The participation of couples in the labor market: an econometric analysis[†]

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Abstract

This paper examines the interactions between household members' utilities when deciding whether or not to join the labor market. Using asymptotic least squares, we analyze a sample of 5425 couples living in France in 1997. By comparing the results obtained with more standard methods, we find that the man's participation equation is the most affected by the introduction of simultaneous decision making in the couple. The woman's decision to participate has a positive and significant influence on their spouse's decision to work, as do the number of children and the birth of a new child. The fact that the presence of children increases the participation of men and reduces the participation of women suggests that the added-worker effect should be interpreted more as a demographic phenomenon than as a consequence of unemployment.

Keyword: Collective labor supply, labor market participation, couples, asymptotic least squares.

JEL Classification: C35, D13, J12, J22.

La participation des couples au marché du travail : une analyse économétrique

Résumé

Cette étude examine la question des interactions entre les utilités des deux membres d'un couple lorsqu'ils prennent leur décision de participation au marché du travail. Elle est effectuée à partir d'un échantillon de 5425 couples résidant en France, à partir de la méthode des moindres carrés asymptotiques. En comparant nos résultats avec ceux fournis par des méthodes d'estimation plus répandues, nous trouvons que l'équation de participation des hommes est la plus fortement affectée par l'introduction de la simultanéité des décisions en couple. La participation des femmes a un effet positif sur la participation des hommes, de même que le nombre d'enfants et la naissance d'un enfant. Le fait que la présence des enfants augmente la participation masculine et réduit la participation féminine suggère une réinterprétation de l'effet du travailleur additionnel : Cet effet serait relié à la démographie plutôt qu'au chômage.

Mots-clés: choix collectifs, offre de travail, participation au marché du travail, couple, moindres carrés asymptotiques.

Introduction

The labor force participation of men and women has evolved significantly over the last 40 years. While the activity and employment rates of men have been decreasing, the employment rate of women has been steadily increasing, mainly among married women. One can therefore question the origin of this change and, more generally, look for the labor supply determinants of men and women in couples. How do the characteristics of one spouse influence the labor market decision of the other member of the couple? Do the local labor market conditions influence the participation of both household members in the same manner? We study these issues by estimating a model of couples' labor market participation where the utilities of both household members are interdependent and where the characteristics of the local labor market are accounted for. We allow for a simple form of labor supply complementarity between members of the couple and focus on the sources of differences in the decision-making processes of the two household members.

The literature contains relatively few models of the labor market participation decisions of couples. The models of collective labor supply (Chiappori, 1992) that account for the role of the bargaining power of the household members are mostly restricted to the case where both household members work. The analysis of "corner solutions" has not been fully developed, even though the decision to participate in the labor market often represents a more important decision for a woman than her working hours' choice (Lollivier, 2001). A first set of studies therefore focused on the participation decision of women, but they all treat the decision of the other household member as exogenous. In this literature, the inclusion of the husband's participation in a married woman's labor supply is often used to test for the presence of an added worker effect, according to which the spouse of an unemployed man would offer more labor than a woman with an employed spouse in order to compensate the income loss of the household (Lundberg, 1985). Several applied studies have rejected this theory (Barrere-Maurisson et al., 1985; Davies et al., 1992) and found strong complementarity in the participation status of the members of the couple. Another approach focuses on game theoretic explanations. Interestingly, Kooreman (1994) finds that a Stackelberg model with the woman as leader gives the best description of household participation decisions, which contradicts the standard practice of treating men's decisions as exogenous with respect to the decisions of women.

In this paper, we propose a simple model to determine whether labor market participation decisions are made simultaneity or sequentially. We estimate a model of collective labor supply in which the decision of a household member to participate in the labor market depends on the utility of his (her) spouse rather than on his (her) decision to join the labor market. The utilities of the two members are directly related and jointly determine the decisions to participate in the labor market. The inclusion of the spousal utility and not the spouse's decision itself is consistent with the collective aspect of the decision process. Indeed, the observed decision of a household member is the *outcome* of the collective decision process, implying that including it in the other spouse's utility would be equivalent to imposing that second spouse takes the decision of the first one as given. In other words,

this is equivalent to saying that the first spouse is the leader of the couple, in the sense that he (she) is able to impose his (her) decision to the other household member. Here, we define leadership as the independence of the utility of the leader from the utility of the follower *conditional* on the characteristics of the household. This implies that, given the characteristics of the household, a leader will maximize his (her) own utility.

We find that the introduction of the possibility of simultaneous decision making in the couple affects essentially the men's participation equation. Men's decisions to work are positively influenced by the women's utility gain from work, by the number of children and by the birth of a child. The women's decisions to work are not affected by the men's utility gain from work and depend negatively of the number of children and the birth of a child. This implies, on the one hand, that there is female leadership in the decisions to participate in the labor market and, on the other hand, that a reinterpretation of the added-worker effect is needed. The decision to participate does not seem to depend on the unemployment situation of the spouse but on the number of children. Therefore the added-worker effect appears more related to the evolution of the birth rate than to the evolution of the unemployment rate.

In the next section, we present the theoretical context of the study. The data and descriptive statistics are presented in section 3. In section 4, we develop the model and the estimation method. We comment the results in section 5 and conclude in the last section.

1. Theoretical background

The participation of couples in the labor market has strongly changed over the last 40 years. While the activity and employment rate of men diminished in most advanced countries after 1973, the employment rate of women has steadily increased. In France increase in the participation of women in the labor market has been ongoing, reaching 48% globally and 80% between the ages of 25 and 49. Women currently represent 46% of the active population against 35% in 1968.

This increase in the female labor force participation rate originates for the largest part in a change of behavior of the married women. This evolution, as well as the decrease in male labor force participation in the labor market, has driven important changes in the contribution of men and women to household income and (potentially) important changes in collective choices of consumption. It thus becomes interesting to consider the origin of this change and more generally look at the determinants of labor supply for men and women in couples. The main factors explaining the rise in female labor force participation have been stronger investment in human capital, an increase in the number of job opportunities, the creation of services that allow women to reconcile family obligations and their professional lives and the need to contribute to the household income when the household as a whole is poor. Since the unemployment rate of men has increased over the last twenty years, the growth in female labor force participation could reflect a desire to counterbalance the bad performance of their husbands on the labor market. This is the essence of the added-worker effect. Several studies conducted in the United States and in the United Kingdom in the 70's and the 80's showed a slightly

positive relationship between male unemployment and the labor supply of married women (Lundberg, 1985). However, an opposite relationship has been found recently in the United Kingdom, Italy and France. Barrere-Maurisson et al. (1985), Davies et al. (1992), Dex et al. (1995) and Giannelli and Micklewright (1995) have all shown that the participation rates of the women married to unemployed men are far lower than the participation rates of the women married to employed men. Nevertheless, there is little consensus concerning the cause of this positive correlation. One possible explanation is the assortative mating hypothesis. According to Winkler (1998), persons with high education levels and high incomes are more likely to marry each other. Moreover, Del Boca, Locatelli and Pasqua (2001) and Rosetti and Tanda (2000) show that working women are more often married with employed men that have high incomes and high levels of education. Elsewhere, Gianelli and Micklewright (1995) have shown that the effect of men participation on women participation collapses once they control for the individual characteristics of the members of the couple and for individual fixed effects. If unemployment of men is associated with lower market participation by women in the short run, the authors insist that this empirical relation could be driven by missing variable bias, with the characteristics of the local labor market being a prime suspect. This strand of the literature, based on the empirical analysis of married women's behavior, relies on individual choice modeling.

