GREDI
Groupe de Recherche en Économie et Développement International

Cahier de Recherche / Working Paper
11-19

A segmented labor supply model estimation for the construction of a CGE microsimulation model: An application to the Philippines

Dorothée Boccanfuso

Luc Savard

UNIVERSITÉ DE SHERBROOKE

A segmented labor supply model estimation for the construction of a CGE microsimulation model: An application to the Philippines[1]

D. Boccanfuso[⬩] and L. Savard[❖]

November 2011

Abstract: Labour market analysis is an important element to understand the inequality and poverty within a given population. The literature reveals that the informal sector is characterised by a great deal of flexibility and exempt from formal market rigidities but on the other hand, this sector can constitute a trap from which it is difficult to exit for workers active in the sector with low wages. In this paper we aim to identify the main characteristics differentiating the labor supply of workers on the informal and formal market in the Philippines while estimating these two labor supplies, capturing discrete choice or changes in employment status. We use these estimates to construct a labor supply model that can serve as an input for a broader macro-microsimulation model applied to the Philippines. The results of the estimation provide relatively intuitive findings, highlighting some differences between the two markets. We also contribute to shedding some light into this macro-microsimulation modelling framework that is generally opaque in describing how to construct a microsimulation model with endogenous discrete choice model linked to a CGE model.

Key-words: labor supply, informal sector, microsimulation, discrete choice model, Philippines

JEL Classification: C35, O53, J24, C81, O17

[1] The authors would like to thank François Bourguignon for the inspiration for this article and for his precious comments to improve it but standard caveats apply and we are solely responsible for the content of this paper.

[⬩] Professor GRÉDI, Université de Sherbrooke, Département d'économique, Faculté d'Administration; 2500, boulevard de l'Université, Sherbrooke (Québec), J1K 2R1; dorothee.boccanfuso@usherbrooke.ca

[❖] Professor GRÉDI, Université de Sherbrooke, Département d'économique, Faculté d'Administration; 2500, boulevard de l'Université, Sherbrooke (Québec), J1K 2R1; luc.savard@usherbrooke.ca

1. Introduction

Labour market analysis is an important element to understand the inequality and poverty within a given population. The type of employment held by workers in an economy is a key determinant to the income they will draw and hence on the welfare of the households in a given population. Identifying and understanding factors influencing the labor supply in a developing country is a crucial element to improve the welfare of households (Fields, 2009). Indeed, this allows for improved policy design targeting poverty and inequality reductions. However, as Thomas and Vallée (1996) suggest, the traditional programs targeting poverty reduction can fail if labor market segmentation is not taken into account. Labour market segmentation in developing countries is often perceived as a barrier to social progress of poor households (Fields, 1975; Gindling, 1991). Moreover, as described by Thomas and Vallée (1996), Leontaridi (1998) or Gupta and Mitra (2002), working in the informal sector[2] can constitute a trap from which it is difficult to exit since workers need to work long hours for low wages. In addition to this problem, the time spent at work prevents them from acquiring skills or qualifications required in the formal sector jobs. These workers have much less free time to seek employment in the formal sector segment of the labor market. According to Piore (1972), persistence of poverty is at the origin of the labor market segmentation theory (LMS).

The informal sector is often characterised by a great deal of flexibility (entry into the sector and exit, flexible wages, flexible hours, and weak margins) and exempt from formal market rigidities. Some see the sector as a source of growth (Gang and Gangopadhyay, 1990; Besley and Burgess, 2004; Loayza, Oviedo and Serven. 2006; D'Souza, 2010). The labor market segment is also seen as the social security net in economies that don't have the resources or the political will to implement unemployment insurance or social security system for workers that don't have access to the formal sector employment. For these authors, a dynamic informal sector plays shock absorption for exogenous or endogenous negative impact on the formal sector. However, many

[2] Herein, we define the informal sector as one that does not comply with regulations and that is not covered by fiscal control from the government. The ILO popularized this dualism concept (formal-informal) with their series of studies on the informal sector in the early 1970s.

empirical studies (Lewis, 1958; Peng, Zucker and Darby, 1997) have demonstrated that this sector is much less productive compared to the formal sector which greatly limits its potential to contribute to growth of an economy. Fortin, Marceau and Savard (1997), show that the growth of an informal firm is correlated with its cost to remain in the informal sector. Moreover, informal firms in general do not have access to government programs promoting the development of small and medium size firms.

The origin of the informal sector in which workers are faced with "underemployment" is often explained by the high cost for firms of becoming formal. These costs can include fees that must be paid to acquire all permits, licenses and authorizations to operate in the formal sector. Furthermore, the weight of taxation can be very important in addition to the cost of complying with various forms of rules and regulations imposed on formal sector firms (Bargain and Kwenda, 2009). Many authors (Fortin, Marceau and Savard, 1997; Badaoui, Strobl, and Walsh, 2010) have illustrated that the presence of these factors in developing countries is associated the emergence or presence of important informal sector.

When investigating the competitiveness of formal and informal labor markets, two views emerge in the literature. On one hand, authors argue that participation in the different markets is a voluntary choice of workers. With this perspective, the worker is perceived as a utility maximizing agent and not a revenue maximising agent (Rosenzweig, 1988; Gindling, 1991; Maloney, 2004). On the other hand, authors assume that workers participate in the informal segment of the labor market as a result of barriers (institutional and fiscal) or to escape involuntary unemployment prevailing in the formal labor market segment and therefore limiting the access to this formal sector[3]. We can then make reference to labor market segmentation.

Many arguments justify the wage gap between the two sectors when workers are endowed with the same skills. First, government interventions to impose a minimum wage above the natural equilibrium wage level and/or of regulation on wages for workers

[3] We can highlight that the wage gap between the two labor market segments does not necessarily imply a formal-informal segmentation. Indeed, the gap can originate from different returns to education or again from experience (Rosenzweig, 1988; Magnac, 1991; Günther and Launov, 2011).

based on their education level. (Fields, 1975; Dickens and Lang, 1985; Lemos, 2009).

The second explanation is linked to the presence of a trade union that bargains for collective agreement with benefits (wage and other benefits) above the ones that would prevail on the free market. Finally, another constraint is associated with the presence of rules and regulation introducing rigidities in the labor market among which restrictions to layoffs, taxes on labor, compulsory degree requirements, etc.

In developing economies, the atrophied formal sector can offer rents and rent seeking behaviour by producers of this sector (Pratap and Quintin, 2006; Badaoui, Strobl, and Walsh, 2010). This allows the owners of these firms to use part of the rent to offer wages to its employees above the market wage. Moreover, the use of efficiency wage in the formal sector can also explain the fact that wages in the formal sector are higher compared to the ones prevailing in the informal sector. Some of these explanations for the wage gap and existence of the informal sector are used and detailed in the presentation of the structural model used in the paper.

From an empirical standpoint, many authors have developed models to verify this labor market segmentation in developing countries and developed countries. Banerjee (1983) provides an interesting analysis testing for the segmentation of the formal and informal labour market. Another good example of such an analysis is found in Lanot and Muller (1997) in which they analyse the women labor supply on the two markets in the Cameroon economy. Lehmann and Pignatti (2007) provide evidences for a transition economy for the case of Ukraine.

