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Abstract

Lone mothers are overrepresented among poor people in many European countries. In 1998, in Norway, a welfare reform increased the amount of benefits and introduced working requirements. Using a quasi-experimental model, Mogstad and Pronzato (2012) find a positive effect of the reform on lone mothers' labour supply and a small reduction in poverty. Is the best result that policy makers could obtain in terms of poverty reduction? In this paper, I estimate a discrete choice model of earnings and welfare participation decisions, and use the behavioural estimates to derive the policy parameters which would have minimized poverty among lone mothers.

JEL-Code: I380, J220, C250.

Keywords: lone mothers, in-work benefits, poverty, discrete choice models, comparison of methods.

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Chiara Daniela Pronzato

1 Introduction

Lone mothers are overrepresented among poor people in many European countries, with detrimental consequences for themselves and their children. Also in Norway, which is known as a country of economic and welfare success, lone mothers were at least three times more likely to be poor than married mothers with children in the same age-range. To this aim, in 1998, a reform of lone parental welfare was undertaken. The main changes involved the most generous benefits, the so-called transitional benefit. The maximum amount of the benefits was increased, working requirements were introduced, and new time limits were imposed. Both lone mothers and lone fathers were eligible for the benefit, but the policy discussion concerning the transitional benefit and how to reform it to avoid work disincentives was carried out primarily thinking about lone mothers' work and poverty rates. The reasons are twofold. First of all, as much as 9 lone parents in 10 were women at the time of the reform. But more importantly, the human capital levels and socio-economic status of lone fathers have been shown to differ substantially from those of lone mothers, presumably due to a strong selection process for lone fathers to actually get daily custody of their children (Kjeldstad and Rønsen, 2004).

Mogstad and Pronzato (2012), using a quasi-experimental model, find a positive effect of the reform on lone mothers' labour supply and a small reduction in poverty. Is the best result that policy makers could obtain in terms of poverty reduction given the amount of public resources invested? Using the reform as an instrument, in a quasi-experimental setting, we cannot answer this question. We can understand whether lone mothers' behaviour is influenced by public policies, without strong assumptions and referring only intuitively to the economic theory. However, we cannot distinguish the effects of the different parts of the reform, cannot understand the mechanisms, and cannot predict what kind of policy would have made lone mothers better off. To know what policy would make lone mothers less likely to be poor, we need a more structural approach: thinking what matters for lone mothers' decisions (income, hours of

work, age of the children,…), estimate what weight they give to income, hours of work,... when taking decisions, and use the estimates behavioural parameters to predict new policy scenarios.

Nevertheless the advantages of a structural model in providing policy suggestions, structural models are based on relatively stronger assumptions compared to quasi-experimental methods. How can be sure that the economic model I construct and estimate can reproduce how women take their decisions in a realistic way? What I do in this paper is to simulate the changes brought by the 1998 reform in Norway using the behavioural estimates and then to compare its predictions with the effects of the reform estimated with a quasi-experimental design whose assumptions are considered less strong. Once validated the discrete choice model, I can use it for policy suggestions.

The comparison between quasi-experimental methods and structural models for policy evaluation seems to be an area of research investigated only by a few papers, but necessary to give credibility to both the approaches, and to reconcile them. This is the appeal to young economists made by Keane (2006, 2010), during his keynote lecture at the Duke Conference on Structural Models in Labor, Aging and Health (2005), titled "Structural versus Atheoretic Approaches to Econometrics". He underlines the necessity of considering descriptive statistics, reduced and structural forms as well as experimental methods as complementary approaches to the study of the effects of policy changes. He encourages researchers to perform validation exercises to test the extent to which structural models give "reasonable" predictions of the reality. The adjective "reasonable" may be still judged in a subjective way, but via multiple validation exercises consensus may be reached. Recently, as a part of the Mirrlees Review, Blundell (2012) has underlined the importance of different empirical strategies to evaluate the effects of earnings taxation on labour market decisions in order to design better tax policy reforms.

Examples are offered by Todd and Wolpin (2006), Blundell (2006), Brewer et al. (2006), Keane and Wolpin (2007) and, more recently, by Bernal an Keane (2010), Hansen and Liu (2011), Geyen et al. (2012), Thoresen and Vattø (2012). Todd and Wolpin (2006) use data from a randomized social experiment in Mexico to study and validate a dynamic behavioural model of parental decisions about fertility and child schooling. The PROGRESA is a randomized social experiment implemented by the Mexican government, in which around 500 rural villages were randomly assigned to participate or not in the program which provided payments to parents who regularly send their children to school. They estimate the behavioural model without using observations from the

treated villages and predict the potential fertility and child schooling of families in untreated villages. The impact of the program predicted by the behavioural model tracks the experimental results. Keane and Wolpin (2007) adopt another approach to validate a behavioural model. They construct and estimate a dynamic structural model of female behaviour, in which work, welfare participation, marriage and fertility decisions are jointly considered. In order to validate the model, they use a "holdout sample", a sample which differs from the sample used in the estimation and whose policy regime is well outside the support of the data. They use data from some US states to estimate the model, and from others to predict and validate the model. Bernal an Keane (2010) evaluate the effects of maternal work and childcare use on cognitive child development using a sample of single mothers in the National Longitudinal Survey of Youth. In order to take into account the selection process in work and childcare use, they develop a model of mothers' employment and childcare decisions. To identify the model, they use exogenous variations in welfare rules and local demand conditions across States and over time. They also employ the same instrumental variables for a straight linear IV regression. The estimated effects on children's cognitive development are very close when comparing the IV strategy and the structural model.