The models of collective labor supply (Chiappori, 1992) that consider the decision of couples to participate in the labor market and account for the role of the bargaining power of the household members are, on the other hand, mostly restricted to the case where both household members work. The applied studies derived from these theoretical models concentrate on the working times of men and women in order to reveal the sharing rule of non-labor income (Chiappori, Fortin, Lacroix, 2002). In this case, the sample is limited to couples where both members work. Few studies cover the case where only one member of the household works or where neither does (Blundell, Chiappori, Magnac, Meghir, 2001; Donni, 2000). But as their theoretical analyses exclude public goods, the empirical analysis is performed on married couples without children. Moreover, it is restricted to the case where the man just decides to participate or not, while the woman can freely choose her working hours. The difficulties raised by the estimation of two interdependent discrete choices have not been fully overcome.

The other approaches focus on game theoretic explanations, relying either or non-cooperative games (Nash, Stackelberg) or on Nash bargaining in a cooperative game (McElroy; 1990, Kooreman, 1994). These approaches allow reintroducing the simultaneity of labor market participation decisions. Interestingly, Kooreman (1994) finds that a Stackelberg model with women's leadership gives a better description of the decisions than simple Nash bargaining. This result contradicts the usual practice whereby the man's decision enters directly in the objective function for the woman, since Kooreman's result implies that, on the contrary, it is the woman's decision that should directly enter man's decision process. Our model allows us to examine this issue.

In France, the studies on the labor force participation of couples have highlighted both a strong complementarity in the working times of the members of the couple and a strong child effect. Anxo, Flood and Kocoglu (2002) note that the presence of young children strongly reduces the labor

supply by women and that they often completely withdraw from the labor market after giving birth. Lollivier (2001), using longitudinal data, finds strong exit rates from the labor market for women when they have their two first children. Female participation rates start to increase again when the youngest child reaches four years old. Lollivier also finds that the short-term income variations of the men have a weak effect on women's participation while a persistently higher income would tend to diminish women's participation rates.

Fermanian and Lagarde (1999) account for the simultaneity in the number of hours worked. They find, on the one hand, that there is a strong and positive correlation between the hours worked by men and women in couple and, on the other hand, that the presence of children reduces female labor supply and increases male labor supply. The estimation of a collective choice model on similar data by Moreau (2000) confirms the importance of children, even though the author recognizes that the presence of children should affect the wife's decision to participate or not more than the number of hours she works. Nevertheless, no study to this date has explicitly addresses the joint decision to join the labor market.

2. The data

This study is based on the "Youth and Careers Survey" (Enquête Jeunes et Carrières) supplement to INSEE's (French National Institute of Statistics and Economic Studies) 1997 household survey, called the Enquête Emploi. This survey covers 20770 individuals between 19 and 45 years old, including 7973 that are less than 30 years old. Since all household members are surveyed, we obtain 9260 households (where the reference person was born between 1952 and 1978) and consider the labor market history of 5681 couples. The survey includes detailed data about an individual's schooling and provides information on their professional history, family events, health problems and changes of residence. Information about the social and national origins of the household members is also available. These data allow us to include the characteristics of all the household members when examining the decisions to participate in the labor market.

Two variables are available to measure the participation in the labor market in 1997. The first variable, AJC97, indicates whether the person has a job at the time of the survey. The second variable, EE7, provides the same information but from the Enquête Emploi's survey. For this study, we restrict the sample to heterosexual couples where both household members have completed their education. The absence of employment in the labor market therefore implies either unemployment or inactivity. Our final sample includes 5425 couples.

Four sets of explanative variables have been retained: individual characteristics (age, nationality, education, parents' nationality and occupation, existence of health problems), the corresponding characteristics of the spouse, the children (total number and birth events) and local labor market variables. In order to account for the local labor market conditions, we have matched our data set with the "Atlas of Employment Zones" (Atlas des zones d'emploi, INSEE) that provides 335

socio-economic indictors for each of the 348 employment zones in France.[1] The sample statistics are reported in Tables 1 and 2.

Table 1 illustrates an assortative mating result on the education levels of the household members. In more than one third of the cases, both household members have exactly the same education level and, for the extreme levels (no diploma or college education) the proportion is higher than 50%. These results confirm, but are weaker than, the results of Del Bocca et al. (2000). They are close to the results of Winkler (1998) on American data, even though both Del Bocca et al. and Winkler restrict their observations to couples where both members work.

Table 2 shows that the women with no children or one child are more often employed than other women and that, on the contrary, couples with 4 children or more often include two persons without a job. French people are disproportionately in couples where both members are employed, while the opposite is the case for people of North African origin. The employment rate of both men and women increases with their education level and jobless couples more often include people with the lowest level of schooling. Finally, people for whom at least one of their parents is deceased are more often jobless than those with both parents still alive.

The partition of the French territory into 348 employment areas allows us to account for variations in the local labor market. These zones regroup a variable number of cities and are defined on the basis of “home-to-work” commutes. This fine partition of the territory allows us to measure the (sometimes important) differences across local labor markets. In particular, the distribution of unemployment is highly skewed (Le Toqueux and Moreau, 2002) and this is partly due to the sectoral specialization of the geographic area. These differences in the local labor market conditions could have a significant effect on the labor supply. It has been shown, for many countries, that the employment probability of the young workers is strongly correlated to the total unemployment rate and to the rate of economic growth (OECD, 1996). One can also suggest that the employment possibilities for unskilled workers are linked to their location because they tend to be less geographically mobile.

We account for three aspects of the local labor market: the level of economic activity, its evolution and the importance of the public transfers linked to children.[2] In particular, we exploit the ILO unemployment rate in the fourth quarter of 1996, its change between 1991 and 1996 and the rate of “pure” firm creations over the 1993-96 period. A high unemployment rate could discourage workers to look for a job while, on the contrary, the creation of new firms could positively influence their expectations about finding a job in case of participation. The other set of local variables refers to public transfers given either to families with children or to low income families. The data refer to the percentage of persons that benefit from each of the following programs (one variable per program) in 1996.

[1] Due to confidentiality requirements, the matching was performed by INSEE.

[2] The broad sectoral decomposition between agriculture, industry and services was not found to be significant.

- Allocation Familiale (AF): a non-means tested transfer granted to all the families with at least two children, whose amount increases with the number of children
- Allocation Parentale d'Education (APE)[3]: a revenue compensation for the mothers with at least two children that pass from full-time to part-time jobs or that stop working)
- Aide à la Famille pour l'Emploi d'une Assistante Maternelle (AFEAMA) and Allocation Garde d'Enfants à Domicile (AGED) : two measures available to working women that provide financial assistance for in-home child care
- Allocation Pour le Logement (APL), Aide au Logement à caractère Social (ALS) and Allocation pour le Logement Familial (ALF) : three measures that provide rent subsidies to low income families.

We also include the share of the population living below the poverty threshold.[4] It should be noted that the above-mentioned variables do not allow us to evaluate the impact of these policy measures on a particular household's labor supply (unavailable) but rather the impact of the frequency of these variables in the same economic area. This allows us to answer questions such as: does the fact that APE is widespread in a zone reduce the labor supply of women? Or, does broad use of the AFEAMA and AGED in an area increase female labor supply?

3. Model and estimation

3.1 Model

Let $(U_{1,i}, U_{2,i})$ be the utilities of the spouses when they work and $(\bar{U}_{1,i}, \bar{U}_{2,i})$ the corresponding utilities when they do not work. The differences $U_{k,i} - \bar{U}_{k,i}$ (k=1,2) represent the incentives to work. This incentive comes, for example, from the possibility of increasing consumption with the gains obtained from work. The model we estimate is equivalent to the following specification:

$$\begin{aligned} U_{1,i} - \bar{U}_{1,i} &= a_1\left(U_{2,i} - \bar{U}_{2,i}\right) + X_{1,i}b_1 + u_{1,i} \\ U_{2,i} - \bar{U}_{2,i} &= a_2\left(U_{1,i} - \bar{U}_{1,i}\right) + X_{2,i}b_2 + u_{2,i} \end{aligned} \qquad (1)$$

The utility of a participation in the labor market, $U_{k,i} - \bar{U}_{k,i}$ (k=1,2), depends potentially on the other spouse's utility and on a set of explanatory variables $X_{k,i}$. We also add a random variable $u_{k,i}$ to account for unobserved heterogeneity. The explanatory variables may refer either to the individual or his or her spouse. For instance, more education increases the return to employment and, therefore, should increase the incentive to join the labor market. Similarly, we will see that when women have a

[3] See Afsa (1998).

father that is an executive or a middle manager; this opens up family networks for their spouse so that his returns to participation on the labor market improve.