In this paper we aim to respond to two main objectives. The first one is to identify the main characteristics differentiating the labor supply of workers on the informal and formal market in the Philippines while estimating these two labor supplies. Our second main objective is to construct a labor supply model from these estimations that will serve as an input for a broader macro-microsimulation model applied to the Philippines[4].

Before entering into our description of our data and econometric structural model, we present a brief description of the macro-micro modelling context in which our model

[4] The macro model we refer to is a computable general equilibrium model (CGE).

results will contribute an important input. In the last decade, a vast literature has been expending to perform distributional impact analysis of policy reforms or external shocks. In the early 2000, authors such as Decaluwé, Dumont and Savard (2000) and Cogneau and Robilliard (2001), have linked CGE models with microsimulation models to enrich the methodologies used to perform distributional impact analysis. Without going into a great detailed review of these models[5], we focus on the approach that aims to integrate endogenous labor supply into this methodology. The main difficulty in introducing an endogenous labor supply in a macro-micro context is the presence of discrete choice by the workers. Since CGE models cannot readily make use of discontinuous functions, this feature presents important challenges that are thoroughly reviewed in Boeters and Savard (2012). Savard (2003) present one of the first illustrations of this approach and was soon followed by Bourguignon, Robillard and Robinson (2005) among others. In this paper, the authors rigorously integrate labor supply behaviours at a micro level and construct a CGE module that feeds price changes into a micro-simulation household model[6]. The main interests of this approach are that it allows for rich distributional impact analysis while providing the flexibility to integrate discontinuous labor supply models stemming from an econometric labor supply literature.

These models integrate estimates of an econometric labor supply model into a microsimulation household model. These microsimulation models generally include equations that specify how the household generates their income with an endogenous labor supply component in addition to other sources of non-labor income. It also incorporates household consumption functions which can be used in combination with the income and prices to compute changes in welfare or real income. Various types of linkages between CGE models can be developed. One option is to apply a policy simulation directly into a microsimulation model which generates an output (labor supply and or consumption) which is fed into a CGE model. The opposite is also possible where the CGE model receives a policy shock which produces an output that feeds into a

[5] The reader can consult the following literature reviews of macro-micro modelling for poverty analysis in Davis, 2009; Hertel and Reimer, 2005 and Bourguignon and Spadaro, 2006.

[6] We will provide further references of such applications that use the results presented in this paper to feed into a CGE-microsimulation model.

microsimualtion model. We will present and estimate an econometric model which will contribute to such a methodological application.

The rest of this paper is structured as follows. In the first part, we present characteristics of the labor market in the Philippines (section 2), we follow with a presentation of the structural model (section 3), and provide a presentation of data used for the analysis (section 4). We follow with a presentation and analysis of our results (section 5) and a presentation of the implementation of labor supply model in the macro-micro modelling framework (section 6). We complete the paper with some concluding remarks (section 7).

2. Characteristics of the labor market in the Philippines

The national export promotion policy in the Philippines strongly influenced the prevailing situation observed in labor market. This policy aimed to increase the competitiveness of exports by reducing labor cost and increasing labor market flexibility. In parallel, in the 1980 and 1990's, the trade unions increased their power on the labor market. At the end of the 1990's Schneider (2002) estimated the size on the informal economy at 43.4 per cent, giving the Philippines the third position out of 26 Asian countries analysed. On his part Ofreneo (1998) estimated its size at 45 per cent of GDP. According to Blunch, Canagarajah and Raju (2001), the informal employment accounted for 66.9 per cent of the non agricultural employment at the end of the 1990s. For Glipo-Carasco (2001), the growth of the informal sector in the Philippines during the 1990s was mainly a consequence of the application of the structural adjustment program and the liberalization of the economy. The economic crisis that affected Asian economies in the late 1990s also contributed to amplifying the size of the sector. Glipo-Carasco (2001) also mentions that formal manufacturing firms' weight in the economy decreased from 32 to 26 per cent between 1981 and 1995. During the same period, employment in the informal retail sales sector increased from 15 to 22 per cent of total employment while that of the service sector remained stable at 40 per cent.

Figure 1 presents the evolution of the labor force in the past 15 years in the Philippines. Generally, we observe that the unemployment rate is relatively stable between 1995 and 2003, with a few year of volatility (2003 to 2006) and a slightly decreasing trend

afterwards. The participation rate increased in the first part (1995 to 2002) and a decreasing trend is observed since then. As for underemployment, a decreasing trend was observed between 1998 and 2002 and increasing for the five following years and a very slight decrease is observed since 2007. This rate is relatively high around 20 per cent for most of the last 15 years. This is an indicator that the informal labor market segment seems to be relatively constant in the country[7].

FIGURE 1: ABOUT HERE

3. The econometric model

The theoretical framework of the model we present is based on the non competitive model proposed by Magnac (1991). This model exhibits two labor market segments: the first one is formal with a fixed nominal wage and the second is informal with a flexible nominal wage. On the first market (formal), the wage is fixed above the market clearing wage and therefore we have an excess supply of workers willing to supply their labor on this market. The rigid wage can be seen as a result of different government policy interventions, collective agreements negotiated by labor unions or even an efficiency wage implemented by the firms. The government interventions generally take the form of regulation or salary grid based on the level of education of workers or for certain types of qualifications or again with the implementation of a general minimum wage or specific minimum wages[8]. This type of labor market segmentation is also commonly used in computable general equilibrium (CGE) models as in Fortin, Marceau and Savard, 1997; Savard and Adjovi, 1998; Devarajan, Ghanem and Thierfelder, 1999; Agénor, Izquierdo and Fofack, 2003 and Sinha and Adam (2006) for an Indian application[9]. In addition to the minimum wage fixed by government authorities, formal wage fixed by collective agreements are also rigid. This modelling of segmentation is used in CGE context in Thierfelder and Shiells, 1997; Devarajan, Ghanem and Thierfelder, 1997 and Gersbach and Schniewin, 2001. Finally, examples of efficiency wage applications can be found in

[7] Underemployment is often seen as a good proxy of informal sector employment.
[8] In the Philippines, formal minimum wages are set by regional wage boards.
[9] The Sinha and Adam (2006) paper presents various alternative closure for the labour market with options where both real wages are flexible and others where the formal wage is sticky downwards.

Azam, 1997; Thierfelder and Shiells, 1997; Agénor and Aizenman, 1999; and Marouani, 2000. It is interesting to highlight that most of these applications in CGE model do not rely on econometric estimation and draw elasticities from the literature. Moreover, the models all use a single elasticity for one or a few representative households. In this paper, we estimate a labor supply model that can then be used in the same CGE context as the applications cited above but allowing use in the micro-simulation context with a large number of households and workers. Providing such an estimation of labor supply is very useful as CGE combined with micro-simulation provides for a much richer analytical tool for policy analysis especially when income distribution is of interest[10].

Let us complete our description of our labor market. As in the models proposed by Magnac (1991) and Cogneau and Robilliard (2001), the workers in our model face a cost to enter into the formal sector. This cost can be interpreted as a price to pay in order to enter into the formal segment of the market to obtain a job. This cost can be direct or indirect cost such as opportunity cost associated with job search and not working in the informal sector to find a formal sector job[11]. As we will illustrate in our structural model, this cost is specific to each worker and will depend on the workers' characteristics (social, educational, demographic among others).

