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ABSTRACT

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The purpose of this Paper is to study the causes of unemployment empirically, using individual data and an approach that refines that of Meyer and Wise. Using the French 1997 Labour Survey data, we decompose non-employment of married women into three components: voluntary, classical (due to the minimum wage) and ‘other’ (a residual category). We find that the minimum wage explains close to 15% of non-employment for these women and that the disincentive effects of some welfare policy measures may be large. Our approach also allows us to evaluate various labour and welfare policy experiments in their effects on participation and employment.

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NON-TECHNICAL SUMMARY

Unemployment in France has been hovering around or above 10% for the last fifteen years. Many potential culprits have been pointed: the minimum wage, a rigid labour market, the power of insiders, recessionary conditions (especially in the current decade), a generous welfare state, more recently globalization... The purpose of this Paper is to present an empirical investigation into the causes of non-employment, using individual data from the French Labour Force Survey of 1997.

We posit that in order to hold a job, an individual must clear three conditions:

- She must be willing to work
- She must be productive enough that employers are willing to offer her at least the minimum wage
- She must not be caught in a recession or in frictional unemployment.

Failure to clear one of these conditions results in non-employment. For the first condition, we call it 'voluntary non-employment'; for the second, 'classical non-employment'; and for the third, 'other non-employment'. Our goal is to evaluate the number of married women who fit into each of these three categories and to simulate the effects of various labour market and welfare policy reforms on these numbers.

While basic microeconomics teaches us that on competitive labour markets, a minimum wage set higher than the equilibrium wage creates unemployment for those categories whose productivity is lower than the minimum wage, empirical studies have not so far substantiated this theoretical claim very strongly. One main difficulty is that macroeconomic data on employment are not very informative on this issue. A highly-publicized study by Card-Krueger used more disaggregated data and found a negligibly small employment effect for raises in the minimum wage; but this study makes implicit assumptions that we find unpalatable. Since we think that individual household data may shed much light on these issues, we resort to an estimation strategy first used by Meyer and Wise in 1983. Their method consists of estimating the wage distribution of workers, taking into account the fact that the minimum wage truncates this distribution to the left. This allows them to deduce the percentage of individuals whose implied wage is lower than the minimum wage (what we call 'classical non-employment').

One difficulty with this approach is that some low-productivity individuals who cannot clear the minimum wage hurdle would not accept working for such low

implied wages anyway; this is compounded in France by the existence of a minimum-income guarantee (the RMI) that, combined with various means-tested benefits, may have strong disincentive effects on labour force participation. Neglecting this would attribute to the minimum wage negative employment effects that more properly reside within the welfare system. To avoid such confusions, we complement the model with a participation equation that takes into account most of the actual features of the French tax-benefit system: social contributions, the income tax, family benefits, housing subsidies, the RMI and the housing tax. We believe, and our empirical investigation seems to prove, that a proper modelling of the tax-benefit system is essential in understanding the labour supply behaviour of individuals.

Our results suggest that even when controlling for the effects of the welfare system, the minimum wage has very strong negative effects on employment for married women. In fact, more than 8% of these women would be willing to work but cannot get a job because they are too unproductive: employers are not ready to offer them any more than the minimum wage. This amounts to about 20% of actual employment. The figures are even higher for low-skilled women, as should be expected. They are in any case much higher than comparable results on US data, where the ratio of the minimum wage to the average wage (expressed in terms of cost to the employer) is much lower than in France. Indeed, reducing the French minimum wage to the US level would essentially eliminate classical non-employment, which goes some way towards reconciling our results and those of studies on the US.

Our detailed modelling of the tax-benefit system also demonstrates that many married women are caught in a poverty trap: if their husband is not working, their household is eligible to the RMI, which induces a 100% marginal tax rate at the bottom of the pay scale. Further up the pay scale, the RMI is replaced with several benefits that are means-tested; the combination of these welfare policy measures makes taking a job unattractive, especially for low-skilled women who are bound to get a low wage. This seems to be more important for women with children, as the presence of children in the household both increases the amount of means-tested benefits and reduces the willingness of these women to work for any given wage.

Taken together, these results suggest that much more attention should be paid to institutional matters when attempting to explain low employment rates, at least in countries like France that combine a high minimum wage and a relatively generous welfare system.

Breaking Down Married Female Non-Employment in France

Guy Laroque and Bernard Salanié*

August 1999

Abstract

The purpose of this paper is to study the causes of unemployment empirically, using individual data and an approach that refines on that of Meyer and Wise (1983a, 1983b). Using the French 1997 Labor Survey data, we decompose non-employment of married women into three components: voluntary, classical (due to the minimum wage) and "other" (a residual category). We find that the minimum wage explains close to 15% of non-employment for these women and that the disincentive effects of some welfare policy measures may be large. Our approach also allows us to evaluate various labor and welfare policy experiments in their effects on participation and employment.

Introduction

> If the misery of our poor be due not to the laws of nature,
> but to our institutions, great is our sin.
> Charles Darwin, *The Voyage of the Beagle.*

The unemployment rate in France has been hovering around or above 10% for the last fifteen years. Many potential culprits have been pointed: the minimum wage, a rigid labor market, the power of insiders, recessionary conditions (especially in the current decade), a generous welfare state, more recently globalization... The purpose of

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this paper is to present an empirical investigation into the causes of unemployment, using individual data and an approach that refines on that of Meyer and Wise (1983a, 1983b). Our model posits that to hold a job, an individual must clear three conditions:

1. she must be willing to work
2. she must be productive enough that employers offer her at least the minimum wage
3. she must not be caught in a recession or in frictional unemployment.

Failure to clear one of these conditions results in non-employment. For the first condition, we call it "voluntary non-employment"; for the second, "classical non-employment"; and for the third, "other non-employment". In estimating this breakdown of non-employment, our paper is related both to the literature on the effect of the minimum wage and to that on labor supply.

One of the main goals of this paper is to evaluate the share of non-employment that is linked with the existence of the minimum wage. While basic microeconomics teaches us that on competitive labor markets, a minimum wage set higher than the equilibrium wage creates unemployment for those categories whose productivity is lower than the minimum wage, empirical studies have not so far substantiated this theoretical claim very strongly[1]. Most existing studies have adopted one of the following three approaches. The first approach regresses the employment rate of, say, the young on the minimum wage, using aggregate time series. This sometimes yields a significant effect, but it is usually weak and not robust[2]. Macro data do not seem in fact to contain enough information to convincingly decide that question. Sometimes sectoral data (see Bazen and Skourias (1997) or Dickens, Machin, and Manning (1999)) are used, but the results then are also imprecise and fragile. There seem to be too many omitted variables for this approach to yield any useful conclusions.

The second approach relies on the natural experiments methodology. Thus, Card and Krueger (1995) used the fact that minimum wage laws differ across American states to analyze the effect of the increase of the minimum wage in New Jersey in 1992, whereas it remained constant in neighboring Pennsylvania. They found that employment in New Jersey fast-foods in fact increased more than in Pennsylvania

[1]See Dolado, Kramarz, Machin, Manning, Margolis, and Teulings (1996) for an ambivalent viewpoint.

[2]See the survey by Brown, Gilroy, and Kohen (1982), and, for France, Bazen and Martin (1991).

after the raise. They conclude that in this case at least, the minimum wage had a (weak) *positive* effect on employment. This study is very controversial (see for instance Kennan (1995)). As Kennan says, an explanation for its results may simply be that "teenagers like cheeseburgers": New Jersey teenagers who already held a job may have spent part of their wage increase on fast foods. If this is the case, then the estimated effect may be hard to generalize. Moreover, the natural experiments approach is always open to the criticism that the control group may not be a valid one. In a recent reanalysis of their findings, Card and Krueger (1999) use Bureau of Labor Statistics data to plot the evolutions of fast-food employment in New Jersey and Pennsylvania over the last ten years. It appears clearly from their plot that these series have fluctuated and diverged very widely. The Card-Krueger methodology attributes these changes to changes in the minimum wage, which we do not find a very palatable identification assumption.

