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Labor Force Participation in a Developing Metropolis

Does Sex Matter?

Rakesh Mohan

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Washington, D.C., U.S.A.

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First printing August 1985

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Library of Congress Cataloging-in-Publication Data

Rakesh, Mohan, 1948-

Labor force participation in a developing metropolis.

(World Bank staff working papers ; no. 749)

Bibliography: p.

1. Labor supply--Colombia. 2. Labor supply--
Colombia--Bogotá. I. Title. II. Series.

HD5757.A6R35 1985 331.11'09861'4 85-16929

ISBN 0-8213-0591-3

ABSTRACT

After sustained economic growth in Colombia over two decades, the labor market in Bogota exhibited considerable tightening up in the late 1970s. Unemployment rates were seen to have declined and the rate of participation of women to have increased perceptibly over the decade. This study uses data from a 1978 household survey to examine the determinants of labor force participation. The sample is divided into seven age/sex groups to capture the life-cycle effects on participation. Different estimation methods (ordinary least squares, Probit, and Tobit) are used to estimate the elasticity of labor supply with respect to our earnings, wealth, household income, and education, along with other variables. Particular attention is paid to estimation technique to eliminate sample censorship bias, selectivity bias, and variable censorship bias.

The estimates show that the main component of the labor force that can be expected to expand rapidly with rising real wages is that of married women. As access to secondary and higher education improves further, more young men and women will stay longer in school before entering the labor force. Hence, fewer young men and women will enter the labor force at a young age. The same forces that induce greater participation of married women will serve to reduce the entry of young women into the labor force at a young age. These economic inducements are essentially the likelihood of receiving relatively higher wages with higher level education in relation to the opportunity cost of nonmarket work. Women have been catching up with men rapidly in average educational attainment. This suggests an increasing desire of women to enter the labor market and this can be expected to continue for some time.

Once these results are coupled with the association of labor force participation with lower fertility, the future expansion of women in the labor force can be appreciated further. At the same time, the late 1970s showed the increased participation of poor women in response to the real wage increases observed over that period. Among nonmarried women (widows, divorcees, never married), there is a clear element of necessity in their labor market participation, especially of those who are household heads. They simply have to work at whatever the existing wage level; and, hence, their labor force participation rates are not as responsive to wage changes as those of married women. Prime age men are similar since almost all of them are in the labor force anyway.

These results have implications for urban labor markets in developing countries in general. It may be the case that the remarkable increase in female labor participation that has taken place in developed countries may occur in developing countries earlier than might be expected at rather lower absolute income levels.

PREFACE

A rather large amount of data handling, documentation and preparation has gone into the work leading to this paper. I would like to thank Sungyong Kang and M. Wilhelm Wagner for making the 1978 City Study-DANE Household Survey ready for use. Yoon Joo Lee was responsible for the early estimations for this paper and the original literature search. A particular word of appreciation goes to him for his help over a protracted length of time. John Roseman and Sungyong Kang did the final computations under considerable time pressure. A special word of appreciation goes to the staff of DANE for having painstakingly conducted the survey. The high quality of the 1978 City Study-DANE Household survey owes much to the diligence of Roberto Pinilla and Maria-Christina Jimenez of DANE and Gary Losee, Alfredo Aliaga, Alvaro Pachon, Jose Fernando Pineda and Jairo Arias for CCRP-World Bank.

I would also like to thank Michael Hartley for introducing me to the intricate world of limited dependent variables and the pitfalls in their estimation, Surjit Bhalla for useful discussion, and Dennis de Tray, Manny Jimenez and Nancy Birdsall for helpful comments on an earlier draft.

This paper is part of a program of research which has been conducted by the World Bank on Bogota and Cali, Colombia. The goal of the program, entitled The City Study, is to increase our understanding of the working of five major urban sectors--housing, transport, employment location, labor markets and the public sector--in order that the impact of policies and projects can be assessed more accurately. This paper is part of the labor market and income distribution portion of the study which is coordinated by Rakesh Mohan. Other papers in this series are:

Gary Fields, "How Segmented in the Bogota Labour Market", World Bank Staff Working Paper No. 434, Washington D.C., October 1980.

Rakesh Mohan "The People of Bogota: Who They Are, What They Earn, Where They Live", World Bank Staff Working Paper No. 390, Washington D.C., May 1980.

_____, "The Determinants of Labour Earnings in Developing Metropolises: Estimates from Bogota and Cali, Colombia", World Bank Staff Working Paper No.498, Washington, D.C., 1981.

_____, M. Wilhelm Wagner and Jorge Garcia, "Measuring Urban Malnutrition and Poverty: A Case Study of Bogota and Cali, Colombia", World Bank Staff Working Paper No. 447, Washington D.C., April 1981.

_____ and Nancy Hartline, "The Poor of Bogota: Who They Are, What They Do, Where They Live", World Bank Staff Working Paper No. 635, Washington D.C. 1984.

_____ "An Anatomy of the Distribution of Urban Income: A Tale of Two Cities in Colombia", World Bank Staff Working Paper No. 651, Washington, D.C., 1984.

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I. INTRODUCTION: EVOLUTION OF THE URBAN LABOR MARKET IN COLOMBIA

There is now widespread agreement that the Colombian urban economy underwent a remarkable series of changes during the decade of the seventies which has led inevitably to a number of perceptible changes in the urban labor market.^{1/} With a sustained overall real growth rate in GNP of about 6 percent a year annually over 2 decades from 1960 to 1980, per capita incomes in Colombia doubled over that period. There has been rapid structural change in the economy so that agriculture and industry now each contribute about a quarter of gross national product with the tertiary sector accounting for the rest. The level of urbanization rose drastically from about 38 percent in 1951 to 52 percent in 1964, 60 percent in 1973 and, at a somewhat slower rate to about 65 percent (estimated) in 1980-82. All of these changes resulted in a perceptible tightening in the labor market in the late seventies.

A dramatic expansion in employment took place in Colombia in the late seventies. The growth in overall employment was about 6.2 percent a year between 1973 and 1978, with the manufacturing and tertiary sector employment expanding at over 8 percent annually (World Bank, 1983). This occurred in a period when overall expansion in the labor force was at a rate of 3.4 percent a year. As a result, the labor market visibly tightened up and urban unemployment rates were observed to fall along with increased participation rates. The key component of these higher participation rates was the increased participation of women in the labor force. That this occurred is shown in Table 1 which shows the labor force participation of men and women

^{1/} These are well summarized by Miguel Urrutia (1985) in his careful examination of the changing income distribution in Colombia in the 1970s.

from 1964 to 1978. In the earlier years, the expansion of education served to reduce the participation rate of young men and women. This expansion in education was substantially completed by the mid seventies and the participation rates of the young stabilized or increased slightly. Among men, the participation rate of the prime working age group (25-54) has remained roughly constant at between 93 and 97 percent. Among women, however, the same age group has clearly increased its participation and specifically in the late seventies, after a possible decline earlier. There is some evidence that the participation rates of poor women particularly increased in these years. Table 2 gives indirect indication of this by giving the labor force participation (LFP) rates broken down by educational attainments of men and women. The LFP rates of women with primary education increased significantly toward the latter part of the decade. A striking feature of Table 2 is the comparatively higher LFP rates of higher educated women--but they account for only 9 percent of all women.

The most significant change in the labor markets of the developed countries in the post-war period has also been a secularly increasing proportion of women participating in the labor force and considerable analytical work has therefore been devoted to explaining this phenomenon. The maintained hypothesis is essentially that LFP can be expected to increase when the expected wage in market work is greater than the perceived opportunity cost of alternative activities. In the case of married women, this is the perceived returns from non-market or house work. As the economy expands and

Table 1: BOGOTA PARTICIPATION RATES BY AGE GROUP

Age group	1964	1973	1975	1977	1978
<u>Men</u>					
15-24	66.7	61.2	52.2	50.6	52.2
25-34	94.9	92.8	94.3	94.3	92.7
35-44	97.2	93.7	96.2	96.2	96.0
45-54	94.4	88.2	91.9	94.9	87.3
55-64	81.8	68.8	73.8	72.0	68.9
65+	41.6	36.5	42.1	33.7	37.5
Total 15+	75.1	70.2	66.9	65.9	65.4
<u>Women</u>					
15-19	40.4)	36.2	36.8	38.8	37.5
20-24	47.5)				
25-34	37.4	37.0	42.2	46.1	45.1
35-44	34.0	34.4	33.9	41.2	37.9
45-54	27.3	26.9	26.3	31.0	35.6
55-64	18.0	17.2	14.6	17.5	19.6
65+	9.3	13.9	6.7	7.2	6.6
Total 15+	33.5	30.7	30.7	33.8	33.4

Source: City Study estimates from 1964, 1973 Population Censuses and 1975, 1977 and 1978 DANE Household Surveys.

the stock of educated women deepens, it can be expected that the market work opportunity costs increase disproportionately to the returns from house-work, which would lead to increased participation of women. This is an important issue for the fast growing "Newly Industrializing Countries" from both the supply and the demand side of the labor market. From the supply side, as educational opportunities expand, it may be expected that more and more women would expect to be in the market labor force. Thus, policies for educational expansion need to take this phenomenon into account, both in terms of quality of education supplied and the types of education supplied. Similarly, from the demand side, in conditions of rapid economic expansion, the supply of labor could become a constraint once the traditional unlimited supply from the countryside slows down. The importance of increasing female LFP in the income distribution has also been indicated.

This study has been conducted in the context of a wider study of Bogota in an attempt to understand the implications of a rapidly growing city on the labor market--but in the context of wider economy wide concerns. The overall tightening of the labor market and falling urban unemployment which occurred in the late seventies in Colombia is a novel phenomenon for developing countries and deserves greater analysis than it has received. The events in recent years have, of course, reversed these trends but the importance of the events of the late seventies remain, since they suggest conditions in which rapid urbanization is not necessarily accompanied by secularly rising urban unemployment as is often suggested.

Table 2: BOGOTA PARTICIPATION RATES BY EDUCATION
 (Percentage of persons in labor force above 15 years)

Education	1973	1975	1977	1978
None	69.4	64.3	63.2	60.2
Primary	74.3	74.6	71.8	73.0
Secondary	63.7	58.3	58.5	57.3
Higher	71.7	72.0	72.5	70.6
Total	70.2	67.1	65.9	65.4

	<u>Women</u>			
None	30.0	27.9	34.0	31.3
Primary	30.2	32.3	36.2	35.5
Secondary	31.1	26.7	29.0	27.9
Higher	42.5	48.6	49.4	53.0
Total	30.7	30.8	33.8	33.4

Source; City Study estimates from 1973 Population Census.
 1975, 1977, 1978 DANE Household Survey (EH8E, EH15 AND EH21).

II. ESTIMATING LABOR SUPPLY: THEORETICAL CONSIDERATIONS

Most work on labor supply is of relatively recent origin and has largely been conducted since the early sixties. This is one branch of economics where theoretical and empirical work has progressed hand in hand. The availability of new kinds of data has spurred the development of new extensions to theory, while at the same time, theoretical developments have been closely linked with new estimation techniques. An excellent extensive and almost exhaustive review is available in Killingsworth (1983) so only a brief review of theory relevant for this paper will be made here.

The explosion of research on labor supply has to a large extent been stimulated by the observation of dramatically increasing labor force participation (henceforth LFP) rate of women in western countries in the post-second World War period. There had been little interest prior to that since there is little historical variance in the LFP of prime age men, being universally near 100 percent in the urban labor market. The interest in prime age men is much more in cyclical changes in the labor market, that is, in changes in the unemployment rate. Significant changes have also taken place in the LFP of other groups of secondary workers. Thus the expansion of education has typically decreased the LFP of young men and women, while the provision of better social security has affected the LFP of old men and women. There are, however, other considerations as well. The improvements in life expectancy and general health levels have on the other hand, tended to increase the LFP of older people. The declines in fertility, availability of home appliances, etc. have tended to increase the LFP of women at all age

levels. The explanation of LFP is therefore not a simple matter and earlier ad hoc approaches have gradually led to a unified theoretical framework.

Earlier work on LFP had to rely on variance in LFP rates between and among different sex and age groups in different cities and regions and over different periods of time to derive inferences on the determinants of LFP. ^{1/} Thus the average participation rate of a group was typically taken as the dependent variable to be explained. The implications of such an approach are several. First, the average LFP rate for the group is implicitly interpreted as the probability of participation of each individual. Second, the participation decision of the individual, as revealed by the group average, is abstracted from his position in the household. Again, it was the focus on the LFP of married women that forced the consideration of labor supply in the household context (Mincer (1962) and Becker (1965), Ashenfelter and Heckman (1973)). It was the increased availability of household level data which made it feasible to examine the individual LFP decision within the household context.

The basic theory is derived from the traditional utility maximization framework. Although the theory is relatively straightforward and available in other sources (e.g. Heckman (1974), Nakamura and others (1978) and Killingsworth (1983)) it is presented here in brief in Appendix II because of its close relationship with the estimation technique. As reviewed in Killingsworth (1983), the estimation of labor supply can be done in a bewildering number of ways. Consequently, a number of different techniques

^{1/} An exhaustive work of this kind was Bowen and Finnegan (1969) for the U.S.

have been employed in this study in order to (a) test for the robustness of the estimates and (b) to test for the need for the more sophisticated methods.

2.1 Estimation Technique

As derived in Appendix II the basic labor market equations are Appendix equations (A17), (A18) and (A30).

$$\begin{aligned} w_i^* &= \alpha_0 + \alpha_1 h_i + \alpha_2 y_i + \alpha_3 A_i + \alpha_4 Z_i + u_i \\ &= \alpha_1 h_i + Z_i^* \alpha + u_i \end{aligned} \quad (1)$$

$$\begin{aligned} w_i &= \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 X_i + e_i \\ &= X_i^* \beta + e_i \end{aligned} \quad (2)$$

and

$$\begin{aligned} P_i &= f(w_i - w_i^*) \quad h_i = 0 \\ &= f(X_i^* \beta - Z_i^* \alpha + e_i - u_i) \end{aligned} \quad (3)$$

where

w_i^* = shadow price of the individual's time,

w_i = market wage rate, and

P_i = 1 when $h_i > 0$

= 0 when $h_i = 0$;

h_i is the number of hours of market work,

y_i is the household labor income,

A_i is household non-labor income, i.e. return from assets,

Z_i is a vector of other individual and household characteristics arrived at through earlier decisions,

S_i is years of schooling,

E_i is years of market experience,

X_i is a vector of other individual characteristics relevant for market work,

u_i and e_i are random disturbances,

u_i is $\sim N(0, \sigma_1)$

e_i is $\sim N(0, \sigma_2)$

and may be correlated with each other.