On the informal segment, the wage is flexible in addition to being lower compared to the formal wage. Moreover, some workers who do not exhibit characteristics that allow them to obtain a job in the formal sector and will not be interested or willing to work on the informal market segment. These workers will exhibit a reservation wage above the wage prevailing on the informal market segment. The informal labor market is competitive with a flexible wage that clears this market. The supply on this market will be strongly

[10] For a detailed discussion on the advantages of CGE microsimulation with endogenous labor supply, one can read Boeters and Savard, 2012; Bourguignon and Savard, 2008; and Savard, 2005.

[11] This type of cost is also used to calibrate the Harris-Todaro (1970) model of migration between for formal and informal sector to fit empirical data. The standard model does not provide a good fit the empirical data and this cost of entry capture all the implicit cost associated with the entry into the formal sector. A good description of this type of application can be found in Boeters and Savard (2012).

dependent on the reservation wages of the potential workers of this market. The cost of entry in the formal sector will also play a key role in determining their labor supply[12].

Our structural econometric model allows us to estimate parameters required to construct labor supplies on the two markets. We will follow the model presentation with a graphical representation of conditions for workers to supply their labor. The model is represented by the following set of equations. The first equation (**1**) represents the potential wage of each workers on each market. This wage is dependent on the price of qualification and the level of qualification for the respective markets.

$$(1) \qquad \ln w_h^{\,j} = \ln \pi^{\,j} + \ln \tau_h^{\,j} \quad \text{où} \ln \tau_h^{\,j} = H_h \gamma^{\,j} + u_h^{\,j},$$

where w_h^j is the potential wage of worker h on market j with $j=1$ for the formal market and $j=2$ for the informal market, π^j is the price of the qualification for market j, and τ_h^j is the endowment level for qualification of worker h. This endowment level is explained by H_h which is the level of human capital of the worker h associated with $\gamma^{\,j}$[13], the elasticity of observable characteristics of the household and u_h^j the error term. The function representing the non observable reservation wage ($\overline{w}_h^0$) is determined by the following equation:

$$(2) \qquad \ln \overline{w}_h^0 = H_h \overline{\gamma}^{\,0} + u_h^0$$

where $\overline{\gamma}^{\,0}$ are the elasticities of the observable characteristics of workers and $u_h^{\,0}$ the workers specific fixed effect which is a random walk process. With these equations, we can represent the Roy (1951) model in which workers compare their reservation wage with wages prevailing on each market. We extend from this model by adding another variable that characterizes the labor market segmentation. This variable is the cost of entry into the formal sector that we described previously. It includes implicit and explicit cost of entering into the formal segment of the market. According to Magnac (1991), in

[12] It is important to highlight that when this model in linked to a CGE model, the demand for formal and informal workers will be driven by the optimal demand of profit maximizing firms with a fixed nominal wage in the formal sector but with and endogenous real wages for the firms.

[13] The variables used capture the human capital are education, age, age^2, experience, gender and size of household. These variables will be explained in more detail subsequently.

the implicit cost we also have the difference in utility between working in one sector versus the other. For example, we could think that a formal sector job has more social value compared to an equivalent position in the informal sector or that the flexibility offered in the informal sector is more attractive for certain workers compared to the rigidities of a formal sector job. It is extremely difficult to decompose these different costs and therefore they are implicitly integrated to the cost (c_h). Hence, we model is as in Magnac (1991) as a cost of entry into the formal sector (sector 1):

$$(3) \qquad \ln c_h = H_h \bar{\gamma}^c + e_h$$

We can summarize the model described above with the following conditions where the worker chooses:

$$(4) \quad \begin{array}{lll} \text{sector 1 (formal) if :} & w^1 - c_h > w^2, \text{ and } & w^1 - c_h > \overline{w}_h^0 \\ \text{sector 2 (informal) if :} & w^2 > w^1 - c_h, \text{ and } & w^2 > \overline{w}_h^0 \\ \text{unemployed if :} & \overline{w}_h^0 > w^1 - c_h, \text{ and } & \overline{w}_h^0 > w^2 \end{array}$$

In which w^1 is the formal sector wage fixed by rigidities, w^2 is the prevailing market wage of the informal sector, $\overline{w}_h^0$ the reservation wage of the worker h, and c_h the cost of entry into the formal sector job of worker h.

We provide a graph that illustrates the assumptions we have just described, namely the conditions under which the workers will supply their labor on the different markets or stay unemployed. The axis of Figure 2 is the reservation wage on the horizontal axis and cost of entry to the formal sector on the vertical axis. These two variables are worker specific.

FIGURE 2: ABOUT HERE

Considering the conditions of our structural model, we have three straight lines in our graph. The first horizontal line $(c = w^1 - w^2)$ represents the equalization between cost of entry and the wage gap between the two markets. On this line, workers are indifferent between offering their labor on either of the two markets. The second line $(c = w^1 - \overline{w}^0)$ with a negative slope balances the cost of entry into the formal sector and the gap between the formal sector wage and the reservation wage. On this line, workers are indifferent to staying unemployed and working in the formal sector. Finally, the third line which is vertical $(w^2 = \overline{w}_h^0)$ represents the boundary between the choice of working in the informal sector or being unemployed. If we combine two conditions for each of the three options that are available to workers given by the structural model (equation 4), we have the following results presented in Table 1.

TABLE 1: ABOUT HERE

In order to determine the labor supply on each market, the two conditions of equation 4 must be fulfilled for either of the three options available and therefore these conditions are represented by the intersection of condition 1 and condition 2 of Table 1. Hence, we have workers that are in region A and B who will supply their labor on the formal labor market, the workers in region D and G will offer their labor on the informal market segment and finally, the waiting (voluntary) unemployed are in region E and F.

4. Source of data

The database used to estimate our model was constructed with data originating from two sets of surveys implemented by the National Statistics Office of the Republic of the Philippines. The first one is the "Family Income and Expenditure Survey" (FIES) of 1997 which is a national household survey implemented every three years. The second source of data is the “Labour force survey” (LFS). We used three passages of this survey implemented in 1997 and the FIES of 1997 to construct our database. The survey samples for the LFS and FIES are drawn from the same master sample originating from the national census of 1995. The FIES gathers information on the various sources of incomes

(including payment in kind) as well as information on expenditure. The survey also provides rich socio-demographic information such as the size of the households, number of workers, type of work, occupation, age and education of head of household among others. This survey includes information on 39,520 households. The survey was implemented between July 1997 and January 1998. The data collection was performed with double interview sessions with the same questionnaire with a six months interval between each passage. The incomes data were estimated by adding information gathered from the two passages. In general, most households were surveyed in July 1997 for the first round and in January 1998 for the second round. The sample structure is a two stage stratified cluster. The two sample domains are the urban and the rural areas and the primary sample unit is the "barangays" which are classified as urban or rural. The households of the barangays constitute the secondary unit of the sample.

As we mentioned, data from the LFS are also used to construct our database. We used three quarterly surveys from 1997 of which the ones from July 1997, October 1997 and January 1998. The period is the same as the one covered by the FIES. Moreover, the three passages of the LFS use the same master sample as the FIES. The main objective of this survey is to provide information in view of designing policies targeted at the labor market. Specifically, the survey is designed to supply information on the level and trends of employment, unemployment and underemployment for the country and for the administrative regions of the country such as provinces and large cities. The method used for these LFS surveys considers work performed in the previous week as a period of reference and also integrates the concept of availability for work and job search.