While the above studies construct and estimate structural models which are dynamic, there is a number of empirical works which validate static structural models with quasi-experimental evidence and which mainly look at labour market changes due to a change in the welfare. Brewer, Duncan, Shephard and Suarez (2006) estimate a static structural model of labour supply and programme participation using data from before and after the introduction of the Working Families' Tax Credit in the UK. They simulate the effect of the reform, taking into account all related changes in benefits and taxes, and compare the results with the ones obtained from other ex-ante (Blundell et al., 2000a, 2000b) and ex-post evaluations (Blundell et al., 2005; Francesconi and Van der Klaauw, 2004, 2007; Leigh, 2005; Gregg and Harkness, 2009). Blundell (2006) focuses on the effects of the Earned Income Tax Credit policies on lone mothers' working decisions, by validating a structural model of labour supply with a difference-in-difference evaluation strategy, and then finds the optimal policy, defined by a certain social welfare function. Other recent papers compare results from quasi-experimental methods and structural models exploiting the introduction of a certain reform: Geyen, Hann, and Wrohlich (2012) estimate the introduction of a parental leave reform in Germany by comparing working behaviour of mothers of children born just before or after the reform and compare results with the ones obtained by a structural model

of return to work; Thoresen and Vattø (2012) evaluates a tax reform by comparing a before-after change in labour supply with the effect predicted by a structural model of labour supply; Hansen and Liu (2011) compares the effect of an increase of the generosity of welfare benefits for young people in Quebec predicted by their structural model of labour supply and welfare participation with the one estimated with a discontinuity regression model by Le Mieux and Milligan (2008).

Using a similar approach in a comparable policy context as in Blundell (2006), in this paper, I validate a discrete choice model of work and welfare participation decisions with the results provided by a quasi-experimental design, using the same data and the same outcome variable for the two analyses. Once validated the discrete choice model, the behavioural parameters are then used to find the optimal policy, defined as the policy which provides the lowest level of poverty.

The paper is organized as follows. The 1998 reform is described in Section 2. The two evaluation strategies (the quasi-experimental model and the discrete choice model) and the assumptions they rely on are explained in Section3, while the data are presented in Section 4. After estimating the behavioural parameters, the reform is simulated, and its predictions compared with the estimated effects obtained with the quasi-experimental method: despite the discrete choice model making stronger assumptions, the predictions from the discrete choice model are close to the quasi-experimental ones (Section 5). New policy scenarios are then simulated in Section 6 while conclusions follow in Section 7.

2 The 1998 Reform of the Transitional Benefit

In this section I describe the transitional benefit and how has been changed with the 1998 reform. The reform is then directly evaluated through the quasi-experimental design while simulated through the discrete choice model.

The transitional benefit used to be the most generous benefit targeted exclusively at lone parents, mainly taken-up by lone mothers. Lone mothers with at least one child younger than 10 years old used to receive up to 700€ per month. The receipt of the benefit was independent of their labour market decisions but 40% of their monthly earnings exceeding 200€ used to be withdrawn from the maximum amount. A reform of the transitional benefit was undertaken on the 1st of January 1998. First, work requirements were imposed: lone mothers, in order to be eligible for the benefit,

were supposed to work at least part-time, to actively seek work, or to be in training. However, the working requirements were only introduced for lone mothers with the youngest child older than 3 years old. Second, the timing of the benefit was changed: lone mothers could receive the benefit until the youngest child was 8 years old (instead of 10)[1] and for a period up to 3 years (while it was potentially 10 years before the reform). Finally, the maximum benefit amount was increased from around 700€ to 800€ per month.

3 Evaluating the Effect of the Reform

In this section, I describe the two methods used to evaluate the effect of the 1998 reform on lone mothers' working decisions. The first strategy to evaluate the 1998 reform is a quasi-experimental design (a triple-difference model), where the working behaviour is compared before and after the 1998, for a group of lone mothers (treatment group) and a group of married mothers (control group). The second is a discrete choice model where women are assumed to take their decisions about work and welfare participation under a certain budget constrain. After estimating the model, the changes brought by the 1998 reform (new working requirements, new age limits, increased amount of the benefit) are included in the model and the effect of the 1998 reform is simulated by using the estimated behavioural parameters.

3.1 A Quasi-Experimental Evaluation Design

In this sub-section, I introduce an evaluation design which exploits the availability of data on working decisions of mothers, before and after the time of the reform. However, I cannot use the classical difference-in-difference model, since I cannot observe exactly the same women both before and after the reform. The reform, in fact, is characterized by a long phase-in period: all lone mothers who were already in welfare at the time of the reform were allowed to receive the benefit according to the pre-reform rules for another 3 years. Therefore, lone mothers who may be observed both before and after the reform – whose observations could be used for a classical

[1] Before the refom a lone mother could receive the benefit until June of the 10th birthday of the youngest child; after the reform, until the youngest does not become 9 years old. The main difference is that the ninth year of life of the child, after the reform, does not give the right to the benefit anymore.

