

## A MULTI-CHOICE MODEL OF FORMAL AND INFORMAL SECTOR EMPLOYMENT BY WOMEN IN LIMA, PERU

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### RESUMEN

Usando los modelos logit multinomiales, la presente investigación ha verificado la heterogeneidad del empleo en el sector informal urbano y la significancia del trabajo informal remunerado para las mujeres trabajadoras en Lima, Perú. Para el análisis de la oferta de trabajo femenina, las mujeres entre los 15-65 años se clasificaron en siete niveles de ocupación: no trabajadoras, trabajadoras familiares no remuneradas, trabajadoras domésticas, trabajadoras informales remuneradas, auto-empleadas, trabajadoras en el sector privado y trabajadoras en el sector público.

La teoría de la nueva economía del hogar es usada para identificar tanto los determinantes de la participación de la mujer en el mercado de trabajo como de la elección de la ocupación. El análisis descriptivo muestra que las trabajadoras del sector informal son jóvenes y las más educadas trabajan en el sector informal. El análisis empírico muestra que el sector informal no es homogéneo, de tal manera que cree diferentes oportunidades de empleo para las trabajadoras en Lima. La investigación adicional sobre el trabajo informal en el sector urbano es crucial para entender la vinculación entre los sectores formal e informal y el desarrollo de la economía urbana.

### ABSTRACT

Using the multinomial logit (MNL) models, this research has verified the heterogeneity of the urban informal employment sector and the significance of informal wage work for female workers in Lima, Peru. For the analysis of female labor supply, women aged 15-65 in Lima are disaggregated into the seven occupations: non-working, unpaid family work, domestic work, informal wage work, self-employment, formal private sector work, and formal public sector work.

The theory of the new household economics is used to identify the determinants of women's labor market participation and occupation choice. The descriptive analysis shows that informal wage workers are young and the most educated workers are in the informal sector. The empirical analysis indicates that informal sector work is not homogeneous such that it creates different employment opportunities to female worker in Lima. The further research on informal wage work in urban area is critical to understand the gray area between formal and informal sectors, and the development of urban economy.

### Introduction

The importance of integrating women into development policy has been stressed in academic and non-academic work for the last decade. For this purpose, many studies have concentrated on conceptualizing and estimat-

ing women's economic activities<sup>1</sup>. The structure of women's decision to work has been studied by modeling women's labor force participation and analyzing the factors affecting it<sup>2</sup>. The results of previous research suggest that the labor market environment surrounding women differs across countries, which

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contributes to the different attitudes of women towards labor force participation.

One of the significant factors which create differences in women's labor force participation among regions and countries is the employment opportunities in the informal sector in developing countries. In Latin America, female labor force participation in the informal sector has expanded for the last decades. To meet subsistence needs, many women have increased labor force participation through informal sector work mainly because of its compatibility with household chores and child care. Thanks to past work, the significance of informal sector work to modeling women's labor force participation is widely acknowledged today. The heterogeneity of informal sector work, however, has not been rigorously studied in empirical work. This research claims that ignoring distinctive occupation choices and treating them as identical creates a specification bias in women's labor force participation models.

Specifically, this research tries to overcome the three problems in past research. First, in previous research, the disproportionate increase of female workers in the informal sector is explained and analyzed as a consequence of the economic crisis, international competition, and structural adjustment policy<sup>3</sup>. But little research has been initiated to understand the relation between different types of occupations and the socioeconomic characteristics of female workers in an empirical and theoretical framework.

Second, the past research with women's occupation choice models lacks the idea of informal wage work while strongly emphasizing the effect of self-employment and/or home-based economic activities on women's decision to work. Considering the expansionary growth of informal employment opportunities in urban labor markets in Latin American countries, such an approach seems to be irrelevant.

Portes and other structuralists assert the inappropriateness of such a definition is the most serious in Latin America where a large

portion of wage workers are working at small production units in a precarious environment<sup>4</sup>. In the case of Peru, 6.8% of the economically active population (EAP) or almost 10% of informal sector workers are identified as informal wage workers under the definition by the structuralist. Yamada also reported the proportion of informal wage workers in the total labor force in Lima in 1985 as 19%, using the same data as this research. This figure indicates that informal wage workers compose of approximately 36% of informal sector workers and 29% of wage workers. All these numbers strongly suggest the significance of informal wage work as a women's occupation choice.

The third problem in estimating women's labor force participation in previous studies is that informal and formal occupations are defined without careful investigation into the criteria which distinguish one from the other. The definition of the informal sector has been intensively and extensively studied since the early 1970's from the enterprise and the employment sides. Nevertheless, the contribution of that research is not fully utilized in the empirical work.

Fixing these deficiencies of the previous research, this study creates and tests a multinomial logit (MNL) model with seven occupation choices: non-working, unpaid family work, domestic work, informal wage work, self-employed work, formal private-sector work, and formal public-sector work. Information on women aged 15-65 living in Lima is used for this analysis. The model evaluates how the women's human capital endowments and demographic characteristics can explain the probability that they would choose an occupation among the seven choices.

The implications of the MNL model depends on the quantitative results. After examining some models, this research finds that the MNL model with seven choices is statistically significant relative to the other models. This means that informal wage work and the other six occupations are distinctive occupation choices for female workers and informal wage work is a significant occupation choice at

least in the way that it is defined in this research. Divided into four sections, the empirical analysis is rigorously implemented in the following way.

First, whether or not informal wage work can be combined with one of the other occupation choices is tested. For this purpose, five MNL models with six occupation choices are created. Second, employee or non-employee work choice models are tested. Third, formal or informal choice models are examined. This inquires whether informal wage work is a close substitution for formal employee work or for informal non-employee work. Finally, whether or not unpaid family work is significantly different from not working is examined.

Besides these problems in model specification, it is of great interest to understand how having a primary man living with the woman in the same household affects her occupation choice. This research defines a primary man as either a husband or father. If the woman lives with her husband, then he will be the primary man. If woman does not live with her husband but with her father, then the father will be the primary man. Assuming that the woman's labor force participation and occupation choice do not affect the primary man's occupation choice, the analysis considers the extent to which information on the man can explain the woman's labor force participation.

The general objective of this research is, therefore, to examine the characteristics of female workers in different occupations across the informal and formal sectors and to test the significance of informal wage work as a woman's occupation choice. The specific objectives are:

1. To demonstrate how previous studies' definition of informal activity can be utilized to classify female workers into occupation choices for this research.
2. To present a descriptive analysis for female workers in Lima.
3. To analyze how women's human capital endowments and demographic charac-

teristics affect their occupation choice and decision to work.

4. To test whether or not the presence of a husband or father has an impact on the women's occupation choice.
5. To investigate how the primary man's education and occupation choice influence the women's occupation choice.
6. To inquire if informal wage work is a distinctive occupation choice for women in Lima.
7. To examine the similarities between:
  - (1) the occupations in the informal sector;
  - (2) the occupations in the formal sector;
  - (3) employee work;
  - (4) non-employee work;
  - (5) non-working and unpaid family work.

## 1. Literature Review

### 1.1 The Three Groups of Studies

Using the Peruvian Living Standard Survey (PLSS), this research decomposes female workers in Lima into seven occupations: non-working, unpaid family work, domestic work, self-employment, informal wage work, formal private sector work, and formal public sector work. The critical point is how to distinguish informal and formal employees in the private sector. What kind of criteria can be used to identify informal wage workers?

The three groups of studies: the International Labour Office (ILO), the structuralist, and the legalist developed the definition of the informal sector. Even though the way they define the informal worker is different, all three approaches identify unpaid family worker, domestic worker, and self-employed worker as informal sector workers. However, defining informal workers among the employees in the private sector is controversial. That is the focal point where the ideas of the three approach diverge. Each approach defines the informality of employees based on different aspects, which reflects the different criteria.

Table 1

## COMPARISON OF THE THREE APPROACHES

Types of Approach	ILO	Structuralist	Legalist
Aspects of economic activities	Enterprise	Worker	Enterprise
Aspects of production operation	Objective of production	Legality	Legality
Locations where the informal activities were studied	Africa Ghana, Kenya	Latin America	Latin America
Period of time when the concepts were developed	1970's	1980's	1980's

Table 1 summarizes the similarities and differences of these three approaches. The three approaches diverge in the units of study -enterprise or worker- as well as in the aspects of a production operation -objective or legality of production activity- to examine the formality and informality of economic activity.

According to the legalists represented by De Soto who is a Peruvian economist, the expansion of the informal sector is mainly attributed to the survival strategy of small-scale entrepreneurs who try to avoid costs associated with being formal enterprises and/or legalizing the business operations.

Having studied the idea of informality since the 1970's based on research started in Kenya, the ILO approach considers the origin of informal activities as the households' income-generating behavior to survive under subsistence circumstances. Extending the ILO approach, Sethuraman presented a working definition of informal activity specifically as a research guideline in Latin America as "(...) small-scale units engaged in the production and distribution of goods and services with the primary objective of generating employment and incomes to their participants not with standing the constraints on capital, both physical and human, and knowhow"<sup>5</sup>. This statement describes very well women's self-employment activities in Latin America after the crisis in the 1980's.

Referring to deteriorated economies in Latin America, Oliveira and Roberts also state that "(...) in light of lower real incomes and

increasing unemployment, even the low salaries of the young and women were necessary to sustain the household, and this has been the major factor increasing female labor force participation in the poorest households"<sup>6</sup>.

Structuralists developed their concept of informality based on economic observation of the 1980's Latin America. They formed the conceptual framework for analyzing informal activity by investigating the survival strategy of not households, but large firms. In the economic crisis enterprises are forced to implement cost minimization strategies which focus on reduction of labor costs to maintain their competitive price in the market. Technological change under structural adjustment policy and export-oriented industrialization makes it also possible for the large firms to decentralize and minimize their production activity. Making their production small and hiring workers under informal contracts without the social securities and other fringe benefits, the enterprises can reduce labor costs. From the structuralist point of view, therefore, the disproportionate increase of women's labor force participation in informal activity is a phenomena corresponding to an increasing demand for a cheap labor force.

Pondering the three approaches to informal sector, three points should be emphasized. First, both the objective and legality of the enterprises' performance are important factors in explaining the increase of women's labor force participation through informal activity. Second, the differences in the central

points among the three approaches create the different criteria used to identify informal (wage) worker. Third, even though the three approaches emphasize different aspects of informality, as a method to define it they are usually complementary rather than competing with each other.

## 1.2 Method for Identifying the Informal Wage Worker

Reflecting the different aspects of economic performance each approach has studied, the ILO and the structuralists developed an individual identification method to define informality, which is summarized in Table 2. The ILO approach identifies informal workers based on the objective of production operation in the enterprise where the employee works, while structuralists claim that it is better to distinguish informal and formal workers based on the legal condition of employees.

Table 3 indicates how these two approaches can be utilized to identify informal wage workers. If the enterprise is identified as informal because it is operated for sustaining daily life, then the employee working there is also identified as informal. When informal wage workers can not be identified in such a manner, then the legal condition of the worker, i.e. entitlement to social security, is used as a proxy to identify whether or not the employee

is an informal worker. Therefore, the first procedure is to exam whether or not workers can be identified as informal according to the enterprise-oriented ILO approach.