From (1), the labor supply equation can be derived,

$$h_i = \frac{1}{\alpha_1} \{w_i^* - (\alpha_0 + \alpha_2 y_i + \alpha_3 A_i + \alpha_4 Z_i + u_i)\} \quad (4)$$

There are five basic problems in the estimation of (2), (3) and (4):

- (i) Censored Dependent Variable: The labor supply equation (4) and the participation equation (3), both have dependent variables which are censored since h_i is observed only when $h_i > 0$ and P_i is a binary variable.
- (ii) Censored Sample: In the cases of both equation (2) for w_i and equation (4) for h_i (if estimated for workers only), the sample itself is censored since it is composed of workers only and not the whole population. As shown in the appendix, u_i and e_i are both correlated with each other and are truncated as well.
- (iii) Selectivity Bias: Again, in the cases of equations (2) and (A), the available sample of workers is one resulting from systematic decision making in the past (the decision on schooling, age at marriage, number of children, etc.) the sample is therefore subject to selectivity bias. Naturally, this is more important for groups of people among whom levels of participation are low, that is, different types of secondary workers. It is, for example, not important for prime age men, almost all of whom work.

- (iv) Errors in Measurement: This is the most serious for hours of work and wages. Annual or monthly income is the sum of the product of hours and wages and bonus payments, etc. Thus, invariably, the "true" wage has to be calculated by dividing some index of total labor income by the number of hours worked. Moreover, income is notoriously subject to reporting error.
- (v) Costs of Entry into the Labor Market: The derivation of the labor supply function has characterized the function to be continuous in the positive quadrant. This assumes zero costs of entry. In practice there are considerable search costs and the hours of work are also not entirely flexible so that the decision to work can be dependent on the minimum hours of work feasible.

The different estimations account for these problems in varying degrees. The four methods that have been used are:

Method I: This is a one stage procedure which estimates (3) and (4) in reduced form. This procedure uses the whole sample so problems (ii) and (iii) do not arise. Problem (iv) is also muted since w_i is not used. Problem (i) is solved by using Tobit for estimation of (4) and Probit or logit for equation (3). The main drawback in this procedure is that it is difficult to interpret the coefficients derived since the supply and demand sides are mixed up. Moreover, elasticities of interest, e.g. the own wage elasticity of labor supply has to be calculated indirectly--which itself gives rise to selectivity bias. This procedure also ignores the differences between workers and non-

workers, $\frac{1}{\alpha_1}$ in terms of their decision making. Thus method I can be written as:

$$h_i = \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha + e_i - u_i) \quad i = 1 \dots n \quad (4a)$$

$$P_i = f(X_i^* \beta - Z_i^* \alpha + e_i - u_i) \quad i = 1 \dots n \quad (3a)$$

Method IA. OLS.

Method IB. Tobit for equation (4a)

Probit or logit for equation (3a).

Note also, that if (3) is linearized, the coefficients from equation (4a) and (3a) should differ by only a factor of proportionality.

Method II: 2 Stage Procedure

The first stage is to estimate w_i by equation (2) over a sample of workers and then to use \hat{w}_i as an instrumental variable to estimate equations (3) and (4) over the whole sample. The assumption here is that sample selectivity bias does not exist and that the wage estimated from the market demand equation for workers applies equally well to non-workers. Both of these can be estimated by OLS (admitting problem (i)) or by logit or probit for equation (3) and tobit for equation (4). Thus Method II can be written as

$$w_i = X_i^* \beta + e_i \quad i = 1 \dots m \quad (2b)$$

$$h_i = \frac{1}{\alpha_1} \{ \hat{w}_i - (Z_i^* \alpha + u_i) \} \quad i = 1 \dots n \quad (4b)$$

1/ Heckman (1974) formed a likelihood function of workers and non workers and then solved the resulting simultaneous equation system by Full Information Maximum Likelihood procedures. This is also a "one stage" method but too costly to implement.

$$P_i = f\{\hat{w}_i - (Z_i^* \alpha + u_i)\} \quad i = 1 \dots n \quad (3b)$$

where there are m workers and n-m non-workers.

Method IIA OLS for all equations.

Method IIB OLS for equation (2b).

Probit or Logit for equation (3b)

Tobit for equation (4b)

Method III 3 Stage Procedure

The first stage is to estimate P (reduced form) by probit to calculate the probability of selection as a worker and thereby to account for sample selectivity bias in equations (2) and (4). The second stage is to estimate equation (2) admitting selectivity bias by the inclusion of

$$\lambda_i = \frac{\phi(I_i)}{\Phi(I_i)} \quad \underline{1/}$$

as an explanatory variable. The third stage is to estimate equation (4) by using \hat{w}_i (corrected for selectivity bias) and λ_i as explanatory variables. Here equation (3) is estimated over the whole sample and equations (2) and (4) over workers only. Equation (3) is estimated by probit and equation (2) and (3) by OLS. Here problem (i) is accounted for in equation (3) and does not arise in equation (4) since the sample itself is censored but

1/ See appendix.

selectivity bias (problem (iii)) is accounted for. Thus Method III can be written as:

$$P_i = f(X_i^* \beta - Z_i^* \alpha + e_i - u_i) \quad \text{Probit} \quad i = 1 \dots n. \quad (3c)$$

$$w_i = X_i^* \beta + \beta_k \lambda_i + V_{i2} \quad \text{OLS} \quad i = 1 \dots m. \quad (2c)$$

$$h_i = \frac{1}{\alpha_1} (\hat{w}_i - Z_i^* \alpha + \alpha_k \lambda_i - V_{i1}) \quad \text{OLS} \quad i = 1 \dots m \quad (4c)$$

Method IV 3 Stage

This is the same as method II except that (4) is estimated over the whole sample by Tobit. The assumption is that \hat{w}_i having accounted for sample selectivity bias is a good predictor of potential market earnings for non-workers as well. Thus Method IV can be written as -

$$P_i = f(X_i^* \beta - Z_i^* \alpha + e_i - u_i) \quad \text{Probit} \quad i = 1 \dots n \quad (3d)$$

$$w_i = X_i^* \beta + \beta_k \lambda_i + V_{i2} \quad \text{OLS} \quad i = 1 \dots m \quad (2d)$$

$$h_i = \frac{1}{\alpha_1} (\hat{w}_i - Z_i^* \alpha + - u_i) \quad \text{Tobit} \quad i = 1 \dots n \quad (4d)$$

No comments have been made above on problems (iv) and (v). The reason for using \hat{w}_i as opposed to observed w_i (for workers) is to eliminate measurement error and transitory variations in earnings. Measurement error in h_i remains. The variation in experience due to costs of entry are accounted for, in part, by the inclusion of family non-labor income and total family labor income in equation (4) as explanatory variables. Presumably, people with high family income are better able to search. That the supply of labor function is not continuous is suggested in our data by the fact that, of those who work, very few work less than 15 hours a week.

It is useful at this point to summarize what has been derived so far. The individual labor supply schedule has been derived in the Appendix from the optimization of the household utility function. Subsequently all the discussion has been in terms of the individual and the household has been lost sight of to some extent. It should be noted that, in terms of the derivation, the main result of the household optimization is that family labor income as well as non-labor income are arguments in the supply function. Second, 'Z' contains family characteristics which have been achieved by earlier household decisions. These characteristics essentially include variables which affect the opportunity cost of the individual's time--such as number of children present, size of house, etc. The discussion so far has also been "system-free" or "culture-free" with the implicit argument that, at this level of generality, the specification of the labor supply function is equally valid for developing as well as developed countries. It is in the specification of the two vectors, Z on the labor supply side and X on the market demand side, that the differences between different situations can be brought in. Similarly, the discussion so far has not distinguished between the male labor

supply and the female labor supply function. Again, at this level of generality, it is argued that the framework is a unified one and that the differences between men and women would be in the specifications of Z and X, to the extent that different kinds of variables affect the opportunity cost of time and of market demand for men and women. Lastly, the optimization made has been a static one with no dynamic elements to capture life cycle effects.

Life Cycle Effects

In principle, a dynamic household utility function could be optimized to obtain a lifetime labor supply function, as has been done for women by Lehrer and Nerlove (1980). Here, as in most other studies, the life cycle effects are captured by dividing the sample into groups at different stages of the life cycle. Two key results from Lehrer and Nerlove are worth noting. First, a woman may supply labor to the market at a given time even if her shadow price of time is higher than the market wage at that time, if this results in an increase in her life time earnings which is more than compensating over her life cycle. Second, husband's (or other family) income has a bigger effect on the wife's labor supply after the arrival of children than before. The first result means that we should observe higher participation of women who expect higher incomes later, at all stages of their life cycle. Thus, women with higher education who expect an increasing age-earnings profile should have higher participation rates at early ages as well. This is clearly true in the sample. But this result also implies that a lower return to education should be observed for women. Although these results are not directly captured by the procedures used in this study, the results are quite consistent. However, the knowledge of these results helps

to interpret the coefficients estimated, and to delineate the variables that should be included in Z.

The different groups used in this study are:

<u>Group</u>	<u>Age group</u>	<u>Other comments</u>
I. Young men (YM)	15-24	
II. Prime age men (PM)	25-54	
III. Old men (OM)	55+	
IV. Young women (YF)	15-24	
V. Married women (MF)	All ages	With husband present
VI. Prime age unmarried women (UF)	25-54	All prime age other than MF
VII. Old women (OF)	55+	

While estimations have been made for all the categories for the sake of completeness, the group of greatest interest is that of married women, and then UF, YM and YF--since they are the main secondary worker group whose participation is seen to vary more as a result of different economic conditions. Prime age men are of less interest since almost all work. We do not have enough information on OM and OF to derive any results of interest. For the old people, it would be useful if there was better information on their social security provisions and on their other living arrangements in lieu of social security. In the case of old women, the working sample is often too small for good estimation. Hence, although estimations were made for these two groups, the results have not been reported here.

2.2 Final Empirical Specification and Variables Used

The estimation equations for each group have a common structure. The vectors Z_i and X_i in equations (4) and (2) can be divided into subvectors Z_{ji} and X_{ki} for convenience. Hence:

$$h_i = \frac{1}{\alpha_1} \{w_i^* - (\alpha_0 + \alpha_2 y_i + \alpha_3 A_i + \alpha_4 Z_{1i} + \alpha_5 Z_{2i} + \alpha_6 Z_{3i} + \alpha_7 Z_{4i} + u_i)\}$$

$$= \delta_0 + \delta_1^* w_i + \delta_2 y_i + \delta_3 A_i + \delta_4 Z_{1i} + \delta_5 Z_{2i} + \delta_6 Z_{3i} + \delta_7 Z_{4i} + u_i \quad (5)$$

and

$$w_i = \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 X_{1i} + \beta_4 X_{2i} + \beta_5 X_{3i} + e_i \quad (6)$$

where

- Z_{1i} = quality of leisure variables
- Z_{2i} = life cycle variables
- Z_{3i} = background variables
- Z_{4i} = home activity variables, and among the X_s 's,
- X_{1i} = region of origin
- X_{2i} = location of residence
- X_{3i} = characteristic of employment.

The earnings function--equation (6)--has been investigated in detail elsewhere (Mohan, 1981) and is therefore not discussed here. The only concern here is in the magnitude of selectivity bias and in the use of equation (6) in predicting \hat{w}_i for use in equation (5). Moreover, since x_{3i} , the characteristics of employment are available, by definition, for workers only, they are not used in these estimations.

A detailed description of the variables used follows:

- (i) y_i : Household labor income: This has been redefined to be "other family labor income" (OFLY). This has been done to purge it of w_i , the individual's own contribution to y_i .
OFLY: Total monthly labor income of all other household members (in '000 pesos). The coefficient of OFLY is expected to be negative, if leisure is taken as a normal goal.
- (ii) A_i : Household non-labor income: FNLy: Monthly non-labor income of the household. ('000 pesos). This variable includes

interest/dividend earnings, rental income, pensions, gifts and other transfers.

(iii) Z_{1i} Quality of Leisure Variables: Only one variable has been used here, YRSEDU: The number of years of education. It is expected that education pushes up the value of a person's time since he can use leisure time more productivity. Hence it should have a negative effect on labor supply (purged of its effect of increasing expected market wages).

(iv) Z_{2i} Life Cycle Variables:

AGE: years

AGESQ: (Age)², (years²)

MARRIED: = 1 if currently married
0 otherwise

WIDOW = 1 if widowed (and not remarried)
= 0 otherwise

HHHEAD = 1 if individual is identified as the head of
household
0 otherwise.

FREUNI = 1 if individual is living with a spouse but not
formally married.
0 otherwise

These variables are included to account for life cycle effects. The last four variables measure some sense of "need to work". It would be expected that being married or being household head would increase the responsibility of the individual, thus making it important that they work. Naturally, these variables are of more importance for young men and women. FREUNI may capture

the lack of security for women, if the lack of formal marriage implies lack of a permanent commitment. It may be expected to increase their labor supply. Being a widow, among currently unmarried women, may increase their compulsion to work.

(v) Z_{3i} Background variables:

MIG3 = 1 if the individual is a recent migrant and has been in Bogota for less than 3 years.
= 0 otherwise.

HUSBLU = 1 if the head of the individual's household is a blue collar worker.
0 otherwise.

It may be expected that recent migrants have a lower value placed on their leisure time and hence are more likely to participate and work more. The variable HUSBLU could capture some social background effects. If it is expected that blue collar workers are more socially conservative, they would have a negative effect on the labor supply of women.

(vi) Z_{4i} Home Activity Variables:

CH1L6 : The number of children in the household under 6
CH1L612 : The number of children in the household between 6 and 12 years in age.