We combined information originating from the FIES and the three LFS to construct our database and we obtained 38,800 households that were included in the four surveys. This represents 98 per cent of the households found in the FIES. The main difficulty we needed to overcome in constructing our database was the fact that the FIES does not attribute the income of the household to various workers in the households. It is an

aggregate figure in each household. In the LFS, we have the number of hours worked by each member of the household that is active on the labor market for the period covered by the survey. Given the information we had for the head of the household in the FIES, it was possible to isolate its part of the income. This was possible since we had information on the origin of the source of income and the sector of activity of the head of household. Given this constraint and the size of our sample (more the 200,000 individuals included in the LFS) we opted to use only the head of household in our database for the estimation. Most of the information from the three LFS was averaged out for the workers using the three rounds of this survey. Our master database included information on the income of head of household, work status, age, level of education, number of workers in the household, size of household, sex, number of hours worked, number of years on the job market and number of child below the age of 14 years[14]. We drew a random sample of 13,000 workers from our original sample of 38,800 for our estimations[15].

5. Estimation of our structural model

It is important to highlight that we are working with the labor supply of the head of household or the main employee of the household[16] given our data constraint. The model was estimated using a Heckman two step estimation which is also called the Heckit method. This approach is used to correct for section bias. In the first step we estimate a Probit model. This model helps in determining the probability that a worker will be present on either markets or choose to be inactive. In the second step, we estimate the labor supply on each market with an OLS estimation. We make corrections to the covariance matrix by applying the inverse Mills ratio that considers the censored information on each market resulting from the Probit estimation of the first stage. The

[14] We assumed that the number of child could have an impact on the human capital since it can change the behaviour of potential workers and their human capital through experienced gained in child caring practices but this variables was insignificant in all our estimations.
[15] The total sample was too large and estimations would not run with our software used for estimations.
[16] We used the main worker of the household when the head of household was not active on the job markets (retired, inactive because of health reasons or other reason).

results from the OLS determine the characteristics of workers and their importance on each market[17]. Results of the estimations are presented in Table 2.

Before proceeding to the interpretation of results it is important to link the parameters estimated and the structural model presented previously. First, we can start with the bottom two panels in which results of the OLS results are presented. The parameters estimated for the formal sector, are in panel 2 are $\hat{\gamma}^1$ of equation 4 and for panel 3 the values represent the $\hat{\gamma}^2$ vector of the informal sector. From these parameters ($\hat{\gamma}^j$) and the w_h^j and H_h observed in the survey, we can generate the workers specific error terms (u_h^j). For the second equation (2), as we have stated, we do not observe the reservation wage $\overline{w}_h^0$ and the u_h^0. Estimates presented in the panel 1 for parameters $\bar{\gamma}^0$ are required to obtain the reservation wage $\overline{w}_h^0$. We use the same approach as Magnac (1991) to compute the reservation wage. This procedure consists in a random draw of u_h^0 from a distribution with the moments (mean and variance) of the data used for the estimation. This specific random effect (u_h^0) allows us to compute the reservation wages for each worker.

TABLE 2: ABOUT HERE

Finally, the cost of entry in the formal sector is obtained with the gap between the parameters estimated in the two markets. From the two conditions determining the choice of each market drawn from equation 4, we can directly see the inflection point in the decision by the worker. This point is obtained by replacing the inequality sign by an equality sign such that we have $w^1 - c_h = w^2$. We can directly isolate the cost of entry in the formal sector and compute this as the gap between w^1-w^2. This is also the horizontal line in Graph 1. Using the equation 1 for the two markets we have:

$$\ln c_h = H_h\left(\gamma^1 - \gamma^2\right) + \left(u_h^1 - u_h^2\right) \qquad (5)$$

[17] This estimation approach is different from the one used by Magnac (1991) in which a Probit is estimated in the first step and a bi-variate Probit in the second step. With this approach, the author can assume independence of choice between the choices of working on each market while we make the implicit assumption that the choice is dependent.

Where the elasticity of equation 3 ($\hat{\hat{\gamma}}^{c}$) is computed from the estimated elasticity presented in panel 2 and 3 in Table 2 such that we have $\hat{\hat{\gamma}}^{c} = \hat{\gamma}^{1} - \hat{\gamma}^{2}$ and $\hat{e}_h = \hat{u}_h^1 - \hat{u}_h^2$ for the individual fixed effect. Hence, with the functions and estimates of panel 2 and 3 of Table 2, we can obtain the specific cost of entry in the formal sector for each worker.

To arrive at our final choice of characteristics of households (H_h) used to estimate our structural econometric model (equations 1 to 4), we selected the ones having a level of significance of 90 per cent for at least one estimation. From equation 5, we clearly see that we need to use parameters for a characteristic for each market to compute our cost of entry into the formal sector. In other words, we need to have vectors of the same dimension to compute our cost of equation 5.

For the interpretation of our results, as expected, education is the most important factor in determining the choice of a person to participate or not on either of the labor market. Indeed, the higher the level of education, the greater the probability of participating in the labor markets will be[18]. Moreover, the level of education is positively correlated with the wages on each market but with a correlation being twice as strong to explain the formal sector wage compared to the informal sector wage. Hence, achieving a higher level of education will increase the wage in the formal sector by 23 per cent and only by 12.5 per cent in the informal sector. On the other hand, age contributes negatively in the choice of working or not working. In other words, the probability of working will decrease with age. The age will contribute positively to increasing the wage on the two markets. This relation is stronger on the formal market with a 6.7 per cent contribution compared to a 5.3 per cent contribution in the informal sector.

The age square interpreted as the life cycle is weakly correlated and has a negative sign to determine the wages in the formal and informal markets. The negative contribution is stronger in the formal market (-0.064%) compared to the informal sector (0.055%). The negative relationship informs us on the non linearity in regards to the link between these

[18] The education variable used corresponds to a level of education attained and not in terms of number of years attending an educational facility. Seven levels of education used are: no education, primary with no diploma, primary with diploma, high school (secondary level) without diploma, secondary with diploma, post-secondary without diploma, post-secondary with diploma.

two variables in the two sectors. Hence, we find that beyond 33.5 years, the correlation between the age and the wage in the formal sector becomes negative and in the informal sector that reversal of the correlation is observed at 26.5 years old. In other words, the wage continues to increase for seven additional years in the formal sector compared to the informal sector.

Turning to the experience[19], as expected, this characteristic has a positive relationship with the choice of working and is significant above 99 per cent. However, this characteristic is not significant in determining the level of the wages in the formal and informal sectors. The gender dimension[20] does not contribute significantly to choosing to work or not to work but it has significant effect at 99 per cent in explaining the fact that women have a lower wage compared to men in the formal sector by 26.8 per cent. This variable (gender) is not significant in the informal sector and hence we cannot say that the impact of being a female worker has an impact on the informal sector wage. Hence, the women head of household will be penalised in terms of the level of the wage compared to men in the formal market but not in the informal market. Finally, the size of the household influences positively the decision of participating in the labor market but this variable does not seem to have a significant impact of the level of wages in the informal and formal markets.

The inverse Mills ratio is significant for the two markets and therefore we cannot reject the absence of selection bias and that the relationship between what is unobservable in the selection has a negative effect on wages in either the formal and informal markets.

6. Construction of labor supply from estimations

As we have mentioned at the end of the introduction, one of the objective of this paper is to illustrate how the estimated structural labor supply model can be used to construct a labor supply used in a CGE microsimulation model. In this section we provide a brief description of the steps taken to implement such a labor supply component in a macro-microsimulation framework.