The interdependence between the utilities of the spouses can arise through several channels. For instance, the effects can pass through consumption and leisure. On the one hand, an increase in the activity of one spouse may raise the income of the household and, therefore, allow an increase in consumption by both household members. This should increase both of their utilities. On the other hand, an increase in the activity of one spouse reduces his or her leisure time, and this could have a negative effect on the value of the leisure of the other household member (provided that the two leisure times are complementary). Such an effect would reduce the utility of the household.

The model (1) suggests using an econometric *latent variable* model, because the utilities of the household members are not observable. The only observable data that is related to these utilities are the decisions that have been taken by the spouses. Without loss of generality, we will set these participation variables to 0 when there is no participation and to 1 otherwise. They are defined by:

$$y_{k,i} = \begin{cases} 1 & \text{if} \quad U_{k,i} - \bar{U}_{k,i} > 0 \\ 0 & \text{if} \quad U_{k,i} - \bar{U}_{k,i} \leq 0 \end{cases} \quad \text{k=1,2.}$$

3.2 Econometric model

The interdependence of the utilities within a household implies that the labor supply of each member of the couple depends (at least indirectly) on all of the characteristics of both members of the couple. Let $y^*_{k,i} = U_{k,i} - \bar{U}_{k,i}$ (k=1,2) and X regroup the explanatory variables X_1 and X_2. Solving the system (1) according to the incentives to join the labor market, we get:

$$\begin{aligned} y^*_{1,i} &= X_i\pi_1 + v_{1,i} \\ y^*_{2,i} &= X_i\pi_2 + v_{2,i} \end{aligned} \tag{2}$$

with $v_{1,i} = (u_{1,i} + a_1 u_{2,i})/(1 - a_1 a_2)$ and $v_{2,i} = (u_{2,i} + a_2 u_{1,i})/(1 - a_1 a_2)$.

In this paper, we propose to estimate the structural form of the model (1) rather than the reduced form (2). In order to identify the parameters of the model, we assume that there exists at least one variable that influences the labor supply of one household member without influencing directly the other member's labor supply. Note that such variables have an indirect influence through the spouse's utility and so are not excluded from the model, but they are constrained to act through a particular channel. We can rewrite the system (1) as:

$$\begin{aligned} y^*_{1,i} &= a_1 y^*_{2,i} + X_{1,i} b_1 + u_{1,i} \\ y^*_{2,i} &= a_2 y^*_{1,i} + X_{2,i} b_2 + u_{2,i} \end{aligned}$$

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[4] The poverty line is defined as 60% of median French monthly earnings. It corresponds to earnings of 640 Euros per month per consumption unit in 1996.

In this form, the decision of a household member to participate in the labor market depends on the utility of his (her) spouse rather than on his (her) decision to join the labor market. The utilities are thus directly related and both spouses' decisions to join the labor market will be a function of the two utilities. The reason why we do not include the decision itself in the previous system is that it would contradict the collective aspect of the decision making process: the decision of a household member is the *outcome* of the decision process, which means that including it in the spouse's utility would imply that the second spouse takes the decision of the first as given. This is equivalent to saying that the first spouse is the leader of the couple, in the sense that he (she) is able to impose his (her) decision on the other household member. We propose to test leadership in a simple way based on the previous model: one member of the couple is a leader when his (her) utility influences the choice of the other while his own decision is independent of the other's utility. In system (2), the first member is the leader when $a_1 = 0$ and the second member is the leader when $a_2 = 0$.

Concerning the exclusion restriction to be applied, we have chosen to exclude the nationality of the spouse. The idea is that this variable has no *direct* influence on the probability of someone to get a job. Of course, it is allowed to have an indirect influence insofar as it affects the ability of the spouse to find a job. Testing this exclusion restriction (as described in the next section) does not allow us to reject the hypothesis that the spouse's nationality should be excluded from having a direct influence on the individual's decision process.

3.3 Estimation

The estimation method, asymptotic least squares (or minimum distance), can be used for a wide range of simultaneous equation, limited dependent variable models. We estimate our model in two steps. In the first step, we estimate the reduced form of the model (1) and, in a second step, we infer the structural form parameters from the reduced form parameters and the identification constraints.

3.3.1 The reduced form

Assuming that the disturbances of the structural form (1) have a bivariate normal distribution, the disturbances of the reduced form (2) are also jointly normal. We can thus estimate the reduced form, which is essentially a bivariate probit model, by maximum likelihood. The estimator of the reduced form parameters, denoted $\hat{\pi}' = (\hat{\pi}_1', \hat{\pi}_2')$, has an asymptotically normal distribution:

$\sqrt{n}(\hat{\pi} - \pi) \xrightarrow{d} N(0, J^{-1})$ with $J = E\left(-\frac{\partial^2 \ell}{\partial \pi \partial \pi'}(\pi)\right)$, where $\ell(\pi)$ denotes the log-likelihood of the bivariate probit model.[5]

[5] Notice that the joint estimation of the reduced form of the model is not required. It just provides a more efficient estimate of the reduced form. For an example of application where the reduced form is estimated equation by equation and

3.3.2 The identification constraints

We use the identification constraints of the model to obtain estimates of the structural parameters from the reduced form parameter estimates. Equating the endogenous variables in expressions (1) and (2), we get:

$$\begin{cases} X\pi_1 + v_1 &= a_1(X\pi_2 + v_2) + X_1 b_1 + u_1 \\ X\pi_2 + v_2 &= a_2(X\pi_1 + v_1) + X_2 b_2 + u_2 \end{cases}$$

Taking expectations and using $E(u_1) = E(u_2) = 0$,[6] we get:

$$\begin{cases} X\pi_1 &= X\pi_2 a_1 + X_1 b_1 \\ X\pi_2 &= X\pi_1 a_2 + X_2 b_2 \end{cases}$$

Identification is based on the exclusion constraints and the standard normalizations. We represent the exclusion constraints by two matrices, E_1 and E_2, whose elements equal 0 or 1 and are defined so that

$X E_1 = X_1$ and $X E_2 = X_2$.

Replacing X_1 and X_2 by their expression in the previous system, we get the identification constraints:

$$\begin{cases} X\pi_1 &= X(\pi_2 a_1 + E_1 b_1) \\ X\pi_2 &= X(\pi_1 a_2 + E_2 b_2) \end{cases} \Rightarrow \begin{cases} \pi_1 &= \pi_2 a_1 + E_1 b_1 \\ \pi_2 &= \pi_1 a_2 + E_2 b_2 \end{cases}$$

because X is of full column rank.

3.3.3 The structural form

The estimation by asymptotic least squares is related in the literature, to Amemiya's method (see Lee, 1981). The goal is to recover the structural parameters (β in Lee's notation), also called the parameters of interest, from a consistent and asymptotically normal (CAN) estimator of the reduced form parameters π, also called the auxiliary parameters. The relation between these two parameter vectors is summarized by the identification constraints. More precisely, we can write:

$$\pi = H(\pi)\beta \quad \text{with} \quad H(\pi) = \begin{pmatrix} \pi_2 & E_1 & 0 & 0 \\ 0 & 0 & \pi_1 & E_2 \end{pmatrix} \quad \text{and} \quad \beta = \begin{pmatrix} a_1 \\ b_1 \\ a_2 \\ b_2 \end{pmatrix}$$

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the econometric treatment required to recover the structural parameters is presented, see Crépon, Duguet and Mairesse (1998).

[6] This assumption can be made without loss of generality provided that the two equations include a constant term. Moreover it implies that $E(v_1) = E(v_2) = 0$.