MREL = 1 if there is a maid or adult relative in the household.
0 otherwise.

NROOMS : The number of rooms in the house.

Table 3: SPECIFICATION OF LABOR SUPPLY EQUATIONS

Variable	Young men	Prime age men	Young women	Married women	Prime age unmarried women
1. OFLY	x	x	x	x	x
2. FNLY	x	x	x	x	x
3. Z_{1i}					
YRSEDU	x	x	x	x	x
4. Z_{2i}					
AGE	x	x	x	x	x
AGESO	x	x	x	x	x
MARRIED	x		x		
FREUNI				x	
WIDOW					x
HHHEAD	x	x	x		x
5. Z_{3i}					
MIG3	x	x	x	x	x
HUSBLU				x	
6. Z_{4i}					
CHIL6			x	x	
CHIL612			x	x	
MREL			x	x	
NROOMS				x	

These variables are expected to capture the opportunity cost of womens' time in terms of the degree of home activity. The signs of their expected effects are the obvious ones. The data can only identify the presence of children in the household and their relationship to the household head. Hence the number of children are not necessarily those of the women in question. It has been assumed (a) that in almost all cases of married women (with husband present), they would be their children; and, (b) that for other women, the presence of young children in the household raise the demand for home-work for the women, even if they are not her own.

Table 3 gives the specification of equation (5) used in the different labor supply equations.

The variables used in equation (6) are:

(i) \underline{S}_i : YRSEDU

(ii) \underline{E}_i : Work experience

EXPER = Age - YRSEDU -6 (years)

EXPSQ = (EXPER)² (years)

The data do not give a direct measure of experience, except for a measure of the number of years spent by a worker in the same firm or in the same occupation. As demonstrated in Mohan (1981), the indirect measure performed better than these limited direct measures. This is therefore regarded as an accurate enough measure for men. It is clearly inadequate for married women who may have interrupted their careers. Experiments with constructing a better measure by using the number of children to impute number of years interrupted did not succeed either. Thus this inadequate measure has been used for women as well.

(iii) X_{1i} : Region of Origin

There are a set of dummy variables designed to account for the origin of the individual.

DCITY = 1 if migrant was born in the three next largest cities 1/
0 otherwise.

DBOG = 1 if the individual was born in Bogota or migrated before
the age of 10.
0 Otherwise.

DTOWN = 1 if migrant was born in towns over 100,000 people. 2/
= 0 otherwise.

DURB = 1 if migrant was born in other urban places.

The excluded category is migrants from rural areas.

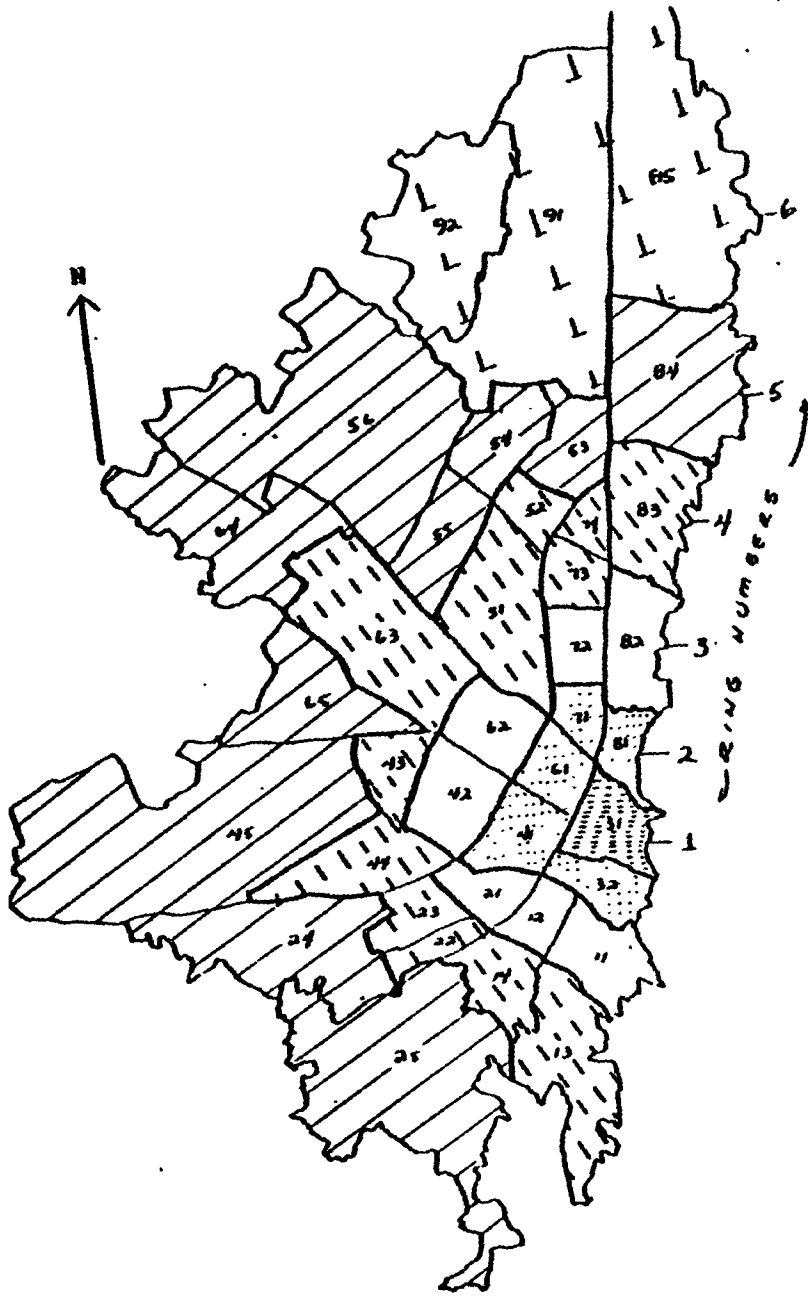
(This set of variables has been used in some estimations only but not reported here).

(iv) X_{2i} The Location of Residence

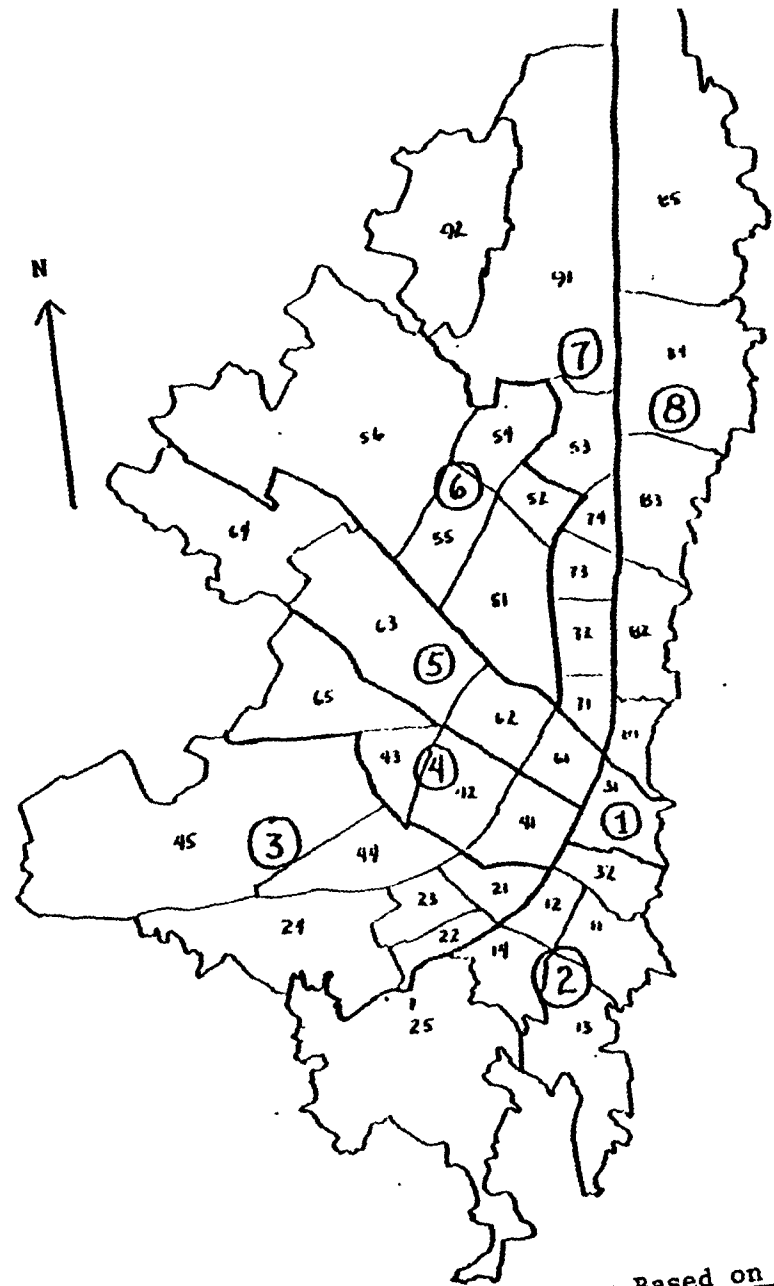
Mohan (1981) showed that the current location of worker's residence in the city was a good proxy for other background variables such as quality of schooling, ability, etc. Map 1 gives the division of Bogota into radial sectors and rings. The location of residence of each worker can be classified according to which sector he lives in. The residential sectors are controlled for by a set of seven dummy variables with sector 2 (the poorest sector located in the south of the city) acting as the reference sector. The seven

1/ Medellin, Cali, Barranquilla.

2/ Bucaramanga, Cartagena, Cucuta, Manizales, Pereira, Ibague, Armenia, Palmira, Pasto, Buenaventura, Neiva, Santa Marta.



Map 1 BOGOTA: Ring System Based on 1973 Comunas



Map 2 BOGOTA: Radial Sector System Based on 1973 Comunas

dummy variables are: RSECT1, RSECT3, RSECT4, RSECT5, RSECT6, RSECT7 and RSECT8. Each takes the value 1 if the worker lives in that sector, 0 otherwise.

The specification of equation (6) is same for all the groups so all the variables are used for estimating the earnings function for each.

Where reduced form estimation is done, all the variables specified are used as appropriate for each group.

2.3 Dependent Variables

There are three different dependent variables:

- (i) $P_i = 1$ if the person is in the labor force or not,
0 otherwise.

A person is in the labor force if he (she) is 15 years old or more, is defined to be working or unemployed during the week previous to the survey (live-in domestic servants have been excluded from the sample).

- (ii) h_i = the number of weekly working hours as reported by the workers.

- (iii) w_i = log of hourly wage.

Workers were asked the periodicity of their wage payments along with the unit wage. A second question was asked to elicit the same information: their total labor earnings in the previous month. The monthly earnings is the derived monthly earnings for employees who report the periodicity of wage payment and unit wage. For others, it is the monthly earnings reported for the previous month. The hourly wage variable is a constructed variable from the monthly earnings and hours of work information.

The Data

All the estimations are made using the 1978 City Study-DANE Household survey conducted in Bogota in December 1978. The survey sampled about 3,000 households in Bogota and the quality of the data is regarded as good, since it covered over 90 percent of labor income. Earnings questions were asked of each individual in the household alongwith other information on their work status and place of worker other details on the survey are available in Mohan (1981) and Mohan (1984). The main exclusions made for the purposes of this study are of all live-in domestic servants who are almost all female. The reason is that since they are listed with the households for whom they work there is no background information on their own families. A small number of other workers also had to be excluded because of no information on their hours of work.

III. ESTIMATES OF THE DETERMINANTS OF LABOR SUPPLY

3.1 Introduction

This section reports the empirical results obtained from the different methods outlined in the last section. The aim in this section is both to obtain robust parameter estimates for labor supply in Bogota and also to make judgements on the estimation strategy used. It is cumbersome to report the results of all the 4 models seriatem. Moreover, the methods overlap and the aim is partially to compare results. Hence, first all the results for the participation equation (3) are reported and subsequently all the results for the hours worked equation (4).

3.2 The Labor Force Participation Decision

3.21 Comparing OLS and Probit Estimates

There are essentially two participation equations: equation (3a) and (3b) (since equation (3c) and (3d) are identical to (3a)). Tables (4a) and (4b) report the parameter estimates along with the means of each variable used. The first two estimates reported are of the reduced form equation (OLS and Probit A), corresponding to Model Ia and Ib respectively and the third equation includes estimated own wage as determinant 1/ (Model II). As explained in the last section, the OLS estimates are biased because the dependent variable is censored, and is in fact a dichotomous variable. It is, however, useful to see the magnitude and direction of the bias.

Overall, it is observed that for each of the groups, the Probit coefficients are larger in absolute magnitude than the OLS coefficients in almost all cases. The effect is clearer when the coefficient is significant, and in each of these cases the t statistic is higher for the probit coefficient. This is as should be expected, but it is worth noting that the OLS coefficients are all of the right sign and of a similar order of magnitude. Chi-square statistics with the appropriate degrees of freedom are reported in the tables. The chi-square statistics exceeds the critical value of χ^2 0.995 for all the regressions. Thus the null hypothesis that all slope parameters are equal to zero is rejected.

1/ See Appendix I for estimation of the wage equation.

The probit coefficients reported are transformed since the probit model is:

$$P(I_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{I_i} e^{-t^2/2} dt \quad i = 1 \dots n \quad (\text{equation A.30})$$

(where $P(I_i)$ is the probability that a person participates and

$$I_i = \frac{X_i^* \beta - Z_i^* \alpha}{\sigma_3})$$

(see Appendix II for derivation).

Hence the probit coefficients β and α are not comparable to OLS coefficients and are difficult to interpret intuitively. However, our interest is in the marginal effect of each variable on participation, i.e. in $\frac{\partial E(P)}{\partial x_{ij}}$ which is analogous to OLS coefficients. It can be shown that

$$\frac{\partial E(P)}{\partial x_{ij}} = \phi(I_i) \cdot \beta_j \quad (5)$$

evaluated at (I_i) , where $\phi(I_i)$ is the standard normal distribution function. At the mean, $\Phi(I_i)$, the cumulative normal distribution, is merely the proportion of people participating, hence $\phi(I_i)$ can also be found at the mean. The coefficients reported are those given by (5) evaluated at the mean. The linear approximation suggested by Amemiya (1981) for the constant term is $\phi(I_i) \beta_1 + 0.5$ and this is reported in Tables 4a and 4b.