We focus in this paper on the third approach, which uses household individual data. This is exemplified by Abowd, Kramarz, Lemieux, and Margolis (1999) and Kramarz and Philippon (1999), which analyze how minimum wage increases affect transition probabilities between employment and non-employment. As mentioned earlier, we start from the papers by Meyer and Wise (1983a, 1983b). Their method consists in estimating the wage distribution of workers, conditional on their characteristics, taking into account the left censoring induced by the minimum wage. This allows then to deduce the percentage of individuals whose implied wage is lower than the minimum wage (what we call "classical non-employment"). Applying this method on American data, they estimated a significant and sizable effect of the minimum wage on employment probabilities of the young[3].

The Meyer and Wise approach has several shortcomings. The first one is that it partly relies on data on the distribution of wages below the minimum. After analyzing these observations in our dataset, we find that they are not reliable, so that we choose to exclude them from the data. A much more serious objection is that Meyer and Wise used a participation equation that is a very restrictive reduced form. This completely neglects the fact that some low-productivity individuals may find the additional income obtained when working so low that they decide not to look for a job; in our opinion, this type of non-employment should be called "voluntary" and not classical. To remedy this, we estimate a structural participation equation, taking into account most of the actual features of the French tax-benefit

[3]van Soest (1989) estimated a similar model on Dutch data.

system[4].

Finally, the model used by Meyer and Wise only allows for (in our terminology) classical and voluntary non-employment. In fact, people may also be non-employed even though they want to work and are productive enough to clear the minimum wage hurdle. This is the case for frictional non-employment (say, people in between jobs) and for cyclical non-employment (for instance of a Keynesian nature). We make a first try towards estimating the importance of this category, which we call "other non-employment" for want of a more descriptive term.

Typically, empirical studies of labor supply identify participation and employment. One shortcoming of labour supply studies in countries with a minimum wage is therefore that they effectively label individuals who are not very productive but are willing to work as non-participants, which may be a major source of bias. By allowing for this other cause of non-employment, our paper also contributes to the labor supply literature. Our rather exhaustive modeling of the tax-benefit system also lets us hope that we describe the work incentives facing households much more faithfully than many earlier studies, which only model a small part of it such as the income tax. As a by-product, this allows us to estimate the effect of a large number of policy parameters on participation and employment.

Section 1 presents the dataset we use and explains how we selected observations on married women aged 25-49. In section 2, we set up our model and describe how we assign non-employment to the three categories defined above. Since our participation equation simulates the effect of the tax-benefit system, we describe the features of the French system and how we modeled it in section 3 (with more details in Appendix 1). Section 4 presents our estimation results; the resulting breakdown of non-employment is given in section 5 and section 6 gives some examples of using our model for policy evaluation. Finally, section 7 contains some concluding remarks.

1 The Data

Every year, the French statistical institute INSEE runs a Labor Force Survey ("Enquête Emploi"). All members of about 70,000 households are asked for their job status, their net monthly wage[5] if they earn one, and personal characteristics (age, sex, number and ages of children,

[4] van Soest (1989) also makes a step in that direction.

[5] In France, the "net wage" is what people get on their pay checks, before they pay the income tax.

highest diploma, age at leaving school, type of residence,...). We used the most recent survey available when we started this project: the March 1997 Labor Force Survey.

As is well-known, it is easier to estimate a structural participation equation for women than for men, especially for women who have a partner. Moreover, we wanted to avoid the modeling difficulties caused both by young people deciding to stay at school and by older people retiring or using one of the state-subsidized pre-retirement programs that operate in France. Therefore we focus in this paper on women aged 25-49 who live with a partner (for simplicity, we will call them "spouses" and refer to the women as "married").

The Labor Force Survey only reports wages (and, less thoroughly, unemployment benefits), as opposed to pensions and other non-wage income. We thus had to eliminate households in which one of the spouses is retired, works as an independent or an employer. We also eliminated households in which the woman works as a civil servant, as civil servants have tenure in France. Part-time work creates another difficulty. There are several questions about hours in the Survey, so that we could attempt to model the choice of hours. However, it is well-known that French workers rarely choose their hours, much less that comparable workers do in other countries. In fact, surveys consistently show that about half of part-time workers would like to work more. To take this properly into account, we would have to model how many individuals who would like to work full-time end up working part-time. We decided that at this stage, this would make the model untractable. We therefore focus in this paper on women who either declare working full-time (at least 35 hours per week) or not working at all. We also eliminated women who both declare working full-time and report a number of hours per week smaller than 30 or larger than 50.

Even so, a few percent of the employed women declare wages that are lower than the minimum wage, sometimes very much so. These women represent about 3% of our sample. In similar circumstances, Meyer and Wise chose to use these data points for estimation; they justified this treatment by the fact that, in the US (but not in France), there are exceptions to the minimum wage legislation that still give information on the wage distribution. Our own analysis of these observations shows that two-thirds of these women have no diploma and work in the "services to households" sector. This suggests that many of them are cleaning persons or hold similar occupations, where hours are ill-defined, there is a lot of underground activity, and measurement error is probably rampant. We eventually decided to exclude

Table 1

Descriptive statistics

Variable	Minimum	Mean	Maximum
Employment	0	0.426	1
Employment of spouse	0	0.876	1
Net monthly wage	5000	7,947	31,667
School-leaving age	6	18.0	35
Experience	0	18.7	40
Graduate	0	0.059	1
Undergraduate	0	0.095	1
High school	0	0.126	1
Basic technical training	0	0.288	1
Junior high school	0	0.093	1
No diploma	0	0.339	1
Number of children	0	1.445	9
Children less than 3	0	0.208	3
Children 3 to 6	0	0.258	3
Children 6 to 18	0	0.979	8
No children	0	0.254	1
Age 25 to 30	0	0.232	1
Age 31 to 40	0	0.446	1
Weekly hours worked	30	39.15	50

these women from our sample[6]. The resulting sample size of 10,789 represents about 3,500,000 women.

Table 1 describes our sample[7]. About 42.6% of women in our sample work, as compared to 87.6% of their spouses. Our wage statistics refer to the net wage (including premia), corrected to bring it to the legal standard of 39 hours per month. By construction, the net minimum wage in our sample should be the legal minimum wage, which was 5,037 francs per month[8] in March 1997. However, given that wages are known to be declared with rounding error, we set the

[6]After a first estimation, we also dropped 4 observations which were clear outliers in the wage equation. They all correspond to employed women with low diplomas but very high wages.

[7]The figures in Table 1 are unweighted by sample weights, unlike those in Tables 5 to 7.

[8]The nominal exchange rate fluctuated between 5.5 and 6 francs to the dollar in 1997.

minimum bound in our programs to 5,000 francs. The mean wage of our women is about 60% higher than the minimum wage. For lack of more detailed information about job spells, "experience" refers to the number of years since leaving school. Unfortunately, we could not find any good proxy for the time spent raising children or unemployed.

Diplomas are listed from highest to lowest. The names we give them probably only give a rough English equivalent. Note that a full 33.9% of the sample has no diploma. The next variables describe the composition of the family. A quarter of women have no children, but there is a large variability: a sixth have at least three children. We also use dummy variables for age, according to whether the woman is in her twenties, in her thirties, or older. Also note that the average hours per week is very close to the legal standard of 39 hours; in fact, about three-quarters of the sample report that they work exactly 39 hours per week.

Figures 1 and 2 plot the distribution of wages for all employees and by diploma. The histograms are computed by steps of 100 francs, from the minimum of 5,000 francs to 20,000 francs. There is clearly a large amount of rounding error. Beyond this, however, there does not seem to exist a cluster at the minimum wage. The left censoring effect induced by the minimum wage obviously is stronger for women with low diplomas (or no diploma at all).

2 The Model

Our model rests on a wage equation and a participation equation. The wage equation represents what employers are prepared to pay for a woman of characteristics X. Since employers only care about the cost of labor, the relevant wage variable must be gross of all wage taxes, which in France are social contribution taxes. We therefore define:

- w, the net wage received by the woman (before income tax, family allowances and other social benefits)
- W, the cost of labor to the employer (the "gross wage"), which includes social contributions.