According to the definition of informality in Table 3, the ILO defines informal workers as unpaid family workers, domestic servants, and self-employed workers except professional entrepreneurs. Notice that all these workers are engaged in non-wage work. At this point the weakness of the ILO approach is revealed. It categorizes and identifies workers such that non-wage work(er) is an informal sector work(er) and wage work(er) is a formal sector work(er); the idea of informal wage work(er) can not be perceived from the ILO approach.

This inadequacy, however, can be remedied by introducing the structuralist approach. After using the identification procedure of the ILO approach, wage workers in the public and private sectors are left to identify. Since public sector employees are defined as formal wage workers by the ILO approach, the issue is to categorize the employees in the private sector into formal and informal wage workers. According to the structuralists, the private employees can be categorized as formal or informal depending on their legal condition of employment. As a proxy for legality, entitlement to social security is frequently used: if the worker is entitled to social security, then he/she is a formal wage worker.

Table 2

### IDENTIFICATION METHODS FOR INFORMAL WAGE WORKERS

Types of Approach	ILO	Structuralist
Category	Enterprise.	Worker.
Criteria	Objective of production.	Legality of employment.
Working definition of informality	Production activities oriented to income generation and employment creation in order to sustain daily life.	"Unprotected" worker. Uncovered with social security and other fringe benefits, i.e. paid sick days, pension funds, etc. Lack of contract and labor union.

Table 3

## PROCEDURE TO IDENTIFY INFORMAL WAGE WORKER

<b>ILO Approach</b>	<p>Select employed worker among the EAP or Total Labor Forces.</p> <p style="text-align: center;">⇓</p> <p>Identify professional entrepreneurs and non-wage workers: Unpaid family workers, domestic servant and self-employed workers except professional entrepreneurs.</p> <p style="text-align: center;">⇓</p> <p>Total wage workers are left.</p> <p style="text-align: center;">⇓</p> <p>Identify public sector workers.</p> <p style="text-align: center;">⇓</p> <p>Total private sector workers are left.</p> <p style="text-align: center;">⇓</p>
<b>Structuralist Approach</b>	<p>Identify informal wage workers based on legality of employment, i.e. entitlement to social security.</p>

For example, one of the famous structuralists, Portes<sup>7</sup> applies this method in his research. He at first estimated the proportion of informal workers to the EAP in Latin American countries in 1980 by the ILO approach and then by the structuralist approach. Comparing the two figures, he states that the gap between those numbers is the approximate proportion of informal wage workers in the EAP which he describes as "the proportion of wage workers who labor under irregular conditions"<sup>8</sup>. In this way, Portes demonstrates that information on possession of social security coverage can be used to distinguish informal and formal wage workers. In practice this is the most frequently applied method by many researchers. This research also uses this procedure to identify informal wage workers.

Comparing Table 3 to the previous research, the next section discusses how the definitions of informal sector work developed by the ILO and the structuralists were applied to specify the occupation choices in the empirical research with the women's labor force participation model.

### 1.3 Analysis of Occupation Choice Specification

Referring to the framework for identifying informal (wage) workers in Table 3, we analyze how the previous research specified the occupation choice in a women's labor force participation model.

Modeling and estimating women's labor force participation decision in the light of informal sector work was initiated by Hill. Using data collected in 1975 in Japan, she classified all family workers as informal workers after eliminating a small portion of women (5.6%) working for self-employment and home-production for market sale. Remaining female workers were identified as formal sector workers. The occupation choices were formal workers, informal workers, and those who did not participate in market activity. Her classification procedure used only the concept of informality of the ILO. However, considering labor market conditions in Japan in the 1970's, the idea of informal wage work is irrelevant and, therefore, there is no reason to apply the structuralist approach to the specification of occupation choice. As a result

of her research, Hill concluded that the three choice model cannot be collapsed to a two choice model such as working and not-working, and it made a difference for Japanese women to work as an employee or as a family worker.

To test whether Hill's model is appropriate or not to a developing country's setting, S. Khandker<sup>9</sup> applied the model to estimate married women's labor market participation in rural Bangladesh in the 1980's. The occupation choices are divided into market work, family work, and no work. Family workers are those women who work at home either as partners or unpaid family workers producing cash income in the family enterprise. Market workers are women who produce cash income from employment outside the family such as teaching, nonagricultural wage work, and other salaried services. Khandker distinguished between employment inside and outside home, considering the significance of market participation cost to married women. In the light of the ILO approach, Khandker's occupation categories can be simply recognized as a choice between wage and non-wage work. As in Hill's model, the idea of informal wage work is not found in this model.

To test whether the multi-sector model collapses to a two choice model, J. Tiefenthaler<sup>10</sup> extended Hill's work to the Island of Cebu in the Philippines. Using data of women with infants, women are classified into occupation status as piece sector work, informal work, formal work, and nonparticipation in paid work such as unpaid family work. Piece sector work is defined as work at home making handicrafts on contract. Informal workers include all workers who are self-employed while those who work on a wage-for-time basis are classified as formal workers. This indicates that all wage workers except women earning on a piece-basis at home are identified as formal workers. Informal work is used as a synonym for self-employed work. Here again the concept of informal wage work and its application to the women's labor force participation model cannot be observed; however, it

is important to notice that she separated piece sector work from other informal works. Regarding the characteristics of work in Cebu, Tiefenthaler may have specified the occupation choice in an appropriate way. To distinguish informal wage work as an occupation choice may not create significant differences in estimating the model for women in Cebu.

In contrast to these three works, the following two examples from Latin America, utilized the concept of informal work developed by the structuralists. Based on Nicaragua data in 1977-1978, J. Behrman and B. Wolfe classified female workers into the three occupations: domestic work, informal work, and formal work. Informal workers are those who work under "no contracts, no benefits like social security, and small production units which often operate out of the home, on the streets, in open market or in other transitory quarters with a high proportion of family workers"<sup>11</sup>. Formal sector workers are defined as those workers with "ongoing implicit and explicit fringe benefits such as social security and often large-scale employers"<sup>12</sup>. From these definition, it can be observed that Behrman and Wolfe used the concepts of informality developed by the ILO approach as well as by the structuralist approach.

Analyzing how specification of occupation by Behrman and Wolfe works with these two approaches, Table 3 explains that; first, you find the domestic workers (the ILO approach); second, classify all the rest of the workers between informal and formal work using the criteria such as entitlement to implicit and explicit fringe benefits (the structuralist approach). In this way, it is clearly understood how Behrman and Wolfe applied the definitions of informal work developed by the ILO and the structuralists. The problem of this occupation identification, however, is that self-employed work, unpaid family work, and informal wage work are combined as informal work. Considering the cost of labor force participation, self-employment and informal wage work can not be the same occupation choice to

women. This point will be tested in this research.

Similar work is found in a Brazilian female labor force participation model studied by E. Telles. He determines the informality of occupation based on entitlement to social security. He states that "(...) in Brazil, as in the rest of Latin America, access to social security also designates as officially recognized work contract shared by both employees and employees"<sup>13</sup>. Citing a definition of the informal sector elaborated by Portes and Castell (1989), Telles asserts that the definition is strongly supported by intensive ethnographic fieldwork in Brazil.

Extending the results of the previous research for the Brazilian and Latin American labor market and applying the definition of informal worker by the structuralists, Telles classifies employees and self-employed workers without social security, and domestic workers as informal workers. Different from Berhman and Wolfe, Telles does not distinguish domestic workers from the rest of informal workers. Telles created the occupation choice such as informal work and formal work. This is because he considers that "the lack of social security payment, rather than occupation, industry, and self-employment, was by far the best indicator for differentiating jobs"<sup>14</sup>, mentioning the previous study by Silva. In the specification of occupation choice, therefore, Telles uses the concept of informality only of the structuralists.

Reviewing the ways the occupation choices are established in the previous research, it is obvious that the idea of informal wage worker is not applied specifically. In order to define informal wage worker using a household survey, both the ILO and the structuralist approaches need to be used in the identification work as illustrated in Table 3, which is practice in section 4.

## 2. The Conceptual Framework

This section discusses how economic theory can be used to identify the determinants of women's labor market participation and

occupation choice in the context of formal and informal sector work. The ILO and the structuralists explain the disproportionate increase of female workers in the informal sector by observing the structure of the supply of and demand for female labor in urban markets. However, these approaches are not profound enough to establish the theoretical framework for the analysis of the disproportionately increasing female labor market participation in informal activity.

The characteristics of women both in the labor market and in the household as well as features of informal sector work must be the critical determinants of the disproportionate increase of women's labor market participation in the informal sector. From the previous research, it is understood that the characteristics of women as a labor or in the household significantly affect their occupation choice and decision to work in urban markets. Oliveira and Roberts pointed out that "the characteristics of workers combine with domestic responsibilities to encourage informal employment"<sup>15</sup>.

This statement implies that the concept of opportunity cost helps to explain the increasing women's labor force participation in informal activity. The previous studies support the idea that significant differences in opportunity costs exist between formal and informal sector work. Formal sector jobs usually require work for a fixed range of time at a certain location away from home. Also work in the formal sector usually does not allow women to take care of children at the work site. All these conditions of working in the formal sector increase women's opportunity and monetary cost of labor market participation.

The differences in opportunity cost of labor market participation must be a critical determinant affecting the occupation choice between wage and non-wage work. Contrary to wage work in the formal and informal sector, self-employment, unpaid family work, and domestic work are more accessible to women because they offer flexibility in terms of time and location. Some women may not be able to

afford the time to participate in wage work. In order to empirically test these hypotheses, it is necessary to analyze this issue based on economic theory so that the influential determinants can be inferred on the basis of a conceptual framework.

To perceive of the woman's occupation choice and labor market participation decision as a result of utility maximization, this research uses the New Household Economic Theory pioneered by Becker<sup>16</sup> for the conceptual analysis of the research problem. Classifying the woman's occupation choice such as non-working, unpaid family work, domestic work, self-employment, informal wage work, formal private sector work, and formal public sector work, it is expected that informal relative to formal sector work and non-wage work relative to wage work require the lower level of human capital endowments and also incur the lower fixed cost of labor market participation for women.