The approximate similarity of the OLS and probit coefficients is then only at the mean, where the OLS coefficients are downward biased in absolute terms. The slopes would be quite different the further away one is from the mean.

Table 4a: THE PARTICIPATION DECISION
(Dichotomous dependent variable)

Variable	Young Men				Young women			
	Mean	OLS	Probit A ²	Probit B ²	Mean	OLS	Probit A ²	Probit B ²
CONSTANT		-2.769 (3.29)			-1.839			
AGE	19.26	0.304 (3.42)	0.376 (4.25)	0.412 (4.67)	19.35	0.169 (2.03)	0.349 (5.02)	0.347 (5.02)
AGESQ	379.16	-0.006 (2.46)	-0.007 (2.94)	-0.007 (2.93)	382.86	-0.003 (1.20)	-0.007 (3.93)	-0.007 (3.92)
YRSEDU	8.24	-0.045 (7.69)	-0.064 (10.87)		8.11	-0.008 (1.39)	-0.008 (1.99)	
OFLY	11.95	-0.001 (0.81)	-0.002 (1.27)	-0.002 (1.48)	11.89	-0.001 (1.13)	-0.002 (1.93)	-0.002 (2.09)
FNLY	2.11	-0.012 (3.48)	-0.023 (5.29)	-0.024 (5.58)	1.78	-0.007 (1.95)	-0.009 (2.94)	-0.010 (3.19)
HHHEAD	0.116	0.129 (1.79)	0.472 (4.22)	0.499 (4.50)	0.023	0.156 (1.51)	0.128 (1.74)	0.137 (1.87)
MIG3	0.121	0.069 (1.40)	0.105 (2.20)	0.112 (2.40)	0.134	-0.033 (0.73)	-0.033 (0.96)	-0.031 (0.93)
SECT1	0.015	-0.054 (0.40)	-0.148 (1.12)		0.011	-0.126 (0.84)	-0.227 (1.47)	
SECT3	0.278	-0.055 (1.15)	-0.093 (1.96)		0.283	-0.014 (0.30)	-0.027 (0.79)	
SECT4	0.082	-0.119 (1.76)	-0.172 (2.60)		0.078	-0.060 (0.91)	-0.077 (1.50)	
SECT5	0.072	-0.066 (0.95)	-0.124 (1.79)		0.066	0.039 (0.55)	+0.042 (0.82)	
SECT6	0.194	-0.095 (1.80)	-0.134 (2.62)		0.211	-0.001 (0.02)	-0.010 (0.27)	
SECT7	0.119	-0.054 (0.89)	-0.081 (1.37)		0.111	-0.008 (0.13)	-0.017 (0.38)	
SECT8	0.058	-0.139 (1.70)	-0.237 (2.84)		0.068	-0.029 (0.38)	-0.035 (0.63)	
CHIL6					0.474	-0.069 (3.07)	-0.078 (4.49)	-0.076 (4.39)
CHIL612					0.515	-0.005 (0.25)	-0.006 (0.40)	-0.005 (0.35)
MREL					0.352	0.048 (1.43)	0.052 (2.12)	0.055 (2.24)
MARRIED	0.108	0.062 (0.85)	0.278 (2.70)	0.254 (2.48)	0.263	-0.188 (4.32)	-0.188 (5.94)	-0.185 (5.88)
OWNYHAT ¹	2.964			-0.663 (11.97)	3.050			-0.062 (1.79)
R ²		0.391	0.393	0.385		0.177	0.176	0.172
Log likelihood			-727.4	-738.9			-904.4	-909.1
χ ² statistic			820	797			355	345
No. of observations		1044	1641	1641		1830	1830	1830
Mean dependent variable								
φ(I ₁)	0.502				0.278			
φ(I)			0.3989	0.3989			0.3352	0.3352

t statistics in parentheses

Note: 1. OWNYHAT is estimated ln of expected own hourly wage. (See Table A.1)

2. The coefficients reported for the probit estimations are transformed coefficients to give the marginal effect of each variable on P i.e. $\frac{\partial P}{\partial x_{ij}} = \phi(I_i) \cdot \beta_j$ where $\phi(I_i)$ is the standard normal distribution evaluated at the mean of P, and β_j is the probit coefficient.

3. t statistics reported are of the probit coefficients themselves.

3.22 Young Men and Young Women

It is of interest to compare the results for young men and young women. The mean values of the independent variables for the two groups are quite similar. In particular, it is worth noting that both the groups have mean schooling of just over eight years, with the men having a marginally higher mean. The deepening of education in Colombia in recent years was mentioned earlier in the introduction. This indicates that this deepening has been of almost equal importance for men and women and that the women have now almost caught up.

Education: In these groups of young people (15-24), one would expect education to be a negative influence on participation since many people would still be in their schooling years: in fact those in the labor force are almost bound to be with less schooling and will comprise of the early entrants. This effect is quite pronounced for the men but only barely so for the women, despite the fact that about half of the men are participating while only about a quarter of the women are in the labor force. Clearly, the women are still largely secondary workers.

Family Income and Assets:

The coefficient of OFLY ^{1/} measures the cross substitution effect and that of FNLY ^{1/} the pure income effect. Both have coefficients in the predicted direction, i.e., negative, but have different magnitudes and significance between men and women. The cross substitution effect on women is stronger as might be expected, while the pure income effect is stronger on the

^{1/} OFLY - other family labor income.
FNLY - family nonlabor income.

men. Again, this points to the behavior of women as secondary workers. As may be expected, men from wealthier families are more apt to stay in school longer.

Life Cycle Effects

Life cycle effects are observable for both young men and women, but in different directions. In the case of men, as might be expected, the responsibilities of marriage along with duties as head of household have a strongly positive effect on the probability of participation. For women, the effect is opposite, marriage would seem to take them out of the labor force. In this age group, only about 11 percent of the men are married while about 26 percent of the women are married. The coefficients of age are quite similar and in the right direction (positive) for both the groups.

Home Activity: These variables are relevant for the women only and their coefficients are all in the expected direction. The presence of small children inhibits labor force participation while the presence of a maid or adult relative in the household is quite conducive to it.

Background: The location of residence has been used as a proxy for background. In previous work on the determinants of earnings (Mohan, 1981), these proxies were found to have quite significant effects on labor earnings. The normalising sector is sector 2, the poorest part of the city. For both men and women, all the remaining sectors have a negative sign, implying that the poor are more likely to leave school and participate early. Note, however, that none of the coefficients for women are significant. These results do not imply that the poor are disadvantaged in terms of participation. They reinforce the earlier result that people from wealthier families tend to stay in school longer and thus have a lower

probability of participation at a young age. The other background variable tested is for whether a person is a recent migrant. For men, the coefficient is significant and positive implying that, *ceteris paribus*, young migrant men are more likely to be in the labor force than natives in a city. This is again as might be expected since it may be presumed that recent young male migrants have come to the city in search of jobs. For women, however, the coefficient is not significant. It should be recalled that a large proportion of young women workers are live-in domestic servants many of whom are recent migrants (MOhan, 1980), but they have been excluded from this sample.

Own Wage: The second probit estimation (Probit B) includes an estimated value of expected hourly wage. 1/ The key determinants of wage are education and experience with location of residence used as background proxies. The intention in this estimation was partly to obtain a direct estimate of own wage elasticity of participation but also to distinguish education as a quality of leisure variable as distinct from its contribution to expected earnings. It was found, however, that education and estimated own wage were too collinear and so education was dropped from this equation. Standard theory predicts a positive association between LFP and expected wage: the higher the expected wage, the more likely a person is to participate in the labor force. In these samples of young men and women, the main alternative is to invest in education for higher future earnings: hence LFP is found to be negatively associated with higher expected earnings. The effect is much more pronounced for young men than for women.

1/ See Appendix I for the estimation.

The coefficients of the other variable which are common between Probit A and Probit B are very similar, the confidence in their magnitudes is therefore reinforced.

In summary, these estimates indicate that the participation of young women in the labor force is far more dictated by life cycle and home activity considerations than by labor market career aspirations despite a considerable deepening of the education system and almost equal investment in education by men and women. Many more women get married earlier than men and enter the child bearing stage and can therefore not enter the labor market. The presence of household help in the shape of a domestic servant or of a live-in adult relative is quite significant in assisting participation in the labor market.^{1/} Given these results, the indications are that women still enter the labor market mainly as secondary workers. For the young men, the estimations give largely expected results. Investment in education for later higher earnings takes precedence over current labor force participation. It is clear that family wealth assists in this process: the negative coefficients for the richer residence locations in the city support this conclusion. Life cycle considerations are also evident in that married young men and heads of household are more likely to participate--but there may be some self selection here.

^{1/} There is a simultaneity problem in the use of this variable. The presence of a domestic servant cannot really be regarded as exogenous. The decision to participate often involve the contingent hiring of domestic help. The causation then runs the opposite way.

3.23 Prime Age Unmarried Women and Married Women

Table 4b reports the results on LFP for prime age unmarried women (UF) and for married women (MF). These results are of great interest since they pertain to women over similar age groups 1/ with the main difference being their marital status. Unmarried women include widowed, divorced and separated women. Married women include only those with husband present.

The two groups are quite similar in characteristics except that the UF are somewhat better educated (average YRSEDU = 6.85) than the MF (average YRSEDU = 6.38). At the same time there is a paradoxical result that average expected earnings are lower for the UF. The UF also have higher family non-labor income (FNLY) but naturally lower other family labor income (OFLY). Presumably this is partially explained by the fact that about 44 percent of the UF are widows who may be expected to have higher shares of non-labor income from bequests, insurance and transfers. The participation rate of the UF (0.69) is more than twice that of the MF (0.28).

The striking result for the UF is that most of the coefficients are not significant with the exceptions of widowhood and household headship. Clearly, these women appear to have little choice in that they have to work as breadwinners of their families. Higher education and higher expected earnings do have a small but significant positive effect as might be expected.

Family Income and Assets

As might be expected, both other family labor and non-labor income reduce the probability of a married women working. The cross-substitution

1/ The married women include all married women of all ages while UF are in the 25-54 age group.

Table 4b: THE PARTICIPATION DECISION
(Dichotomous dependent variable)

Variable	Prime Single Women				Married Women			
	Mean	OLS	Probit A ²	Probit B ²	Mean	OLS	Probit A ²	Probit B ²
CONSTANT		0.412 (0.74)	0.475	0.345		-0.190 (1.22)	-0.377	-0.518
AGE	36.8	0.025 (0.82)	0.022 (0.96)	0.016 (0.71)	35.54	0.024 (3.15)	0.037 (5.61)	0.027 (4.07)
AGESQ	1436.9	-0.0005 (1.27)	-0.0004 (1.63)	-0.0004 (1.30)	1394.4	-0.0003 (3.53)	-0.0003 (5.92)	-0.0003 (4.57)
YRSEDU	6.85	0.013 (1.90)	0.014 (2.84)		6.38	0.028 (5.84)	0.031 (8.77)	
OPLY	8.17	-0.002 (0.90)	-0.002 (1.39)	-0.002 (1.23)	11.06	-0.004 (3.26)	-0.004 (4.13)	-0.004 (4.11)
FNLY	2.23	-0.003 (0.55)	-0.003 (0.95)	-0.002 (0.77)	1.43	-0.005 (1.66)	-0.007 (2.34)	-0.007 (2.53)
HHHEAD	0.51	0.191 (2.97)	0.221 (4.58)	0.223 (4.71)				
MIG3	0.07	-0.161 (1.57)	-0.171 (2.31)	-0.150 (2.05)	0.088	0.082 (1.60)	-0.092 (2.40)	-0.097 (2.57)
FREUNI					0.101	0.053 (1.07)	0.049 (1.41)	0.040 (1.19)
HUSELU					0.211	0.001 (0.03)	-0.004 (0.16)	-0.021 (0.83)
SECT1	0.010	0.046 (0.18)	0.151 (0.61)		0.012	0.050 (0.38)	0.039 (0.43)	
SECT3	0.275	-0.064 (0.85)	-0.066 (1.19)		0.295	-0.027 (0.64)	-0.027 (0.87)	
SECT4	0.066	-0.136 (1.18)	-0.159 (1.95)		0.074	0.003 (0.05)	0.014 (0.31)	
SECT5	0.067	-0.012 (0.11)	-0.008 (0.09)		0.061	-0.084 (1.25)	-0.103 (2.02)	
SECT6	0.195	-0.078 (0.94)	-0.085 (1.42)		0.195	0.005 (0.11)	0.013 (0.39)	
SECT7	0.121	0.043 (0.45)	0.060 (0.83)		0.108	0.023 (0.41)	0.022 (0.55)	
SECT8	0.070	0.038 (0.30)	+0.055 (0.59)		0.068	-0.029 (0.40)	-0.011 (0.21)	
CHIL6					0.781	-0.046 (2.56)	-0.053 (4.05)	-0.053 (4.09)
CHIL612					0.710	-0.013 (0.84)	-0.017 (1.47)	-0.020 (1.77)
MREL					0.293	0.112 (3.38)	0.126 (5.34)	0.125 (5.35)
NROOMS					3.394	-0.009 (1.54)	-0.024 (3.38)	-0.021 (2.97)
WIDOW	0.441	-0.079 (1.26)	-0.094 (2.00)	-0.096 (2.07)				
OWNYHAT ¹	2.748			+0.096 (3.03)	3.120			0.175 (7.73)
R ²		0.131	0.128	0.114		0.089	0.093	0.080
Log likelihood			-387.17	-392.93			-1180.5	-1195.9
χ ² statistic			96	85			213	182
No. of observations		701	701	701		2169	2169	2169
Mean of dependent variable								
φ(I ₁)	0.688				0.280			
φ(I)		0.3538	0.3538				0.3372	0.3372

t statistics in parentheses.

Notes: 1. OWNYHAT is estimated ln of expected own hourly wage. (See Table---).