There is an increasing relationship $W = G(w)$ between these two measures of wages[9]. Since weekly hours H vary across employed women, we standardize W to the legal 39-hour week by defining $C = 39 * W/H$. This implies a mild approximation, as the function G is only piecewise

[9]Section 3 and Appendix 1 explain how we simulate the function G.

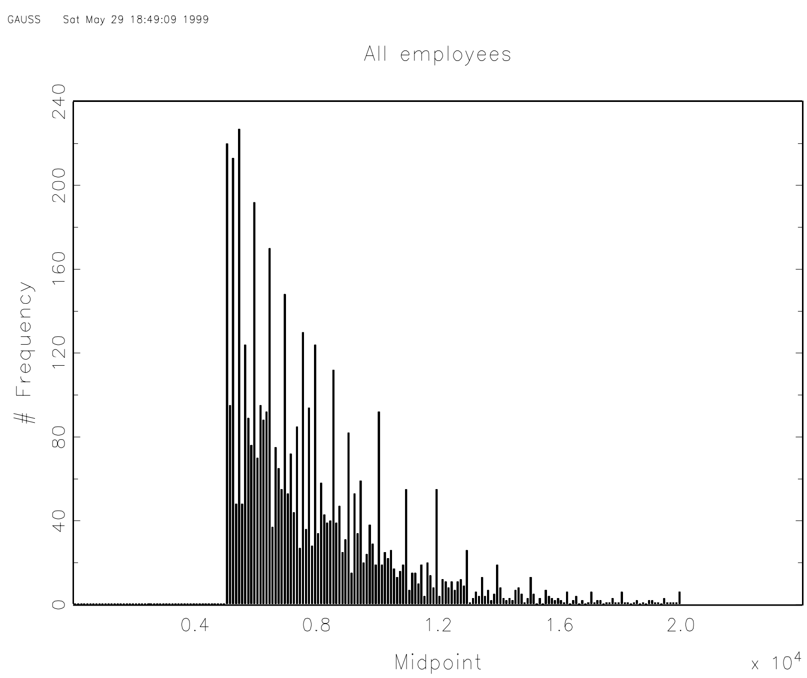

Figure 1: Distribution of wages

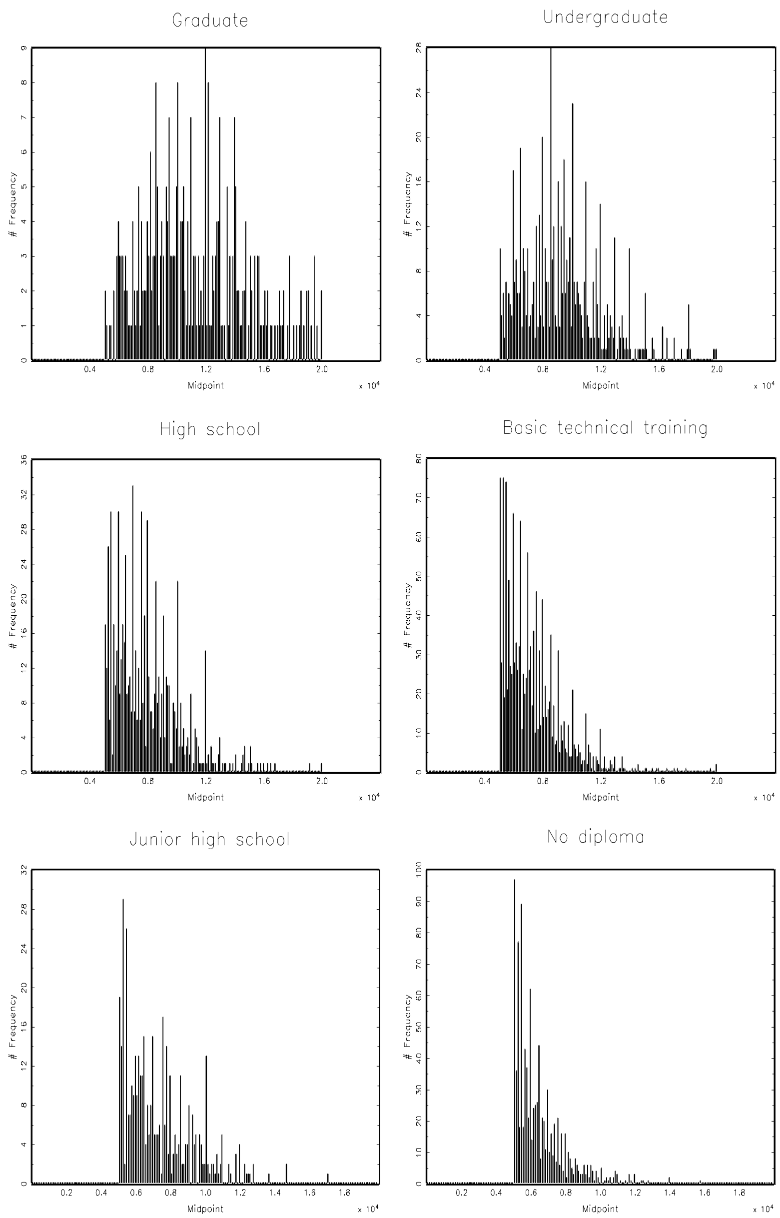

Figure 2: Distribution of wages by diploma

linear and there is a premium for overtime pay. The wage equation then is

$$\ln C = X\alpha + \sigma\varepsilon$$

where X includes school-leaving age and experience, their squares, the diploma variables (except for the "no diploma" variable) and a constant[10]. We allow for heteroskedasticity:

$$\sigma = \sigma_0 + \sigma_1(\text{school-leaving age})$$

Given that women in our sample are either employed full-time or non-employed, the participation equation is based on comparing potential household net resources when the woman works at a labor cost W and when she does not. Thus a woman participates if

$$R(W) > RNR + \tau\eta$$

where RNR, which we call the "reservation net resources", is modelled as[11]

$$RNR = R(0)Z\beta + Z'\gamma$$

and for estimation purposes, we assume that the disturbances are uncorrelated across individuals and that they have the joint normal distribution

$$\begin{pmatrix} \varepsilon \\ \eta \end{pmatrix} \longrightarrow N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right)$$

R is the function that associates the net resources of the household to the woman's labor cost W; of course, R takes into account the wages of the spouse, if any. For an employed woman, W can be computed as $G(w)$, where the net wage w is reported in the survey. For women without a job, W is given by the wage equation (which implicitly sets $H = 39$ for these women), so that the left-hand variable is a complicated function of the unobservable wage disturbance ε.

Section 3 explains how we simulated the function R, taking into account as well as we could the complexities of the French tax-benefit system. In our estimation, Z will include the children variables and the two dummy variables describing the woman's age listed in Table 1. Z' includes the same variables plus "excess" hours $(H - 39)$ (to take into account the disutility of hours)[12]. We again allow for

[10]Our equation thus only allows for individual characteristics, as opposed to sectoral characteristics or regional variables, which may change over time.

[11]We allow the household to maximize utility and not income, so that $Z\beta$ may differ from one.

[12]For unemployed women, we again set $H = 39$. We could also have drawn H from the observed distribution of hours and adjusted the left-hand side of the participation equation accordingly; in fact, both effects seem to roughly cancel out.

heteroskedasticity:

$$\tau = \tau_0 + \tau_1 R(0)$$

All in all, there are four possibilities. If

$$R(W) < RNR + \tau\eta$$

then the woman does not want to work. We call this "voluntary non-employment" (VNE). If she does want to work, then it may still be that employers are not ready to offer her a wage greater than the legal minimum:

$$X\alpha + \sigma\varepsilon < \ln G(\underline{w})$$

where $\underline{w}$ is the net minimum wage (5,000 francs per month). In that case, we talk of "classical non-employment". Finally, if the woman wants to work and is productive enough, we assume that she ends up being employed with a probability P which we allow to depend on the diploma and on whether the woman is younger or older than 35. Thus with probability $(1 - P)$, such a woman does not have a job[13]. This may be due to frictional non-employment (she is between two jobs) or cyclical non-employment (e.g., of a Keynesian nature). We then talk of "other non-employment", as this is a rather heterogeneous category.

