods: Testing Assumptions About Informal Sector Activity by Women and Men." Current Sociology 35, Winter, 1-81.

Tokman, Victor (1986). "Adjustment and Employment in Latin America." International Labour Review 125: No. 5.

Tokman, Victor (1978). "An Exploration into the Nature of Formal-Informal Sector Relationships." World Development 6: No. 9-10, 1065-75.

Ullah, Aman (1988). "Non-parametric Estimation of Econometric Functionals." Canadian Journal of Economics 20: No. 3, 625-58.

United Nations (1985). Bank Credit for Rural Women: Report on Study Tour of Grameen Bank in Bangladesh. Bangkok: Economic and Social Commission for Asia and the Pacific.

van der Gaag, Jacques, Morton Stelcner, and Wim Vijverberg (1989). "Wage Differentials and Moonlighting by Civil Servants: Evidence from Cote d'Ivoire and Peru." The World Bank Economic Review 5: No. 3, 67-98.

Vargas-Llo a, Mario (1987). "The Silent Revolution." Journal of Economic Growth 2: No. 1, 3-7.

Webb, Richard C. (1977). Government Policy and the Distribution of Income in Peru: 1963-1973. Cambridge, Mass.: Harvard University Press.

World Bank (1989). World Development Report. New York: Oxford University Press and the World Bank.

World Bank (1987). World Development Report. New York: Oxford University Press and the World Bank.

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS444	The Political Economy of Inflation and Stabilization in Middle-Income Countries	Stephan Haggard Robert Kaufman	June 1990	A. Oropesa 39176
WPS445	Pricing, Cost Recovery, and Production Efficiency in Transport: A Critique	Rachel E. Kranton	June 1990	W. Wright 33744
WPS446	MEXAGMKTS: A Model of Crop and Livestock Markets in Mexico	Gerald T. O'Mara Merlinda Ingco	July 1990	C. Spooner 30464
WPS447	Analyzing the Effects of U.S. Agricultural Policy on Mexican Agricultural Markets Using the MEXAGMKTS Model	Gerald T. O'Mara	July 1990	C. Spooner 30464
WPS448	A Model of U.S. Corn, Sorghum, and Soybean Markets and the Role of Government Programs (USAGMKTS)	Richard E. Just	July 1990	C. Spooner 30464
WPS449	Analysis of the Effects of U.S. Macroeconomic Policy on U.S. Agriculture Using the USAGMKTS Model	Richard E. Just	July 1990	C. Spooner 30464
WPS450	Portfolio Effects of Debt-Equity Swaps and Debt Exchanges with Some Applications to Latin America	Daniel Oks	June 1990	S. King-Watson 31047
WPS451	Productivity, Imperfect Competition and Trade Liberalization in the Côte d'Ivoire	Ann E. Harrison	July 1990	S. Fallon 38009
WPS452	Modeling Investment Behavior in Developing Countries: An Application to Egypt	Nemat Shafik	June 1990	J. Israel 31285
WPS453	Do Steel Prices Move Together? A Cointegration Test	Ying Qian	June 1990	S. Lipscomb 33718
WPS454	Asset and Liability Management in the Developing Countries: Modern Financial Techniques -- A Primer	Toshiya Masuoka	June 1990	S. Bertelsmeier 33767
WPS455	A Formal Estimation of the Effect of the MFA on Clothing Exports from LDCs	Junichi Goto	June 1990	M. T. Sanchez 33731

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS456	Improving the Supply and Use of Essential Drugs in Sub-Saharan Africa	S. D. Foster	June 1990	Z. Vania 33664
WPS457	Financing Health Services in Africa: An Assessment of Alternative Approaches	Germano Mwabu	June 1990	Z. Vania 33664
WPS458	Does Japanese Direct Foreign Investment Promote Japanese Imports from Developing Countries?	Kenji Takeuchi	June 1990	J. Epps 33710
WPS459	Policies for Economic Development	Stanley Fischer Vinod Thomas	June 1990	WDR Office 31393
WPS460	Does Food Aid Depress Food Production? The Disincentive Dilemma in the African Context	Victor Lavy	July 1990	A. Murphy 33750
WPS461	Labor Market Participation, Returns to Education, and Male-Female Wage Differences in Peru	Shahidur R. Khandker	July 1990	B. Smith 35108
WPS462	An Alternative View of Tax Incidence Analysis for Developing Countries	Anwar Shah John Whalley	July 1990	A. Bhalla 37699
WPS463	Redefining Government's Role in Agriculture in the Nineties	Odin Knudsen John Nash	August 1990	K. Cabana 37946
WPS464	Does A Woman's Education Affect Her Husband's Earnings? Results for Israel in A Dual Labor Market	Shoshana Neuman Adrian Ziderman	August 1990	V. Charles 33651
WPS465	How Integrated Are Tropical Timber Markets?	Panos Varangis	August 1990	D. Gustafson 33714
WPS466	Is There An Intra-Household Kuznets Curve?	Lawrence Haddad Ravi Kanbur	August 1990	J. Sweeney 31021
WPS467	Structural Adjustment and Living Conditions in Developing Countries	Nanak Kakwani Elene Makonnen Jacques van der Gaag	August 1990	B. Rosa 33751
WPS468	Does the Structure of Production Affect Demand for Schooling in Peru?	Indermit Gill	August 1990	M. Abundo 36820
WPS469	Modeling Economic Behavior in Peru's Informal Urban Retail Sector	J. Barry Smith Morton Stelcner	August 1990	M. Abundo 36820