[19] The experience variable corresponds to the number of years spent on the labor market by a given worker.
[20] This characteristic takes the value of 1 for a man and 2 for a woman. The interpretation needs to be done in this context.

First we start by describing the links between the CGE model and microsimulation model. This will help understand how the two models are linked and how the labor market supply and demand operates. **Figure 3** illustrates this algorithm between the two models and the linking variables. Simulations are applied to the CGE model in which labor supply and household consumption are exogenous. This model generates changes in the price vector (p) including informal sector flexible wage (w). It also determines the labor demand in the formal sector (Ldf) given the exogenous formal wage. The price vector and formal labor demand are fed into the bottom microsimulation model. These variables will determine the new income and expenditure each household in the microsimulation model. The labor endowment of workers is endogenous and explained hereafter. This change in labor endowment will on the one hand have an impact on household income and welfare and on the other hand, also on the labor supply (L_h). The new income with prices will determine the consumption vector for each household (C_h). These two variables (L_h and C_h) are aggregated up to obtain L and C which will be fed back into the CGE model and an iterative loop is implemented[21].

FIGURE 3: ABOUT HERE

The econometric model helped us compute reservation wages, cost of entry and potential wages for each worker in the database as described above. We explained previously how the reservation wage and cost of entry were computed. For the potential wage on the formal labour market, it is computed by applying the estimates of Table 2, Panel 2 (the formal labour market) to the characteristics of workers and unemployed in combination with the randomly drawn u_h^1. This procedure generates a potential wage for each worker and potential worker with respect to the formal market. Hence, a worker with higher level of education, that relatively old and with a small household will have a higher potential wage compared to a worker with no education, that is relatively young with a large family. We use the reservation wages and cost of entry to verify the conditions of equation 4 and the potential wage to rank our workers to proceed in constructing our labor supply for the formal and informal sector used in the microsimulation model.

[21] This loop is performed until convergence between two runs. A formal and complete presentation of this algorithm is presented in Bourguignon and Savard (2008).

Before describing the construction of our labor supply, we must state that we make the assumption that employers have perfect information of workers and suppliers of labour to the formal sector as in Bourguignon et al (2005) and Bourguignon and Savard (2008).

On the formal market, the labor supply takes the form of a waiting queue. The suppliers of labor on this market can be either unemployed or active in the informal sector in the original database. The potential workers must first respect the conditions imposed in the first line in equation 4. Once these conditions are verified, we proceed with the ranking of our workers (and unemployed) in a queue presented in Figure 4. This queue starts from Lsf_N on the left hand side with workers exhibiting a lowest potential wage to Lsf_{h+1} in the middle of the queue with potential workers in the formal sector with the highest potential wages. In Figure 4, the Ldfo represents the lower bound of the formal labor demand at the reference period in the CGE model and household database. All workers to the right of this line are active in the formal market. Hence, this point (Ldfo) is the border between workers offering their labor on this market and the ones working in the formal sector. On the right hand side of Ldfo, the workers are also ranked based on their potential wage with the ones having a lower potential wage being place just above Ldfo at Lsf_h and the ones with the highest potential wage on the far right of this queue at Lsf_1.

When a formal labor demand increase (decrease) arrives from the CGE model, the Ldf line moves to the left (right) starting from the reference point at Ldfo. The first workers starting from Lsf_{h+1} will be hired and moving leftward to the point where the new formal demand will be satisfied by the supply of workers in our queue. The decrease in demand will push active formal workers of the reference period out of the sector starting at Lsf_h (middle of the queue) and moving rightwards to the point where the new demand for formal labour is satisfied. This labour supply process using this queue implies that the most productive workers (measured by the potential wage) will be the first ones hired if the formal labor demand increases and the least productive will be the first one laid off when the labor demand will decrease.

FIGURE 4: ABOUT HERE

The labor supply on the informal sector is simpler, since all workers not active in the formal sector will compare their reservation wage $\overline{w}_h^0$ with the wage prevailing on the informal sector (w^I). If a worker has a reservation wage below the informal wage, she will supply her labor and if it is higher, she will become unemployed. This condition check is done at each loop of the iteration process for each worker not in the formal sector. We add up all workers with reservation wage below the informal sector wage to obtain the aggregate informal labor supply (L from Figure 3). This L is fed back into the CGE model as part of the iteration process.

We do not present results of this macro-micro model as it would require an extensive description of the CGE model in addition to the microsimulation model. This is beyond the scope of this paper and the reader can consult Bourguignon and Savard (2008) for this purpose. Results can also be found in various applications such as trade reform analysis in Bourguignon and Savard (2008), pro-poor analysis of investment in public education in Boccanfuso, Missinhoun and Savard (2010), a distributional impact analysis of infrastructure spending in Savard (2010) and a Gini multi-decomposition of fiscal reform to raise public funds in Mussard and Savard (2012).

7. Conclusion

In this paper, we present an original structural model inspired by Magnac (1991) to estimate the segmented labor supply in the Philippines. The results of the estimation provide relatively intuitive findings but highlight some differences between the two markets. The estimations reveal *inter alia* the characteristics of potential workers that contribute to the probability of participation or not in the labor markets. The level of education is the most important factor to contribute in increasing the probability of a worker to participate or not in the labor market and also in determining the formal and informal wage. The returns to education are almost twice as high in the formal sector compared to the informal sector. Age is also a significant variable for all estimates and is linked negatively with the probability of working or not working. The age is also

correlated positively with both formal and informal wages but this variable has a stronger impact on the formal wage compared to the informal wage. Another important and interesting finding is that the level of wages for women on the formal market is lower compared for male workers to the order of 27 per cent while this gap is not present on the informal market. This in turn affects the level of potential wage of female head of household and therefore has an impact on their ranking in the labour supply.

Another important contribution of this paper is the illustrate how the estimates of the discrete choice structural econometric labor supply model can be used to construct an endogenous labor supply in a microsimulation model in combination with a CGE model. All applications of this macro-micro framework failed to provide a detail account of this procedure[22]. It is important to reiterate one of the most interesting contributions of macro-micro tool namely its capacity to capture discrete choice or changes in employment status. These changes in status in and out of employment or in and out of formal and informal sectors have a great impact on household welfare following a policy simulation. Hence, changes on the extensive and intensive margin for labor can be captured simultaneously in the process. Standard CGE models only capture marginal changes and therefore only provide a partial picture when performing distributional impact analysis. The labor supply model constructed based on the structural model presented here has been used in various applications referenced at the end of the previous section. The endogenous discrete labor supply component in the CGE microsimulation model is the main element contributing to the rich distributional analysis performed in these papers. A broad range of poverty, income distribution and pro-poor indicators are used for the impact analysis. This type of methodology combining econometric labor supply models and macro-micro modelling provides for very rich tool and more work is needed to further enrich this literature. One of the barriers for the expansion of this type of work has been the black box nature of the exercise and with this paper we attempt to clarify one of the important steps in this process to implement such a methodology. On the other hand,

[22] Among the papers not discussing the estimation and construction of the labor supply component we can cite Cogneau and Robilliard, 2008; Hérault, 2007; Bussolo, Lay, Medvedev and Van der Mensbrugghe, 2008. The last papers of the previous section could also be included in this list but this was done intentionally to offer the detailed presentation in this paper.

analysts must realise that implementation of such a macro-micro modeling approach with econometric estimations involves the use of very rich data base on household and labor market which are not readily available in all countries. Moreover analyst or research team need to combine analytical tools that have evolved in different research constellations and it can be extremely challenging to adapt the analytical framework for this marriage to be successful. One must also be aware that data processing and data reconciliation are extremely important and can become a great barrier to entry into such a venture.