difference-in-difference model - have basically no incentive to change their behaviour. Therefore, I evaluate the effect of the reform by comparing the effect of becoming a lone mother in the pre-reform and post-reform period (Mogstad and Pronzato, 2012):

$$\zeta = [E(Y_{v+1} - Y_{v-1} \mid S_v = 1, R_v = 1) - E(Y_{v+1} - Y_{v-1} \mid S_v = 1, R_v = 0)] - [E(Y_{v+1} - Y_{v-1} \mid S_v = 0, R_v = 1) - E(Y_{v+1} - Y_{v-1} \mid S_v = 0, R_v = 0)] \quad (1)$$

where

- Y_v are the annual earnings of the woman in the year *v* (hours of work are not available in the Register data, see Section 4)
- S_v is equal to 1 if the woman gets separated and becomes a lone mother in year *v*, 0 if remains married
- R_v is equal to 1 if *v* ≥1998, 0 otherwise.

The intuition behind is that a married mother who gets separated after the reform faces different incentives to change her labour supply: before the reform, she knows that 40% of her earnings are taken from the maximum amount but any change in her labour supply would not modify her right to the benefit; after the reform, she knows that by decreasing her hours of work to less than part-time, she would lose the right to the benefit. The assumption of the model is that, in absence of the reform, married mothers who become lone mothers after the reform would behave the same as married mothers who became lone mothers before the reform. By considering only the flow of new lone mothers, I can overcome the phase-in problem[2]. Not only, new cohorts of lone mothers - observed when have just separated - should be of primary interest for policy-makers, more than a representative sample of lone mothers at a certain point in time, which would over represent lone mothers who have been lone for long time[3].

[2] Robustness checks are carried out and shown in Mogstad and Pronzato (2008, 2012) in order to make sure that compositional changes in the sample of mothers, before and after the reform, do not bias the estimates.
[3] See Mogstad and Pronzato (2012) for what concerns the impact of the refom on long-lasting lone mothers.

3.2 A Discrete Choice Model of Work and Welfare Participation Decisions [4]

The Norwegian register data, I use for the estimation of the model (described in Section 4), provide accurate information on incomes and demographic characteristics but not hours of work. The model outlined below takes this feature into account, allowing time of work to be measured with an error.

A lone mother, labelled *n*, is assumed to maximize a utility function

$$U_n\ (x, t, w) \tag{2}$$

under the budget constraint

$$x_n\ = T(l_n, t_n, y_n) \tag{3}$$

where

- x_n is the net household income,
- l_n is the gross monthly labour income of the lone mother in a full time job,
- t_n is the number of equivalent full time months of work in one calendar year,
- w_n is a welfare participation indicator,
- y_n is exogenous household gross income,
- *T(.)* is the tax-benefit function which transforms gross income into net income.

The lone mother faces a set of *J* discrete alternatives, defined by the combination of earnings and welfare participation decisions. She knows how much utility she would get from each alternative *j* and chooses the alternative which provides the largest one. We can decompose the utility function into two parts: the deterministic part and the stochastic part

[4] This paragraph follows Train's book on Discrete Choice Methods and Simulations, chapter 2 (2003). Other papers used as references to write the model are Mc Fadden (1974), Moffitt (1983), MaCurdy et al. (1990), Ilmakunnas and Pudney (1990), Van Soest (1995), Hoynes (1996), Aaberge et al. (1999), Creedy and Kalb (2005), Creedy et al. (2006), Keane (2011), Bargain et al. (2012).

$$U_{nj} = V_{nj} + \varepsilon_{nj} \qquad \forall j \in J \tag{4},$$

where V_{nj} captures the portion of utility which derives from observable characteristics, while ε_{nj} the portion from unobservable ones. The deterministic part of the utility V_{nj} may be seen as a function which relates the observable characteristics to the lone mothers' utility

$$V_{nj} = V(z_{nj}, s_n) \qquad \forall j \in J \tag{5},$$

where z_{nj} are the observed attributes of the alternatives as faced by the lone mother, and s_n the observed socio-demographic characteristics of the lone mother. I specify the deterministic part of the utility to be linear in parameters with a constant

$$V_{nj} = q'_{nj}\,\theta + k_j \qquad \forall j \in J \tag{6}$$

where q_{nj} is a vector of variables that relate to alternative j as faced by the lone mother n, ϑ are the coefficients of these variables, and k_j is a constant that is specific to alternative j. The constant k_j captures the average effect on utility of all factors not included in the model. The vector z_{nj} includes the net income available to the lone mother at alternative j and its square, the time of work required by alternative j and its square, a welfare participation indicator, and their interactions. The socio-demographic variables s_n cannot enter the model directly, since they do not vary across alternatives. They are interacted with net income, time of work and the welfare indicator to allow utility from income and disutility from time of work and welfare participation to be different for women with different levels of education, age, nationality, numbers and ages of children:

$$\begin{aligned} V_{nj} = {} & \beta_1 x_{nj} + \beta_2 x_{nj}^2 + \beta_3 t_{nj} + \beta_4 t_{nj}^2 + \beta_5 w_{nj} + \beta_6 x_{nj} t_{nj} + \beta_7 t_{nj} w_{nj} + \beta_8 x_{nj} w_{nj} + \\ & + k_j + (x_{nj} s_n)'\delta + (t_{nj} s_n)'\gamma + (w_{nj} s_n)'\lambda \qquad \forall j \in J \end{aligned} \tag{7}$$

where x_{nj} is her net household income, t_{nj} her time of work, w_{nj} her welfare participation indicator in each alternative *j*, and s_n are her demographic characteristics.