After estimation, we therefore end up with a breakdown of non-employment with the following probabilities:

- voluntary non-employment:

$$P_V = \Pr\left(R(W) < RNR + \tau\eta\right)$$

- classical non-employment:

$$\begin{aligned} P_C = \Pr\big(&R(W) > RNR + \tau\eta \\ &\text{and } X\alpha + \sigma\varepsilon < \ln G(\underline{w})\ \big) \end{aligned}$$

- other non-employment:

$$\begin{aligned} P_O = (1 - P)\ \Pr\big(&R(W) > RNR + \tau\eta \\ &\text{and } X\alpha + \sigma\varepsilon > \ln G(\underline{w})\ \big) \end{aligned}$$

In the complementary case, the woman is employed. This happens with probability

$$\begin{aligned} P_E = P\Pr\big(&R(W) > RNR + \tau\eta \\ &\text{and } X\alpha + \sigma\varepsilon > \ln G(\underline{w})\ \big) \end{aligned}$$

[13] We therefore implicitly assume that the underlying disturbance is independent of ε and η. Adding correlation would substantially complicate the model.

The simplest interpretation of our model is that there exists a population with varying productivity C and that firms hire labor competitively. Then, as in optimal taxation models for instance, labor demand for productivity C is horizontal in C. For later reference, we call this the "strict interpretation". On the other hand, the "minimal interpretation" does not make any specific assumption on the workings of the demand side of the labor market. It just interprets the wage equation as a reduced form: however the market works, C is the labor cost that the market will pay for an employee with characteristics X.

Of course, it must be recognized that our approach rests very heavily on parametric identification. In a way, this is inescapable: how else can we estimate the number of jobs created by suppressing the minimum wage, when it has been there for a long time and its level has not fluctuated that much relative to average productivity? We do it by assuming loglinearity and lognormality; these assumptions could and maybe should be relaxed. Our distinction between voluntary non-employment and other non-employment also rests on the parametric shape we assumed for the participation equation. For our defense, it seems difficult to stray from that particular specification.

3 The Tax-Benefit System

In this section, we briefly discuss how we programmed the functions R and G; we also mention our most important omissions, given the limitations of the data. Appendix 1 discusses our modeling of the tax-benefit system in more detail.

3.1 From the Net Wage to the Gross Wage

In France, social contributions are paid in part by employers and in part by workers. That distinction is not economically relevant; it only matters in that the rates of social contributions are defined with respect to the semi-gross wage (gross of workers' social contributions only). The resulting schedule is piecewise linear, so that it is fairly simple to simulate. We should note at this point that since 1993, employers' social contributions are lowered for low wages; in 1997, the ceiling for this deduction is 1.33 times the minimum wage. We also take this into account in the function G and its inverse (G is, of course, strictly increasing).

A by-product of this simulation is the generalized social contribution (CSG). In 1997, CSG is 3.4% of 95% of the semi-gross wage, of which 1.0% is deducted from income before computing the income tax.

Social contributions finance benefits for health, family, unemployment and pensions. For the last two items, it may be argued that contributions in fact are later repaid (in expectation) as deferred income, and that individuals take this into account when deciding whether to participate. We eventually decided against including this feature in the model, as it is not clear whether this is really relevant in practice and it would substantially complicate things. Since medical coverage is almost universal and family benefits are given regardless of contributions, health and family contributions do not give rise to the same problem.

3.2 Income Tax

To compute taxable income, we add net wages of both spouses, adding the 2.4% of non-tax-deductible CSG and the 0.5% CRDS. The schedule again is piecewise linear; more details are given in Appendix 1. It should be noted that income tax in France is highly concentrated: low income households (say, where both spouses earn the minimum wage) pay very little, and nothing if they have at least two children.

3.3 Family Benefits

We simulate most family benefits. Some are means-tested; the relevant income variable then is taxable income. These benefits include:

- the "allocations familiales" (AF). In 1997, this is not means-tested. It is given to all families with at least two children under twenty and increases with the number of children. For a family with two children, it is about 675 francs per month.
- the "complément familial" (CF). This is only given to families with at least three children over three. It is means-tested (with an income ceiling of about 10000 francs per month) and worth about 880 francs/month, independently of the number of children.
- the benefit for young children (APJE) is given to every family with a child below three, conditional on the same means-testing as for the CF. It is about 960 francs per month.
- the "back to school" subsidy (ARS) is given for every child between 6 and 18, subject to a means-testing that depends on the number of children. It is about 80 francs per month and per eligible child.
- the AAS serves a similar purpose (and with a similar amount), but its means-testing is somewhat different.

- the APE (parental benefit for raising young children) is much more generous: about 3000 francs per month for every household with at least two children of whom one is younger than three, provided one of the spouses (typically the woman) stops working[14]. This has had a very strong effect on participation: Piketty (1998) estimates that it may have reduced the participation rate of eligible women by about 15 points.

Family benefits are not subjected to the income tax.

3.4 The Minimum Income Guarantee

Since 1989, there is a minimum income guarantee in France, called the RMI. This works by defining a guaranteed amount RMI for each household in which one of the spouses is at least 25[15]. If the total resources[16] TR of the household are lower than RMI, it gets $(RMI - TR)$ from the state. Thus the RMI induces a 100% marginal tax rate for its beneficiaries[17]. RMI is about 3,000 francs per month (60% of the net minimum wage) for a childless couple and increases with the number of children.

3.5 Housing Subsidies

Households who rent or own a home but are still paying interest on it, are eligible for a means-tested benefit called "allocation logement" (AL) for private sector housing and "aide personnalisée au logement" (APL) for public sector housing. These benefits have different schedules that depend on rent or interest paid, taxable income and the number of children of the household. If the household gets the RMI, its wage income is taken to be zero by the authorities when computing housing subsidies; this induces an infinite marginal tax rate when the income of a household crosses the RMI ceiling.

3.6 The Housing Tax

Every household in France pays a housing tax, whether it owns or rents a home. It is not completely clear that we should model it, as housing

[14] As explained in the Appendix, we could not take this past work condition into account.

[15] Some households where both spouses are under 25 also are entitled to the RMI.

[16] The housing subsidy does not enter total resources here.

[17] This is not completely true. In fact, in 1997 a RMI beneficiary who found a job and whose new resources were larger than RMI could still receive the RMI for six months before losing the benefit. We neglect this feature, as we are more interested in the long-term effects of the welfare system.

is a consumption and the tax depends on the features of the home. However, we did include it since it interacts with the minimum income guarantee: households who receive the RMI are exempted from paying the housing tax and thus lose about 150 francs per month when they cross the RMI threshold.

3.7 Unemployment Benefits

The most glaring omission from our modeling is unemployment benefits. We do have (partial) information on benefits received by the unemployed. On the other hand, we cannot model unemployment benefits for a worker who loses his job, as these depend in a complicated manner on the duration of employment, the previous history of wages and of job status, all of which information is unavailable to us. Therefore we set unemployment benefits to zero. As a consequence, we assign the RMI to many households who in fact may live on more generous unemployment benefits. This effectively increases the gap between income when working and when not working, as the system we model is less generous than the actual system.

4 Estimation Results

Our estimation procedure is maximum likelihood. For a woman who is employed with 39-hour labor cost C and actual labor cost W, the likelihood is[18]

$$l_E = \frac{1}{\sigma}\phi\left(\frac{\ln C - X\alpha}{\sigma}\right)\Phi\left(\frac{\frac{R(W)-RNR}{\tau} - \rho\frac{\ln C - X\alpha}{\sigma}}{\sqrt{1-\rho^2}}\right)P$$

For a non-employed woman, the likelihood is more difficult to compute; as pointed out in the previous section, it involves the highly nonlinear function $R(\exp(X\alpha + \sigma\varepsilon))$. Therefore the probability of employment involves an integral that cannot be computed using standard functions. Denote $\underline{\varepsilon}$ the value of the wage shock which brings 39-hour labor cost to the level of the cost of the minimum wage:

$$X\alpha + \sigma\underline{\varepsilon} = \ln G(\underline{w})$$

Then the probability term we need for non-employed women can be written

$$\int_{\underline{\varepsilon}}^{+\infty} \phi(\varepsilon)\Phi\left(\frac{R(e^{X\alpha+\sigma\varepsilon}) - RNR - \tau\rho\varepsilon}{\tau\sqrt{1-\rho^2}}\right)d\varepsilon$$

[18]We denote ϕ and Φ the p.d.f. and the c.d.f. of the centered normal with unit variance.