- The coefficients reported for the probit estimations are transformed coefficients to give the marginal effect of each variable on p, i.e. $(\frac{\partial p}{\partial x_{1j}} = \phi(I_1) \cdot \beta_j)$ where $\phi(I_1)$ is the standard normal distribution evaluated at the mean of P, and β_j is the probit coefficient.
- t statistics reported are of the probit coefficients themselves.

effect of other family labor income, mainly husbands earnings, is quite significant in magnitude and more important than non-labor income. The negative pure income effect is quite small. Surprisingly, despite the higher mean value of FNLV for UF, it does not have a significant effect on their participation--reinforcing the conclusion that the majority of UF essentially have to work.

Life Cycle Effects

Life cycle effects are quite important for the UF in terms of household headship and widowhood as mentioned earlier. For married women, age is an important factor. Older married women are more likely to work, presumably after their child bearing period is over. The probability of their LFP increases up to age 61 according to these estimates. In the married women sample, about 10 percent are in "Free Union" 1/, i.e. not legally married but living together. The hypothesis was that these women would be more likely to participate if this status involves a greater state of uncertainty. This seems to be only partially confirmed: the coefficient is positive but not statistically significant. This result implies that for the majority of women in this category, the non-legality of their "marriage" is not important in terms of stability and they behave pretty much as if they were married.

Home Activity

These variables are relevant for the married women only. The presence of small children below the age of six inhibits their participation significantly, while the presence of older children is not important in the participation decision. The magnitude of the effect of young children on the

1/ Union Libre.

probability of LFP is of the same order as for young women. The presence of a domestic servant or adult relative (MREL) makes a highly significant effect on LFP making it more likely. Indeed, the magnitude of the effect just about neutralizes the negative effect of a young child. This positive effect of domestic help is much larger for this group than for young women. For young women, the young child will mostly be the first while this sample includes later born children. This result suggests that domestic help is more likely to be seen as a substitute for the mother's care after the first born. NROOMS is the number of rooms in the house being used as a proxy for the volume of housework seen as a competing activity for the married women. The coefficient has the expected negative sign but this may also be interpreted as a proxy for wealth.

Background

As for young women, the location of residence does not emerge as a significant proxy for background affecting the decision to participate in the labor force for both the UF and MF. Again, there is little evidence of spatial disadvantage in terms of labor force participation. Unlike the men, however, recent migrants are less likely to participate among both the groups. The implication is that there are few women migrants who come in search of jobs: most probably come as spouses and are less likely to work.

Own Wage:

Unlike the results for the young men and women, a higher expected wage does increase the probability of women working. The effect is more pronounced for married women than for the unmarried women. Clearly, married women have a greater choice of not working and this is reflected in the estimates made.

Again, as for young men and women, the estimates in Probit B are quite similar to the estimates in Probit A for both the UF and MF for the variables that are common between the two equations.

In summary, the estimates for prime age unmarried women indicate that they behave much more like primary workers, somewhat like prime age men, while the married women behave much more like secondary workers. Their propensity to participate is affected much more by greater schooling and expected earnings, while at the same time inhibited by the presence of small children and other home activities. These results indicate that a tightening in the labor market would indeed increase the participation of married women as has been observed in Colombia in the late seventies. Moreover, higher average levels of education among women will also lead to higher participation--or at least availability for participation. The availability of child care facilities undoubtedly facilitates participation but the results for young women indicate that this has its limitations. It is quite likely that women will still opt out of the labor force for the first child but the availability of child care could hasten their return to the labor force.

3.3 The Total Supply of Labor: Hours Worked in the Labor Market

3.31 Interpreting Tobit and Heckman Coefficients

This section gives estimates for the full labor supply function seen as a continuous function from zero hours worked to the maximum number of hours supplied. The Appendix gives the derivation of two different methods of estimating these functions. The first method is Heckman's procedure which utilizes information from the reduced form participation equation (Model I) to derive estimates of selectivity bias ($\hat{\lambda}_1$). These are then used (i) to make estimates of the wage function corrected for selectivity bias and (ii) the

hours supplied by workers, again corrected for selectivity bias. This is Model III. The second method is a direct Tobit estimation of the censored dependent variable of hours supplied in the market. This itself is done in two ways: first of the reduced form hours equation (Model IB) and second with estimated wage from Model III. This is Model IV. The two Tobit estimations correspond to Probit A and Probit B.

The last section in Appendix II explains the interpretations of different coefficients. For convenience all the Tobit coefficients reported here correspond to the marginal effect of each independent variable y_j on the expected value locus of hours supplied i.e., $\frac{\partial E(h_i)}{\partial y_j}$ evaluated at the mean. The Tobit coefficients are therefore "scaled down" by $\Phi(I_i)$ evaluated at the mean (which is merely the proportion of people working in the sample). The OLS coefficients from Heckman are reported directly.

3.32 The Tobit and Heckman Estimates

Tables 5(a,b,c,d) give the estimates for Model I, Model III and Model IV as explained above for young men, young women, prime age unmarried women and married women respectively. The tobit coefficients are as scaled above.

Overall, the results of the tobit estimates are similar in direction to the probit results and are therefore not discussed in detail. The tobit coefficient estimates (suitably transformed) are of a similar order of magnitude (evaluated at the mean) and in the same direction as the OLS coefficients. In general, the tobit coefficients give a higher slope than the OLS coefficients and have a higher level of significance. Further, the tobit coefficients from the reduced form equation (Model IB) are similar in magnitude to the structural equation with estimated wage as a determinant (Model IV).

In contrast to these generally satisfactory results, it is found that the coefficients in the Heckman procedure (Model III) are quite different from those obtained in the tobit analysis. As shown in the Appendix II, the Heckman coefficients should in principle be identical to the tobit coefficient, i.e. δ_j . In fact, the tables present estimates of $\phi(I_i) \delta_j$ for the tobit regressions while the Heckman coefficients given are δ_j . Almost all the Heckman coefficients are small in magnitude and not significantly different from zero statistically. The reason for this feature of the results is that in these samples, among the people who do work, there is relatively little variance in their weekly hours. The standard deviation in the number of hours worked by workers is in the region of .25 to .37 in all the samples. Moreover, for those who do work the mean is relatively high: between 44 and 47 hours in each group. This suggests that there are some costs of entry to the labor market. It would appear that if a person decides to work he is faced with a decision to work a substantial number of hours or not at all. In addition, for married women in particular, the decision to participate also often involves the simultaneous decision to use childcare services. Hence she participates only if the number of hours worked and the wage are high enough to offset these costs. This is merely another way of saying that her reservation wage is high. If these speculations are correct, the Heckman procedure is inappropriate for this problem without adequate corrections for costs of entry. ^{1/} The correction for sample selectivity is not "enough" to generate the "true" labor supply schedule. There is another problem at issue here. The dependent variable used in this study is weekly hours of work in a reference week as reported in the survey. There is considerable inconclusive

^{1/} See Cogan (1980).

Table 5a: THE SUPPLY OF LABOR SCHEDULE: Young Men

	Mean	Model I (Reduced form)		Model IV	Model III	
		OLS	Tobit 2,3	(w/estimated wage) Tobit 2,3	Heckman: worker only OLS	Mean
CONSTANT		-140.7 (5.23)	-194.1 (6.92)	-176.8 (6.33)	96.64 (2.44)	
AGE	19.26	15.95 (5.63)	19.17 (6.56)	20.64 (6.95)	-2.30 (0.59)	20.61
AGESQ	379.2	-0.308 (4.20)	-0.394 (5.30)	-0.397 (5.30)	0.06 (0.66)	431.4
YRSEDU	8.24	-2.72 (4.68)	-2.039 (11.06)			
OFLY	11.95	-0.057 (1.39)	-0.121 (2.63)	-0.129 (2.85)	-0.093 (1.67)	9.22
FNLY	2.11	-0.560 (5.24)	-0.983 (6.50)	-1.03 (7.01)	-0.285 (1.31)	1.02
HHHEAD	0.116	7.91 (3.44)	3.94 (1.55)	4.63 (1.87)	-0.177 (0.09)	0.227
MIG3	0.121	4.45 (2.84)	4.16 (2.86)	4.46 (3.17)	1.445 (1.04)	0.154
SECT1	0.015	-5.01 (1.17)	03.25 (0.92)			
SECT3	0.278	-3.05 (2.00)	-2.55 (1.74)			
SECT4	0.082	-5.83 (2.69)	-5.21 (2.47)			
SECT5	0.072	-3.95 (1.77)	-3.41 (1.52)			
SECT6	0.194	-4.93 (2.94)	-4.29 (2.66)			
SECT7	0.119	-3.50 (1.80)	-2.43 (1.33)			
SECT8	0.058	-6.86 (2.63)	-7.66 (2.75)			
MARRIED	0.108	4.31 (1.84)	2.54 (1.02)	1.88 (0.74)	0.849 (0.49)	0.210
OWNYHAT ¹				-21.70 (12.08)	-8.12 (3.10)	2.894
SIGMA			17.00 (28.31)	17.16 (28.69)		
LAMBDA					-4.33 (1.78)	0.724
R ²		0.402			0.113	
Log likelihood			-4548.2	-4558.9		
No. of Observations		1641	1641	1641	823	
Mean Dependent variable		23.97	23.97	23.97	47.74	
$\phi(I)$			0.504	0.504		
θ^4			0.37	0.37		

t statistics in parenthesis.

- Notes:
1. OWNYHAT is log of Estimated Expected Hourly Wage.
 2. The Tobit coefficients reported are transformed to make them comparable to OLS estimates. The coefficients reported are $\frac{\partial E(h)}{\partial x_i} = \phi(I_i)\beta_j$
 3. t statistics reported are of original Tobit coefficients.
 4. See text.

Table 5b: THE SUPPLY OF LABOR SCHEDULE: Young Women

	Mean	Model I (Reduced form)		Model IV	Model III	
		OLS	Tobit 2,3	(w/estimated wage) Tobit 2,3	Heckman: worker only	Mean
CONSTANT		97.35 (3.92)	-189.2 (6.88)	-183.2 (6.70)	140.9 (1.17)	
AGE	19.35	9.62 (3.71)	16.45 (5.92)	16.50 (5.92)	-4.52 (0.46)	20.91
AGESQ	382.9	-0.164 (2.47)	-0.336 (4.84)	-0.334 (4.82)	0.105 (0.51)	443.0
YRSEDU	8.11	-0.984 (5.47)	-0.537 (3.27)			
OFLY	11.89	-0.056 (1.44)	-0.072 (1.79)	-0.074 (1.86)	0.089 (1.16)	10.84
FNLY	1.78	0.362 (3.35)	-0.444 (3.38)	-0.470 (3.61)	-0.466 (1.46)	1.42
HHHEAD	0.02	8.27 (2.57)	3.93 (1.49)	4.24 (1.61)	0.081 (0.02)	0.049
MIG3	0.134	-0.060 (0.04)	-0.659 (0.49)	-0.554 (0.41)	4.92 (2.16)	0.118
SECT1	0.011	-5.89 (1.26)	-10.47 (1.69)			
SECT3	0.283	-0.88 (0.60)	-1.57 (1.13)			
SECT4	0.078	-2.30 (1.11)	-2.71 (1.34)			
SECT5	0.066	1.34 (0.61)	1.43 (0.71)			
SECT6	0.212	0.26 (0.17)	-0.61 (0.41)			
SECT7	0.112	-1.45 (0.77)	-1.30 (0.73)			
SECT8	0.068	-0.20 (0.08)	-0.97 (0.44)			
CHIL6	0.474	-3.70 (5.28)	-3.45 (4.88)	-3.36 (4.75)	-1.61 (0.80)	0.385
CHIL612	0.515	-0.25 (0.42)	-0.10 (0.18)	-0.091 (0.16)	0.44 (0.46)	0.403
MREL	0.352	2.16 (2.08)	2.09 (2.15)	2.19 (2.25)	-1.38 (0.73)	0.397
MARRIED	0.263	-9.84 (7.23)	-7.45 (5.90)	-7.37 (5.84)	0.141 (0.03)	0.263
OWNYHAT ¹	3.05			-4.23 (3.10)	-13.28 (5.12)	2.87
SIGMA			774.8 (14.63)	783.4 (14.61)		
LAMBDA					-6.68 (0.71)	1.36
R ²					0.193	
Log likelihood			-3307.4	-3313.1		
No. of Observations		1830	1830	1830	509	
Mean Dependent variable		12.78	12.78	12.78	45.83	
$\phi(I_1)$			0.281	0.281		
θ^4			0.26	0.26		

t statistics in parenthesis

Notes: 1. OWNYHAT is log of Estimated Expected Hourly Wage.

2. The Tobit coefficients reported are transformed to make them comparable to OLS

estimates. The coefficients reported are $\frac{\partial E(h_i)}{\partial x_j} = \phi(I_i)\beta_j$ (see text).

3. t statistics reported are of original Tobit coefficients.

Table 5c: THE SUPPLY OF LABOR SCHEDULE: Prime Single Women

	Mean	Model I (Reduced form)		Model IV	Model III	
		OLS	Tobit 2,3	(w/estimated wage) Tobit 2,3	Heckman: worker only OLS	Mean
CONSTANT		32.19 (1.57)	11.23 (0.55)	10.56 (0.51)	62.75 (2.79)	
AGE	36.77	0.776 (0.70)	1.11 (1.01)	1.03 (0.95)	0.192 (0.18)	35.32
AGESQ	1436.9	-0.020 (1.44)	-0.025 (1.80)	-0.023 (1.71)	-0.008 (0.52)	1321.4
YRSEDU	6.85	-0.217 (0.90)	0.028 (0.11)			
OFFLY	8.17	-0.108 (1.28)	-0.114 (1.39)	-0.107 (1.31)	-0.024 (0.27)	7.71
FNLY	2.23	-0.195 (1.13)	-0.163 (0.93)	-0.151 (0.90)	-0.148 (0.94)	2.12
HHHEAD	0.505	10.35 (4.43)	10.52 (4.60)	10.85 (4.79)	3.27 (0.88)	0.531
MIG3	0.066	-4.08 (1.09)	-6.27 (1.72)	-5.89 (1.64)	3.33 (0.76)	0.052
SECT1	0.010	11.50 (1.20)	8.47 (0.77)			
SECT3	0.275	-1.60 (0.58)	-2.29 (0.85)			
SECT4	0.066	-5.00 (1.19)	-5.54 (1.46)			
SECT5	0.067	2.49 (0.60)	1.78 (0.47)			
SECT6	0.195	-1.67 (0.56)	-2.54 (0.87)			
SECT7	0.121	2.39 (0.69)	2.39 (0.60)			
SECT8	0.070	-1.66 (0.37)	-0.56 (0.11)			
WIDOW	0.441	-2.39 (1.04)	-3.10 (1.39)	-3.50 (0.15)	0.514 (0.21)	0.405
OWNYHAT ¹	2.75			0.255 (1.59)	-6.91 (3.57)	3.01
SIGMA			22.69 (24.46)	22.80 (24.39)		
LAMBDA					8.47 (1.15)	0.717
R ²		0.108			0.126	
Log likelihood			-2576.7	-2580.0		
No. of Observations		701	701	701	482	
Mean Dependent variable		31.79	31.79	31.79	46.17	
$\phi(I_1)$			0.690	0.690		
$\phi^4 I_1$			0.48	0.48		

t statistics in parenthesis.