Time of work t_n is not observed in the register data. I derive the expected time of work $\bar{t}_n$, expressed in equivalent full time months of work in a year, as the ratio between each woman's annual earnings in the register data ($l_n t_n$) and the predicted monthly earnings from survey data ($\overline{l_n}$) in a full time job of a woman with same human capital characteristics:

$$\bar{t}_n = \frac{l_n t_n}{\overline{l_n}} \tag{8}.$$

The relationship between true time of work t_n and expected time of work $\bar{t}_n$ is given by

$$t_n = \frac{\bar{l}_n}{l_n}\overline{t_n} = \alpha \bar{t}_n \tag{9},$$

where α is negatively correlated with the unobservable characteristics which make a woman earn more. If a woman earns more than what, on average, a woman with the same observable characteristics does, it means that she needs to work less time than what I predict as expected time of work. α connects true and expected time of work and is assumed to be normally distributed. Therefore (7) becomes

$$\begin{aligned} V_{nj} = {} & \beta_1 x_{nj} + \beta_2 x_{nj}^{\ 2} + \tilde{\beta}_3 \bar{t}_{nj} + \tilde{\beta}_4 \bar{t}_{nj}^{\,2} + \beta_5 w_{nj} + \tilde{\beta}_6 x_{nj} \bar{t}_{nj} + \tilde{\beta}_7 \bar{t}_{nj} w_{nj} + \beta_8 x_{nj} w_{nj} + \\ & + k_j + (x_{nj} s_n)'\delta + (\bar{t}_{nj} s_n)'\tilde{\gamma} + (w_{nj} s_n)'\lambda \qquad \forall j \in J \end{aligned} \tag{10}$$

where, for example,

$$\tilde{\beta}_6 = \beta_6 \alpha \tag{11}.$$

The model I estimate allows disutility from time $\tilde{\beta}_3$ to be different for women with different unobservable characteristics:

$$V_{nj} = \beta_1 x_{nj} + \beta_2 x_{nj}^2 + (\beta_3 \nu)\bar{t}_{nj} + \tilde{\beta}_4 \bar{t}_{nj}^2 + \beta_5 w_{nj} + \tilde{\beta}_6 x_{nj}\bar{t}_{nj} + \tilde{\beta}_7 \bar{t}_{nj} w_{nj} + \beta_8 x_{nj} w_{nj} + +k_j + (x_{nj} s_n)'\delta + (\bar{t}_{nj} s_n)'\tilde{\gamma} + (w_{nj} s_n)'\lambda \qquad \forall j \in J \tag{12}.$$

ν coincides with α only if there is no difference in tastes due to unobservables among women[5]. However, I do not need to identify α because the main aim is to take into account that time of work is measured with an error.

4 The Data

The data used for the empirical analysis are from the register data of the Norwegian population in the period 1993-2001, which contains household and demographic information, and is merged with detailed income data from the Tax Assessment Files through unique individual identifiers. The income data are collected from tax records and other administrative registers rather than interviews and self-assessment methods. The coverage and reliability of Norwegian register data are considered to be exceptional, as is documented by the fact that the quality of such national data sets received the highest rating in a data quality survey in the Luxembourg Income Study database (Atkinson et al., 1995).

The population of study comprises married, cohabiting and lone mothers who in each year were at least 18 years old and not more than 55, with the youngest child between 4 and 9 years old. From now on, for simplicity, I consider married and cohabiting mothers together, referring generally to

[5] The model is estimated using the software Stata (command: mixlogit). $\tilde{\beta}_4, \tilde{\beta}_6, \tilde{\beta}_7, \tilde{\gamma}$ should be also allowed to vary among women but, in practice, the model does not converge when allowing unobservable heterogeneity in many parameters. For more details, see a longer version of the model in Pronzato (2012).

all of them as "married" [6]. Self-employed women, students, as well as women receiving permanent disability benefits, are excluded from the analysis.

The sample for the triple-difference model is composed of 1,121,898 women: "becoming" lone mothers (treatment group) and "staying" married mothers (control group), before and after the reform. The sample for the discrete choice model is composed of the sub-sample of lone mothers observed before the reform (7,921), representing what one would use in a typical ex-ante evaluation. The effect of the 1998 reform of the transitional benefit is evaluated on annual gross earnings rather than on hours of work. The reason for focusing on earnings to evaluate the effects of the reform on labour market participation is that I do not have data on working hours. To limit measurement error when using annual gross earnings, I use the consumer price index to make incomes from different periods comparable; throughout this paper the reference year is 1998, and €1 is set equal to NOK 8.4. Details on the sample selection are described in the next sections.