For computing such integrals of the form

$$\int_a^b \phi(\varepsilon)F(\varepsilon)d\varepsilon \ ,$$

we first select quantiles of the normal distribution:

$$\Phi(\varepsilon_i) = \Phi(a) + \frac{i}{m}(\Phi(b) - \Phi(a))$$

for $i = 0, \ldots, m$. Then we compute the average (normal-weighted) point $\overline{\varepsilon}_i$ in each interval $[\varepsilon_i, \varepsilon_{i+1}]$, which yields

$$\overline{\varepsilon_i} = m\frac{\phi(\varepsilon_i) - \phi(\varepsilon_{i+1})}{\Phi(b) - \Phi(a)}$$

and finally we approximate the integral with

$$\int_a^b \phi(\varepsilon)F(\varepsilon)d\varepsilon \simeq \frac{\Phi(b) - \Phi(a)}{m}\sum_{i=0}^{m-1} F(\overline{\varepsilon}_i)$$

We found that this strategy, which exploits the shape of the normal density, gives much better results than brute-force approaches such as Monte-Carlo integration: even with $m = 10$, we obtain results that are within one-thousandth of the true value of the integral.

After estimation, it is also easy to compute the probabilities of the three forms of non-employment and of employment; again, this involves the numerical integration method presented above.

Another difficulty is that the tax-benefit system contains many kinks (because of piecewise linear schedules) and even some discontinuities (because of means-tested benefits and minimum payment rules). This would make the likelihood function nondifferentiable and even discontinuous. To avoid these problems, we smoothed the schedules. When it was feasible (for the family allowances and the RMI), we did the smoothing by hand, replacing, e.g., the Heaviside step function with $\Phi(x/h)$, where h is a small number. For more complicated schedules (social contributions, housing benefits and the income tax), we used automatic spline programs.

The maximization converged without much difficulty; starting from reasonable initial values, it takes about a day on a Pentium II 300 microcomputer[19]. One measure of the fit of the model is how well it predicts employment status; we find that on average, P_E is 0.55 for employed women, while it is 0.35 for non-employed women. The average estimated P_E is 0.428, whereas the actual employment rate is 0.426. Therefore it seems that our model fits the data reasonably well.

[19]Most of the CPU time is spent computing integrals.

The estimation results are given in Tables 2 (wage equation), 3 (participation equation) and 4 ("other non-employment" P factor). The only parameter not in these tables is the correlation coefficient ρ, which is estimated at 0.162 with standard error 0.055; thus the correlation between unobserved heterogeneities on wages and on reservation wages is small but significantly positive.

4.1 The Wage Equation

All coefficients in the wage equation are highly significant and go in the expected direction, with a concave profile for the effects of the school-leaving age and of experience. Simple calculations show that, given the correlation between these two variables, the returns to education for zero experience workers hover between 8% and 10% per additional year of schooling when the school-leaving age is between 18 and 24. This estimate seems high but is comparable to what is usually found on French data[20]. The size of the disturbance is almost independent of the number of years spent at school. We tried to interact diplomas and age, but the cross-effects were very small and insignificant.

4.2 The Participation Equation

It is more difficult to interpret the participation equation, given the presence of both cross-effects of $R(0)$ and the other variables and own effects of these variables. Recall that we denote RNR the "reservation net resources", i.e. the deterministic part of the right-hand side of the participation equation. Then on average in the sample, RNR is given by

$$RNR = 1.241R(0) + 1,427$$

Household net resources when the woman does not work $R(0)$ are on average 10,791 francs per month, and never go below 3,028 francs (the minimum income guarantee for a childless couple). Thus on average, a woman will not work if the monthly increase in household resources $(R(W) - R(0))$ is less than about 4,000 francs, while 2,200 francs would suffice for a woman in one of the poorest households. The children effects go in the expected directions[21] and their magnitudes

[20] Another way to present the estimates is that for zero experience workers with no diploma, possession of a high-school diploma would raise expected net wages by 65% and a graduate degree would raise them further by 58%.

[21] The only *a priori* surprising feature is the negative sign on the cross-effect of $R(0)$ and "Children less than 3", which seems to imply that the presence of a young child reduces

Table 2

Estimation results: wage equation

Variable	Estimate	Standard error
School-leaving age	0.109	0.011
—, squared	-0.0018	0.0003
Experience	0.042	0.003
—, squared	-0.0005	0.0001
Graduate	0.783	0.028
Undergraduate	0.553	0.024
High school	0.330	0.021
Basic technical training	0.191	0.017
Junior high school	0.175	0.022
constant	7.182	0.122
σ_0	0.283	0.024
σ_1	0.0010	0.0012

are very reasonable. On the other hand, the age effects are large: younger women tend to participate much more than older women. There appears to be some heteroskedasticity: women with higher non-labor income have a higher standard error. Note that the coefficient on hours implies that one extra hour per month implies a disutility of 36 francs, which is close to the average hourly net wage.

One possible difficulty with our participation equation is that the age effects are additive. Taken at face value, they would suggest that older women request a greater increase in net resources to take a job. As a variant, and also to check the robustness of our policy experiments, we also estimated a model in which the whole participation equation depends on the age class of the woman. The results of estimating and simulating this model differ very little from those given in the body of the text.

It is difficult to give elasticities of participation, given the com-

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participation by more for poorer households. In fact, the tax-benefit system and thus the function R depend in a very complicated way on the number and ages of children. A young child may make the household eligible to the APE, but this is lower than the minimum income guarantee and thus poorer households do not benefit from it. Simulations indeed show that adding one child younger than 3 to all households hardly changes participation for poorer households, while it reduces it by about 15 points for better-off households. The effect of older children on participation varies much less with income.

Table 3

Estimation results: participation equation

Variable	Estimate	Standard error
cross effects β		
constant	1.150	0.050
No children	-0.094	0.065
Children less than 3	-0.169	0.054
Children 3 to 6	-0.047	0.044
Children 6 to 18	0.096	0.025
Age 25 to 30	0.161	0.068
Age 31 to 40	0.069	0.044
own effects γ		
constant	-161	718
No children	1,984	728
Children less than 3	4,391	739
Children 3 to 6	3,990	614
Children 6 to 18	1132	370
Age 25 to 30	-3,766	786
Age 31 to 40	-2,475	557
Hours per week - 39	142	62
standard error		
τ_0	3,008	453
τ_1	0.108	0.024

plex nature of the tax-benefit system and the variation in individual/household characteristics. One possible experiment is to increase the net resources of households when the woman works $R(W)$ by 1%; this results in a 1.72% increase in the number of women who are willing to work. This seems fairly large, but is of a similar order of magnitude to some earlier estimates on French married women. Another experiment consists in increasing the gross wages of spouses by 1%; this has a much smaller effect on participation (the estimated elasticity is -0.22).

Of course, there is a huge dispersion of participation elasticities at the individual level. One main reason is the 100% withdrawal rate created by the minimum income guarantee. The best way to illustrate the interaction between the tax-benefit system and the minimum wage is perhaps to look at some graphs of the R function. In each of the following graphs, we plot the function R as a function of the gross wages of the woman, the estimated RNR[22], and a vertical line for the gross minimum wage. In each of these case studies, the potential job is assumed to be for 39 hours a week.

In case study I, the woman is 35, has two children aged 5 and 7, and her spouse has a net wage of 8,000 francs per month, which is close to average earnings. Apart from local accidents, the function R (see Figure 3) is close to linear. Since the household gets family benefits plus housing subsidies, $R(0)$ is around 9,700 francs. Given the presence of two children, the estimated RNR is 14,800 francs, which is achieved for gross (resp. net) wages of 11,800 (resp. 6,500) francs, somewhat above the minimum wage. If the woman gets the minimum wage of 5,000 francs, the net resources of her household increase by 3,800 francs.