Following Becker's household economic theory and allocation of time, it is assumed that the individual woman chooses her occupation so that she can maximize her utility function given the time and budget constraints. Comparing the various wages and fixed market participation costs across the occupations and considering the production opportunity within the household, a woman decides her market participation and occupation. The individual woman's preference map is defined by a well-behaved utility function ( $U$ ) which is a function of the household produced commodities ( $Z$ ), leisure time ( $T_l$ ), and a vector of exogenous variables affecting occupation choices ( $R$ ). The commodities produced in the household ( $Z$ ) are a function of the purchased commodities ( $X$ ) and time for household production ( $T_p$ ).

$$U = U(Z, T_l; R)$$

where

$$Z = g(T_p, X)$$

Therefore,

$$U = U[g(T_p, X), T_l; R] \quad (2.1)$$

The utility function is twice continuously differentiable, strictly increasing, and strictly quasi-concave; the constraint set is convex and an interior solution exists. Maximization of the utility function subject to the full income constraint which is composed of the time and budget constraints yields a unique interior solution. The time constraint faced by the individual woman is:

$$T = T_w + T_p + T_l \quad (2.2)$$

which means that the total time available to the individual woman ( $T$ ) is equal to the time spent for labor market participation ( $T_w$ ), for household production ( $T_p$ ), and for leisure ( $T_l$ ). The equation for the budget constraint indicates that the total of earned income in the labor market ( $WT_w$ ) and other unearned income ( $N$ ) are equal to the money spent for purchasing the market produced goods ( $\Sigma PX$ ).

$$I = (\Sigma PX) = WT_w + N \quad (2.3)$$

Solving equation (2.2) for  $T_w$  and substituting into (2.3), the full income constraint ( $S$ ) is:

$$S = WT + N = \Sigma PX + WT_p + WT_l \quad (2.4)$$

In order to find the equilibrium conditions for the individual woman, the utility function (2.1) needs to be maximized subject to the full income constraints (2.4). Using the Lagrangian multiplier ( $\lambda$ ), the following equation is obtained:

$$L = U[g(T_p, X), T_l; R] - \lambda(\Sigma PX + WT_p + WT_l - WT + N) \quad (2.5)$$

This is called the Lagrangian function. Differentiating  $L$  with respect to  $T_p$ ,  $T_l$ , and  $X$ , the first order conditions are:

$$U_z \cdot g_{Tp} = \lambda W \quad (2.5a)$$

$$U_{Tl} = \lambda W \quad (2.5b)$$

$$U_z \cdot g_x = P\lambda \quad (2.5c)$$

From the equations (2.5a) and (2.5b),

$$U_z \cdot g_{Tp} = U_{Tl} \quad (2.5d)$$

$$g_{Tp} = U_{Tl}/U_z \quad (2.5e)$$

This means that the marginal productivity of household production equals the marginal rate of substitution of leisure for goods. In other words, when this equation holds, the woman's "willingness" to exchange leisure for goods is exactly equal to her "ability" to exchange leisure for goods by engaging in household production.

For the further analysis, assume that the household produced commodities (Z) are perfect substitutes for the market purchased commodities (X). This means that

$$\partial L/\partial X \equiv \partial L/\partial Z = U_z = P\lambda \quad (2.5f)$$

Dividing (2.5a) by (2.5f);

$$g_{Tp} = W/P \quad (2.5g)$$

This indicates that at the equilibrium condition woman's marginal productivity in household production is equal to the real wage rate and she would be indifferent between working in the labor market or not. As a whole, the equilibrium condition for the individual woman who maximizes her utility subject to the full income constraint is defined such that:

$$U_{Tp}/U_z = g_{Tp} = W/P \quad (2.6)$$

Conventional labor supply theory assumes that a woman participates in the labor force if her real wage exceeds her marginal productivity in household production. When

$$g_{Tp} < W/P \quad (2.6a)$$

the woman works in the market. And when

$$g_{Tp} > W/P \quad (2.6b)$$

the woman works in the household rather than in the market. However, if the individual woman considers the fixed cost of labor market participation including the opportunity cost of working outside of home and/or the efficiency of working in her home, then even though equation (2.6a) holds, the woman still will not work in market. In order to understand such a circumstance, it is critical to examine the demographic condition and the characteristics of the individual female worker which affect her occupation choice and market participation decision. For such an inquiry an empirical analysis is necessary and that is explored in section 5.

### 3. Occupation Choice Model

The recent empirical analyses of female labor supply in developing countries support the idea that flexibility of working hours and location, and compatibility with household responsibilities such as child care in informal employment create different working opportunities to women. Also from the structuralist argument it can be inferred that the differences in the costs of employment to firms between the formal and informal sectors may create different occupation choices for women through the different costs of entry to and exit from the labor market. In terms of the impact of the human capital endowments on the occupation choice, it is known that acquisition of formal education is a primary condition to work in the formal sector especially in public sector work.

Using information on demographic factor and the characteristics of female workers, an empirical model is created in order to exam the structure of women's labor market participation decision. Through out this research, it is assumed that the individual

woman's occupation choice represents the consequence of her utility maximization process which is described in the previous section. The individual may select among the seven mutually exclusive occupations: non-working (indexed  $n$ ), unpaid family work (indexed  $f$ ), domestic work (indexed  $d$ ), informal wage work (indexed  $g$ ), self-employed work (indexed  $e$ ), formal private sector work (indexed  $p$ ) and formal public sector work (indexed  $s$ ). The individual woman compares the maximum utility attainable in each occupation and decides to work in the  $j$ -th occupation which offers her the highest utility among the seven alternatives. In order to analyze the research problem in this framework, this study uses a standard random utility model developed by McFadden<sup>17</sup> and Hanemann<sup>18</sup>.

### 3.1 Multinomial Logit Model

Suppose the utility function ( $U_j^w$ ) of the individual  $w$ -th woman working in the  $j$ -th occupation is composed of a non-stochastic or observed element ( $V_j^w$ ) and a stochastic or unobserved element ( $\mathcal{E}_j^w$ ). Then the individual  $w$ -th woman's indirect utility function is:

$$U_j^w = V_j^w + \mathcal{E}_j^w = \beta'_j X^w + \mathcal{E}_j^w \quad (3.1)$$

where ( $\beta'_j$ ) is a parameter vector and  $X^w$  is a vector of independent variables explaining labor force participation and occupation choice.

According to McFadden<sup>19</sup>, the  $w$ -th individual woman chooses the  $j$ -th occupation if,

$$U_j^w > \text{Max } U_k^w \quad (\text{for } k \neq j, k = d, e, f, g, p, s, n) \quad (3.2)$$

The probability that the  $w$ -th woman selects the  $j$ -th occupation is then specified by:

$$P_j^w = \text{Pr}[U_j^w > \bar{U}_k^w] \quad (\text{for } k \neq j, k = d, e, f, g, p, s, n) \quad (3.3)$$

Substituting equation (3.1) for (3.3),

$$\begin{aligned} P_j^w &= \text{Pr}[\beta'_j X^w + \mathcal{E}_j^w > \beta'_k X^w + \mathcal{E}_k^w] \\ &= \text{Pr}[\beta'_j X^w - \beta'_k X^w > \mathcal{E}_k^w - \mathcal{E}_j^w] \end{aligned} \quad (\text{for } k \neq j, k = d, e, f, g, p, s, n) \quad (3.4)$$

If the  $\mathcal{E}$ 's are independently and identically distributed with a Type I extreme value (or Weibull) distribution, then the difference in the error terms ( $\mathcal{E}_k^w - \mathcal{E}_j^w$ ) has a logistic distribution and the model is called a multinomial logit model.

The probability that the  $w$ -th woman choose the  $j$ -th occupation can be computed in the generalized form:

$$\begin{aligned} P_j^w &= \exp(V_j^w) / \sum_{K=1}^T \exp(V_k^w) \\ &= \exp(\beta'_j X^w) / \sum_{K=1}^T \exp(\beta'_k X^w) \end{aligned} \quad (3.5)$$

Specifically defined as:

$$P_j^w = \frac{\exp(\beta'_j X^w)}{\exp(\beta'_d X^w) + \exp(\beta'_e X^w) + \exp(\beta'_f X^w) + \exp(\beta'_g X^w) + \exp(\beta'_p X^w) + \exp(\beta'_s X^w)}$$

The model specified in this form has to satisfy the independence from irrelevant alternatives (IIA) property. This is an important assumption of multinomial logit models and implies that the ratio of the probability choosing the occupation  $j$  to the probability of choosing the occupation  $k$  is independent of the other available occupation choices in the model.

This condition, however, is difficult to satisfy in modeling women's occupation choice in the context of the urban formal and informal activities. It is expected that some similarities exist among the occupations within the informal sector or within non-wage work. Such an assumption can be tested in two different ways.

One of the testing methods is to examine the correlation between some of the stochastic components,  $\mathcal{E}_j^w$ 's, of the indirect

utility functions. If, for example, domestic work (*d*) and unpaid family work (*f*) are very similar choices to women, then the stochastic components of these two choices are highly correlated and  $\varepsilon_d^w$  and  $\varepsilon_f^w$  are not independent, indicating a violation of the IIA property between these two occupation choices and the rest of alternative occupation choices. In such a case, the choices are divided into subsets within which IIA holds and a nested multinomial logit model will be used to incorporate the IIA violation between the subsets into the model.

Technically speaking, for estimating the nested multinomial logit model, it is necessary to include at least one explanatory variable which represents the attribute of each occupation in the model. In labor force participation models, the estimated wage rate is usually included for this purpose. It is, however, doubtful how much the estimated wage rate can explain the attribute of each occupation in the informal sector. The urban labor market in developing countries in terms of the informal and formal sectors is expected to be relatively segmented compared with developed countries. Therefore, the estimated wage rate for the individual woman is not determined under a market environment as competitively as in developed countries. Furthermore, due to the informality of work such as self-employment or unpaid family work, not only the human capital endowments but also entrepreneurship or dexterity may affect the wage rate. It is very difficult to take these factors into consideration for model estimation.

For these reasons, this research uses the other way to test the similarities among the occupation choices. That approach is to combine some of the occupations which are thought to share some common characteristics as an occupation choice and estimate a reduced multinomial logit model. For example, in this research the four informal sector occupations will be combined to test whether or not they are similar enough to be identified as an informal sector occupation. Given three other occupation choices -non-working, formal private sector work, and formal public sector

work- the total number of occupation choices becomes four. The estimation result of this reduced multinomial logit model with four choices is compared with one with seven occupation choices. If the statistical test indicates that the reduced model with four choices can explain women's labor force participation as well as one with seven choices, then it implies that the four informal sector occupations are similar enough to be combined, otherwise not. In order to test the similarities among the occupation choices, this research estimates ten different reduced form multinomial logit models. The results and their implications are discussed in section 5.

### 3.2 Interpretation of Estimation Result of the MNL model

Regarding the estimated coefficients of the MNL model, if the model has *n* alternatives, only *n-1* parameter vectors are estimated. To interpret the change of probability of participating in each occupation ( $P_j^w$ ) with respect to the change of each exogenous variable ( $X^w$ ), it is useful to calculate the partial derivatives.

The partial derivatives are:

$$\frac{\partial P_j^w}{\partial X^w} = P_j^w (1 - P_j^w) \frac{\partial V_j^w}{\partial X^w} - \sum_{k \neq j} P_j^w P_k^w \frac{\partial V_k^w}{\partial X^w} \quad (3.7)$$

where  $j \neq k$  and  $j, k = d, e, f, g, p, s,$  and  $n$ .