8. Bibliographie

Agénor, P.-R. & Aizenman, J. (1999). Macroeconomic adjustment with segmented labor markets, *Journal of Development Economics*, 58(2), 277-296.

Agénor P.-R., Izquierdo A. & Fofack, H. (2003). IMMPA: A quantitative macroeconomic framework for the analysis of poverty reduction strategies, Mimeo World Bank, 2003, Washington.

Azam, J.-P., (1997). Efficiency wage and the family: An explanation for the impact of the agricultural minimum wage in Morocco, *Kyklos*, 50(3), 369 – 382.

Badaoui, E. El, Strobl E. A., & Walsh F. (2010). The formal sector wage premium and firm size, *Journal of Development Economics*, 91(1), 37-47.

Banerjee, B. (1983), The role of the informal sector in the migration process: A test of probalistic migration models and labour market segmentation for India, *Oxford Economic Papers*, 35(1), 399-422.

Bargain O. and Kwenda P. (2009). The informal sector wage gap: New evidence using quantile estimations on panel data, IZA Discussion Paper No. 4286. Available at SSRN: http://ssrn.com/abstract=1434620.

Besley T. & Burgess R. (2004). Can labor regulation hinder economic performance? evidence grom India, *Quarterly Journal of Economics*, 119(1), 91-134.

Blunch, N-H., Canagarajah S. & Raju D. (2001). The informal sector revisited: A synthesis across space and time, World Bank Social Protection Discussion Paper Series No. 0119.

Boccanfuso, D., Missinhoun R. A. & Savard L. (2010). Réformes économiques et croissance pro-pauvre : Une application aux Philippines, *Louvain Economic Review,* 76(3), 257-288.

Boeters, S. & Savard L., (2012). Labour market modelling in a CGE Context, in P. Dixon and D. Jorgenson, (Eds.), *Handbook of Computable General Equilibrium Modeling*, Elsevier Oxford (forthcoming).

Bourguignon F., Robilliard A.-S. & Robinson S. (2005). Representative versus real households in the macroeconomic modelling of inequality , in T. J. Kehoe, T.N. Srinivasan and J. Whalley (eds.) , *Frontiers in applied general equilibrium modelling*, Cambridge, Cambridge University Press.

Bourguignon, F., & Savard L. (2008). A CGE integrated multi-household model with segmented labor markets and unemployment in Bourguignon, F., L.A. Pereira da Silva and M. Bussolo, (Eds.), *The impact of macroeconomic policies on poverty and income distribution: Macro-micro evaluation techniques and tools,* (pp. 177-212), Palgrave-Macmillan Publishers Limited, Houndmills..

Bourguignon, F., & Spadaro A. (2006). Microsimulation as a tool for evaluating redistribution policies , *Journal of Economic Inequality*, 4(1), 77-106.

Bussolo, M., Lay J., Medvedev D. & van der Mensbrugghe D. (2008). Trade options for Latin America: A poverty assessment using a top-down 86 macro-micro modeling framework, in Bourguignon, F., L.A. Pereira da Silva and M. Bussolo, (Eds.), *The impact of macroeconomic policies on poverty and income distribution: Macro-micro evaluation techniques and tools, ,* (pp. 61-90), Palgrave-Macmillan Publishers Limited, Houndmills.

Cogneau D. & Robilliard A.-S. (2001). Croissance, distribution et pauvreté : un modèle de micro simulation en équilibre général appliqué à Madagascar, Working Papers DT/2001/19, DIAL (Développement, Institutions & Analyses de Long terme).

Cogneau, D. & Robilliard A.-S. (2008). Simulating targeted policies with macro impacts: Poverty alleveation policies in Madagascar, in Bourguignon, F., L.A. Pereira da Silva and M. Bussolo, (Eds.), *The impact of macroeconomic policies on poverty and income distribution: Macro-micro evaluation techniques and tools,* (pp. 212-245), Palgrave-Macmillan Publishers Limited, Houndmills.

Davies. J.B, (2009), Combining microsimulation with CGE and macro modelling for distributional analysis in developing and transition countries, *International Journal of Microsimulation* 2(1), 49-65.

Decaluwé, B., Dumont J.-C. & Savard L. (2000). Measuring poverty and inequality in a computable general equilibrium model, Cahiers de recherche n°99-26, Université Laval Québec.

Devarajan S., Ghanem H. & Thierfelder K. (1999). Labor market regulations, trade liberalization and the distribution of income in Bangladesh, *Journal of Policy Reform*, 1999, 3(1), 1-28.

D'Souza, E. (2010). The employment effects of labor legislation in India: a critical essay, *Industrial Relations Journal*, 41(2), 122-135.

Dickens, W. & Lang K. (1985). A test of the dual labor market theory, *American Economic Review*, 75(4), 792-805

Fields, G. S. (1975). Rural-urban migration, urban unemployment and underemployment, and job search activity in LDCs, *Journal of Development Economics*, 2(2), 165-187.

Fields, G. S. (2009). Segmented labor market models in developing countries. In H. Kincaid and D. Ross (Eds.) *The Oxford handbook of philosophy of economics* (pp. 476-510). Oxford: Oxford University Press.

Fortin B., Marceau N. & Savard L. (1997). Taxation, wage controls and the informal sector, *Journal of Public Economics*, 66(2), 293-312.

Gang, I. & Gangopadhyay S. (1990). A model of the informal sector in development, *Journal of Economic Studies*, 17(5) 19-31.

Gersbach H. & Schniewin A. (2001). Awareness of general equilibrium effects and unemployment, IZA Discussion Paper No 394.

Gindling, T. H. (1991). Labor market segmentation and the determination of wages in the public, private-formal, and informal sectors in San Jose, Costa Rica¸ *Economic Development and Cultural Change*, 39(3), 584-605.

Glipo-Carasco, A. (2001). Effects of globalization on women in the informal sector: harnessing local capacity in times of crisis, in Linking work, skills and knowledge: learning for survival and growth international conference, 10-12 September 2001, Interlaken, Switzerland: conference report, ed. R Gerster, Swiss Agency for Development and Cooperation, Bern, 8p.

Günther, I. & Launov A. (2011). Informal employment in developing countries opportunity or last resort, *Journal of Development Economics,* article in press.

Gupta I. & Mitra A. (2002). Rural migrants and labour segmentation: micro-level evidence from Delhi slums, *Economic and Political Weekly,* 37(2), 163-168.

Harris, J. R. & Todaro M. P. (1970). Migration, unemployment and development: A two-sector analysis, *American Economic Review* 60(1), 126–142.

Hérault, N. (2007). Trade liberalization, poverty and inequality in South Africa: A computable general equilibrum-microsimulation analysis, *Economic Record*, 83(262), 317-328.

Hertel, T. & Reimer, J. (2005). Predicting the poverty impacts of trade reform, *Journal of International Trade & Economic Development*, 14(4), 377-405.

Lanot, G. & Muller, C. (1997). Dualistic sector choice and female labor supply: evidence from formal and informal sectors in Cameroon, The Centre for the Study of African Economies Working Paper Series, Paper #57.