Notes: 1. OWNYHAT is log of Estimated Expected Hourly Wage.

2. The Tobit coefficients reported are transformed to make them comparable to OLS estimates. The coefficients reported are $\frac{\partial E(h_1)}{\partial x_j} = \phi(I_1)\beta_j$ (see text).

3. t statistics reported are of original Tobit coefficients.

4. See text.

Table 5d: THE SUPPLY OF LABOR SCHEDULE: Married Women

	Mean	Model I (Reduced form)		Model IV	Model III	
		OLS	Tobit 2,3	(w/estimated wage) Tobit 2,3	Heckman: worker only OLS	Mean
CONSTANT		-2.84 (0.56)	-36.43 (6.26)	-41.87 (6.44)	28.02 (0.90)	
AGE	35.54	1.01 (3.99)	1.68 (5.95)	1.30 (4.91)	0.888 (1.05)	34.08
AGESQ	1394.4	-0.014 (4.66)	-0.023 (6.54)	-0.019 (5.64)	-0.013 (1.16)	1252.5
YRSEDU	6.38	0.798 (5.14)	1.105 (5.58)			
OFLY	11.06	-0.187 (4.22)	-0.186 (4.11)	-0.179 (4.00)	-0.104 (0.85)	10.65
FNLY	1.43	-0.278 (2.62)	-0.342 (2.49)	-0.358 (2.64)	-0.458 (1.45)	1.11
MIG3	0.088	-2.58 (1.54)	-3.55 (2.09)	-3.82 (2.26)	2.82 (0.67)	0.066
FREUNI	0.101	1.38 (0.86)	1.53 (0.99)	1.30 (0.84)	-2.69 (0.83)	0.105
HUSBLU	0.211	-0.91 (0.76)	-0.668 (0.58)	-1.31 (1.15)	-3.93 (1.56)	0.189
SECT1	0.012	0.873 (0.20)	1.00 (0.26)			
SECT3	0.295	-0.486 (0.35)	-0.734 (0.54)			
SECT4	0.074	1.45 (0.71)	1.46 (0.76)			
SECT5	0.061	-3.88 (1.76)	-4.52 (1.96)			
SECT6	0.195	-0.84 (0.54)	0.204 (0.14)			
SECT7	0.108	0.770 (0.41)	0.947 (0.51)			
SECT8	0.068	-0.639 (0.27)	0.174 (0.08)			
CHIL6	0.781	-2.73 (4.58)	-2.68 (4.29)	-2.70 (4.32)	-3.64 (2.33)	0.714
CHIL612	0.710	-0.426 (0.82)	-0.69 (1.41)	-0.82 (1.66)	0.465 (0.42)	0.673
MREL	0.293	4.88 (4.47)	5.40 (4.59)	5.42 (4.60)	4.08 (1.31)	0.373
NROOMS	3.39	-0.448 (2.43)	-1.13 (3.36)	-0.976 (2.99)	-1.05 (1.33)	3.36
OWNYHAT ¹	3.12			6.34 (5.08)	-2.45 (0.62)	2.88
SIGMA			16.36 (16.86)	16.47 (16.71)		
LAMBDA					11.56 (1.33)	1.47
R ²		0.057			0.115	
Log likelihood			-4082.7	-4094.6		
No. of Observations		2169	2169	2169	608	
Mean Dependent variable		12.64	12.64	12.64	44.91	
$\phi(I_1)$			0.285	0.285		
θ^4			0.26	0.26		

t statistics in parenthesis.

Notes: 1. OWNYHAT is log of Estimated Expected hourly wage.

2. The Tobit coefficients reported are transformed to make them comparable to OLS estimates. The coefficients reported are $\frac{\partial E(h_j)}{\partial x_j} = \phi(I_1)\beta_j$ (see text).

3. t statistics reported are of original Tobit coefficients.

4. See text.

debate in the literature on which is the correct dependent variable to use in a labor supply study. Annual hours accounting for vacation time and also other weeks not worked are often suggested as a better measure to use. It is probably the case that the use of this measure would at least inject greater variance in the hours variable. In view of all these problems, the specification of the model for using the Heckman procedure is simply inadequate here.

As is shown in Appendix II, the tobit coefficients can be used to obtain three types of information:

- (i) The marginal effect of each explanatory variable on the latent tobit index. This is the estimated coefficient δ .
- (ii) The marginal effect on the observed hours supplied. This is $\phi(I_i)\delta$, evaluated at I_i . In a study of hours supplied this is the marginal effect of interest, i.e., the effect of an explanatory variable on actual hours supplied.
- (iii) The proportion of the effect that is due to variation in the hours supplied given that a person is participating. This is given by:
$$\theta = \left(1 - I_i \frac{\phi(I_i)}{\phi(I_i)} - \frac{\phi(I_i)^2}{\phi(I_i)^2} \right)$$
and $(1 - \theta)$ would be the effect on the probability of the person participating. The value of θ is noted in the tables in each case. In principle, the probit coefficients should be equivalent to $(1 - \theta)$ of the tobit coefficients.

3.4 Comparison of Estimates Across Models

Table 6 gives the elasticities of participation and labor supply for each of the models estimated. The elasticities given are for only a few key variables: OWNYHAT (expected own wage), OFLY (other family labor income), FNLY

(family non-labor income) YRSEDU (years of schooling) and CHIL6 (number of children less than 6, for women). These are discussed in turn for each group. The elasticity for OWNYHAT measures the gross uncompensated income elasticity; that for OFLY measures the cross substitution effect of (mainly) spouse's income and that for FNLV measures the pure income effect. The elasticity with respect to education is important in a situation where there is continuing educational deepening as is occurring in Colombia. Finally, the elasticity with respect to the presence of young children gives an estimate of the importance of childcare facilities in assisting married women to work.

3.41 Young Men and Young Women

The own wage elasticity of participation as well as labor supply is highly negative for young men and women. The negative effect is much greater for young men. It seems that in both cases, for those who do work, it is the poorer who tend to work longer hours since the Heckman elasticities are significant and negative in both cases. The probit and tobit characteristics are roughly comparable for men. For women, the participation elasticity is not statistically significant. These results, though plausible in that young men and women expecting higher income are likely to delay participation, are at odds with most estimates in the U.S. where own wage elasticity is invariably positive. Results are, however, always difficult to compare across studies because of different model formulations and variable definitions. In Jen's (1983) study of urban female labor force participation in Brazil she found the elasticity for young women (daughters) to be about .2. Further disaggregated into age groups of 15-19 and 20-24 the elasticities were about -1.0 and 0.1 respectively--which are consistent with our results. Moreover, her income variable was a monthly income measure which tends to inflate the

wage elasticities if there is a positive association between hours worked and wage.

The estimates of cross substitution elasticity with respect to other family income are generally not significant for these groups. This is somewhat surprising since the family nonlabor income elasticities are significantly negative and are between -0.05 and -0.1 for both the groups. These are quite consistent with most estimates in other studies.

As might be expected from the OWNYHAT elasticity estimates, the education elasticities are significantly negative and much more so for the men for all the same reasons.

For young women, the presence of young children is a major inhibitor of labor force participation. The magnitudes of the tobit and probit elasticities are very similar. It would seem that the presence of the child is important in the decision to participate but once the decision is made it has little effect on hours supplied.

3.42 Prime Age Unmarried Women (UF) and Married Women (MF)

For both these groups, the participation elasticities with respect to own expected wage and to education are positive. For UF the estimate is about 0.14-0.15 while for MF the estimate is about 0.6-0.7. These are quite consistent with other studies although, as documented by Killingsworth (1983), there is still no general agreement on their magnitude. Elasticities as high as 4 to 5 have been calculated by Heckman (1980), but most estimates are in the range of 0.5 to 2.0 (e.g. Layard, Barton and Zabalza (1980) for the U.K., Schultz (1980) for the U.S., Jen (1983) for Brazil). ^{1/} In both cases, the Heckman elasticities are negative and the tobit elasticities are lower than

^{1/} See Killingsworth (1983) for a full survey.

Table 6: ELASTICITIES OF PARTICIPATION AND OF SUPPLY OF LABOR

(All elasticities calculated at the mean)

Variable	Work hours						
	Participation			Workers Only			
	OLS	Probit A	Probit B	Model I OLS	Model I Tobit	Model IV Tobit	Model III OLS
<u>Young Men</u>							
OWNYHAT 1		-0.828 ⁴	-1.321		-0.552 ⁴	-0.905	-0.170
OFLY	-0.024*	-0.048*	-0.048*	-0.028*	-0.060	-0.064	-0.018*
FNLY	-0.050	-0.097	-0.101	-0.049	-0.087	-0.091	-0.006*
YRSEDU	-0.739	-1.051		-0.936	-0.701		
<u>Young Women</u>							
OWNYHAT 1		-0.208 ⁴	-0.223*		-0.304 ⁴	-0.331	-0.290
OFLY	-0.043*	-0.086	-0.086	-0.052*	-0.067*	-0.069*	0.021*
FNLY	-0.045	-0.058	-0.064	-0.050	-0.062	-0.065	-0.015*
YRSEDU	-0.233*	-0.233		-0.625	-0.341		
CHIL6	-0.118	-0.133	-0.129	-0.137	-0.128	-0.125	-0.014*
<u>Prime Age Unmarried Women</u>							
OWNYHAT 1		0.155 ⁴	0.140		-0.007 ⁴	0.008*	-0.150
OFLY	-0.024*	-0.024*	-0.024*	-0.028*	-0.029*	-0.028*	-0.004*
FNLY	-0.010*	-0.010*	-0.007*	-0.014*	-0.011*	-0.011*	-0.007*
YRSEDU	0.129	0.139		-0.047*	-0.006*		
<u>Married Women</u>							
OWNYHAT 1		0.772 ⁴	0.624		0.610 ⁴	0.501	-0.055*
OFLY	-0.158	-0.158	-0.158	-0.164	-0.163	-0.157	-0.025*
FNLY	-0.025	-0.036	-0.036	-0.031	-0.039	-0.040	-0.011*
YRSEDU	0.637	0.705		0.402	0.557		
CHIL6	-0.128	-0.148	-0.148	-0.168	-0.165	-0.167	-0.058

- Notes: 1. All elasticities for OWNYHAT are with respect to Estimated Expected Hourly Wage.
 2. All Tobit elasticities are for the Expected Value Locus (not for the Tobit Index).
 3. * The elasticities marked with an asterisk are derived from coefficients not significant at the 5% level.
 4. Calculated through the coefficient on education in the participation or hours equation and that in the wage equation.

the probit ones. The implication is that people earning lower wages are apt to work longer hours. This has been documented for Bogota workers in an earlier paper (Mohan and Hartline, 1984). This effect is much stronger for the UF as might be expected. Many of them have to work out of necessity (about 40 percent are widows) and could be working long hours at low wages because of earlier low educational investments. Jen (1983) reports similar participation elasticities for wives (0.9) and female household heads (0.2) in urban Brazil. The positive participation elasticities are consistent with, indeed explain, the increased participation of women in the late seventies in Bogota documented in section I. The rise in average real wages was also documented.

The elasticities for both OFLY and FPLY are not significant for UF, as might be expected. For MF, however, both are significantly negative but unlike the young men and women, OFLY (mainly spouse's income) is much more important than FPLY. The magnitude of the elasticity with respect to OFLY for MF is about -0.15 to -0.16, while that for FPLY is about -0.03 to -0.04. The latter are quite consistent with Schultz's estimates for the U.S. but he finds a much higher elasticity for spouse's income (about -1.0) than found here.

The participation elasticity with respect to CHIL6 for MF is quite comparable (about -0.15) to that for YF. In addition, in this case, the tobit elasticities are greater in magnitude: married women with small children who do work tend to work fewer hours.

Once again, the Heckman elasticities are generally not statistically significant.

IV. LABOR SUPPLY IN A DEVELOPING METROPOLIS: WHAT HAVE WE LEARNED?

4.1 Supply of Labor in Bogota

The tightening of the labor market in the late seventies in Colombia has provided an interesting data set for investigating the determinants of changes in urban labor supply in a situation of relatively rapid economic growth. Although changes in the overall labor supply in urban Colombia are not readily discernible because of compensating changes in different components of the labor force the changes that have been occurring have provided important pointers for the future. The estimations made in this paper provide useful guides to understanding the forces underlying the observed changes.

The estimates show that the main component of the labor force that can be expected to expand rapidly with rising real wages is that of married women. Until the expansion of education is complete there will be a continuing diminution in the number of young people--both men and women--who will enter the labor force at young ages. The same forces that induce greater participation of married women slow down the entry of young women into the labor force (and vice versa). Rising real wages are associated with increases in marginal returns to human capital which, in turn, is related to overall increases in productivity. The increase in marginal returns to human capital that is observed is really an increase in the average endowment in human capital. In fact, I have shown elsewhere (Mohan 1981), that increases in the stock of human capital in Colombia have tended to decrease the returns to education over time. This is consistent with increasing average real wages if the average stock of human capital is increasing. This seems to have been the case in Colombia in the seventies and was reflected in increases in the

participation of prime age women. At the same time, women have been catching up with the men rapidly in terms of average educational attainment: the estimates show marked negative association of the probability of participation with expected wage for both young men and women. Clearly, the achievement of high education levels has become important for women.