The method of asymptotic least squares estimates β as

$$\hat{\beta} = \arg\min_{\beta} \left\| \hat{\pi} - H(\hat{\pi})\beta \right\|^2$$

In our case, this reduces to ordinary least squares applied to the identification constraints:

$$\hat{\beta} = (H(\hat{\pi})' H(\hat{\pi}))^{-1} H(\hat{\pi})' \hat{\pi} .$$

Two important points immediately appear. First, one cannot estimate the variance of this estimator by the standard OLS formula because the estimators of the reduced form generally have different variances and are correlated with each other.[7] Second, this estimator is not optimal for the previous reason. Therefore, we compute an optimal second-step estimator, using the feasible generalized least squares method. More precisely, one can write the identification constraints in the following form:

$$\begin{cases} \hat{\pi}_1 &= \hat{\pi}_2 a_1 + E_1 b_1 + \omega_1 \\ \hat{\pi}_2 &= \hat{\pi}_1 a_2 + E_2 b_2 + \omega_2 \end{cases}$$

where the random variable $\omega = (\omega_1', \omega_2')'$ converges in probability to zero. This provides us with a linear auxiliary model based on the estimates from the reduced form estimation. The covariance of this disturbance is needed to derive the weight matrix for the GLS estimation of the system. We have:

$$\Omega = V(\omega) = A\, V(\hat{\pi} - \pi) A' \quad \text{with} \quad A = \begin{pmatrix} 1 & -a_1 \\ -a_2 & 1 \end{pmatrix} \otimes I_k$$

where *k* is the number of parameters in each equation of the reduced form. The two-step optimal estimator of the reduced form is thus given by:

$$\beta^* = \left(H(\hat{\pi})' \Omega^{-1} H(\hat{\pi}) \right)^{-1} H(\hat{\pi})' \Omega^{-1} \hat{\pi}$$

and its asymptotic covariance matrix equals

$$Vas(\beta^*) = \left(H(\hat{\pi})' \Omega^{-1} H(\hat{\pi}) \right)^{-1}$$

We substitute our estimate $\hat{\Omega}$ for the unknown Ω in the preceding expressions and present results based on the use of this optimal estimator.

3.3.4 Overidentification test

The model is overidentified, in that there are more exclusion constraints than needed to estimate the structural form of the model. The null hypothesis is simply:

$$H_0 : \omega = 0 \Leftrightarrow \|\omega\|^2 = 0.$$

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[7] This is referred to as the “non-spherical” case in the literature.

We test this assumption with the following statistic:

$$\xi = \omega^{*} \hat{V}as\left(\omega^{*}\right)^{-1} \omega^{*} \xrightarrow[H_0]{d} \chi^2_p ,$$

where $\omega^{*} = \hat{\pi} - H(\hat{\pi})\beta^{*}$ and p is the difference between the number of parameters in the reduced form and the number of parameters in the structural form of the model.

3.3.5 Implementation

The bivariate probit model and the ALS estimations were programmed under SAS-IML by the authors. From the bivariate probit model we recover $\hat{\pi}$ and $\hat{V}as(\hat{\pi})$. We then estimate the parameter vector $\hat{\beta}$ with the OLS formula. This gives us the estimates of $\hat{a}_1$ and $\hat{a}_2$ that we need to estimate Ω. Let $\hat{\Omega}$ denote the corresponding estimator. We use it to get the optimal ALS estimator (using the GLS formula): $\beta^{*} = \left(H(\hat{\pi})'\hat{\Omega}^{-1}H(\hat{\pi})\right)^{-1} H(\hat{\pi})'\hat{\Omega}^{-1}\hat{\pi}$. This gives us updated estimates a_1^{*} and a_2^{*} that are again used to re-estimate Ω. The asymptotic variance of the optimal estimator is then dervide as $\hat{V}as(\beta^{*}) = \left(H(\hat{\pi})'\Omega^{*-1}H(\hat{\pi})\right)^{-1}$, where Ω^{*} denotes the estimator of Ω using a_1^{*} and a_2^{*}.

4. Results

The first result we find is that the woman's utility gain from participation has a positive and significant influence on the man's decision to work (Table 3). Employed men in couples are more likely to have employed spouses. This implies that, ceteris paribus and after accounting for the fact that men and women with similar characteristics are more often together, we observe an additional polarization of the activities of the two household members. However, while the woman's decision to participate has a positive influence on the man's participation, the coefficient of the man's utility gain from participation is not a significant determinant of the woman's decision to work. Our results are therefore consistent with those of Kooreman (1994) and Giannelli and Micklewright (1995) who also find that the man's decision to participate does not significantly influence the woman's decisions.

Perhaps surprisingly, we find that the estimation of the husband's participation equation is strongly affected by allowing for simultaneous decision making in the couple. By taking into account the interaction between the two participation decisions, we can examine additional determinants of the husband's decision to participate. Among these new determinants, we find that the number of children and the birth of a child increase significantly the likelihood that a man decides to work. Men with two or three children or who have had a baby the year before the survey have a higher probability of working than others. This result does not appear when the spouse's decision to work is assumed to be exogenous. One explanation may be that the presence of children significantly reduces the likelihood of the wife's participation in the labor market. As the husband's decision to participate is positively correlated with the wife's probability participation, the presence of children should reduce the husband's probability of participation. However, the presence of children has a positive and significant

direct effect on men's decision to work. So, when we do not take into account the simultaneity of decisions, the coefficient associated with the number of children becomes subject to omitted variable bias, captures the two opposing effects and becomes insignificant.

The fact that the presence of children increases the participation of men and reduces the participation of women can be interpreted in light of the added-worker effect. The decision to participate does not seem to depend negatively on the employment situation of the spouse – we observe a polarization of the labor market situations of the two members of the household - but on the number of children. Therefore the so-called added-worker effect seems to be more attributable to the evolution of the birth rate than to the evolution of the unemployment rate. When children are born in the household, the decisions to participate of the mother and the father seem to be taken jointly and on average, the participation of men increases while the participation of women decreases. Quantitatively, the presence of children is the most important determinant of the woman's participation in the labor market. By comparing the coefficients in the women's regression, the disutility of work (the disincentive effect) associated with the presence of two children is only comparable to the utility gain associated with a baccalauréat diploma (levels 4 or 5) relative to no diploma or only the first year of a CAP (unskilled professional training), while there is no diploma that can counterbalance the presence of three or more children.

The man's participation probability, interestingly, also depends on his father-in-law's occupation. The son-in-law of a farmer, a craftsman, an executive or a middle manager has a higher probability of participation than men whose father-in-law is a blue collar worker. This result may be a reflection the importance of family networks in France (Margolis and Simonnet, 2003). Nevertheless, the spouse's own education level has no significant effect on the man's decision to participate when the simultaneity of the decision is taken into account. Men married to high-educated women are not more likely to work than the other men. The positive coefficient obtained when the woman's decision to work is assumed exogenous is due to the fact that high-educated women are more likely to participate and men married to working women are more likely to work.

By comparing the reduced form[8] and the structural form, we observe that the positive correlation between the employment statuses of husbands and wives is the consequence of three factors: age, education and family background. The coefficients associated with age are positive and significant in the reduced form estimation of the man's decision to participate but they are not significant in the structural form estimation. The woman's age is positive and significant in both the reduced form and structural estimations. This implies that while both the husband's and the wife's decision to participate increases with their age, the man's decision receives an additional boost via the indirect effect of increased participation of his wife and the positive correlation of their ages. We find the same result with respect to the level of education. Its coefficient is significant in the spouse's reduced form estimation but not in the spouse's structural form estimation. As the probability of participating increases with the education level and as men and women frequently similar levels of

[8] Results of the bivariate probit are not reported but are available on request.

education as their spouses, a woman's higher probability of participation (partly due to a high education level) would be directly, and indirectly, linked to her husband's having a higher probability of participation.