Lehmann, H. & Pignatti, N. (2007). Informal employment relationships and labor market segmentation in transition economies: evidence from Ukraine, IZA Discussion Paper Series No. 3269.

Lemos S., (2009). Minimum wage effects in a developing country, *Labour Economics*, 16(2), 224-237.

Leontaridi, M., (1998). Segmented labor markets: Theory and evidence, *Journal of Economic Surveys,* 12(1), 103-109.

Lewis, W. A., (1958). Economic development with unlimited supplies of labor, in H. N. Agarwaïa and S. P. Singh (Eds.): The Economics of underdevelopment (Bombay), pp. 400-409.

Loayza, N., Oviedo A.- M. & Servén, L. (2006). The impact of regulation on growth and informality: Cross-country evidence, in Basudeb Guha-Khasnobis, Ravi Kanbur and Elinor Ostrom (Eds.), *Linking the formal and informal economy: Concepts and policies*. Oxford, Oxford University Press, pp. 121–144.

Magnac T., (1991). Segmented or competitive labor markets?, *Econometrica*, 59(1), 165-187.

Maloney, W. F. (2004). Informality revisited, *World Development*, 32 (7), 1159-1178.

Marouani, M.A. (2000). Ouverture commerciale et emploi: un modèle d'équilibre général avec salaires d'efficience appliqué à la Tunisie, *Revue Economique*, 51(3), 557-569.

Mussard, S. & Savard, L. (2012). The gini multi-decomposition and the role of Gini's transvariation: Application to partial trade liberalization in Philippines, *Applied Economics,* 44(10), 1235-1249.

Ofreneo, R., (1998). Philippine industrial relations and the Asian economic crisis. A paper presented at the Regional Workshop on the Economic Crisis and Labour in Asia, Bandung, Indonesia.

Peng, Y., Zucker L. G. & Darby M. R., (1997). Chinese rural industrial productivity and urban spillovers, National Bureau of Economic Research Working Paper 6202.

Piore, M., (1972). The dual labor market: Theory and implications, in D. M. Gordon (Eds.) *Problems in political economy: An urban perspective*. Lexington, MA: DC Heath and Company, 90-94.

Pratap S. & Quintin, E. (2006), Are labor markets segmented in developing countries? A semiparametric approach, *European Economic Review*, 50(7),1817-1841.

Rosenzweig, M., (1988). *Labor markets in low income countries*, In Chenery, H., Srinivasan, T.N. (Eds.), *Handbook of Development Economics*, vol. 1. North Holland Publishing, Amsterdam.

Roy, A. (1951). Some thoughts on the distribution of earnings, *Oxford Economic Papers*, 3(2), 135-146.

Savard L., (2003). Poverty and income distribution in a CGE-household micro-simulation model: Top-down/bottom up approach, Cahiers de recherche 0343, CIRPEE.

Savard, L., (2005). Poverty and inequality analysis within a CGE framework: A comparative analysis of the representative agent and microsimulation approaches, *Development Policy Review*, 23(3), 313-332.

Savard, L., (2010). Scaling up infrastructure spending in the Philippines: A top-down bottom up micro-simulation approach, *International Journal of Microsimulation.* 3(1), 43-59.

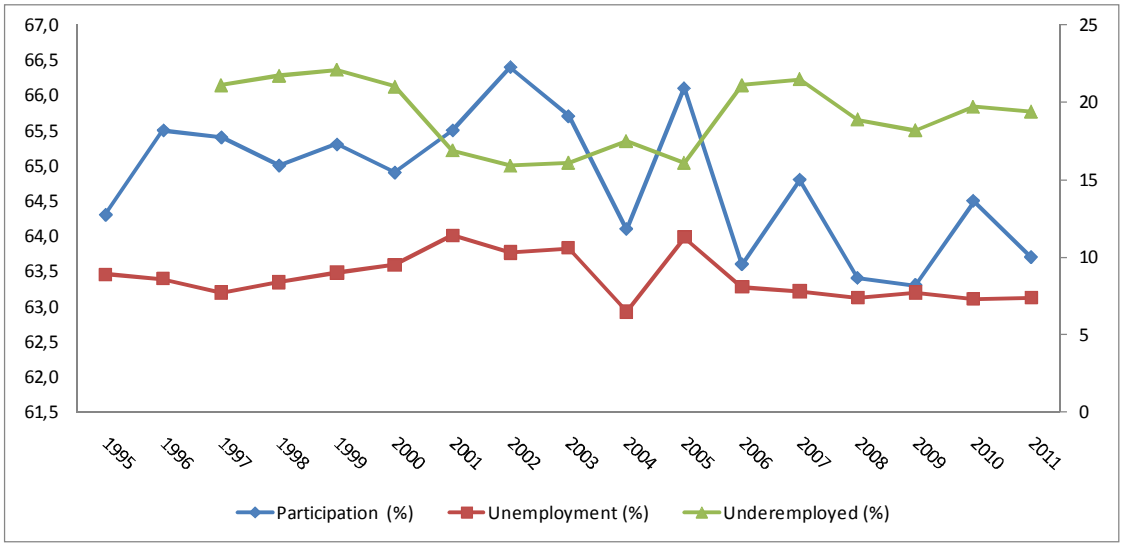
Savard L. & Adjovi, E. (1998). Externalités de la santé et de l'éducation et bien-être : Un MEGC appliqué au Bénin, *L'Actualité Économique*, 74(3), 523-560.

Schneider, F. (2002). Size and measurement of the informal economy in 110 countries around the world, Paper presented at the Workshop of Australian National Tax Centre, Canberra, Australia, July 17th 2002.

Thierfelder, K. & Shiells, C.R. (1997). *Trade and labor market behavior.* In, (Eds.) by Francois, J. and Reinert, K. *Applied methods for trade policy analysis – A Handbook* Cambridge: University Press.

Thomas M., & Vallée, L. (1996). Labor market segmentation in Cameroonian manufacturing, *Journal of Development Studies*, 1996, 32(6), 876-898.

Figure 1 : Evolution of participation rate and unemployment rates between January 1995 and January 2004



Sources: Labor Force Survey, Income and Employment Statistics Division, Household Statistics Department, National Statistics Office Republic of the Philippines.