4.1 Data for the Estimation of the Quasi-Experimental Evaluation Design

The way the information is registered is very important for understanding the evaluation design: we know the marital status of the woman on January 1st of each year while gross earnings are measured annually, from January 1st to December 31st of each year. The sample is then selected as follows. The treatment group after the reform is composed of the cohort of mothers who are married on January 1st 1997 (with the youngest child 2-7 years old), who are still married on January 1st 1998 (with the youngest child 3-8 years old), who are lone on January 1st 1999 (with the youngest 4-9 years old), therefore getting separated any day between January 2nd and December 31st 1998. By comparing their earnings between 1999 and 1997, we estimate a change in earnings which may be due to many factors, among which the fact of becoming a lone mother, the work-incentives provided by the welfare system, and other time varying factors[7]. The comparison with married mothers on January 1st 1997 (with the youngest child 2-7 years old), who are still married on January 1st 1998 (with the youngest child 3-8 years old), who stay married on January 1st 1999

[6] Register data do not allow for identification of cohabitant couples directly, but Galloway and Aaberge (2007) constructed a household type variable, derived from a large variety of information which can help to identify cohabitants indirectly.

[7] For this cohort of mothers, we do not use information about their earnings in 1998, since we cannot know for what part of the year the mother was married and for what part of the year the mother was lone. Moreover, this temporal lag allows mothers to have time to adjust their behaviour.

(with the youngest 4-9 years old) helps to clean the total change in earnings by the other time-varying factors (mainly, the child who is growing and the economic trend) and to identify the causal effect of becoming a lone mother on earnings after the reform. By doing the same exercise before the reform (married mothers in 1995, in 1996, who may or may not be lone in 1997), I can identify the causal effect of becoming a lone mother on earnings before the reform. The difference between the effect of becoming a lone mother before and after the reform identifies the casual effect of the reform. In the analysis, I exploit all cohorts available in the data[8], and include local unemployment rate and year time dummies as furthers control of the economic cycle.

4.2 Data for the Estimation of the Discrete Choice Model

From the sample described in the previous session, I select new lone mothers before the reform (in the years 1995, 1996, 1997). I assume lone mothers face at most 8 alternative choices, given by the joint decision of how much to work (4 alternatives) and whether or not participating in the welfare (2 alternatives).

As explained in Section 3, expected time of work is obtained comparing annual earnings observed in the register data with potential monthly full time earnings from survey data. In order to construct potential earnings, I use the Norwegian part of the European Union Survey of Income and Living Conditions for the year 2004, I select women in the same age-range (18-55), and I estimate a Heckman regression. The dependent variable is hourly gross labour income. In the outcome equation I include two dummy variables for education (secondary and tertiary education), a variable for potential working experience (age - years of schooling - 7), its square, and a part time dummy.[9] In the selection equation, I also consider the presence of dependent children, other household income, whether being in a couple, and living in a city. Results are reported in Table A1. In order to make survey earnings comparable to earnings in the register data, predicted hourly earnings are multiplied by typical hours of work in a full time job (38) and

[8] Mothers married in 1993/1994/1995/1997/1998/1999, who are still married in 1994/1995/1996/1998/1999/2000, who may or may not be lone mothers in 1995/1996/1997/1999/2000/2001. The first three cohorts are not influenced by the reform, while the last three are influenced by the reform. Time dummy variables are included in the regression model.

[9] I include a part time dummy to test whether the wage rate can be considered constant over time of work. Part time wage rate is not significantly different from full time wage rate, as shown in Table A1.

number of weeks in a month, and adjusted in order to take into account nominal and real growth. [10]

The 4 work alternatives are defined in the following way:

1) First work alternative (which will be called "no work"): ratio between annual observed earnings and expected monthly earnings in a full time job smaller than 3, which corresponds to less than 9.5 hours a week (on average, in the data, 1 hour and half per week).
2) Second work alternative (which will be called "short part time"): ratio between observed annual earnings and expected monthly earnings in a full time job larger or equal to 3 and smaller than 6, which corresponds to 9.5-19 hours a week (on average, in the data, 13 hours per week).
3) Third work alternative (which will be called "part time"): ratio between observed annual earnings and expected monthly earnings in a full time job larger or equal to 6 and smaller than 9, which corresponds to 19-28.5 hours a week (on average, in the data, 22 hours per week).
4) Fourth work alternative (which will be called "full time"): ratio between observed annual earnings and expected monthly earnings in a full time job larger or equal to 9, which corresponds to more than 28.5 hours a week (on average, in the data, 33 hours per week).

In the observed choice, the three objects of the utility function are defined as follows: (i) the observed welfare participation decision, (ii) the net income which derives from observed earnings through the tax-benefit function (2) and (iii) the expected number of months of work, obtained dividing the observed annual earning by potential monthly earnings in a full time job. For the other 7 alternatives I construct counterfactuals.

Suppose her observed earnings are €17,500 and she participates in the welfare (see example in Table 1). Given her human capital characteristics, she is supposed for example to earn €2,500 per month in a full time job. I classify her as working "part time" (17,500 / 2,500 = 7 equivalent full

[10] Prices are deflated to €-1998. Real growth is taken into account looking at the variation, year by year, of the basic amount (*grunnbeløp*), which is the official reference amount used for the up-rating of benefits and pensions.

time months; 22 hours per week). I construct three other earning alternatives: "no work", working "short part time", working "full time" (see Table 1, first five columns). The number of months chosen for each untaken work alternative (no work / short part time / full time) is drawn from the distribution of months of people choosing that alternative (no work / short part time / full time) (Aaberge et al., 2009). Predicted earnings are then imputed. In the example, Table 1, the drawn numbers of months are 0, 4 and 12, and earnings are, respectively, €0, €10,000, and €30,000.