In addition to these indirect effects, the husband's education level as well as the father's occupation still have a direct impact on the woman's decision to work when accounting for the simultaneity of participation decisions, although the size of the effect is reduced. We observe that a woman whose husband has the highest level of education is less likely to participate than a spouse of man with no degree. Moreover, the daughter of a male executive is less likely to participate than the daughter of a blue collar worker. If we consider that incomes are closely, and positively, related to the level of educational or the hierarchical level of the occupation, it becomes possible that these two results reflect an income effect: women with higher non-wage incomes are less likely to participate than women with lower non-labor market incomes. The woman whose spouse has a high education level and potentially a high wage and the woman whose father is upper manager come from households with potentially high incomes and thereby work less, ceteris paribus. Each income effect is compensated be the possession of a diploma of at least a 2-year technical college (BTS, level 6) level.

Concerning family background, we note that people who come from North Africa or from outside Europe have a lower probability of working than the Europeans. Moreover, these people have a higher probability of living with a person who comes also from North Africa or from outside the EU countries. They also have a higher probability of belonging to a couple where nobody works. The difficulty of getting a job is especially serious for the men who come from North Africa in that there is no diploma available such that the increase in the chance of finding a job associated with such a diploma (relative to no diploma or the first year of a technical education) can compensate the lower participation probability associated for North African nationality. The effect is also important for women who come from North Africa and for those whose father comes from North Africa. Several explanations are possible for these results, such as the ineligibility of non-EU foreigners for some public jobs, discrimination, weaker networks of labor market contacts than French people and cultural differences.

As noted in section 2, the local labor market context also plays a role in determining labor force participation, albeit somewhat weak. In particular, the husband's labor supply varies with the local unemployment rate but insensitive to the job creation rate while the wife's labor supply seems to be invariant to most of the local labor market variable we introduce, with the exception of the share of female entrepreneurs. In addition, we find that the introduction of the employment zone characteristics in the equations does not modify the effects of the individual characteristics on the participation decision. This result could reflect the fact that the French population is approximately homogeneously spread over the national territory.

Conclusion

In this paper, we have explicitly considered the role of simultaneous participation decision making within married couples. The introduction of simultaneity produces the two following results that do not appear otherwise. First, we find that the the probability of labor market participation for men in couples increases when the spouse participates, whereas the participation decisions of women in couples do not depend on their spouse's participation. This result is compatible with a Stackelberg game with female leadership as has been put forward by certain game theoretical approaches to labor market participation. Second, we note that the probability of a woman joining the labor market strongly decreases with the number of children, while the participation probability of the men increases up to the third child and when there is a birth in the household. This latter result for men only appears when the simultaneity of decision making is accounted for. Without it, children are not found to influence the labor supply of men. Moreover, local labor market characteristics have a limited effect on participation (except for the unemployment rate, which is negatively correlated with the men participation) and the introduction of these statistics in the participation equations do not modify the individual characteristics' effects we found.

Overall, we find that accounting for simultaneity produces interesting new results. In particular, these results could partly explain the weakness of the added-worker effect. This effect should be reinterpreted as being due to the number of children: when the number of children increases, the participation of women decreases which, indirectly, causes that of the men to increase. This implies that the added-worker effect is more related to demography than to unemployment.

The methodology employed in this paper could also be used to improve on the estimates found elsewhere in the literature of the number of hours worked by members of a couple. Our paper clearly indicates a potential for significant selection bias for both men and women in these hours estimations, as they are conditional on participation in the labor market. Our results suggest that a reasonable extension in the hours context would be the estimation of a simultaneous generalized Tobit model, in order to explicitly account for the endogenous participation of both members of the couple.

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Table 1: Education levels in couples

Education level (husband)	Identical level	Wife > Husband	Husband > Wife	Number of couples	%
1	48.3	51.7	0	776	14.3
2	21.7	59.8	18.5	860	15.6
3	36.2	29.3	34.6	2025	37.3
4	18.6	33.5	47.9	489	9.0
5	24.3	31.6	44.1	247	4.6
6	33.7	19.9	46.4	448	8.3
7	52.9	0	47.1	580	10.7
Number of couples	1904	1838	1683	5425	
%	35.1	33.9	31.0		

1 : without diploma or first year of CAP (unskilled professional training)
2 : without diploma, last year of CAP or 3 years before the O-level
3 : CAP or BEP (unskilled professional training)
4 : Professional Baccalauréat (O-level)
5 : General Baccalauréat or college education without diploma
6 : Two years of technical college education
7 : College education (with a diploma)

Table 2 : Sample statistics by employment profile

Employment profile (Husband,Wife)	(0,0)	(0,1)	(1,0)	(1,1)	All couples
Percentage	4.5	4.3	29.1	62.1	100.0
Couple characteristics					
Number of children :					
- none	18.8	30.2	12.4	21.8	19.2
- 1	19.2	27.6	20.6	26.9	24.8
- 2	29.8	26.7	35.4	37.0	35.8
- 3	15.1	11.6	21.5	12.4	15.1
- 4 and more	17.1	3.9	10.1	1.9	5.1
Birth in 1996-1997	16.3	6.9	18.3	8.7	11.8
Husband's characteristics					
Nationality :					
- French	82.0	87.5	92.3	96.5	94.2
- North African	10.2	5.2	2.9	0.5	1.8
- European	2.1	3.4	2.5	2.1	2.3
- Other	5.7	3.9	2.3	0.9	1.7
Education level :					
- 1	35.4	20.3	18.0	10.6	14.3
- 2	19.2	15.9	16.3	15.4	15.8
- 3	29.0	27.1	38.0	38.3	37.3
- 4	6.1	12.5	7.4	9.8	9.0
- 5	3.7	3.0	4.6	4.7	4.6
- 6	3.3	11.2	6.3	9.3	8.3
- 7	3.3	10.0	9.4	11.9	10.7
Father missing	10.6	3.9	3.9	3.1	3.7
Mother missing	8.2	2.6	4.1	2.9	3.5
Inactive mother	38.4	30.6	33.8	28.5	30.6
Nationality of the father :					
- missing	1.6	1.8	0.6	0.4	0.5
- French	64.5	75.0	78.3	83.9	81.1
- North African	9.8	6.0	4.8	2.6	3.7
- European	3.3	7.3	4.6	4.7	4.8
- Other	20.8	9.9	11.7	8.4	10.0
Wife's characteristics					
Nationality:					
- French	82.0	90.9	91.3	97.0	94.2
- North African	8.6	2.2	3.3	0.3	1.7
- European	1.6	3.9	2.1	1.8	1.9
- Other	7.8	3.0	3.3	0.9	2.2
Education level :					
- 1	44.4	17.7	27.3	13.2	18.9
- 2	19.6	12.9	16.9	12.3	14.0
- 3	20.4	25.8	26.5	26.4	26.1
- 4	5.3	9.1	8.2	11.9	10.4
- 5	3.7	6.9	7.4	8.9	8.1
- 6	3.3	13.4	6.2	14.5	11.6
- 7	3.3	14.2	7.5	12.8	10.9

(continued)

(Table 2 continued)

Father missing	8.2	2.6	4.8	2.8	3.6
Mother missing	4.9	2.6	4.4	2.4	3.1
Inactive mother	39.2	25.0	31.6	25.2	27.7
Nationality of the father :					
- missing	1.6	0.4	0.4	0.3	0.3
- French	69.4	78.9	77.6	84.8	81.8
- North African	9.8	3.0	5.1	2.4	3.6
- European	2.9	7.8	5.2	4.8	5.0
- Other	16.3	9.9	11.7	7.7	9.3

Table 3 : Participation of couples in the labor market

From the « Jeunes et Carrières » survey.