Since  $V_j^w = \beta_j' X$ , the equation above can be rewritten as:

$$\frac{\partial P_j^w}{\partial X^w} = P_j^w (1 - P_j^w) \beta_j' - \sum_{j,k} P_j^w P_k^w \beta_k'$$

Let

$$\sum_{j=d}^{j=n} P_j^w \beta_j' = \beta'$$

$$= P_j^w \beta_j' - P_j^w \sum_{j=d}^{j=n} P_j^w \beta_j'$$

$$= P_j^w [\beta'_j - (\sum_{j=d}^{j=n} P_j^w \beta'_j)] \quad (3.8)$$

Then equation (3.8) will be simplified such that:

$$\frac{\partial P_j^w}{\partial X^w} = P_j^w (\beta'_j - \beta') \quad (3.9)$$

This is the equation for the partial derivatives of  $P_j^w$  with respect to  $X^w$  for the seven occupation choices evaluated at the sample means of the coefficients. It is important to recognize from this equation that the actual effects of changes in the independent variables ( $X^w$ ) on the probability of  $w$ -th women in  $j$ -th occupation ( $P_j^w$ ) depends on each individual's own probabilities.

The bold numbers in Table 11 and 12 in section 5 are the partial derivatives for the seven occupation choices evaluated at the sample means following the logit coefficients and the value of the t-statistic in parentheses, respectively.

The goodness-of-fit for the multinomial logit model can be tested by using a likelihood ratio statistic:

$$-2 \ln \lambda = -2 [L(\beta_0) - L(\beta)]$$

which, under the null hypothesis that all parameters equal zero, is asymptotically distributed as a chi-square variate with  $k$  degrees of freedom, where  $k$  is the number of estimated parameters.

The likelihood ratio index ( $\rho^2$ ) is analogous to a least square multiple correlation coefficients;

$$\rho^2 = 1 - \frac{L(\beta)}{L(\beta_0)}$$

$L(\beta_0)$  is the restricted log likelihood evaluated at  $(\beta_0)$ , a vector of zeros, and  $L(\beta)$  is the log likelihood function evaluated at  $(\beta)$ , the maximum likelihood estimations of the parameter vector.

Following the estimation results, the number of observations, the likelihood function  $L(\beta)$ , the likelihood ratio index ( $\rho^2$ ), chi-squared statistic which is the likelihood statistic, and the degrees of freedom are presented in each table in section 5.

#### 4. Data And Descriptive Analysis

##### 4.1 The Survey and Classification of the Occupation Status

The data used in this research are obtained from a comprehensive household survey initiated by the Peruvian Instituto Nacional de Estadística (INE) and the World Bank. This survey, the Peruvian Living Standards and Informal Sector Survey (PLSS), was conducted from June 1985 to July 1986 for the purpose of inquiring into the living standards and informal economic activities in Peru. The survey interviewed a random sample of 5,120 households and the household members. Of the total sample distribution, metropolitan Lima shares 25.4% and 47.5% of the sample in urban areas.

For the analysis of female labor supply, women aged 15-65 in Lima are classified into the seven occupations: non-working, unpaid family work, domestic work, informal wage work, self-employment, formal private sector work, and formal public sector work. The classification procedure is clarified in Chart 1. First, those who have worked only on the farm or raised livestock belonging to a household are excluded from the empirical analysis, since according to the latest ILO resolution<sup>20</sup>, they belong neither to the formal nor informal sector. Also, it is reasonable to assume that those farmers are living near the border with rural areas next to Lima since access to land and water is very limited in the urban area of Lima; it may not be appropriate to count farmers as part of the urban labor force. After excluding farmers from the data, it is expected that most of the self-employed/family workers who do not have cash income can be recognized as unpaid family workers for non-agricultural

self-employment activities in their household. Unpaid family workers, domestic workers, paid self-employed workers including entrepreneurs, and employees are identified in the second stage of sorting. Only six out of all the paid self-employed workers offered IPSS (Instituto Peruano de Seguridad Social) to their employees and were identified as formal entrepreneurs. Those entrepreneurs are counted as formal private sector workers. In the fourth stage, after distinguishing employees from non-employees, paid and unpaid employees are sorted from one another. Those unpaid

employees are regarded as informal wage workers. Among the paid employees, public and private sector workers are identified. And at last among those in the private sector, formal and informal workers are classified based on entitlement to social security, IPSS in Peru, or to other employment insurance. Those who possess IPSS or other insurance are identified as formal private sector worker and the others are classified as informal wage workers.

Referring to Chart 1, it can be seen that we have 81 domestic workers, 153 unpaid family workers, and 199 formal public sector

Chart 1

OCCUPATION CLASSIFICATION OF FEMALE LABOR FORCES IN LIMA <sup>1/</sup>

Women Aged 15-65 in Lima 1985-86

2,387

↓

° Employed Labor Force except those who are engaged in agricultural production as a main job.		• Not Working	• Farmer
1,217		1,007	163
↓			
° Self-employed		• Domestic Worker	
° Unpaid family worker			
° Employee			
1,142		81	
↓			
° Employees		° Self-employed	
599		° Unpaid family worker	
↓		543	
° Paid Employees		• Unpaid family worker	
• Unpaid Employees			
(Informal Wage worker)			
569		390	
↓		↓	
° Private		• IPSS	
• Public		IPSS Offer	
• No		(Self-employed)	
370		199	
↓		Offer	
		(Formal private sector worker)	
° No IPSS		384	
• IPSS		6	
(Informal wage worker)			
(Formal private sector worker)			
206		158	

1/ The bolded numbers indicate the number of observations used for the descriptive analysis.

workers for the analysis. The 163 farmers are not considered in the empirical analysis in section 5 but in the descriptive analysis in the next section. Among the paid self-employed, only those who do not offer IPSS to their employees are identified as self-employed in the informal sector. The six paid self-employed workers who offer IPSS to the employees are classified as workers in the formal private sector. This means that 384 workers are identified as self-employed and 164 workers are classified as formal private sector workers which is the total of the 6 paid self-employed workers and the 158 private sector employees with IPSS. The rest of the female workers, which is composed of 30 unpaid employees and 206 private sector workers without IPSS, are classified as informal wage workers. As a whole, 1,217 females in the labor force composed of 81 domestic workers, 153 unpaid family workers, 236 informal wage workers, 384 self-employed workers, 164 formal private sector workers, and 199 formal public sector workers are the focus of the analysis.

#### 4.2 Descriptive Data Analysis

A basic descriptive data analysis is performed in such a way that it is compared with that of a previous study, Living Standard Measurement Study (LSMS)<sup>21</sup>, which also used

the same Peruvian household survey for the analysis of women's labor market participation in Peru. The significant difference in these two research derives from the identification procedure for occupation for female workers. The LSMS research did not distinguish between farmer, unpaid family worker, and unpaid employee and identified all of them as unpaid worker. In contrast, this research, first, sorts out farmers from the data and, second, combined the unpaid employees with those paid employees without social security and identified them as informal wage workers. Finally the rest of the unpaid workers are classified as unpaid family workers<sup>22</sup>. By excluding farmers from the data, this study tries to limit unpaid family workers to those who are engaged in supportive work for non-agricultural self-employed activity implemented by other family member(s) in household production units. In this way unpaid family workers can be narrowly defined as an employment status and its characteristics can be more rigorously depicted.

Using Table 4, the analysis of a contingency table is performed<sup>23</sup>. The null hypothesis is that women's age and their occupation choice are independent<sup>24</sup>. Comparing the expected frequencies with the actual ones in Table 4, the null hypothesis is rejected; there is a relationship between women's age and their occupation choice.

Table 4

#### NUMERICAL DISTRIBUTION OF WOMEN AGED 15-65 IN LIMA BY EMPLOYMENT STATUS<sup>1/</sup>

Age	Not working	Farmer	Unpaid family worker	Paid self-employed worker	Domestic worker	Informal wage worker	Formal private worker	Formal public worker	Total
15-24	412	22	64	50	47	104	37	39	775
25-34	182	47	41	105	14	94	72	84	639
35-44	142	37	26	114	12	22	31	59	443
45-54	129	32	16	71	7	10	19	14	298
55-65	142	25	6	44	1	6	5	3	232
Total	1,007	163	153	384	81	236	164	199	2,387

1/ Using data of last 7 days and last 12 months activities.

Carefully reading Table 4 as well as 5 and comparing them with results in the LSMS, some important findings should be stated. In terms of women's labor force participation as a whole, Table 5 indicates that women's labor force participation increased only up to ages 25-34, not 35-44 as reported by the LSMS. The findings in this research are consistent with the report of female economic activity described by Irma Arriagada<sup>25</sup>. She pointed out that it is a myth that female labor participation has a "U" shape with two maximum points: one before the birth of the first child and the other after the youngest child starts school. According to her research in 13 urban areas of Latin America, women's labor force participation increased up to ages 25-34 in 1980's and 35-44 in 1990's.

The LSMS also explains that "the proportion of paid workers in Lima increases up to ages 35-44". From Table 5, it can be more precisely depicted that this trend of paid workers in the labor market is attributed to self-employed and formal public sector workers. It can also be noticed that the female labor force in informal wage work and formal private sector work increases only up to ages 25-34.

In order to understand the urban life of female workers in each occupation, information on mean hours per week and mean months per year of work are presented in Table 6 through Table 9. Distinguishing farmers from unpaid family workers, it can be seen

that the working hours per week of unpaid family workers are very similar to that of the other workers in urban labor markets. LSMS summarized that "paid workers work much longer during a week than unpaid workers"<sup>26</sup>. Table 6, however, reveals that this statement does not describe the working life of unpaid family workers very well. It is fallacious to combine both unpaid family work and farm activity as unpaid work and to perceive it as part-time work to female workers.

Regarding the total number of working hours at home and in the market, self-employed and domestic workers work much longer than the other workers. This indicate that many women working in these two occupations are responsible for both the household chores and income earning activity due to the women's household headship and/or the absence of a husband. Long working hours per week in these two occupations may also have some relation with the lower education level of those female workers in terms of education in years. For more detailed information, see the descriptive analysis in section 4.4.

Considering mean months per year of work in each occupation, some of unpaid family workers, domestic workers, and informal wage workers work very short periods during a year. While these three occupations are not part-time work in terms of mean working hours during a week, they show some characteristics of temporary work in terms of working months per year.

Table 5

PERCENTAGE DISTRIBUTION OF WOMEN AGED 15-65<sup>1/</sup>

Age	Not working	Farmer	Informal Sector Work			Formal Sector Work			Total
			Non Wage Work		Domestic worker	Wage work			
			Unpaid family worker	Paid self-employed worker		Informal wage worker	Formal private worker	Formal public worker	
15-24	53.2	2.8	8.3	6.4	6.1	13.4	4.8	5.0	100.0
25-34	28.5	7.4	6.4	16.4	2.2	14.7	11.3	13.1	100.0
35-44	32.1	8.3	5.9	25.7	2.7	5.0	7.0	13.3	100.0
45-54	43.3	10.7	5.4	23.8	2.3	3.4	6.4	4.7	100.0
55-65	61.2	10.8	2.6	19.0	0.4	2.6	2.1	1.3	100.0

1/ Using data of last 7 days and last 12 months activities.