The elasticity estimates found for labor force participation were found to be quite robust across different estimation methods and therefore can be relied on. It would seem that married women are the most wage responsive group, followed by prime age unmarried women. There is clearly an element of necessity in the participation of unmarried women--specially those who are household heads. They are therefore less responsive to wage increases. While estimates for prime age men have not been reported here, it was found that, since almost all are in the labor force anyway, their participation is not wage responsive. One consequence of the results for young men and women is that as these cohorts move up in age we can expect much higher levels of desired labor force participation in the future. Once these results are coupled with the association of LFP with fertility, the future expansion of women in the labor force can be appreciated further. The presence of young children was found to be a key determinant of the participation of married women. As fertility declines, as it has in Colombia, there will be fewer married women of prime age with young children. We can therefore expect the combined effect of higher educational attainment with lower fertility to work itself out over the rest of the decade leading to marked increases in the desire of women to join the labor force. Coupled with this we can also expect a higher demand for childcare services. Both of these issues are important for policy in the coming decades.

The results on the hours of work decision are less robust than those on the participation decision. The fact that the poor work longer hours in Bogota leads to evidence of little or no elasticity of labor supply with respect to wage. Indeed, the labor supply curve seems to be backward bending, once the decision to participate has been made. This indicates that there is a limitation in choices available to poor women: they need income for survival and are willing to work long hours if a job is at all available. This is quite consistent with the observation that there was a major increase in the participation of poor women in the tightened labor market in urban Colombia in the late seventies. It is possible, however, that somewhat different results might have been obtained had the measure of labor supply been something different from weekly work hours.

Migrants do not appear to have any disadvantage in terms of LFP as is often supposed in the literature. Earlier papers have shown (Mohan (1981), Mohan and Hartline (1984)) that migrants are not any worse paid than non-migrants, if anything they are marginally better off. The results for young men show that migrants have, ceteris paribus, higher LFP than others. It must therefore be concluded that migrants are neither disadvantaged in terms of getting a job nor do they earn less than others once they do have a job.

Earlier work has found the location of residence of workers to be a good proxy for ability and background in that equivalent people from richer neighborhoods are found to earn significantly more than those from poorer neighborhoods. No such differences are found to suggest any degree of locational disadvantage in labor force participation. In fact, the probability of LFP of equivalent people from poor neighborhoods is found to be marginally higher than those from better off neighborhoods. The poor simply have to work.

4.2 Econometric Considerations

Considerable attention has been given to econometric considerations in the estimation of both participation and hours worked in this study. I am not aware of other similar work on developing countries, except for Jen (1983) and this did not extent to estimation of hours worked. It is therefore difficult to compare results. Jen's results for urban Brazil are quite similar, however. As household level data sets get more easily available in developing countries we can expect an outpouring of this of work in the future. It is therefore important to give attention to estimation issues so that biased estimates do not lead to wrong understanding.

There have been a number of studies using OLS for participation. My results suggest that OLS is a good first approximation and is therefore better than no estimation. Since the direction of bias is known, viz. OLS tends to understate the effect of different variables on LFP, a reasonable understanding of the participation decision can be achieved by merely doing OLS estimates. However, there is no question that the estimates are seriously biased. The probit estimates were found to be quite robust and are therefore recommended as the best estimates. The hours of work estimates from the tobit analysis suffered from relatively little variance in the hours of work of those who do work so little additional information was gained in addition to the probit estimates. Given the significant additional costs and difficulties of tobit estimation the additional information gained from these estimations was probably not worth the time devoted to them. It would be more useful to use tobit analysis if the data do contain somewhat more variance in the hours of work.

The Heckman method was found to be not too useful in this study although the wage estimates corrected for selectivity bias were mildly different from the uncorrected ones. The hours worked estimation suffered from the same problem mentioned above and hence the Heckman procedure was inappropriate. It is therefore important to specify the model more carefully and to tailor the estimation accordingly. In any case, the utility of the Heckman procedure is limited if a tobit algorithm is easily available.

The choice of variables was found to be important. Much early estimation was done using monthly earnings rather than hourly wages. The reason was that this was the primary data available in the survey and with which much earlier earnings function work was conducted. Since monthly income is a product of monthly hours and hourly wages, the results obtained can be quite misleading. If, for example, LFP is positively associated with expected wage, then the own earnings participation elasticity is highly overstated. This was found to be the case and therefore corrected. Results obtained from a typical census when only monthly earnings are available should therefore be treated with caution. The problem with the choice of labor supply variable has been mentioned earlier: it is probably the case that a measure of annual supply is better than weekly hours and more likely to have greater variance.

APPENDIX I

WAGE FUNCTION ESTIMATES

Table A.1 gives the estimated wage functions for each of the four groups under consideration. These estimates are corrected for sample selection bias as set up in Model III (see Section II).

There is only mild evidence of sample selection bias in these samples since the coefficients of LAMBDA are not statistically significant. The last row in the table gives the schooling (YRSEDU) coefficient if the regressions are run without LAMBDA. These are higher than the corrected regression in all cases: suggesting that women with higher education who do work are those with a higher propensity to work and therefore the returns to schooling are exaggerated. The difference is least among the prime age unmarried women-- those with the least choice in their decision to work or not to work as shown in the main part of this paper.

The experience variable in the equations is not very appropriate. There was no direct information in the sample on the number of years spent working by women. Hence, the usual (Age-Schooling-6) approximation was made. This naturally takes no account of the time taken out by women for childbearing, etc. The low experience coefficients provide evidence of this problem. As shown by Heckman (1980) it is women's experience which is much more susceptible to sample selectivity bias, but this cannot be shown in this estimation.

Table A.1: WAGE FUNCTIONS
(Corrected for Selectivity Bias)

(Dependent variable Ln (hourly wage) from Model III)

Variable	Young men	Young women	Prime single women	Married women
CONSTANT	1.29 (4.03)	1.70 (3.96)	1.56 (5.40)	1.64 (3.69)
YRSEDU	0.154 (10.63)	0.138 (6.65)	0.131 (9.89)	0.143 (8.46)
EXPER	0.057 (1.51)	0.046 (1.20)	0.026 (1.41)	0.033 (2.24)
EXPSQ	-0.0004 (0.22)	-0.001 (0.57)	-0.0006 (1.72)	-0.0005 (1.82)
SECT1	0.560 (2.94)	-0.068 (0.13)	-0.681 (1.73)	-0.031 (0.09)
SECT3	0.168 (2.49)	0.070 (0.71)	0.015 (0.12)	0.196 (1.44)
SECT4	-0.044 (0.39)	-0.070 (0.46)	0.054 (0.28)	-0.249 (1.34)
SECT5	0.014 (0.14)	0.128 (0.94)	0.285 (1.55)	0.222 (0.95)
SECT6	0.100 (1.25)	-0.065 (0.63)	0.276 (2.01)	0.290 (2.02)
SECT7	0.164 (1.84)	0.179 (1.45)	0.101 (0.66)	0.167 (0.99)
SECT8	0.320 (1.85)	0.260 (1.68)	0.592 (3.13)	0.548 (2.57)
LAMBDA	-0.105 (1.15)	-0.191 (1.73)	0.273 (1.29)	-0.272 (1.43)
R2	0.260	0.311	0.385	0.330
No. of observations	823	509	482	608
Mean of dependent variable	2.89	2.87	3.01	2.88
YRSEDU (not corrected for sample selectivity bias)	0.164	0.162	0.133	0.158

APPENDIX II

DERIVATION OF THE LABOR SUPPLY FUNCTION AND ESTIMATION STRATEGY

Assume that each individual decides on his work-leisure choice such that the utility of the whole household is optimized.^{1/}

If there are n individuals in the household the utility function U may be written as

$$U (l_1, l_2, \dots, l_n; x, Z) \quad (A1)$$

where l_1, l_2, \dots, l_n is the time devoted to leisure by each family member i, x is the Hicksian composite good consumed by the household.^{2/} and Z is a vector of other characteristics of the household arrived at through earlier decisions.

The household maximizes U subject to the budget constraint:

$$px = \sum_{i=1}^n h_i w_i + A \quad (A2)$$

and

$$0 \leq l_i \leq T \quad i = 1, \dots, n \quad (A3)$$

where

h_i is hours worked in the market by individual i, for hourly market wage w_i

p is the price level.

A is the non-labor income of the household.

(A3) states that leisure time is non-negative and is, moreover, bounded by the total time available T.

^{1/} This is not universally accepted. For example, Nwaganga Shields (1980) suggested that in many African countries, both husband and wife provide independently for their material needs and therefore optimize individual utility functions.

^{2/} This assumes that relative prices between goods do not change over the optimization procedure.

(A3) can be rewritten as:

$$l_i + h_i = T \quad i = 1, \dots, n \quad (A4)$$

where h_i can be interpreted as a slack variable in a programming context and $h_i \geq 0$.

Thus the household maximizes U subject to (A2), (A3) and (A4).

Assuming the usual conditions on U , that is, U is a twice differentiable quasiconcave function, and has positive first partial derivatives for all its arguments, the Lagrangian may be written as

$$L = U(l_1, l_2, \dots, l_n; x; Z) + \lambda \left\{ \sum_{i=1}^n h_i w_i + A - px \right\} + \sum_{i=1}^n \gamma_i (T - l_i - h_i) \quad (A5)$$

Now, for simplicity, assume that individual 1 is optimizing l_1 given all other l_j , $j = 2, \dots, n$. We can then interpret $l_2 \dots l_n$ to be included in Z , i.e. decisions taken prior to the problem of individual i .

Now, the Kuhn Tucker conditions are:

$$\frac{\partial L}{\partial X} = U_x - \lambda p = 0 \quad (A6)$$

$$\frac{\partial L}{\partial l_1} = U_{l_1} - \gamma_1 \leq 0 \quad (A7)$$

$$l_1 \frac{\partial L}{\partial l_1} = l_1 (U_{l_1} - \gamma_1) = 0 \quad (A8)$$

$$(l_1 \geq 0) \quad (A9)$$

$$\frac{\partial L}{\partial \lambda} = 0 \quad (A2) \quad \frac{\partial L}{\partial \gamma_1} = 0 \quad (A4)$$

$$\frac{\partial L}{\partial h_1} = -\gamma_1 + \lambda w_1 \leq 0 \quad (A10)$$

$$h_1 \frac{\partial L}{\partial h_1} = (-\gamma_1 + \lambda w_1)h_1 = 0 \quad (A11)$$

$$(h_1 \geq 0)$$

We have five unknowns $(\lambda, \gamma_1, h_1, l_1, x)$ and five equations and given the conditions on U , the system of equations can be solved for these unknowns in terms of p, w_1, A and Z . Our objective is to derive the labor supply function.

From (A6):

$$\lambda = \frac{U_x}{p}$$

and when $l_1 > 0$, from (A7) and (A8)

$$\frac{\partial L}{\partial l_1} = U_{l_1} - \gamma_1 = 0$$

or $\gamma_1 = U_{l_1}$ i.e. the marginal utility from leisure.

when $h_1 > 0$, from (A10) and (A11)

$$\gamma_1 = \lambda w_1$$

$$\text{or } U_{l_1} = \lambda w_1$$

$$\text{or } U_{l_1} = \frac{U_x}{p} \cdot w_1$$

$$\text{i.e. } w_1 = \frac{U_{l_1}}{(U_x/p)} = \frac{MU_{l_1}}{MU_x} \quad \text{when } h_1 > 0 \quad (A12)$$

(A12) shows that when $h_1 > 0$, i.e. when a person works, the market wage is equal to the marginal rate of substitution between leisure and other goods, in other words, the shadow price of the individual's time.

However, if $h_1 = 0$, from (A10) and (A11)

$$\gamma_1 - \lambda w_1 > 0$$

$$\frac{U_{\ell_1}}{U_x/p} - w_1 > 0$$

We can write the first term as w_1^* , the shadow price of the individual's time, then

$$w_1^* - w_1 > 0 \quad \text{if } h = 0 \quad (\text{A13})$$

$$\text{where } w_1^* = \frac{U_{\ell_1}}{(U_x/p)} \quad (\text{A14})$$

Equations (A12), (A13) and (A14) determine the labor supply schedule and, incidentally also suggest the estimation procedure.

(A14) holds for both $h = 0$ and $h > 0$ and can be written as

$$\begin{aligned} w_1^* &= f(\ell_1, x; Z; p) \\ &= f(h_1, \sum w_i h_i + A; p; Z) \end{aligned} \quad (\text{A15})$$

This is the result of the household's optimization process. If f exists and is continuous, the labor supply function for h_1 also exists in terms of w_1^* and the other variables.

The demand side function for the market wage rate w_1 is well known and is generally expressed in terms of Education (S), Experience (E) and other background variables (X).

$$\text{i.e. } w_1 = g(S, E; X) \quad (\text{A16})$$

but w_1 is only observed if $h > 0$.

The problem now is to estimate these functions econometrically.

Estimation Strategy

For estimation purposes, (A15) and (A16) can be re-written as linear functions along with a stochastic disturbance term. For convenience, the individual identifier (within the household) subscripts are now omitted for h and w .

Hence,

$$w_i^* = \alpha_0 + \alpha_1 h_i + \alpha_2 y_i + \alpha_3 A_i + \alpha_4 Z_i + u_i \quad (A17)$$

$$w_i = \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 X_i + e_i \quad (A18)$$

$$\text{where } E(u_i) = 0, \quad E(u_i^2) = \sigma_1^2, \quad E(u_i u_j) = 0 \\ i \neq j$$

$$E(e_i) = 0, \quad E(e_i^2) = \sigma_2^2, \quad E(e_i e_j) = 0 \\ i \neq j$$

Assume that e_i, u_i are jointly normally distributed, and may be correlated i.e. $E(u_i e_i) = \rho \sigma_1 \sigma_2$

where ρ is the correlation coefficient between e_i and u_i .