Model	**With spouse's participation endogenous**		**With spouse's participation exogenous (for comparison)**	
Estimation method	**Asymptotic Least Squares (ξ statistic p-value : 0.402)**		**2 separate probit estimations (most probably affected by simultaneity bias)**	
Gender	**Man**	**Woman**	**Man**	**Woman**
Intercept	-0.89 (0.74)	0.14 (0.57)	-0.96 (0.73)	-0.06 (0.53)
Participation of the spouse	0.33 (0.13)**	0.08 (0.21)	0.21 (0.06)**	0.22 (0.07)**
Individual characteristics				
Age	0.01 (0.01)	0.05 (0.01)**	0.02 (0.01)**	0.05 (0.01)**
Number of children (ref. None) :				
- 1	0.12 (0.09)	-0.22 (0.06)**	0.07 (0.08)	-0.22 (0.06)**
- 2	0.24 (0.11)**	-0.55 (0.07)**	0.11 (0.09)	-0.56 (0.07)**
- 3	0.37 (0.16)**	-0.93 (0.08)**	0.14 (0.10)	-0.94 (0.08)**
- 4 and more	0.14 (0.24)	-1.56 (0.14)**	-0.24 (0.13)*	-1.59 (0.11)**
Child born in 1996-1997 (ref. No) :	0.22 (0.10)**	-0.34 (0.07)**	0.12 (0.09)	-0.33 (0.06)**
Health problems (ref. None)	-0.46 (0.07)**	-0.08 (0.08)	-0.47 (0.07)**	-0.09 (0.07)
Occupation of the mother (ref. White collar) :				
- Missing	0.03 (0.14)	-0.27 (0.11)**	0.01 (0.14)	-0.28 (0.11)**
- Agriculture	0.37 (0.17)**	0.17 (0.12)	0.35 (0.17)**	0.16 (0.11)
- Blue collar	0.03 (0.08)	-0.05 (0.06)	0.03 (0.08)	-0.06 (0.06)
- Craftsman	-0.06 (0.12)	-0.08 (0.09)	-0.09 (0.12)	-0.08 (0.09)
- Executive	-0.12 (0.13)	-0.22 (0.21)	-0.13 (0.25)	-0.25 (0.18)
- Middle manager	0.12 (0.13)	0.02 (0.09)	0.13 (0.13)	0.01 (0.09)
- Inactive	0.10 (0.07)	-0.09 (0.05)*	0.09 (0.07)	-0.09 (0.05)*
Occupation of the father (ref. Blue collar) :				
- Missing	-0.24 (0.13)*	-0.14 (0.11)	-0.25 (0.12)**	-0.14 (0.11)
- Agriculture	0.14 (0.14)	0.05 (0.11)	0.19 (0.14)	0.07 (0.10)
- White collar	0.11 (0.09)	-0.03 (0.06)	0.13 (0.09)	-0.03 (0.06)
- Craftsman	-0.05 (0.09)	-0.01 (0.08)	-0.03 (0.09)	0.01 (0.07)
- Executive	-0.17 (0.12)	-0.23 (0.12)*	-0.17 (0.12)	-0.21 (0.09)**
- Middle manager	0.08 (0.10)	-0.03 (0.08)	0.10 (0.10)	-0.02 (0.07)
Nationality (ref. French) :				
- North African	-0.66 (0.18)**	-0.68 (0.21)**	-0.76 (0.17)**	-0.73 (0.19)**
- European	-0.13 (0.19)	-0.03 (0.16)	-0.13 (0.18)	-0.03 (0.15)
- Other	-0.45 (0.18)**	-0.70 (0.19)**	-0.57 (0.17)**	-0.71 (0.15)**
Nationality of the father (ref. French) :				
- North African	-0.18 (0.14)	-0.16 (0.12)	-0.19 (0.14)	-0.15 (0.12)
- European	-0.04 (0.14)	0.03 (0.10)	-0.01 (0.14)	0.02 (0.10)
- Other	-0.11 (0.09)	-0.01 (0.07)	-0.15 (0.09)*	-0.01 (0.07)
Education level (ref. 1) :				
- 2	0.28 (0.09)**	0.23 (0.07)**	0.31 (0.09)**	0.24 (0.07)**
- 3	0.41 (0.08)**	0.36 (0.07)**	0.44 (0.08)**	0.37 (0.06)**
- 4	0.20 (0.11)*	0.61 (0.11)**	0.24 (0.11)**	0.63 (0.08)**
- 5	0.44 (0.13)**	0.49 (0.11)**	0.41 (0.16)**	0.51 (0.08)**
- 6	0.28 (0.13)**	0.90 (0.10)**	0.29 (0.12)**	0.91 (0.08)**
- 7	0.47 (0.14)**	0.86 (0.10)**	0.42 (0.14)**	0.86 (0.09)**

(continued)

(Table 3 continued)

Characteristics of the spouse :				
Age	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Health problems (ref. None)	-0.09 (0.09)	-0.15 (0.13)	-0.11 (0.09)	-0.02 (0.06)
Occupation of the mother (ref. White collar) :				
- Missing	0.01 (0.16)	-0.10 (0.11)	-0.06 (0.15)	-0.10 (0.11)
- Agriculture	-0.21 (0.17)	-0.15 (0.13)	-0.16 (0.16)	-0.13 (0.11)
- Blue-collar	-0.02 (0.08)	0.01 (0.06)	-0.04 (0.08)	0.01 (0.06)
- Craftsman	-0.04 (0.14)	-0.09 (0.09)	-0.05 (0.13)	-0.09 (0.09)
- Executive	-0.45 (0.23)*	-0.08 (0.19)	-0.51 (0.22)**	-0.09 (0.18)
- Middle manager	-0.13 (0.12)	0.03 (0.09)	-0.13 (0.12)	0.03 (0.09)
- Inactive	-0.01 (0.07)	-0.04 (0.05)	-0.04 (0.07)	-0.03 (0.05)
Occupation of the father (ref. Blue-collar) :				
- Missing	0.11 (0.14)	-0.03 (0.12)	0.06 (0.13)	-0.04 (0.10)
- Agriculture	0.25 (0.14)*	0.20 (0.10)**	0.25 (0.14)*	0.21 (0.09)**
- White collar	-0.01 (0.08)	0.04 (0.07)	-0.02 (0.08)	0.05 (0.06)
- Craftsman	0.20 (0.10)**	0.07 (0.07)	0.19 (0.10)*	0.07 (0.07)
- Executive	0.44 (0.14)**	0.02 (0.09)	0.38 (0.14)**	0.01 (0.09)
- Middle manager	0.20 (0.10)**	0.09 (0.07)	0.19 (0.10)	0.09 (0.07)
Nationality of the father (ref. French) :				
- North African	0.19 (0.16)	-0.01 (0.13)	0.11 (0.15)	-0.02 (0.11)
- European	-0.02 (0.13)	0.13 (0.10)	-0.01 (0.13)	0.13 (0.10)
- Other	-0.03 (0.09)	-0.14 (0.08)*	-0.05 (0.09)	-0.14 (0.07)**
Education level (ref. 1) :				
- 2	0.01 (0.10)	0.05 (0.10)	0.09 (0.09)	0.06 (0.07)
- 3	0.05 (0.10)	0.03 (0.11)	0.16 (0.08)**	0.05 (0.06)
- 4	0.13 (0.15)	0.09 (0.10)	0.31 (0.11)**	0.10 (0.09)
- 5	0.13 (0.15)	-0.19 (0.13)	0.29 (0.13)**	-0.18 (0.11)*
- 6	-0.09 (0.18)	-0.01 (0.11)	0.18 (0.11)*	0.01 (0.09)
- 7	-0.19 (0.18)	-0.23 (0.13)*	0.07 (0.13)	-0.21 (0.10)**
Employment zone characteristics :				
- Business creation rate (%)	0.01 (0.03)	0.03 (0.02)	0.01 (0.03)	0.03 (0.02)
- Low income population (%)	0.04 (0.03)	0.01 (0.02)	0.05 (0.03)*	0.01 (0.02)
- AF	-0.03 (0.04)	-0.03 (0.03)	-0.04 (0.04)	-0.03 (0.02)
- APE	0.41 (0.20)**	0.10 (0.17)	0.46 (0.20)**	0.12 (0.14)
- AFEAMA	0.08 (0.08)	-0.07 (0.05)	0.06 (0.07)	-0.06 (0.05)
- AGED	0.24 (0.25)	0.19 (0.17)	0.29 (0.24)	0.20 (0.16)
- ILO unemployment rate 1996	-0.10 (0.03)**	-0.03 (0.03)	-0.11 (0.03)**	-0.04 (0.02)*
- ILO unemployment rate variation 1991-96	0.10 (0.05)**	0.03 (0.04)	0.11 (0.05)**	0.04 (0.03)
- APL	-0.01 (0.02)	0.01 (0.01)	-0.01 (0.02)	0.01 (0.01)
- ALS	-0.03 (0.01)**	0.01 (0.01)	-0.03 (0.01)**	0.01 (0.01)
- ALF	0.02 (0.06)	-0.02 (0.04)	0.01 (0.06)	-0.02 (0.04)
- Share of women in entrepreneurs	0.05 (0.02)**	-0.03 (0.01)**	0.04 (0.02)**	-0.03 (0.01)**