Table 6

MEAN HOURS PER WEEK OF HOUSEKEEPING AND WORK OF WOMEN<sup>1/</sup>

	Not working	Farmer	Unpaid family worker	Paid self-employed worker	Domestic worker	Informal wage worker	Formal private worker	Formal public worker
Mean hours per week for house-keeping (st. dev.)	41.82 (25.70)	52.06 (22.46)	34.02 (23.04)	36.25 (22.22)	26.11 (24.21)	27.17 (20.98)	22.98 (17.78)	27.54 (19.22)
Mean hours per week for work (st. dev.)	0	8.10 (6.18)	31.63 (24.02)	38.01 (25.18)	54.25 (20.11)	36.70 (18.44)	42.24 (10.37)	37.10 (9.55)
Total of mean hours per week for house keeping and work	41.82	60.16	65.65	74.26	80.36	63.87	65.22	64.64

1/ Using only last 7 days activities data.

Table 7

PERCENTAGE DISTRIBUTION OF HOURS OF WORK BY OCCUPATION<sup>1/</sup>

Working hours per week	Farmer	Unpaid family worker	Paid self-employed worker	Domestic worker	Informal wage worker	Formal private worker	Formal public worker
1-10	83.0	20.3	14.4	3.6	10.2	2.1	0.6
11-20	11.8	20.6	16.7	5.5	13.9	3.6	5.2
21-30	4.6	17.9	17.3	5.5	15.7	7.1	18.1
31-40	0	5.7	9.5	7.3	18.1	31.4	54.2
41-50	0	12.2	11.4	10.9	24.1	42.9	17.4
51-60	0.7	8.1	12.7	34.5	10.8	10.7	3.9
60+	0	12.2	18.0	32.7	7.2	2.1	0.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Using only last 7 days activities data.

Table 8

MEAN MONTHS PER YEAR OF WORK<sup>1/</sup>

Working months per year	Farmer	Unpaid family worker	Paid self-employed worker	Domestic worker	Informal wage worker	Formal private worker	Formal public worker
Mean months per year (st. dev.)	9.87 (3.81)	8.6 (4.45)	9.7 (3.66)	6.27 (4.64)	6.43 (4.75)	10.76 (2.85)	9.57 (4.13)

1/ Using only last 7 days activities data.

Table 9  
PERCENTAGE DISTRIBUTION OF WORKING MONTHS PER YEAR<sup>1/</sup>

Working months per year	Farmer	Unpaid family worker	Paid self-employed worker	Domestic worker	Informal wage worker	Formal private worker	Formal public worker
1-4	15.7	28.5	15.0	47.3	46.4	7.9	18.1
5-8	9.2	8.9	12.4	14.5	13.3	6.4	6.5
9-10	1.3	4.9	4.6	1.8	2.4	3.6	5.2
11-12	73.9	57.7	68.0	36.4	38.0	82.1	70.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Using only last 7 days activities data.

At last, regarding the two formal sector occupations, formal private sector workers work longer than formal public sector workers both in terms of working hours per week and working months per year.

#### 4.3 Explanatory Variables

For estimating women's labor force participation in Lima with seven occupation choices, the exogenous variables are defined so that they can explain the determinants of the offered wage rate across occupations, the differences in the opportunity cost of employment as well as other influential factors affecting the occupation choice of female workers.

The explanatory variables and their means and standard deviations are listed in Table 10. A dummy variable for academic diploma indicates one if the individual woman has a diploma from secondary technical school, post secondary non-university, university, or other higher educational institution. Defining a primary man as a husband or father of the female worker, this research inquires how husband's or father's education in years and occupation choice affect women's occupation choice<sup>27</sup>. If woman's husband does not live with her in the same household, then her father would be the primary man. A dummy for whether or not the primary man is self-employed indicates the woman's opportunity cost of working outside home.

To point out some important implications of the means and standard deviations of these explanatory variables, unpaid family workers are most frequently found in a household where primary man is self-employed. Domestic workers are the youngest among female workers and all the human capital variables show that they have the least education and training. In terms of the residence of the husband and the number of children in the household, many domestic workers seem to be mothers without husband. The primary men of domestic workers record the lowest schooling years.

The characteristics of formal private worker and formal public worker are very similar except for possession of an academic diploma and migratory status. Formal public sector workers are twice as more likely to possess an academic diploma as formal private sector workers. The mean of the primary male's education of these two formal sector occupations are the highest. Formal sector workers are the least likely to live in a household where the primary male is self-employed. Migratory status indicates an interesting result. Formal private sector workers are the least likely to be found among the recent migrants, while formal public sector workers are tend to be new migrants as likely as unpaid family workers and informal wage workers. This pattern was not observed in previous studies.

Table 10

MEANS AND STANDARD DEVIATION OF EXPLANATORY VARIABLES FOR MNL  
MODEL OF WOMEN'S LABOR FORCE PARTICIPATION IN LIMA <sup>1/</sup>

Exogenous Variables	Not working	Unpaid family work	Domestic work	Informal wage work	Self-employed work	Formal private sector work	Formal public sector work
Women's age (years)	33.23 (15.30)	29.84 (12.05)	26.72 (11.46)	27.43 (9.42)	38.42 (11.92)	32.40 (9.77)	32.80 (9.20)
Women's education (years)	7.54 (3.60)	7.37 (3.34)	5.91 (2.87)	9.12 (3.28)	6.44 (3.97)	10.41 (2.68)	11.16 (3.66)
Academic diploma (1, 0) 1 = yes, 0 = no	0.06 (0.23)	0.06 (0.24)	0.02 (0.16)	0.09 (0.28)	0.05 (0.23)	0.22 (0.42)	0.40 (0.49)
Received training diploma (1, 0) 1 = yes, 0 = no	0.19 (0.39)	0.24 (0.43)	0.09 (0.28)	0.39 (0.49)	0.29 (0.46)	0.58 (0.49)	0.56 (0.49)
Husband lives in the same household (1, 0) 1 = yes, 0 = no	0.50 (0.50)	0.53 (0.50)	0.24 (0.43)	0.31 (0.47)	0.61 (0.49)	0.38 (0.49)	0.48 (0.50)
Father lives in the same household (1, 0) 1 = yes, 0 = no	0.29 (0.46)	0.26 (0.44)	0.31 (0.46)	0.35 (0.48)	0.085 (0.29)	0.32 (0.47)	0.26 (0.45)
Household head (1, 0) 1 = yes, 0 = no	0.05 (0.22)	0.04 (0.15)	0.10 (0.30)	0.06 (0.24)	0.20 (0.40)	0.11 (0.31)	0.08 (0.27)
No. of children 0-2 in household	0.32 (0.60)	0.50 (0.90)	0.48 (1.06)	0.32 (0.57)	0.37 (0.76)	0.26 (0.55)	0.34 (0.60)
No. of children 3-6 in household	0.40 (0.67)	0.56 (0.75)	0.60 (0.92)	0.47 (0.71)	0.49 (0.73)	0.34 (0.63)	0.46 (0.72)
No. of children 7-10 in household	0.50 (0.74)	0.60 (0.92)	0.52 (0.81)	0.60 (0.84)	0.60 (0.90)	0.37 (0.73)	0.49 (0.73)
No. of girls 11-14 in household	0.27 (0.51)	0.24 (0.49)	0.43 (0.63)	0.27 (0.54)	0.28 (0.54)	0.21 (0.45)	0.24 (0.50)
No. of boys 11-14 in household	0.33 (0.59)	0.37 (0.65)	0.48 (0.76)	0.22 (0.48)	0.33 (0.60)	0.20 (0.44)	0.21 (0.53)
No. of women aged over 66 in household	0.10 (0.30)	0.04 (0.20)	0.11 (0.32)	0.08 (0.27)	0.07 (0.26)	0.11 (0.33)	0.18 (0.39)
No. of men aged over 66 in household	0.08 (0.27)	0.04 (0.195)	0.05 (0.22)	0.06 (0.26)	0.067 (0.25)	0.11 (0.31)	0.15 (0.36)
No. of non-working women 19-65 besides the woman herself in household	0.487 (0.714)	0.307 (0.565)	0.395 (0.54)	0.475 (0.687)	0.255 (0.557)	0.616 (0.778)	0.437 (0.714)
No. of non-working women 19-65 in household	1.28 (0.75)	0.31 (0.57)	0.395 (0.54)	0.481 (0.689)	0.255 (0.557)	0.616 (0.778)	0.439 (0.715)
Migratory status (1, 0) 1 = live in Lima less than 5 years, 0 = otherwise	0.11 (0.31)	0.12 (0.32)	0.17 (0.38)	0.11 (0.31)	0.07 (0.26)	0.04 (0.22)	0.12 (0.33)
No. of domestic workers residence in household	0.11 (0.39)	0.07 (0.27)	0 0	0.07 (0.27)	0.06 (0.36)	0.17 (0.46)	0.17 (0.46)
Primary male's education (years)	8.50 (4.10)	7.75 (3.60)	4.86 (2.40)	7.98 (4.10)	7.66 (3.70)	10.10 (4.10)	10.1 (4.30)
Primary male is self-employed (1, 0) 1 = yes, 0 = no	0.32 (0.47)	0.56 (0.49)	0.44 (0.50)	0.33 (0.47)	0.32 (0.47)	0.30 (0.46)	0.28 (0.45)

1/ Standard errors are in parentheses.

Informal wage workers reveal their mixed characteristics as compared to the other workers. Among wage workers, informal wage workers are the least likely to live with their husband and to be a household head. They are the youngest among wage workers and the second youngest of all workers, next to domestic workers. Only informal wage worker and domestic worker have higher mean value for the residence of father than for the residence of husband. In terms of the human capital endowments of female workers themselves and of the primary man in a household, all the educational variables of informal wage workers have the lowest mean value among wage workers but the highest mean among informal sector workers. Compared to the other wage workers, informal wage workers are found more frequently in a household where the primary man is self-employed.

In the previous section, it was shown that self-employed work constitutes one third of the female labor force in Lima. They are the most likely to be a household head. This is consistent with the findings of the previous studies that the female household heads are most likely to be self-employed. The rationale behind this is that the female household heads, who are frequently found in the poor households facing strong budget and time constraints, tend to choose to work as self-employed workers due to its compatibility with their family responsibilities. Contrary to this common observation, however, the dummy variable for the residence of husband shows that self-employed women are the most likely to live with their husband in the same household as compared to the other female workers. What can be hypothesized from this descriptive analysis is that self-employed workers are composed of two demographically distinctive groups of female workers.

## 5. Empirical Results

### 5.1 Results of MNL Model without Primary Male Information

The results of the maximum likelihood estimates of a multinomial logit (MNL) model of women's labor force participation are presented in Table 11. The statistically not significant explanatory variables are deleted from the full model and only the significant variables for determining some or all occupation choices are listed in Table 11<sup>28</sup>. The full model with all explanatory variables is included in the Appendix.