For convenience, rewrite (A17) as

$$w_i^* = \alpha_1 h_i + Z_i^* \alpha + u_i \quad (A20)$$

and (A18) as

$$w_i = X_i^* \beta + e_i \quad (A21)$$

Now, the problem in the estimation of (A20) and (A21) is that

- (i) w_i^* is unobservable.

(ii) h_i and w_i are observed only when $h_i > 0$.

In a population sample, we have 2 groups of people: those who are currently in the labor force and for whom h_i and w_i are observed; and others who are not, and for whom h_i and w_i are not observed. However, X_i^* and Z_i^* are available for all.

From conditions (A12) and (A13), $h_i = 0$ if

$$w_i^* - w_i > 0$$

i.e. $\Pr(h_i = 0) = \Pr\{(w_i^* - w_i)_{h_i=0} > 0\}$. whose complement is

$$\Pr(h_i > 0) = \Pr\{(w_i - w_i^*)_{h_i=0} > 0\} .$$

At $h_i = 0$,

$$w_i^* = Z_i^* \alpha + u_i$$

and hence,

$$\begin{aligned} \Pr(h_i > 0) &= \Pr[\{(X_i^* \beta - Z_i^* \alpha) - (u_i - e_i)\} > 0] \\ &= \Pr\{(X_i^* \beta - Z_i^* \alpha) > (u_i - e_i)\} \end{aligned} \tag{A22}$$

For $h_i > 0$, market wage w_i is observed,

from (A21)

$$\begin{aligned} E(w_i | h_i > 0) &= X_i^* \beta + E(e_i | h_i > 0) \\ &= X_i^* \beta + E\{e_i | (X_i^* \beta - Z_i^* \alpha) > (u_i - e_i)\} \end{aligned} \tag{A23}$$

Hence e_i is truncated and the conditional expectation of $e_i \neq 0$.

Similarly, from (A20), for $h_i > 0$, $w_i^* = w_i$ and hence,

$$h_i = \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha + e_i - u_i)$$

and

$$\begin{aligned} E(h_i | h_i > 0) &= \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha) + \frac{1}{\alpha_1} E\{(e_i - u_i) | h_i > 0\} \\ &= \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha) + \frac{1}{\alpha_1} E\{(e_i - u_i) | (X_i^* \beta - Z_i^* \alpha) > (u_i - e_i)\} \\ &= \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha) + \frac{1}{\alpha_1} E\{(e_i - u_i) | (e_i - u_i) > (X_i^* \beta - Z_i^* \alpha)\} \end{aligned} \quad (A24)$$

Again it is clear that the conditional expectation of the disturbance term is not zero.

However, both (A23) and (A24) can be estimated if estimators for $E(e_i | \cdot)$ and $E(e_i - u_i | \cdot)$ can be utilized as R.H.S. variables.

Now, u_i is $\sim N(0, \sigma_1^2)$

and e_i is $\sim N(0, \sigma_2^2)$.

Hence $e_i - u_i$ is $\sim N(0, \sigma_1^2 + \sigma_2^2 - 2 \sigma_1 \sigma_2)$

$\sim N(0, \sigma_3^2)$

Then, using the standard result for a truncated normal distribution 1/

$$E\{(e_i - u_i) | h_i > 0\} = \frac{\sigma_3^2}{\sigma_3} \frac{\phi(I_i)}{1 - \Phi(I_i)} \quad (\text{A25})$$

where $\phi(I)$ and $\Phi(I)$ are the standard normal density and cumulative distribution function respectively, and

$$I_i = \frac{X_i^* \beta - Z_i^* \alpha}{\sigma_3}$$

Similarly,

$$E(e_i | h_i > 0) = \frac{\sigma_{13}}{\sigma_3} \cdot \frac{\phi(I_i)}{1 - \Phi(I_i)}$$

where $\sigma_{13} = \text{cov}(e_i, e_i - u_i)$

$$\text{i.e. } E(e_i | h_i > 0) = \frac{\sigma_1^2 - \rho \sigma_1 \sigma_2}{\sigma_3} \cdot \frac{\phi(I_i)}{1 - \Phi(I_i)} \quad (\text{A26})$$

write $\lambda_i = \frac{\phi(I)}{1 - \Phi(I)}$

Then

$$h_i = \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha + \sigma_3 \lambda_i + V_{i1}) \quad (\text{A27})$$

and $w_i = X_i^* \beta + \frac{\sigma_{13}}{\sigma_3} \lambda_i - V_{i2}$

1/ e.g. Maddala (1983), Appendix.

where

$$E(V_{i1} | h_i > 0) = 0$$

and $E(V_{i2} | h_i > 0) = 0$ (A28)

Now, if estimates of λ are available, then (A27) and (A28) can be estimated from data on workers only.

Now, return to (A22),

$$\Pr(h_i > 0) = \Pr\{\sigma I_i > u_i - e_i\}$$

$$\Pr(h_i = 0) = \Pr\{I_i < \frac{u_i - e_i}{\sigma_3}\} = \Phi(-I_i)$$

and $\Pr(h_i > 0) = \Pr\{I_i > \frac{u_i - e_i}{\sigma}\} = \Phi(I_i)$

The likelihood function for the participation decision is then

$$L = \prod_{i=1}^m \Phi(I_i) \prod_{i=m+1}^n \Phi(-I_i) \tag{A29}$$

Maximum likelihood techniques yield the probit estimates for the participation decision and hence the values of λ_i which can be used in (A27) and (A28).

The full estimation model is then

$$P(I_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{I_i} e^{-t^2/2} dt \quad i = 1 \dots n \tag{A30}$$

(where $I_i = \frac{X_i^* \beta - Z_i^* \alpha}{\sigma_3}$)

$$w_i = X_i^* \beta + \frac{\sigma_{13}}{\sigma_3} \hat{\lambda}_i + V_{i2} \quad i = 1 \dots m \quad (A28)$$

and
$$h_i = \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha + \sigma_3 \lambda_i + V_{i1}) \quad i = 1 \dots m \quad (A27)$$

in a sample of n people of whom m are in the labor force.

The procedure of (A30), (A28) and (A27) describes the Heckman procedure which is essentially a two step procedure to estimate an equation in which the left hand variable, in this case h_i , is censored and is only observable for positive values. An alternative procedure is to estimate a censored regression model directly, i.e., a tobit model.

The Tobit Procedure

The tobit procedure merely extends the likelihood function of (A29) utilising the information on observations of $h_i > 0$. For the observations h_i that are zero,

$$P_r(h_i = 0) = \phi(-I_i) \quad (\text{as above}) \quad (A31)$$

For the observations h_i greater than zero

$$\begin{aligned} P_r(h_i > 0) \cdot f(h_i | h_i > 0) &= \phi(I_i) \cdot \frac{\frac{1}{\sigma_3} \phi(I_i)}{\phi(I_i)} \\ &= \frac{1}{\sigma_3} \phi(I_i) \end{aligned}$$

The likelihood function is therefore

$$L = \prod_{i=1}^m \frac{1}{\sigma_3} \phi(I_i) \prod_{i=m+1}^n \phi(-I_i) \quad (A33)$$

Maximum likelihood techniques then yield direct estimates of β , α and σ_3 from (A33).

Interpreting Tobit Coefficients ^{1/}

To interpret the coefficients derived from the tobit technique and to see their relationship with both the OLS procedure and Heckman procedure it is useful to rewrite the mode as follows:

$$h_i = \frac{1}{\alpha_1} (X_i^* \beta - Z_i^* \alpha + e_i - u_i) \quad \text{when RHS} > 0 \quad (\text{A34})$$

$$h_i = 0 \text{ otherwise.}$$

To simplify notation rewrite (A34)

$$h_i^* = Y_i \delta + u_i^* \quad (\text{A35})$$

where $Y_i = (X_i^*, Z_i^*)$

$$\delta = \left(\frac{\beta}{\alpha_1}, \frac{\alpha}{\alpha_1} \right)$$

$$u_i^* = \frac{1}{\alpha_1} (e_i - u_i) \sim N(0, \sigma_3^2) .$$

We can now write

$$h_i = h_i^* \text{ when } h_i^* > 0$$

$$h_i = 0 \text{ otherwise.}$$

h_i^* is a latent variable observable only when positive.

Now,

^{1/} See Maddala (1983) Ch. 6 for more detailed discussion, and McDonald and Moffitt (1980) for interpretation of tobit coefficients.

$$E(h_i^*) = Y_i \delta \quad \text{since} \quad E(u_i^*) = 0. \quad (\text{A36})$$

$$E(h_i^* | h_i^* > 0) = E(h_i | h_i > 0) \quad \text{is the same as equation (A27)}$$

hence

$$E(h_i^* | h_i^* > 0) = Y_i \delta + \sigma_3 \lambda_i \quad (\text{A37})$$

(A36) gives the expected value of h_i^* , i.e., the latent unrestricted variable. The tobit coefficients that are obtained are $\underline{\delta}$.

(A37) gives the expected value of h_i given that h_i is positive. Thus the coefficients given by Heckman's procedure are also in principle $\underline{\delta}$ if $\hat{\lambda}_i$ is a good estimator of λ_i in that procedure.

What we now need is the expected value of h_i , that is the mean of all observed values of h_i , both positive and zero.

$$\begin{aligned} E(h_i) &= \Pr(h_i > 0) \cdot E(h_i | h_i > 0) + \Pr(h_i = 0) E(h_i | h_i = 0) \\ &= \phi(I_i) (Y_i \delta + \sigma_3 \lambda_i) + \phi(-I_i) \cdot 0 \\ &= \phi(I_i) (Y_i \delta + \sigma_3 \lambda_i) \\ &[= \phi(I_i) \cdot E(h_i | h_i > 0)] \end{aligned} \quad (\text{A38})$$

The expected value of all observations is then merely the expected value conditional upon being above the limit multiplied by the probability of being above the limit. (A38) gives the expected value locus of labor supply.

Corresponding to each of these three expected values are their derivatives with respect to each y_j (in Y_i)

$$\text{from (A36)} \quad \frac{\partial E(h_i^*)}{\partial y_j} = \delta_j \quad (\text{A39})$$

$$\text{from (A38)} \quad \frac{\partial E(h_i)}{\partial y_j} = \phi(I_i) \cdot \delta_j \quad (\text{A40})$$

$$\text{from (A37)} \quad \frac{\partial E(h_i^* | h_i^* > 0)}{\partial y_j} = \delta_j [1 - I_i \lambda_i - \lambda_i^2] \quad (\text{A41})$$

$$\text{where } \lambda_i = \frac{\phi(I_i)}{\Phi(I_i)} \quad \text{as before.}$$

δ_j is then the slope of the fitted tobit line relating the tobit index or latent variable h_i^* to the y_i .

Since hours of work cannot in principle be negative, this is not the slope of interest in a study of labor supply. The slope that is sought here is the second one

$$\frac{\partial E(h_i)}{\partial y_j} = \phi(I_i) \cdot \delta_j$$

the slope of the expected value locus. At the mean, $\phi(I_i)$ is merely the proportion of observations that are positive.

(A41) gives the fraction of total effect of y_j on h_i due to variation above the limit. Thus $(1 - I_i \lambda_i - \lambda_i^2)$ gives the portion of response of h_i given that it is positive. If $\phi(I_i)$ is known, $\phi(I_i)$ and I_j can be calculated and hence λ_i .

OLS coefficients are analogous to $\frac{\partial E(h_i)}{\partial y_j}$ and are therefore to be compared with $\phi(I_i) \cdot \delta_j$. This makes intuitive sense as the marginal effect of y_j on h_i and is therefore the estimate reported in all tobit tables.

As mentioned earlier, the Heckman coefficients estimated in (A27) correspond to δ_j . If, however, the derived estimates of $\hat{\lambda}_i$ are not "good" estimates the Heckman coefficients may correspond to (A41) since the OLS regression is done on workers only and the variance in h_i is only due to effects above the limit, i.e., zero hours.

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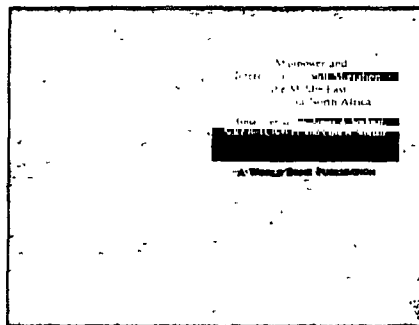
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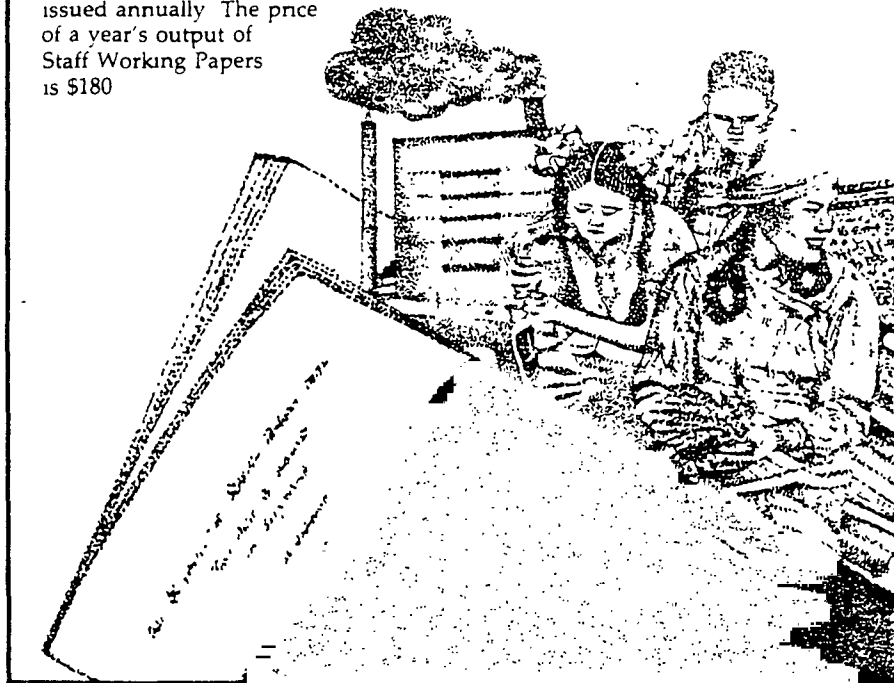
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