(continued)

(Table 3 continued)

Location (ref. Ile de France) :				
Champagne	0.38 (0.26)	-0.11 (0.19)	0.35 (0.25)	-0.09 (0.18)
Picardie	-0.08 (0.23)	0.08 (0.16)	-0.06 (0.22)	0.08 (0.16)
Haute Normandie	-0.07 (0.24)	0.13 (0.17)	-0.05 (0.23)	0.13 (0.17)
Centre	-0.03 (0.24)	0.12 (0.17)	-0.01 (0.23)	0.12 (0.16)
Basse Normandie	-0.38 (0.26)	-0.04 (0.20)	-0.39 (0.25)	-0.06 (0.18)
Bourgogne	0.05 (0.26)	-0.06 (0.18)	0.02 (0.25)	-0.06 (0.17)
Nord Pas de Calais	-0.28 (0.25)	-0.06 (0.19)	-0.31 (0.24)	-0.08 (0.17)
Lorraine	0.16 (0.26)	-0.03 (0.17)	0.15 (0.26)	-0.02 (0.17)
Alsace	-0.32 (0.24)	-0.17 (0.18)	-0.38 (0.23)	-0.19 (0.16)
Franche Comté	0.19 (0.27)	0.05 (0.18)	0.19 (0.27)	0.06 (0.17)
Pays de la Loire	-0.15 (0.28)	0.21 (0.19)	-0.10 (0.27)	0.21 (0.19)
Bretagne	-0.19 (0.27)	0.01 (0.19)	-0.21 (026)	-0.01 (0.18)
Poitou	0.30 (0.26)	0.17 (0.20)	0.34 (0.25)	0.19 (0.18)
Aquitaine	0.38 (0.23)*	-0.24 (0.17)	0.31 (0.23)	-0.22 (0.16)
Midi Pyrénées	-0.43 (0.25)*	-0.01 (0.21)	-0.45 (0.24)*	-0.03 (0.18)
Limousin	-0.02 (0.27)	-0.10 (0.19)	-0.05 (0.27)	-0.10 (0.19)
Rhône Alpes	-0.21 (0.21)	-0.06 (0.15)	-0.23 (0.21)	-0.07 (0.14)
Auvergne	0.10 (0.26)	0.03 (0.19)	0.10 (0.26)	0.03 (0.18)
Languedoc	-0.14 (0.25)	-0.35 (0.19)*	-0.25 (0.24)	-0.36 (0.18)**
Provence Alpes Côte d'Azur	0.12 (0.23)	-0.32 (0.16)**	0.02 (0.22)	-0.32 (0.16)**

* significant at 10% ; ** significant at 5%.

Appendix 1 : With the "Enquête Emploi" participation definition

Model	**With spouse's participation endogenous**		**With spouse's participation exogenous (for comparison)**	
Estimation method	**Asymptotic Least Squares (ξ statistic p-value : 0.472)**		**2 separate probit estimations (most probably affected by simultaneity bias)**	
Gender	**Man**	**Woman**	**Man**	**Woman**
Intercept	-0.71 (0.73)	0.11 (0.55)	-0.78 (0.72)	-0.07 (0.53)
Participation of the spouse	0.33 (0.14)**	0.08 (0.20)	0.21 (0.06)**	0.22 (0.07)**
Individual characteristics				
Age	0.01 (0.01)	0.05 (0.01)**	0.02 (0.01)**	0.05 (0.01)**
Number of children (ref. None) :				
- 1	0.10 (0.09)	-0.19 (0.06)**	0.06 (0.08)	-0.19 (0.06)**
- 2	0.26 (0.11)**	-0.53 (0.07)**	0.14 (0.08)*	-0.53 (0.07)**
- 3	0.36 (0.16)**	-0.91 (0.08)**	0.14 (0.10)	-0.91 (0.08)**
- 4 and more	0.15 (0.24)	-1.53 (0.13)**	-0.21 (0.13)	-1.55 (0.11)**
Child born in 1996-1997 (ref. No) :	0.21 (0.10)**	-0.33 (0.07)**	0.12 (0.08)	-0.33 (0.06)**
Health problems (ref. None)	-0.45 (0.08)**	-0.08 (0.07)	-0.47 (0.07)**	-0.09 (0.07)
Occupation of the mother (ref. White collar) :				
- Missing	-0.05 (0.14)	-0.27 (0.11)**	-0.06 (0.13)	-0.28 (0.11)**
- Agriculture	0.34 (0.17)**	0.17 (0.12)	0.32 (0.17)*	0.16 (0.11)
- Blue collar	0.01 (0.08)	-0.06 (0.06)	0.02 (0.08)	-0.06 (0.06)
- Craftsman	-0.07 (0.12)	-0.08 (0.09)	-0.10 (0.12)	-0.08 (0.09)
- Executive	-0.08 (0.26)	-0.23 (0.21)	-0.10 (0.25)	-0.26 (0.18)
- Middle manager	0.15 (0.13)	-0.01 (0.09)	0.16 (0.13)	-0.02 (0.09)
- Inactive	0.08 (0.07)	-0.11 (0.05)**	0.07 (0.07)	-0.11 (0.05)**
Occupation of the father (ref. Blue collar) :				
- Missing	-0.20 (0.13)	-0.13 (0.11)	-0.21 (0.12)*	-0.13 (0.11)
- Agriculture	0.11 (0.14)	0.03 (0.11)	0.17 (0.13)	0.04 (0.10)
- White collar	0.11 (0.09)	-0.05 (0.06)	0.12 (0.09)	-0.05 (0.06)
- Craftsman	-0.04 (0.09)	-0.02 (0.08)	-0.02 (0.09)	-0.01 (0.07)
- Executive	-0.14 (0.12)	-0.24 (0.11)**	-0.15 (0.11)	-0.22 (0.09)**
- Middle manager	0.03 (0.10)	-0.05 (0.06)	0.06 (0.10)	-0.04 (0.07)
Nationality (ref. French) :				
- North African	-0.64 (0.18)**	-0.66 (0.21)**	-0.74 (0.17)**	-0.71 (0.19)**
- European	-0.05 (0.18)	-0.05 (0.15)	-0.05 (0.18)	-0.04 (0.15)
- Other	-0.51 (0.17)**	-0.68 (0.19)**	-0.63 (0.16)**	-0.69 (0.15)**
Nationality of the father (ref. French) :				
- North African	-0.18 (0.14)	-0.18 (0.12)	-0.20 (0.14)	-0.17 (0.12)
- European	-0.11 (0.13)	0.04 (0.10)	-0.07 (0.13)	0.03 (0.10)
- Other	-0.12 (0.09)	-0.01 (0.07)	-0.15 (0.08)*	-0.01 (0.07)
Education level (ref. 1) :				
- 2	0.25 (0.09)**	0.23 (0.07)**	0.27 (0.09)**	0.23 (0.07)**
- 3	0.39 (0.08)**	0.36 (0.07)**	0.42 (0.08)**	0.37 (0.06)**
- 4	0.21 (0.11)*	0.62 (0.11)**	0.26 (0.11)**	0.64 (0.08)**
- 5	0.46 (0.16)**	0.50 (0.10)**	0.43 (0.16)**	0.52 (0.08)**
- 6	0.29 (0.13)**	0.92 (0.10)**	0.30 (0.12)**	0.94 (0.08)**
- 7	0.43 (0.14)**	0.88 (0.10)**	0.38 (0.13)**	0.88 (0.09)**