The results of the maximum likelihood estimates of the reduced MNL model in Table 11 reject the null hypothesis that all parameters equal zero at the 1% significance level having a 1,036.148 value of the test chi-squared statistic with 84 degrees of freedom. By differentiating the estimated equation with respect to age, it can be observed that labor force participation is maximized in each occupation at a different age: 29.7 for unpaid family worker, 29.4 for domestic worker, 31.7 for informal wage worker, 39 for self-employed worker, 38.1 for formal private sector work, and 37 for formal public sector work. The negative coefficients for Age2 (Age squared) indicate that women increase their labor force participation at a decreasing rate until they reach about age 30-40.

The overall impact of education on women's labor force participation is positive; however, its effect is not homogeneous among the occupation choices. Education affects negatively the probabilities of participation through self-employed and informal wage work and positively the probabilities of being engaged in other occupations. Education has a negative effect on self-employed work which is significant at the 5% level. On the contrary, the effect of education is positive and significant at the 5% level for domestic work and at the 10% level for formal private sector work. The probability of women working in the formal private sector is maximized at 13.3 years education.

Table 11

**MAXIMUM LIKELIHOOD ESTIMATES OF MNL OF WOMEN'S LABOR FORCE PARTICIPATION  
WITHOUT PRIMARY MAN'S INFORMATION<sup>1/</sup>**

Exogenous Variables	Not working	Unpaid family work	Domestic work	Informal wage work	Self-employed work	Formal private sector work	Formal public sector work
Constant	1.394	-2.67 (-2.94) <b>-0.0032</b>	-3.24 (-2.75) <b>-0.0107</b>	-4.243 (-4.977) <b>-0.168</b>	-4.74 (-6.65) <b>-0.358</b>	-12.73 (-9.304) <b>-0.435</b>	-9.37 (-8.07) <b>-0.415</b>
Age	-0.066	0.098* (1.99) <b>-0.002</b>	0.186** (2.77) <b>0.00106</b>	0.246** (5.17) <b>0.0126</b>	0.257** (7.01) <b>0.0222</b>	0.466** (7.79) <b>0.0147</b>	0.414** (6.97) <b>-0.0177</b>
Age2	0.0009	-0.00165** (-2.58) <b>0.000007</b>	-0.00316** (-3.34) <b>-0.000024</b>	-0.00388** (-5.78) <b>-0.00022</b>	-0.00329** (-7.40) <b>-0.00026</b>	-0.0061** (-7.67) <b>-0.000186</b>	-0.00559** (-7.06) <b>-0.000237</b>
Education in years	-0.0066	0.059 (0.618) <b>0.0036</b>	0.255 (1.725) <b>0.0042</b>	-0.0061 (-0.071) <b>-0.00067</b>	-0.147* (-2.56) <b>-0.027</b>	0.611** (3.76) <b>0.0257</b>	0.026 (0.261) <b>0.00086</b>
Education2	-0.00022	-0.0083 (-1.23) <b>-0.00059</b>	-0.0418** (-3.362) <b>-0.0007</b>	0.0023 (0.449) <b>0.00029</b>	0.0073 (1.78) <b>0.00131</b>	-0.023** (-2.786) <b>-0.00096</b>	0.0071 (1.303) <b>0.00046</b>
Academic diploma (1, 0)	0.0552	0.455 (1.03) <b>0.0264</b>	1.442 (1.79) <b>0.0233</b>	-0.0557 (-0.17) <b>-0.0051</b>	-0.301 (-0.913) <b>-0.068</b>	0.537 (1.73) <b>0.0186</b>	1.09** (3.88) <b>0.0605</b>
Training diploma (1, 0)	-0.174	0.42 (1.87) <b>0.0069</b>	-0.285 (-0.656) <b>-0.0107</b>	0.76** (4.357) <b>0.0449</b>	0.63** (4.04) <b>0.051</b>	1.05** (5.436) <b>0.031</b>	1.15** (6.17) <b>0.0508</b>
Household headship (1, 0)	-0.144	-0.124 (-0.23) <b>-0.0298</b>	0.117 (-0.218) <b>-0.0027</b>	-0.153 (-0.393) <b>-0.0123</b>	1.37** (4.68) <b>0.1853</b>	-0.367 (-0.897) <b>-0.0041</b>	-0.26 (-0.63) <b>-0.00063</b>
Husband residence	0.178	-0.323 (-1.07) <b>0.001</b>	-2.04** (-5.17) <b>-0.0296</b>	-1.308** (-5.38) <b>-0.1013</b>	-0.1438 (-0.63) <b>0.0326</b>	-1.327** (-4.53) <b>-0.0426</b>	-0.96** (-3.44) <b>-0.0385</b>
Father residence	0.125	-0.205 (-0.72) <b>0.0023</b>	-0.57 (-1.77) <b>-0.0059</b>	-0.58** (-2.71) <b>-0.0356</b>	-0.557* (-2.14) <b>-0.0544</b>	-0.63* (-2.26) <b>-0.017</b>	-0.47 (-1.70) <b>-0.0142</b>
No. of children 0-2	-0.03	0.195 (1.72) <b>0.01</b>	0.126 (0.83) <b>0.0012</b>	-0.0019 (-0.015) <b>-0.0062</b>	0.166 (1.71) <b>0.0184</b>	-0.018 (-0.106) <b>-0.0032</b>	0.213 (1.542) <b>0.0096</b>
No. of boys 11-14	0.0272	0.0825 (0.59) <b>0.01</b>	0.205 (1.197) <b>0.0045</b>	-0.355* (-2.37) <b>-0.0317</b>	-0.0069 (-0.064) <b>0.0075</b>	-0.287 (-1.52) <b>-0.0101</b>	-0.174 (-1.05) <b>-0.0075</b>
No. of women aged over 66	0.104	-0.952* (-2.196) <b>-0.0569</b>	-0.086 (-0.217) <b>0.0019</b>	-0.52 (-1.89) <b>-0.0337</b>	-0.359 (-1.53) <b>-0.0275</b>	-0.459 (-1.55) <b>-0.0113</b>	0.178 (0.718) <b>0.0231</b>
No. of non-working women 19-65	0.049	-0.449** (-2.72) <b>-0.0268</b>	-0.272 (-1.36) <b>-0.0031</b>	-0.18 (-1.51) <b>-0.009</b>	-0.252* (-2.13) <b>-0.0268</b>	0.25 (1.90) <b>0.0148</b>	-0.068 (-0.494) <b>0.0015</b>
Migratory status (1, 0)	0.07	-0.0454 (-0.161) <b>0.0066</b>	0.086 (0.252) <b>0.0038</b>	-0.2002 (-0.804) <b>-0.0069</b>	-0.436 (-1.82) <b>-0.0511</b>	-0.828* (-2.07) <b>-0.0298</b>	-0.024 (-0.084) <b>0.0067</b>
No. of observations	1,007	153	81	236	384	164	199
Log likelihood	-3,069.435						
$\rho$	0.1442						
Chi-Squared	1,036.148						
Degrees of freedom	84						

1/ Parameter coefficients are estimated by assuming  $\beta_n = 0$ . The asymptotic t-statistics are given in parentheses and the partial derivatives are indicated with bold numbers.

\*  $P < 0.05$

\*\*  $P < 0.01$

In order to reconsider the impact of education in years on those occupations which indicated the low values of education<sup>2</sup> (education squared) in Table 11, a MNL model without education<sup>2</sup> was estimated. In this way it can be tested whether or not education<sup>2</sup> is reducing the explanatory power of education on those occupation choices. The result of the MNL model revealed a positive effect of education on formal public sector work at the 1% significance level. This indicates that the relation between education in years and formal public sector work is explained very well by a linear rather than a quadratic function.

Not only education in years but also possession of an academic diploma has a positive and significant effect on it. An academic diploma is the dominant factor to enter formal public sector work. Different from an academic diploma, a training diploma significantly increases the likelihood of engaging in not only formal public sector work but also unpaid family work, self-employed work, informal wage work, and formal private sector work.

To consider how demographic conditions affect the individual woman's decision to work, the dummy variables for the presence of a husband, for the presence of a father, and for woman's household headship are included in the model. The presence of a husband in the same household is hypothesized to increase the women's opportunity cost of labor force participation and to reduce the probability of working in the market. The hypothesis is accepted at the 1% significance level for all occupation choices except unpaid family work and self-employed work. Among the occupation choices, the negative impact of a husband on the likelihood of women's labor force participation is the most significant for informal wage work. For self-employed women, the presence of a husband may provide the opportunity for them to have access to credit. This can be a part of the reason for the non-significant effect of a husband on engaging in self-employed work.

The presence of a father negatively and significantly affects women's labor force participation for all occupations except unpaid family work. However, the overall impact of father on women's labor force participation is less significant than that of husband. For only on self-employed women, the presence of father has more negative and significant effect.

Regarding the impact of household headship, remember that the reported household headship used in this research does not necessarily mean that the individual woman heading a household is a major income earner. Rather, they are simply perceived as a head of the household by other members. From previous research, it has been understood that many female workers heading a household are engaged in self-employed work in order to make it possible to work both at home and in the market. The result of this MNL model supports this idea; self-employed work is the only occupation which is positively and significantly related to household headship. Being a household head increases the probability of a woman working as self-employed by 18.5 percent. It might be interesting to test how this result would change if household headship were defined as a major income earner.

As a proxy for child care costs, the number of children in different age and sex groups are included. The number of children 0-2 in the household shows a positive impact on women's labor force participation. Its effect is significant at the 10% level for unpaid family work and self-employed work. This positive relation between the two occupations and the number of children 0-2 indicates the compatibility of work at the household production units with child care. Furthermore, the positive relation between self-employed work and the number of children 0-2 can be explained by the fact that 30 percent of female self-employed workers live without a primary man in the same household and 20 percent of those without a primary man are self-employed. With the re-

sponsibility to raise children without a primary man, the individual woman may choose to work as self-employed, which makes it possible for them to earn income, to do the household chores, and to take care of their children.

The number of women over age 66 has a negative and significant effect on unpaid-family work and informal wage work. Those women over age 66 require care at home, which prevents the individual woman from working in these occupations. An additional woman over age 66 in the household decreases the probability of women working by 10.4 percent.

The number of non-working women 19-65 besides the female worker herself in the household is expected to increase woman's labor force participation by decreasing her opportunity cost of working in the market. The MNL model, however, presents mixed results. The coefficients imply that non-working women 19-65 strongly discourage women from working at unpaid family work and self-employed work but encourage them to work in the formal private sector. The partial derivatives are positive for formal sector work but negative for informal sector work. Further empirical analysis is necessary to fully comprehend the allocation of time between non-working and working women in the household.

At last, the coefficients of the dummy variable for migratory status are estimated. It is interesting to notice that migratory status does not affect entrance to formal public sector work. The estimated results imply that once the characteristics to be an employee in the formal public sector such as schooling years and possession of an academic diploma are satisfied, migratory status does not affect working there. To the contrary, the effect of migratory status is negative and significant at the 10% level for self-employed and at the 5% level for formal private sector work. If a woman lived in Lima less than 5 years, it would be difficult for her to participate in the labor market through these two occupations.