Now assume (case study II) that the spouse is unemployed. Then the graph (Figure 4) looks very different. The graph of the function R now starts with a horizontal plateau that corresponds to the minimum-income guarantee, of about 4,600 francs in that case ($R(0)$ is higher, at 7,000 francs, because of the housing subsidies). When the woman starts getting wages, it takes a while before the household breaks out of this poverty trap, which is made more severe by the drop in housing subsidies and the increase in the housing tax when the household stops qualifying for the minimum-income guarantee (which together induce a 400 franc drop). In fact, earning the minimum wage only results in a paltry increase of 500 francs per month in the net resources of the

[22] Recall that the RNR represents the average net household resources the woman requires in order to be willing to work. Also remember that the participation equation has a fairly large standard error of about 4,000 francs.

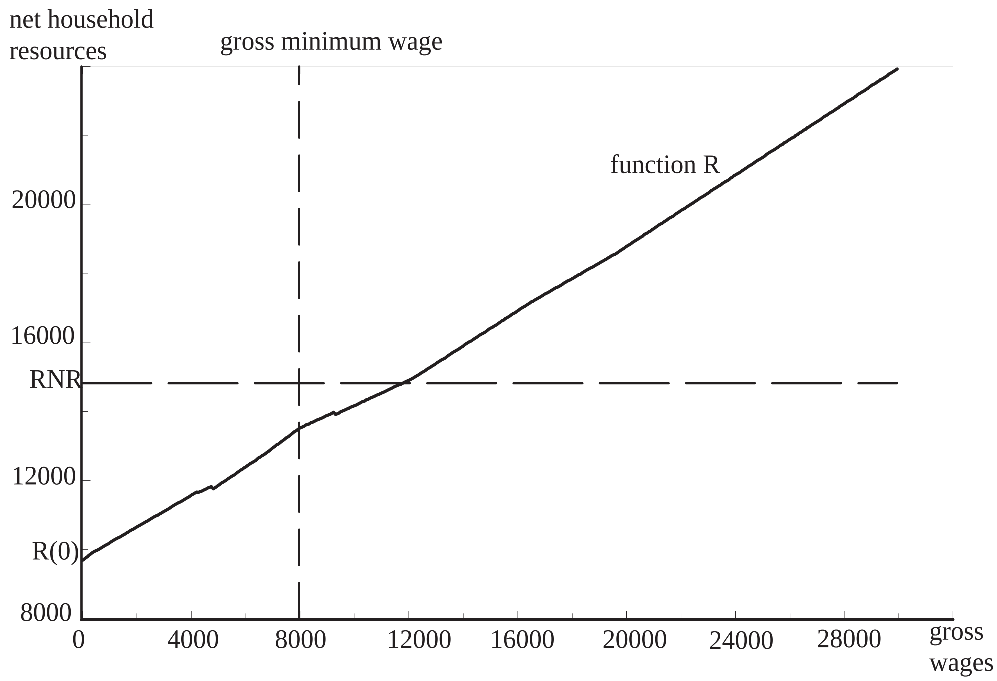

Figure 3: The R function: case study I

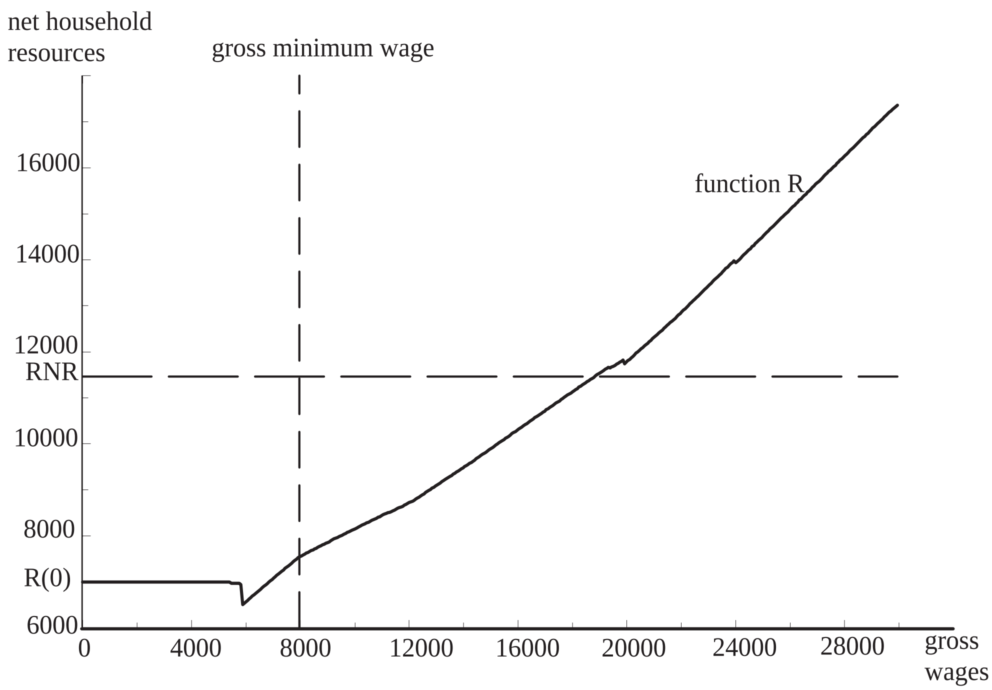

Figure 4: The R function: case study II

household[23]. Indeed, even though the estimated RNR is lower than in case study I at 11,400 francs, it would take more than twice the minimum wage to reach it.

Comparing Figure 3 and Figure 4 shows that in that case and contrary to basic theory, an increased wage for the spouse actually increases participation. The usual argument assumes that the woman maximizes utility of consumption and leisure $u(C, L)$ under a budget constraint

$$pC \leq w(T - L) + \overline{w}$$

where $\overline{w}$ is the wage of the spouse. Then an increase in $\overline{w}$ only has an income effect, which reduces labor supply if leisure is a normal good. Taking into account the tax-benefit system transforms the budget constraint into

$$pC \leq R\left(w(T - L) + \overline{w}\right)$$

When R is increasing, which is the case for most women, barring

[23] This is not an extreme case; we could have constructed even worse situations.

accidents such as leaving the minimum-guarantee income zone, an increase in $\overline{w}$ again reduces labor supply through the income effect. But this time there is also a substitution effect, as the local perceived net wage is $R'w$ and the derivative R' depends on $\overline{w}$. When R' increases in $\overline{w}$ (which is the case for poorer households), an increase in $\overline{w}$ increases the perceived net wage and therefore increases labor supply; this substitution effect here appears to be much stronger than the usual income effect. Again, this is entirely an effect of the tax-benefit system: a decent wage for the spouse allows the household to escape the poverty trap, and thus to be subjected to less forbidding withdrawal rates. The usual argument remains valid (but its empirical effects are weak) when the wage of the spouse increases further.

Because many means-tested benefits (the minimum-income guarantee, the housing subsidy, some of the family benefits) increase with the number of children, the poverty trap is somewhat less striking when the couple has no children, as in our case studies III. Figure 5 is the analog of Figure 4 for such a childless couple, i.e. the spouse is unemployed. Earning the minimum wage increases net resources by 900 francs, which is a bit better. In any case, it appears that such a woman would be (on average) willing to work for little extra money, so that the minimum wage is enough to induce her to participate.