(continued)

(Appendix table 1 continued)

Characteristics of the spouse :				
Age	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Health problems (ref. None)	-0.07 (0.09)	-0.02 (0.11)	-0.10 (0.09)	-0.03 (0.06)
Occupation of the mother (ref. White collar) :				
- Missing	-0.02 (0.15)	-0.07 (0.11)	-0.09 (0.14)	-0.07 (0.11)
- Agriculture	-0.21 (0.17)	-0.13 (0.12)	-0.16 (0.16)	-0.11 (0.11)
- Blue-collar	-0.01 (0.08)	0.01 (0.06)	-0.03 (0.08)	0.01 (0.06)
- Craftsman	-0.01 (0.14)	-0.07 (0.09)	-0.02 (0.13)	-0.08 (0.09)
- Executive	-0.40 (0.23)*	-0.06 (0.19)	-0.46 (0.22)	-0.07 (0.18)
- Middle manager	-0.15 (0.12)	0.04 (0.09)	-0.15 (0.11)	0.05 (0.09)
- Inactive	0.02 (0.07)	-0.04 (0.05)	-0.02(0.07)	-0.03 (0.05)
Occupation of the father (ref. Blue-collar) :				
- Missing	0.10 (0.14)	-0.02 (0.11)	0.05 (0.13)	-0.02 (0.10)
- Agriculture	0.22 (0.14)*	0.21 (0.10)**	0.22 (0.14)	0.22 (0.09)**
- White collar	-0.01 (0.08)	0.02 (0.07)	-0.02 (0.08)	0.03 (0.06)
- Craftsman	0.18 (0.10)*	0.08 (0.07)	0.17 (0.10)*	0.08 (0.07)
- Executive	0.39 (0.14)**	0.01 (0.09)	0.33 (0.13)**	0.01 (0.09)
- Middle manager	0.18 (0.10)*	0.09 (0.07)	0.17 (0.09)*	0.09 (0.07)
Nationality of the father (ref. French) :				
- North African	0.21 (0.16)	0.02 (0.13)	0.12 (0.15)	-0.03 (0.11)
- European	-0.08 (0.12)	0.14 (0.10)	-0.07 (0.12)	0.14 (0.10)
- Other	-0.03 (0.09)	-0.14 (0.08)*	-0.05 (0.09)	-0.15 (0.07)**
Education level (ref. 1) :				
- 2	0.03 (0.10)	0.05 (0.09)	0.10 (0.09)	0.06 (0.07)
- 3	0.07 (0.10)	0.02 (0.10)	0.19 (0.08)**	0.04 (0.06)
- 4	0.13 (0.15)	0.11 (0.10)	0.32 (0.11)**	0.12 (0.09)
- 5	0.08 (0.15)	-0.21 (0.13)	0.23 (0.12)**	-0.20 (0.11)*
- 6	-0.06 (0.18)	-0.09 (0.11)	0.22 (0.11)**	0.01 (0.09)
- 7	-0.18 (0.18)	-0.25 (0.12)**	0.08 (0.12)	-0.23 (0.10)**
Employment zone characteristics :				
- Business creation rate (%)	0.01 (0.03)	0.02 (0.02)	0.01 (0.03)	0.02 (0.02)
- Low income population (%)	0.03 (0.03)	0.01 (0.02)	0.04 (0.03)	0.01 (0.02)
- AF	-0.05 (0.04)	-0.02 (0.03)	-0.05 (0.03)	-0.02 (0.02)
- APE	0.39 (0.20)**	0.06 (0.16)	0.42 (0.19)**	0.08 (0.14)
- AFEAMA	0.08 (0.07)	-0.07 (0.05)	0.06 (0.07)	-0.07 (0.05)
- AGED	0.32 (0.25)	0.22 (0.18)	0.38 (0.24)	0.25 (0.16)
- ILO unemployment rate 1996	-0.09 (0.03)**	-0.03 (0.03)	-0.10 (0.03)**	-0.03 (0.02)
- ILO unemployment rate variation 1991-96	0.11 (0.05)**	0.03 (0.04)	0.12 (0.05)**	0.03 (0.03)
- APL	-0.01 (0.02)	0.01 (0.01)	-0.01 (0.02)	0.01 (0.01)
- ALS	-0.03 (0.01)**	0.01 (0.01)	-0.03 (0.01)**	0.01 (0.01)
- ALF	0.04 (0.06)	-0.02 (0.04)	0.03 (0.06)	-0.02 (0.04)
- Share of women in entrepreneurs	0.05 (0.02)**	-0.04 (0.02)**	0.04 (0.02)**	-0.03 (0.01)**

(continued)

(Appendix table 1 continued)

Location (ref. Ile de France) :				
Champagne	0.34 (0.25)	-0.11 (0.19)	0.31 (0.24)	-0.10 (0.18)
Picardie	-0.06 (0.22)	0.08 (0.16)	-0.04 (0.22)	0.07 (0.16)
Haute Normandie	-0.07 (0.23)	0.11 (0.17)	-0.05 (0.22)	0.10 (0.17)
Centre	0.03 (0.23)	0.12 (0.17)	0.06 (0.23)	0.13 (0.16)
Basse Normandie	-0.25 (0.26)	-0.03 (0.19)	-0.27 (0.25)	-0.05 (0.18)
Bourgogne	0.02 (0.25)	-0.06 (0.18)	-0.01 (0.25)	-0.06 (0.17)
Nord Pas de Calais	-0.25 (0.24)	-0.09 (0.18)	-0.29 (0.24)	-0.11 (0.17)
Lorraine	0.20 (0.26)	-0.06 (0.17)	0.19 (0.25)	-0.05 (0.17)
Alsace	-0.20 (0.24)	-0.15 (0.17)	-0.25 (0.23)	-0.17 (0.16)
Franche Comté	0.24 (0.27)	0.02 (0.18)	0.24 (0.26)	0.04 (0.17)
Pays de la Loire	-0.11 (0.27)	0.19 (0.19)	-0.06 (0.26)	0.19 (0.19)
Bretagne	-0.22 (0.26)	-0.02 (0.19)	-0.24 (0.25)	-0.04 (0.18)
Poitou	0.34 (0.26)	0.12 (0.20)	0.37 (0.25)	0.14 (0.18)
Aquitaine	0.39 (0.23)*	-0.23 (0.17)	0.32 (0.23)	-0.21 (0.16)
Midi Pyrénées	-0.43 (0.24)*	0.01 (0.20)	-0.44 (0.24)*	-0.01 (0.18)
Limousin	-0.06 (0.27)	-0.10 (0.19)	-0.10 (0.26)	-0.11 (0.19)
Rhône Alpes	-0.18 (0.21)	-0.06 (0.15)	-0.20 (0.20)	-0.07 (0.14)
Auvergne	0.04 (0.26)	0.01 (0.18)	0.03 (0.25)	0.01 (0.18)
Languedoc	-0.13 (0.25)	-0.29 (0.19)	-0.21 (0.24)	-0.30 (0.18)*
Provence Alpes Côte d'Azur	0.05 (0.23)	-0.27 (0.16)*	-0.03 (0.22)	-0.27 (0.16)*