Table 1: An example of Choice set

Work	Take up	Alternative	Time of work	Labour income	Transitional benefit	…	Total net income	Decision
No Work	Yes	1	0	0	8,000		17,000	0
No Work	No	2	0	0	0		9,000	0
Short Part	Yes	3	4	10,000	5,000		23,000	0
Short Part	No	4	4	10,000	0		18,000	0
Part Time	Yes	5	7	17,500	2,000		26,000	1
Part Time	No	6	7	17,500	0		24,000	0
Full Time	Yes	7	12	30,000	0		-	-
Full Time	No	8	12	30,000	0		33,000	0

Notes: The choice set of a woman who takes-up the transitional benefit with observed earnings equal to €17,500 and potential monthly earnings equal to €2,500.

For each earning alternative, she can decide whether to participate in the welfare. The transitional benefit is calculated as follows. The maximum annual amount of the benefit is around €8,000 per year. From this maximum amount, 40% of earnings exceeding €2,500 are subtracted. In Table 1, 6th column, we can see the corresponding amounts. For this woman, the 7th alternative is dropped, since the related full time earnings are too large to be still eligible for the benefit.

I then simulate the childcare benefit, another benefit which depends on labour supply, given as a reimbursement for extra-costs for childcare, occurred when the mother works. All other remaining benefits are only available in the data as a total amount. However, none of them depends on her working decisions. Finally, I simulate taxes, and obtain the total net income she can have in different work/welfare alternatives (8th column, Table 1). Poverty is defined by a dichotomous variable taking the value of 1 if the lone mother's household has annual equivalent disposable income below 60 percent of the median annual equivalent disposable income in the overall population, and 0 otherwise. The 9th column (Table 2) indicates in which alternatives the

household is considered poor: in the example, the household would be poor if the mother decided not to work, or worked short part time and did not take-up the benefit. The variable, in the 10th column (Table 1), indicates the decision observed.

Descriptive statistics of the sample of lone mothers before the time of the reform are shown in Table 2. This also represents the sample of reference for the simulation of the optimal policy (which minimizes poverty) shown in Section 6.

Table 2: The Sample of Lone Mothers before the Reform

Variable	Mean
Income	24,855
	(6,550)
Time of work	8.38
	(5.14)
Welfare participation	0.489
Age: younger than 32 years old	0.362
Age: 32-36 years old	0.341
Age: older than 36 years old	0.297
< 11 years of schooling	0.253
11-12 years of schooling	0.553
> 12 years of schooling	0.194
Youngest child 4-5 years old	0.499
Youngest child 6-7 years old	0.310
Youngest child 8-9 years old	0.191
One child	0.320
Two children	0.455
More than two children	0.225
Immigrant	0.010
Observations	7,921

Notes: average values, standard deviations in brackets for continuous variables. Time of work expressed in equivalent full time months.

5 Comparing the Estimated Effects of the Reform

5.1 Quasi-Experimental Estimated Effects and Comparison with the Simulated Effects of the Discrete Choice Model

Results of the triple-difference model are shown in Table 3. In general, I find a positive effect of the reform: lone mothers increase their earnings of €384 per year. When distinguishing women by

level of education, results appear positive and significant only for low and medium high educated women, non-significant for highly educated women. We observe that the introduction of the reform has reduced the distance between lone and married mothers: before the reform becoming a lone mother implies, on average, a decrease of 702€ in earnings; after the reform, it implies a decrease of only 320€ (384-704). Results are robust to different specifications and to the inclusion of more control variables[11].

Table 3: Estimated Effects of the Reform, using the Triple-Difference Evaluation Design

	All women	Low educated (< 11 years of schooling)	Medium educated (11-12 years of schooling)	High educated (>12 years of schooling)
Reform	384	658	476	-79
(95% confidence interval)	(195,572)	(276,1040)	(238,714)	(-550,392)
Becoming a lone mother	-704	-1,284	-703	371
(95% confidence interval)	(-841,-567)	(-1,542, 1,026)	(-878, -528)	(16, 727)
Unemployment rate	-121	-51	-135	-123
(95% confidence interval)	(-160, -82)	(-137, 35)	(-186, -84)	(-207, -38)
Observations	1,121,898	207,808	633,870	358,294
Average earnings before the reform	16,748	11,692	15,982	25,508

Notes: estimated effects of the reform when using the triple-difference design, together with the 95% confidence intervals, the number of observations, and the average earnings before the reform.

5.2 Estimated Behavioural Parameters from the Discrete Choice Model

I estimate the effects of income, time of work, welfare participation and their interactions with other socio-demographic variables, on the probability of choosing one of the alternatives, using a mixed logit specification with the coefficient of time of work treated as random coefficient, assumed to be normally distributed, as outlined in Section 3. Results are reported in Table 4. The model is estimated without any restriction imposed on the utility function. To check that the utility function respects the concavity and monotonicity properties, I check the derivatives with respect to the utility arguments. The first derivative with respect to income is positive for the whole sample as well as the first derivative with respect to time of work is negative for the whole sample. Second derivatives are in the expected direction, as shown in Table 4. Utility is decreasing in welfare participation for 96% of the sample. The standard deviation of the random coefficient is

[11] See Mogstad and Pronzato (2008, 2012).

significantly different from zero, revealing an important role of unobserved heterogeneity and/or measurement error.