The strong effect of the welfare system on participation decision can be illustrated by considering a familiar puzzle of French labor data: women whose husband is non-employed have a much lower employment rate than women whose husband is employed[24]. The employment rates are indeed 28.9% and 46.0% in our sample. The puzzle is that past studies which have attempted to regress employment rates on individual characteristics only explain a very small part of this difference. The rest is often put down to "assortative matching", i.e. the fact that low-skilled women marry low-skilled men. Our model, however, predicts employment rates of 30.4% and 45.6% for these two categories, so that it in fact predicts the difference rather well. Our estimates suggest that the welfare system is responsible. The estimated average productivity is only 8.5% higher for women with an employed husband, which is far from solving the puzzle. The biggest difference is in fact voluntary non-employment, which is estimated at 37.0% (resp. a whopping 55.8%) for women with an employed (resp. non-employed) husband. It turns out that the average gain from working, which is 5,830 francs for women with an employed husband, is only 2,830 francs for women whose husband is not employed. The households of the latter indeed receive substantial means-tested benefits when the woman does not work, and they lose them when the

[24]We thank Thomas Piketty for suggesting we explore this issue.

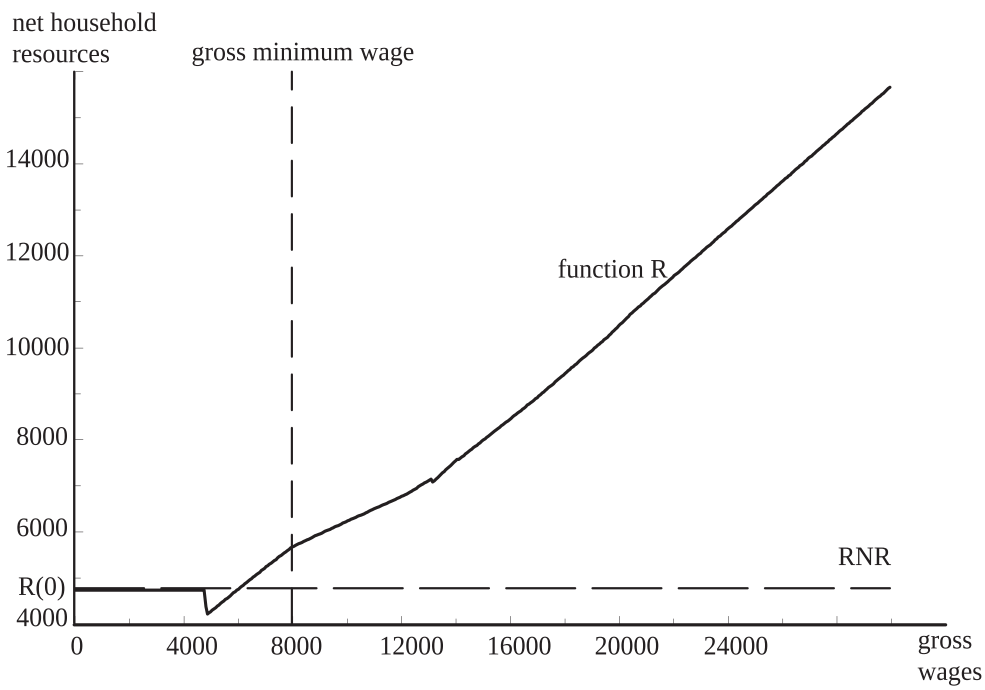

Figure 5: The R function: case study III

Table 4

Estimation results: P factor

Variable	Estimate	Standard error
Graduate (older)	0.607	0.043
Graduate (younger)	0.780	0.033
Undergraduate (older)	0.783	0.037
Undergraduate (younger)	0.887	0.033
High school (older)	0.798	0.039
High school (younger)	0.959	0.044
Basic technical training (older)	0.860	0.039
Basic technical training (younger)	1.000	0.050
Junior high school (older)	0.852	0.048
Junior high school (younger)	0.884	0.069
No diploma (older)	0.731	0.047
No diploma (younger)	1.000	0.084

woman gets a job. Assortative matching does play a role, but only a limited one: the estimated wage disturbance is only less than 2 points higher for working women with an employed husband.

4.3 Other Non-Employment

To interpret the estimated P factors, recall that P is the probability of having a job, conditional on being willing to work and productive. Thus Table 4 shows that other non-employment is particularly prevalent for highly skilled women. This is not that surprising: other non-employment is a catchall category in this model for all sorts of non-employment that are not voluntary or classical. Since high-skilled women can get high wages, they are not very affected by voluntary or classical non-employment; our model therefore must classify non-employed high-skilled women as "other non-employed".

5 Breaking Down Non-employment

Table 5 shows how non-employment breaks down into its three causes. The first three columns report P_V, P_C and P_O. The fourth column is $(1-P_E)$, the simulated probability of non-employment, which should be compared with the fifth column, actual non-employment in the sample. Finally, the last column gives the percentage of officially unemployed women in the sample, for purpose of comparison[25] . All of these figures were computed using the sampling weights provided in the survey.

Table 5 shows a very consistent and dramatic pattern: when going down diploma levels, both voluntary and classical non-employment increase, while other non-employment generally decreases. As mentioned in section 4, the latter only means that we explain non-employment much better for the unskilled. Classical non-employment, which is attributed to the minimum wage in our model, is a full 9.1% of the sample (or about 320,000 women), and even 15.3% for the third of women with no diploma (who therefore represent more than half of these 320,000 classical non-employed). While high-skilled women are unaffected by classical non-employment, they are only a small subpopulation. Thus the minimum wage explains about 15% of non-employment in our sample. Since a large part of non-employment is estimated to be voluntary, another way to put it is that according to our results, the minimum wage explains 55% of involuntary non-employment in this sample.

Of course, even if the model is well-specified, there are two sources of errors in these "regime probabilities". The first one is due to the nature of the survey itself: it implies a sampling error which is in fact fairly small (about 0.2 points for the probabilities for the whole population, up to 0.8 points for smaller subpopulations). The second error is due to the variance of the estimators. We computed it for the whole population; it is about 2 points for voluntary non-employment and other non-employment, but only 0.6 points for classical non-employment.

6 Some Policy Experiments

We distinguished in section 2 two possible interpretations of our model. Under the minimal interpretation, the wage equation is only a reduced form equation for the determination of wages on the labor market. If we stick to that interpretation, then the only thing we can safely say (barring functional form misspecification) is that in the conditions of the year 1997, there were 320,000 women in our sample who wanted

[25]Note that this is not the unemployment rate; the unemployment rate is the ratio of the sixth column to its sum with one minus the fifth column.

Table 5

Breaking down non-employment

Category	Voluntary	Classical	Other	Simulated	Observed	U
All	39.4%	9.1%	7.8%	56.3%	56.2%	16.3%
Graduate	20.3%	0.3%	22.4%	43.1%	42.5%	16.5%
Undergraduate	24.7%	1.8%	11.2%	37.6%	36.9%	13.2%
High school	31.6%	5.5%	7.2%	44.3%	44.1%	14.2%
Basic technical training	39.2%	8.6%	4.3%	52.1%	51.9%	15.7%
Junior high school	40.9%	7.8%	7.1%	55.8%	56.0%	16.0%
No diploma	50.4%	15.3%	7.3%	73.0%	73.2%	18.7%

to work but were not productive enough to be offered a job above the minimum wage. If we want to go further, we have to adopt the strict interpretation under which the wage equation is a productivity equation. Then we can run experiments by modifying some of the (literally dozens of) policy parameters in the model, provided that other non-employment remains at a constant proportion of employment and that the distribution of nominal productivities does not change. There are many possible policy experiments; we study here the effects of the minimum wage and the minimum-income guarantee. Our choice reflects our concern with the low-skilled population in this paper; but experiments on, say, the income tax schedule and family benefits are also easy to program.

In the following, we give the results of experiments weighted by the sampling weights; remember that our sample comprises 3,500,000 women. We ran unconditional simulations (in which the disturbances are sampled from their unconditional distributions) and used the numerical integration procedure detailed in section 4 to compute the relevant integrals.