Figure 2: Conditions of the two labor supplies and for non participation

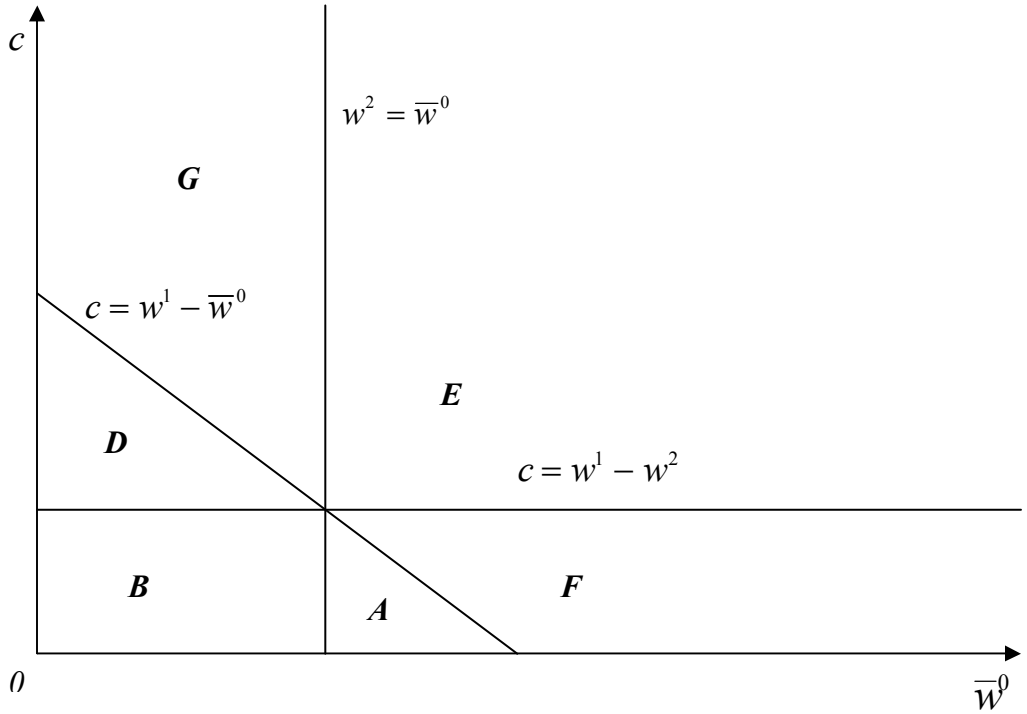


Figure 3: Algorithm for labor supply between CGE and microsimulation model

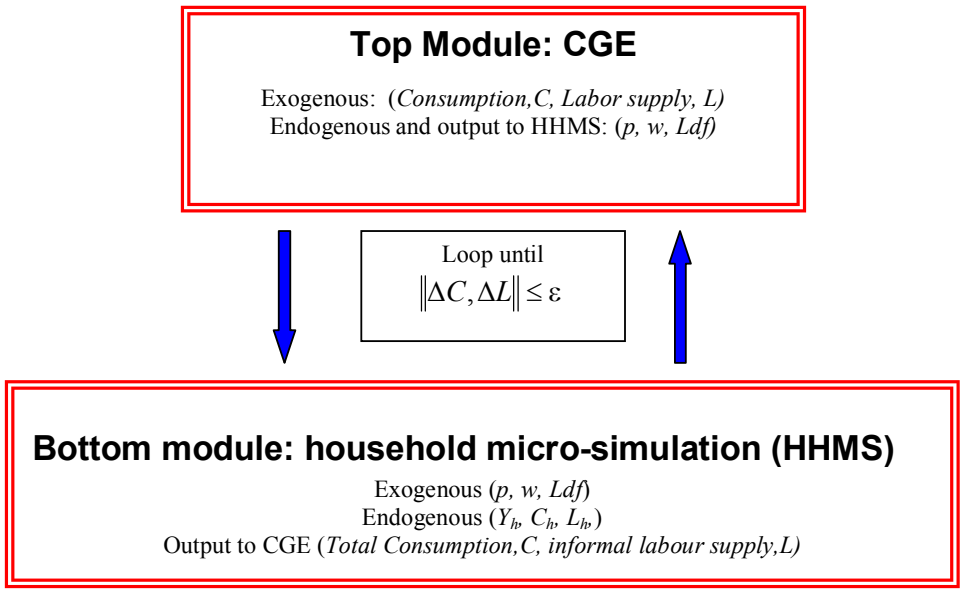


Figure 4: Endogenous formal labor supply

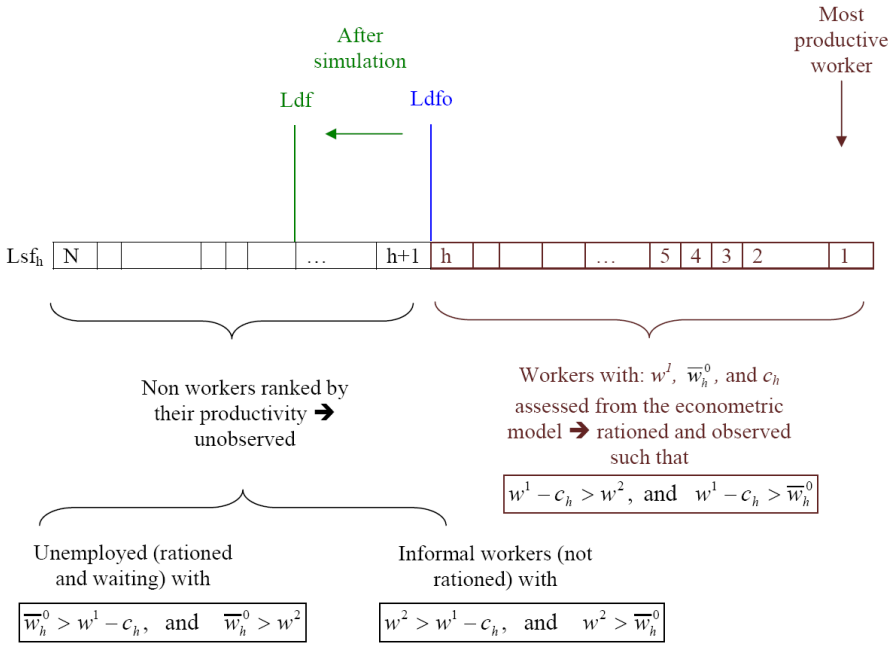


Table 1: Conditions determining the choice of workers

	Condition 1	Condition 2	Intersection
Formal workers (1)	B, A, F	D, B, A	A, B
Informal workers (2)	D, G, E	D, G, B	D, G
Unemployed	G, E, F	E, A, F	E, F

Table 2: Estimation results

Panel 1

Probit				
$\bar{\gamma}^0$	Coefficient (marginal effects)	Standard error	t-stat	Prob>|t|
constant	1.62	0.47	3.44	0.00
education	0.15 (0.049)	0.01	16.02	0.00
age	-0.11 (-0.0351)	0.03	-3.68	0.00
age^2	0.00 (0 .0003)	0.00	4.00	0.00
experience	0.02 (0 .007)	0.01	2.47	0.01
Sex of head of Hsld	-0.03 (-0.0121)	0.05	-0.50	0.31
Size of hsld	0.06 (0.0203)	0.01	8.07	0.00

Panel 2

Two step Heckman estimation of selection model Formal market				
γ^1	Coefficient	Standard error	t-stat	Prob>|t|
constant	4.16	0.56	7.44	0.00
education	0.23	0.03	6.90	0.00
age	0.07	0.02	3.15	0.00
age^2	0.00	0.00	-2.60	0.00
experience	-0.01	0.02	-0.59	0.28
Sex of head of Hsld	-0.27	0.08	-3.25	0.00
Size of hsld	0.01	0.04	0.13	0.45
λ_1	-0.91	0.26	-3.55	0.00

Panel 3

Two step Heckman estimation of selection model Informal market				
γ^2	Coefficient	Standard error	t-stat	Prob>|t|
constant	3.26	0.48	6.72	0.00
education	0.13	0.03	4.00	0.00
age	0.05	0.02	2.78	0.00
age^2	0.00	0.00	-2.52	0.01
experience	-0.02	0.02	-1.04	0.15
Sex of head of Hsld	0.12	0.10	1.20	0.11
Size of hsld	0.04	0.03	1.34	0.11
λ_2	-1.66	0.25	-6.59	0.00