The interaction between income and time of work is positive, which may be explained by the presence of better positions in the labour market that, even if imply longer hours of work, increase woman's utility. The interaction between welfare participation and income is positive: since a large part of lone mothers' income comes from other benefits in Norway, the positive interaction could reveal that the cost of participating is lower for women who also participate in other welfare programs. The interaction between welfare and time of work is also positive: women who work more may be more informed because they are more likely to talk with other people at the place of work or they may suffer less from welfare stigma because they feel they do not completely depend on welfare[12]. Results concerning number and age of children are in the expected direction: on the one hand, having more and younger children increases the cost of working; on the other hand, it increases utility from income. Immigrant women have more disutility from time of work. This finding could result from the fact that, given their level of education, they are in poorly paid jobs. Younger women have less disutility from participating in the welfare while the cost of the welfare is not linear by years of education. Women with secondary schooling have less disutility from participating in the welfare than higher and lower educated women. This may capture different aspects of welfare participation: on the one hand, if information is needed then better educated women may be more prompt to apply for the benefit; on the other hand, better educated women may suffer more to be dependent from welfare.

12 Generally speaking, in the Norwegian context, where applications can be done on line and transfers can be received in the bank account without friends and family necessarily knowing, we could expect the role of the welfare stigma to be relatively less important.

Table 4: Discrete Choice Model Estimates

	Beta	St err		Beta	St err		Beta	St err
Income	1.090***	0.074	Time	-0.793***	0.116	Welfare	-3.647***	0.550
			St dev (time)	0.254***	0.036			
Income sq.	-0.012***	0.001	Time sq.	0.001	0.003			
Income*time	0.009***	0.003	Time*welfare	0.169***	0.046	Income*welfare	0.031***	0.011
Income interacted with			**Time interacted with**			**Welfare interacted with**		
Mother's age (< 32)	0.007	0.030	Mother's age (< 32)	-0.003	0.038	Mother's age (< 32)	0.393**	0.156
Mother's age (32-36)	-0.001	0.025	Mother's age (32-36)	0.053	0.034	Mother's age (32-36)	0.342***	0.124
Mother's age (> 36)			Mother's age (> 36)			Mother's age (> 36)		
Schooling (< 11)	0.077*	0.042	Schooling (< 11)	-0.250***	0.060	Schooling (< 11)	-0.213	0.224
Schooling (11-12)	-0.036	0.035	Schooling (11-12)	-0.128**	0.054	Schooling (11-12)	0.547***	0.158
Schooling (> 12)			Schooling (> 12)			Schooling (> 12)		
One child	-0.154***	0.031	One child	0.389***	0.044	One child	0.044	0.150
Two children	-0.045*	0.024	Two children	0.157***	0.033	Two children	-0.049	0.123
More than two			More than two			More than two		
Youngest child 4-5	0.068**	0.027	Youngest child 4-5	-0.133***	0.036	Youngest child 4-5	-0.208*	0.126
Youngest child 6-7	0.046*	0.027	Youngest child 6-7	-0.081**	0.036	Youngest child 6-7	-0.003	0.12
Youngest child 8-9			Youngest child 8-9			Youngest child 8-9		
Immigrant	0.038	0.082	Immigrant	-0.280**	0.113	Immigrant	-0.261	0.496
No-work intercepts			**Short time intercepts**			**Part time intercepts**		
Welfare	-1.064***	0.242	Welfare	-1.421***	0.159	Welfare	-0.606***	0.106
No welfare	0.654**	0.323	No welfare	-1.059***	0.207	No welfare	-0.770***	0.120
Observations				59,293				

Notes: Mixed logit regression with time treated as random coefficient; *** significant at 1% level, ** significant at 5% level, *significant at 10% level.
Income variables divided by 1,000. Time of work expressed in equivalent full time months.

5.3 Simulating the Effect of the Reform

In order to simulate the reform with the discrete choice model, I need to parameterize the transitional benefit according to the new rules. There are three important changes. First, working requirements are imposed. Second, the age limit for eligibility on the youngest child is lowered, and time limits on welfare participation are introduced. And third, in-work benefit levels are raised.

The increase of the maximum amount (from around 8,300€ to 9,500€ per year) not only makes the transitional benefit more generous but also makes women more likely to be eligible: before the reform, only women earning less than €1,900 per month can receive the benefit while, after the reform, women earning until €2,200 per month are also eligible. This results in a larger number of alternatives in the choice set for those women now eligible to receive the benefit. According to the change of the age limit, women with the youngest child aged 9 years old are not allowed to receive the transitional benefit anymore. The reform requires lone mothers to be in training, to work at least part time, or to seek work. The law does not give details about the "training" and "seeking work" activities. I do not have any information on what these activities consist of, whether it was difficult to have a training period, what women were asked in case they were seeking work. And I do not know whether these activities were easily approved by the public administration, and for how long they were compatible with being eligible for the benefit. Moreover, register data do not have information on training and periods of seeking work, so that I cannot know who was taking this decisions, even after the reform. What I can do is to assume that lone mothers receiving the maximum amount of the transitional benefit after the reform are engaged in one of the two activities. In fact, the maximum amount is given only to women earning less 200€ per month and it is reasonable to assume there is no part time job in Norway paid less than 200€ a month. The percentage of non-working women on welfare after the reform (supposed to be in training or seeking-work activities) is 7.0% while the percentage of non-working women on welfare is 18.5% before the reform. While before the reform, the possibility of receiving the transitional benefit and not working was a woman's decision, after the reform it is the result of the woman's decision and the new constraints imposed by the law. We may expect women with lower level of education to be more likely to be observed in training or seeking work activities after the reform, but this does not seem to be the case when looking at post-reform data. The percentage of non-working women receiving the benefit before the reform was 26.4% among low educated women, 14.0% among medium educated women, 11.0% among highly educated women. The percentage of non-working women receiving the benefit after the reform (assumed to be in training or seeking work activities) is 8.7% among low educated women, 6.3% among medium educated women, 7.6% among high educated women. In order