6.1 Employment Effects of the Minimum Wage

By definition, we know from Table 5 that suppressing the minimum wage altogether would give a job to 9.1% of our sample by suppressing classical non-employment. However, there are two other effects. The first one is that social contributions have a lower rate between the minimum wage and 1.33 times the minimum wage; suppressing the minimum wage also removes these exemptions and thus creates some voluntary non-employment. The second one concerns other non-employment, which by construction is a fixed proportion of employ-

Table 6

Suppressing the minimum wage

Category	Effect on probability	Effect on numbers
Voluntary	1.4%	$+50,000$
Classical	-9.1%	$-320,000$
Other	$+0.8\%$	$+30,000$
Employment	$+6.9\%$	$+240,000$

ment:

$$P_O = \frac{1-P}{P} P_E$$

Since P only depends on diploma and age, any policy reform that increases employment also increases other non-employment. The simulation results reported in Table 6 show that this effect is small: according to our estimates, suppressing the minimum wage would increase employment by 240,000 jobs[26]. This corresponds to an increase in employment of 16%, which is more than double the 7% estimate of Meyer and Wise (1983a) on the 16-24 year old in the US in 1978. Note also that as we do not model the labor market for men, we can only hold the employment rate of spouses constant. Thus we neglect the fact that the suppression of the minimum wage, by creating more jobs for men, allows more households to break out of the poverty trap, which should encourage women's participation and employment. In that sense, we underestimate the job-creating potential of scratching the minimum wage.

This effect is rather precisely estimated: the standard error of jobs created is only 20,000. It is also easy to compute the elasticity of employment to the gross minimum wage as -0.68, which is way below the estimates of -0.1 to -0.3 (for US teenagers only!) quoted in Brown, Gilroy, and Kohen (1982). However, we remind the reader that our sample has much lower skills than the total French population. Also, the minimum wage is much more on the left of the wage distribution in the US than in France; it is estimated that in 1997, the ratio of the gross minimum wage to the average gross wage was about one-third lower in the US than in France. According to our estimates, lowering the gross minimum wage by a third would go a long way towards

[26] Half of this effect is achieved by cutting the cost of the minimum wage by 15%, and essentially all of it by cutting it by 40%.

Table 7

Increasing the RMI ceiling by 10%

Category	Effect on probability	Effect on numbers
Voluntary	+0.6%	+20,000
Classical	−0.1%	−4,000
Other	−0.1%	−3,000
Employment	−0.4%	−14,000

eliminating classical non-employment. Moreover, at this lower level of the gross minimum wage, the employment elasticity would only be -0.10, which is more in line with American estimates.

According to these results, a 10% cut in the minimum wage would increase employment by 2.7 points. This corresponds to a reduction of 16% in involuntary non-employment, which is slightly lower than what van Soest (1989) found on 1984 Dutch data for working-age women.

6.2 Employment Effects of the Minimum Income Guarantee

Recall that since 1988, all households in our sample are entitled to a minimum income guarantee: the RMI, if their resources fall below a specified ceiling. There has been much discussion, but very little empirical evidence, on the disincentive effects of the RMI. We saw in our case studies in section 4 that it does create a noticeable poverty trap, but this does not tell us how individuals react to this trap. Table 7 reports the effects of increasing the ceiling of the RMI by 10%. The induced increase in voluntary non-employment is moderated by a small decrease in classical non-employment (some women who are not willing to work any more would not have cleared the minimum wage hurdle anyway). Employment eventually decreases by 14,000 jobs. These results must be tempered by the fact that as explained in section 3, we assign the RMI to many households who presumably live on unemployment benefits or other income.

7 Conclusion

Our estimates suggest that both the disincentive effects of benefits and the employment effects of the minimum wage are underestimated in the usual policy literature. Our experience of variants of this model is that reasonable variants hardly change the overall diagnosis. By focusing on married women, we have of course chosen to study a subpopulation that is relatively low-skilled and more sensitive to incentives. This clearly implies that the large estimate we obtain for the elasticity of employment to the minimum wage cannot be extended to the entire population. We are currently working to extend the approach of this paper to other samples, men for instance.

Another possible extension is to relax the parametric identification assumptions, e.g. by using a more general functional form than the lognormal in the wage equation. Dickens, Machin, and Manning (1998) argue that the Meyer-Wise approach is very sensitive to the choice of functional form. It is not clear how relevant this criticism is to our study, as Dickens-Machin-Manning do not have a participation equation and use very few explanatory variables in their wage equation. Still, this is worth exploring. We fear, however, that semiparametric econometrics at this stage is not up to estimating such a model.

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Appendix : Modeling the Tax-benefit System

We give here some further details on how we model taxes and benefits. The purpose of this Appendix is not to describe all of our modeling of the tax-benefit system (which runs into a couple hundred lines in GAUSS), but rather to explain where and how we had to make approximations.

A Social Contributions

As mentioned in the text, the schedule for both employers' and workers' social contributions is based on the semi-gross wage (gross of workers' social contributions). The "Social Security ceiling" plays an important role in this schedule, as rates differ in intervals defined by various multiples of this ceiling (which is fixed at 13720 francs/month in 1997, or a bit more than two semi-gross minimum wages). The rates differ somewhat for executives and non-executives, but we clearly cannot model this for non-employed females. Therefore we assume that there are no female executives, whereas there are in fact about 3% in the sample.

Since 1993, measures have been taken to lower the social wedge for low-paid workers. In 1997, their employers' social contributions are reduced by 18.2% of the semi-gross wage at the minimum wage level, and this reduction cancels linearly at 1.33 times the minimum wage. As this is again linear, it poses no particular computation problem.

This part of the model also computes the CSG (a proportional social tax, part of which is deductible from taxable income) and the CRDS (another, small, proportional social tax).

B Income Tax

To compute the income tax, we add the net wages of the spouses[27]. We then add the CRDS and the relevant part of the CSG and apply two successive deductions, of 10% and 20% (both of which are subject to a ceiling). This gives the taxable income, which is used in the means-tested formulae for some family benefits and for housing benefits. Call

[27] Family, social and housing benefits are not subject to any tax (except for the CRDS). On the other hand, we have no information on say, capital income, so that we completely neglect it. This may only be a minor problem, as we are most interested in low-income households.

it I; then the income tax is basically given by

$$T = Nf\left(\frac{I}{N}\right)$$

where N is the number of "parts", a semi-integer that increases with the number of children, and f is a piecewise linear increasing function. This function f is convex (increasing marginal rates), except for low incomes where there is a "décote" mechanism that locally doubles marginal rates[28]. This formula, called the "quotient familial", gives an advantage to families with more children. This advantage is subject to a ceiling. We simulate all of this. Our only departure from the actual income tax is that we neglect the (small) tax credits for children of schooling age.

C Family Benefits

There are some details worth mentioning here.

- for the AF, the benefit is 32% of a monthly basis (of about 2100 francs) for 2 children, 41% for each additional child. There is also a supplement of 9% of the basis for each child aged 10 to 15, and 16% for each child aged over 15. Given that we don't use such detailed information on ages, we give a supplement of 10% of the basis for each child aged 6 to 18.
- for the CF and the APJE, the resource ceiling that defines the means-testing increases when both parents earn wages. Above the ceiling, the benefit decreases by one franc for each additional franc of resources.
- for the AAS, the benefit is given for every child between 10 and 16; again, we approximate this with half the number of children aged 6 to 18. It is a small amount, anyway.
- a household is only eligible to the APE when one of the spouses stops working. We don't have this information, so we give it to every non-working woman with the required household composition. That is a more serious but unfortunately necessary approximation.
- APE, CF and APJE are mutually exclusive. We assume that the household chooses the most generous benefit it is entitled to (in practice the APE, then the APJE, then the CF).

[28] Also, the income tax is not due if it is smaller than 400 francs per year.

- we neglect a few other allocations like the benefit for a handicapped adult, which we don't have enough information to simulate.

D Housing Subsidies

We don't know how much rent each household pays, so we proxied it by an average rent that depends on the number of children. Our modeling should differentiate between households who pay rent and households who pay interest. As we don't have information on interest paid, we just assume that every interest-paying household gets the housing subsidy as if it were a tenant and paid the average rent.

E Housing Tax

The housing tax is due by every household with a home. It depends on an imputed "rent value" of the home, to which a tax rate is applied. Both of these parameters vary a lot across towns. We model an average rent as above and apply to it a national tax rate. We also apply the tax exemptions: households with children pay a lower rate, households who receive the minimum-income guarantee do not pay the housing tax, and other poor households are eligible to discounts.