## 5.2 Results of MNL Model with Primary Male Information

Finding that both the presence of husband and father in the household affect significantly the individual woman's occupation choice in Table 11, this section inquires how the characteristics of the primary man such as their education level and occupation choice affect women's labor market participation and occupation choice. Women's labor market participation is estimated by using the multinomial logit model with numerical variables for the primary man's education and a dummy variable whether or not the primary man is self-employed. Consequently, the number of observations for the analysis decreased to 1,651. The impact of the primary man's education in years can be a proxy to evaluate the cross-wage-rate effects of men on women's allocation of time. The dummy variable predicts how the production opportunities in the household affect women's labor force participation and occupation choice. The dummy variable for the residence of husband is included in the model to observe how it affects the women's occupation choice after controlling the primary man's education in years and occupation choice. The estimation results of the full model with these additional explanatory variables is presented in table A.2 in Appendix.

After deleting the insignificant variables from the full model, the reduced model of women's labor force participation with information for the primary man is presented in Table 12<sup>29</sup>. Comparing the estimation results in Table 11 with those in Table 12, it is important to notice that the significant explanatory variables in each model are different; for women living with a primary man, the number of children 3-6 and the number of children 7-10 is a significant factor in deciding their labor market participation, while the number of women over age 66, migratory status, and household headship are not significant.

Table 12

MAXIMUM LIKELIHOOD ESTIMATES OF MNL OF WOMEN'S LABOR FORCE PARTICIPATION  
WITH PRIMARY MAN'S INFORMATION<sup>1/</sup>

Exogenous Variables	Not working	Unpaid family work	Domestic work	Informal wage work	Self-employed work	Formal private sector work	Formal public sector work
Constant	<b>1.40</b>	-3.70 (-3.99) <b>-0.096</b>	-4.78 (-2.62) <b>-0.022</b>	-3.71 (-3.36) <b>-0.146</b>	-4.72 (-5.27) <b>-0.29</b>	-14.71 (-7.55) <b>-0.444</b>	-9.74 (-6.47) <b>-0.399</b>
Age	<b>-0.089</b>	0.245** (3.89) <b>0.00679</b>	0.431** (3.71) <b>0.00255</b>	0.312** (4.64) <b>0.0173</b>	0.362** (7.08) <b>0.025</b>	0.628** (7.25) <b>0.017</b>	0.508** (6.57) <b>0.019</b>
Age2	<b>0.0011</b>	-0.003** (-3.90) <b>-0.0000828</b>	-0.0063** (-3.60) <b>-0.00004</b>	-0.0045** (-4.62) <b>-0.00027</b>	-0.004** (-6.58) <b>-0.00027</b>	-0.008** (-6.71) <b>-0.0002</b>	-0.0063** (-6.09) <b>-0.00024</b>
Education in years	<b>0.00247</b>	-0.043 (-0.362) <b>-0.00268</b>	0.267 (1.19) <b>0.00243</b>	-0.099 (-0.88) <b>-0.0099</b>	-0.208* (-2.41) <b>-0.025</b>	0.78** (3.10) <b>0.0281</b>	0.075 (0.495) <b>0.0042</b>
Education2	<b>0.00179</b>	0.0052 (0.653) <b>-0.000155</b>	-0.04* (-2.09) <b>-0.00038</b>	0.015* (2.27) <b>0.00127</b>	0.015* (2.55) <b>0.0014</b>	-0.028* (-2.40) <b>-0.0011</b>	0.0107 (1.40) <b>0.00042</b>
Academic diploma (1, 0)	<b>0.0624</b>	-0.211 (-0.382) <b>-0.00747</b>	1.08 (0.94) <b>0.0106</b>	-0.488 (-1.17) <b>-0.0403</b>	-0.925* (-1.99) <b>-0.0994</b>	0.646 (1.79) <b>0.0268</b>	0.777* (2.18) <b>0.0473</b>
Training diploma (1, 0)	<b>-0.186</b>	0.26 (0.924) <b>-0.00326</b>	0.023 (0.042) <b>-0.00255</b>	0.84** (3.68) <b>0.0558</b>	0.754** (3.55) <b>0.054</b>	1.14** (4.61) <b>0.0299</b>	1.28** (5.31) <b>0.0523</b>
Husband residence	<b>0.319</b>	-1.11** (-2.83) <b>-0.04</b>	-2.16** (-3.87) <b>-0.0147</b>	-1.47** (-4.50) <b>-0.099</b>	-0.899** (-2.66) <b>-0.045</b>	-1.92** (-5.33) <b>-0.05</b>	-1.83** (-5.20) <b>-0.0704</b>
No. of children 0-2	<b>-0.055</b>	0.29* (1.99) <b>0.0137</b>	0.25 (1.41) <b>0.0015</b>	0.094 (0.604) <b>0.00033</b>	0.313* (2.43) <b>0.027</b>	-0.024 (-0.109) <b>-0.0041</b>	0.408* (2.49) <b>0.017</b>
No. of children 3-6	<b>-0.041</b>	0.19 (1.26) <b>0.00866</b>	-0.0178 (-0.076) <b>-0.00076</b>	0.18 (1.34) <b>0.012</b>	0.207 (1.65) <b>0.017</b>	-0.168 (-0.887) <b>-0.0084</b>	0.304* (1.99) <b>0.013</b>
No. of children 7-10	<b>-0.002</b>	0.012 (0.086) <b>0.00057</b>	-0.24 (-1.055) <b>-0.0022</b>	0.078 (0.647) <b>0.0078</b>	0.12 (1.13) <b>0.014</b>	-0.45* (-2.49) <b>-0.016</b>	-0.04 (-0.27) <b>-0.0023</b>
No. of boys 11-14	<b>0.041</b>	-0.75 (0.44) <b>0.0098</b>	0.286 (1.34) <b>0.0032</b>	-0.363* (-2.014) <b>-0.031</b>	0.004 (0.029) <b>0.0086</b>	-0.44 (-1.825) <b>-0.0135</b>	-0.41 (-1.818) <b>-0.018</b>
No. of non-working women 19-65 <sup>2/</sup>	<b>0.537</b>	-2.48** (-11.55) <b>-0.109</b>	-1.79** (-6.09) <b>-0.00813</b>	-1.85** (-11.20) <b>-0.10</b>	-2.715** (-15.57) <b>-0.22</b>	-1.58** (-8.52) <b>-0.025</b>	-2.23** (-11.31) <b>-0.072</b>
Primary man's education in years	<b>0.0188</b>	-0.066 (-1.916) <b>-0.0024</b>	-0.244** (-3.85) <b>-0.0019</b>	-0.105** (-3.57) <b>-0.0077</b>	-0.077** (-2.75) <b>-0.0056</b>	-0.0147 (-0.447) <b>0.00058</b>	-0.062 (-1.87) <b>-0.0017</b>
Primary man is self-employed (1, 0)	<b>-0.0238</b>	0.84** (3.80) <b>0.055</b>	0.152 (0.443) <b>0.001</b>	-0.024 (-0.113) <b>-0.0066</b>	-0.145 (-0.771) <b>-0.022</b>	0.153 (0.603) <b>0.004</b>	-0.099 (-0.403) <b>-0.0075</b>
No. of observations	800	121	44	156	268	114	148
Log likelihood	-1,870.378						
$\rho$	0.2728						
Chi-Squared	1,403.892						
Degrees of freedom	84						

1/ Parameter coefficients are estimated by assuming  $\beta_n = 0$ . The asymptotic t-statistics are given in parentheses and the partial derivatives are indicated with bold numbers.

2/ With the variable for the number of non-working women besides the woman herself in the household, the model cannot be estimated due to a singular Hessian. Since the factors causing this problem cannot be found, the model with primary man is estimated by using the information on the number of non-working women in the household. In this way, the non-working women are counted for both right and left hand sides of the equation.

\* P < 0.05

\*\* P < 0.01

In households where the individual woman lives with a primary man, his education in years significantly affects the woman's labor force participation. Its effect is negatively significant at the 1% level on those women who are engaged in domestic work, informal wage work, or self-employed work. The higher the primary man's education, the less likely women keep working in urban labor markets in these occupations<sup>30</sup>. The primary man's education is negatively associated with women's unpaid family work and formal public sector work at the 10% significance level. It is interesting to find out that the primary man's education has no significant impact on women working in the formal private sector.

The dummy variable for self-employment of the primary man is strongly and positively related to women's labor force participation through unpaid family work. If the primary man is self-employed, the probability of the woman being engaged in unpaid family work is increased by 5.5 percent.

Considering the effect of women's own human capital endowment on their occupation choice after controlling for the primary man's education and self-employment status, the woman's education has a significant and positive impact only on those who work in the formal private sector. The probability of working in that sector is maximized with 13.9 years education. Possession of an academic diploma decreases the probability of working as self-employed by 9.94 percent and increases the probability of working in the formal public sector by 4.73 percent. A training diploma affects significantly and positively women's labor market participation in all occupations at the 1% level but unpaid family work and domestic work.

In terms of the factors affecting women's opportunity cost of labor market participation, the overall impact of the presence of husband is strongly negative. The probability of the woman working in the market is reduced by 32 percent, if her husband lives with her in the same household. The number of children 0-2 is positively related with women's decision to participate in the labor market

through unpaid family work, self-employment, and formal public sector work at the 5% significance level. Also the number of children 3-6 has a positive and significant effect on self-employed work at the 10% level and formal public sector work at the 5% level. The positive relation of the number of children 0-2 and 3-6 to women's work in familial production units is explained by the compatibility of that work with child care. Similarly the positive and significant relation between the number of children 0-6 and formal public sector work is interpreted as a result of the fringe benefits and/or the high income of the public sector which makes it possible for young mothers to raise children and to keep working in this sector by hiring domestic workers who do not reside at, but commute to their house.

### 5.3 Test for Combining the Occupation Choices

This section presents the results of the test of whether or not some of the occupation choices can be combined in estimating women's labor force participation in Lima. Rather than combining the occupation choices at random, this research combines them based on the four specific objectives of the tests<sup>31</sup>.

The first objective is to inquire if informal wage work is a distinctive occupation choice for women in Lima. To be specific, the five occupation choice models (Model 1 through Model 5) are created to find an occupation which is the most similar choice to informal wage work and to test whether or not they can be combined as an occupation choice to estimate women's labor force participation in Lima. From Model 1 through Model 5, each model tests whether or not informal wage work can be combined with one of the occupation choices.

Table 13 shows that the value of the chi-squared statistic of Model 1 is the most similar to and that of Model 3 is the least similar to the chi-squared statistic of the original model. This suggests that unpaid family work is the most like and self-employed work is the least like informal wage work.

Table 13

## STATISTICAL RESULTS OF THE COMBINED MODELS

Type of Model	Combined Occupation	Log likelihood function	Restricted log likelihood	Chi-squared	Degrees of freedom
Original model in Table 11	No nesting	-3,069.435	-3,587.509	1,036.1480	84
Model 1	Unpaid family work and Informal wage work	-2,839.196	-3,326.798	975.2044	70
Model 2	Domestic work and Informal wage work	-2,938.864	-3,407.352	936.9757	70
Model 3	Self-employed work and Informal wage work	-2,752.147	-3,175.594	846.8943	70
Model 4	Formal private sector work and Informal wage work	-2,839.064	-3,316.766	955.4036	70
Model 5	Formal public sector work and Informal wage work	-2,825.059	-3,287.566	925.0125	70
Model 6	All informal sector works (Unpaid family work, Domestic work, Informal wage work, Self-employed work)	-2,176.964	-2,523.186	692.4453	42
Model 7	All formal sector work (Formal private work and Formal public work)	-2,841.681	-3,337.587	991.8113	70
Model 8	All employee (Informal wage work, Formal private work, Formal public work)	-2,499.797	-2,935.958	872.3201	56
Model 9	All non-employee (Unpaid family work, Domestic work, Self-employed work)	-2,607.193	-3,026.593	838.8018	56
Model 10	Not working and Unpaid family work	-2,641.029	-3,135.137	988.2155	70

Comparing the chi-squared statistic of the original model with that of Model 1, it can be tested whether or not model 1 can estimate women's labor market participation as well as the original one. If unpaid family and informal wage work are similar enough to be combined as an occupation, then the test result will show that Model 1 is as a good model as the original one.

The null hypothesis is that Model 1 is as good as the original model. Given the 60.94 difference in chi-squared statistics (1,036.148 -

975.2044 = 60.94) with 14 degrees of freedom (84 - 70 = 14), the null hypothesis is rejected at the 1% significance level. The original model with 7 occupation choices predicts the women's labor force participation much better than model 1 with 6 occupation choices. Consequently, it is concluded that informal wage work is a unique occupation choice to women and can not be combined with any other occupation choices.

The second objective is to exam how close the occupation choices are within the

informal and formal sector respectively. Model 6 is designed to test whether or not the four informal sector occupations can be combined. The null hypothesis is that Model 6 can estimate women's labor force participation as well as the original one. If the four informal sector occupations are similar enough to be combined, then the null hypothesis will be accepted<sup>32</sup>. Rejecting the null hypothesis, the statistical results implies that informal sector work is heterogeneous and, therefore, can not be unified as one occupation choice.

Model 7 is created to test whether or not the two formal sector occupations can be combined. The null hypothesis is that Model 7 can estimate the women's labor supply as well as the original one. If the characteristics of the two formal sector occupations are similar enough to be combined, then the null hypothesis will be accepted<sup>33</sup>. The obtained statistics indicates that it is necessary to distinguish between formal private sector work and formal public sector work in order to estimate women's labor force participation in the urban area.

From the results explained above, it is apparent that the original model with seven occupation choices can predict women's labor market participation better than either Model 6 or Model 7. From these statistical tests, it is now obvious that heterogeneity of the occupations exists not only between the informal and formal sector work but also within each sector.

The third objective is to test the similarities of the occupations within the employee and non-employee work. In Model 8, three employee work categories are combined as an occupation choice and women's labor force participation is estimated with five occupation choices<sup>34</sup>. The test result points out that all three employee work categories provide distinctive occupation choice to women working in the urban labor markets in Lima.

To the contrary, Model 9 combines all non-employee informal sector work, creating a five occupation choice model<sup>35</sup>. The statistical analysis implies that non-employee work in the informal sector are not similar enough to

be combined as one occupation choice in the estimation model.

The forth objective is to test whether or not unpaid family work and non-working status can be combined in the MNL model. The past research tends to describe unpaid family work as part-time or fringe work for women in urban labor markets; however, the descriptive analysis in Table 6 and 7 shows that unpaid family work is not significantly different from the other occupations in terms of women's working hours per week.

If unpaid family work tends to be fringe work to women and does not make a difference from a non-working condition, then they can be combined as an occupation choice and Model 10 can estimate women's labor supply as well as the original one. Comparing the two models, the empirical analysis concludes that to be an unpaid family worker is significantly different from not participating in urban labor markets. Unpaid family work is a distinctive occupation choice to women in Lima<sup>36</sup>.

## 6. CONCLUSION

Empirical analysis of this research emphasizes the heterogeneity of the urban informal employment sector and the significance of informal wage work for female workers in Lima, Peru. Some of the findings underlines the deficiencies of previous research and misunderstanding of informal sector.

Pointing out some important findings, both descriptive and empirical analysis showed that unpaid family work is not part-time work in terms of working hours per week. Self-employed and unpaid family work presented their compatibility with household chores and child care, working longer hours for housekeeping than the other workers. Informal wage workers showed mixed characteristics of informal sector workers and formal wage workers. In terms of the human capital endowments of female workers themselves and of a primary man in the household, all the educational variables of informal wage work-

ers had the lowest mean value among the wage workers but the highest mean among the informal sector workers. The results of the MNL models indicated that while education in years and possession of an academic diploma positively and significantly affect formal public- and private- sector work, these factors of human capital endowments do not have any significant impacts on informal wage work.

Also compared to formal wage workers, informal wage workers were more frequently found in the household where the primary man is self-employed. All these findings draw a picture of informal wage work as a transitional occupation from informal sector to formal sector work. It shares the grey area between the formal and informal sector.

The two formal sector occupations, formal private- and public- sector work, are the most similar choices among the seven occupations. However, the distinctive characteristics of these occupations are recognized in such a way that the entrance to public sector work is restricted to those who possess an academic diploma.

In terms of the differences and the similarities of female workers across the seven occupations, the results of this research make it interesting to examine the structure of women's labor market participation decision by using a nested multinomial logit (NMNL) model. Comparing the full and the reduced form of the MNL models, this research verified that none of the seven occupations are similar enough to be combined as an occupation choice. However, it is still worth testing whether some occupations are more substitutable choices for female workers than other occupations. In that way the process of occupation choice by female workers will be understood better.

Regarding the factors affecting women's labor force participation, age plays an important role. In terms of the relation between women's age and self-employed activity, the findings in this research correspond to what Yamada<sup>37</sup> reported in his research. The results of this research and of Yamada's work

indicate the life-cycle pattern of women's labor force participation; as women get older, they are more likely to be engaged in self-employed work rather than to work in the other occupations in the formal and informal sector. This point still needs to be empirically tested by using the longitudinal data for the individual's work experience over time.

Another important factor affecting women's occupation choice is their human capital endowments. Its impact on their labor force participation across the seven occupations and its relation with a primary man's education level is not simple. In terms of general education, controlling for the primary man's education in years and occupation, women's education in years is effective only to formal private sector work and their possession of an academic diploma is positively significant only for formal public sector work. Contrary to general education, specific education represented by a training diploma is positively associated with self-employment, informal wage work, and formal private- and public- sector work at the 1% significance level. This is the only variable for women's human capital endowments for which its positive effect on women's labor force participation does not decrease significantly after controlling for the primary man's education. The overall impact of the primary man's education on women's labor force participation seems to be negative. In future research, it might be interesting to see how the human capital endowments of women and of the primary man affect women's decision of both current and long term labor force participation.

Reviewing the results of this research, what can we suggest to the policy makers? In terms of education, policy implications can be divided into the two segments: expansion and enhancement of specific education i.e. job training in the short-run as well as general education in the long-run. On the one hand, the immediate need for better training opportunities is closely related to poverty alleviation among the female household heads working as self-employed. On the other hand, the im-

provement of general education is an issue of timing when the informal private sector is merged into the formal sector.

The results of the MNL model indicated that household headship increases the probability of women's labor market participation by 14.4 percent and the probability of being self-employed by 18.5 percent. This means that those women heading households are disproportionately represented in self-employment. As described in previous research, subsistence needs of the female headed households are strongly related with poverty in the urban area and expansion of informal activities. A training diploma is the only variable for human capital which is positively and significantly related with self-employment. Increasing training opportunities will support women's self-employment work and such a policy can prevent further growth of poverty.

Considering the impact of general education denoted by education in years and an academic diploma, it is not significantly

related with informal sector work; it shows a positive effect only on domestic work at the 10% significance level. In other words, improvement of women's education level needs to be linked with expansion of the employment opportunities in the formal sector corresponding with the transition of the informal private sector to the formal. Otherwise, there will be no place to utilize the educated female workers.

The results of this research confirmed that it is the female informal wage workers who are in the transitional path between the formal and informal sector. They are young and the most educated workers in the informal sector. On the one hand, policy makers need to find a way to integrate these talented workers into formal economic activity. On the other hand, the further research on informal wage work in urban areas is critical to understand the labor force movement between the formal and informal sector and to integrate women, especially young educated workers, into development.

## NOTES

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  22. In order to see how these specifications of occupation choices create differences between the two studies, the descriptive data analysis includes the farmers; however, they are not included in the empirical analysis in section 5.
  23. For the explanation for the contingency evaluation, see Freund, John E., *Mathematical Statistics*, 5th ed., United States: Prentice Hall, Inc. 1992.
  24. The obtained test chi-square statistic is 449.54, compared with the critical chi-squared statistic with 28 degrees of freedom at the 0.01 significance level ( $\chi^2_{.01,28} = 52.336$ ).
  25. Arriagada, Irma, *op. cit.*
  26. King, Elizabeth M., *op. cit.*
  27. In the Peruvian household survey, the spouse (husband) is defined as those who are living together or married.
  28. After running a MNL model with all explanatory variables, the number of domestic workers, the number of men over age 66, the number of girls 11-14, and the number of children 7-10, and the number of children 3-6 appeared not to be significant in determining women's labor force participation.
  29. The test chi-squared statistic is 1,403.892 with 84 degrees of freedom and, therefore, the null hypothesis that all parameters are equal to zero is rejected at the 1% significance level.
  30. It is expected that the cross-wage-rate effects of the primary man on women's labor supply are strong among female workers in these occupations, which is not tested in this research.
  31. Even though the objectives of the tests are different, the testing procedure is the same. All the testing models (Model 1 through Model 10) are compared with the original model in Table 11 in terms of the chi-squared statistics and the degrees of freedom. Using the results of the model estimation, further details of the procedure are explained later.
  32. Comparing Model 6 with the original one and given the  $343.7027 (1,036.148 - 692.4453 =$

- 343.7027) difference in chi-squared statistics with 42 degrees of freedom ( $84 - 42 = 42$ ), the null hypothesis is rejected at the 1% significance level.
33. Comparing Model 7 with the original one and given the 44.3367 difference in chi-squared statistics with 14 degrees of freedom ( $84 - 70 = 14$ ), the null hypothesis is rejected at the 1% significance level.
  34. Compared with the original model, a 163.828 difference in the test chi-squared statistics with 28 degrees of freedom is obtained. The test statistic rejects the null hypothesis that model 8 can estimate the women's labor supply as well as the original one at the 1% significance level.
  35. The difference in value of the chi-square between Model 9 and the original model is 197.197 with 30 degrees of freedom. The test statistic rejects the null hypothesis that Model 9 can predict women's labor market participation as well as the original one at the 1% significance level.
  36. The null hypothesis is that Model 10 can be an estimation model as good as the original one. Given the 47.9325 difference in value of the chi-square with 14 degrees of freedom, the null hypothesis is rejected at the 1% significance level.
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