to reproduce what I observe in the data, I drop randomly the alternatives of non-working and participating in the welfare for a number of women so that the percentage of women taking this decision - with the new rules - is 7.0%. The simulated effects of the reform from the structural model are calculated as weighted earnings, given by the sum of earnings in each alternative times the probability of choosing that alternative. Results are shown in Table 5. The simulated effect of the whole reform is positive: on average, lone mothers increase their earnings of €450[13] per year. The effect appears heterogeneous for women with different level of education: positive and stronger for low and medium educated women, while negative and smaller for high educated women[14]. We can separate the effects of the introduction of the working requirements and new age limits from the effect of more generous benefits. The bottom part of Table 5 summarizes the results. The introduction of working requirements has increased women's earnings, as expected. The effect is larger for low and medium educated women than for highly educated women. Also the new age limit has a positive but small effect on work decisions. Making the benefit more generous has the expected negative effect on annual earnings. The effect is relatively large also for highly educated women. In fact, for highly educated women, the increase in the maximum amount has made them eligible in more work alternatives. Results from different specifications of the model are included in the Appendix (Table A2).

Table 5: Simulated Effects of the Reform, using the Discrete Choice Model

	All women	**Low educated (< 11 years of schooling)**	**Medium educated (11-12 years of schooling)**	**High educated (>12 years of schooling)**
Reform	450	788	516	-176
(95% confidence interval)	(399,501)	(728,848)	(462,569)	(-215,-136)
Increased generosity	-835	-907	-861	-665
Age limit	115	15	156	130
Activity requirements	916	1,071	1,030	390
Observations	7,921	2,002	4,380	1,539

Notes: simulated effects of the whole reform (with the 95% confidence intervals) and of each policy parameter changed by the reform, predicted by using the estimated parameters of the discrete choice model.

[13] In order to calculate the confidence intervals around the predictions from the structural model, I employ the bootstrap method: I draw 100 new samples from the original one, each of them containing the original number of observations (N = 7,921), where each observation may be repeated more than once (with replacement); I re-estimate the model using each of the 100 new samples; I parameterize the reform and get 100 sets of predictions. From these predictions I calculate means, standard errors, and confidence intervals.

[14] Imposing the proportion of women in training or seeking work activities to 7.0% implies, according to the discrete choice model estimates, to grant the possibility of receiving the benefit without working to 40 women out of 100.

The comparison between tables 3 and 5 represents a first contribution of the paper. Predictions from the discrete choice model, usually considered econometrically more fragile, are confirmed by the triple-difference model. Results of the two methods are, in fact, positive and significant, confidence intervals overlap, and point estimates are rather close. Not only, the discrete choice model predicts well also by level of education: the positive effect is larger for low-medium educated women, while slightly negative for highly educated women.

6 New Policy Scenarios

The comparison between the results of the discrete choice model and the triple-difference model makes me confident in using the behavioural estimates to find which policy changes to the transitional benefit would have minimized poverty among lone mothers. Before the reform, the percentage of poor lone mothers is 11.8, as shown in the 1st column of Table 6. At the bottom of the Table, the parameters of the reform are reported.
The aim is to find the policy parameters which minimize poverty[15]. I look at two situations:

- when the working requirements are those implemented at the time of the reform: in order to be eligible for the benefit, women are required to be in part-time work, to seek work, to be on training (case 1);
- when the working requirements are introduced without the possibility of training or seeking work (case 2).

These two scenarios should be interesting benchmarks for policy makers. The first scenario represents the case in which policy makers want to introduce working requirements but allow women to invest time in training and seeking work. The second scenario can be seen as a "long term" realization of the reform: after the first period spent in training or seeking work, women have to work to be still eligible for the benefit. In this last scenario I also allow time of work to vary in order to choose the working requirement which minimizes poverty. In the first scenario, instead, working requirements are reproduced as observed at the time of the reform. Another difference between the two scenarios is the

[15] As conventionally done, a household is considered poor when the equivalent household income is below 60% of the median equivalent household income in the general population.

amount of resources involved: "stricter" working requirements (case 2) imply a lower public expenditure, which derives from giving less generous benefits (due to the withdrawal rate) and from cancelling welfare for women who eventually decide not to work. In the 2nd and 3rd columns of Table 6, I report the simulated effects of the actual reform on poverty in the two policy scenarios. Poverty decreases to 8.6% (case 1) and to 9.4 (case 2) while the average cost per woman is, respectively, €3,163 and €1,920.

Table 6: New Policy Scenarios

	Before the reform	**Actual reform**		**Optimal policy**	
		Case 1	Case 2	Case 1	Case 2
Poverty (%)	11.8	8.6	9.4	7.2	9.0
Policy parameters					
Max amount	8,340	9,591		8,340	8,173
Withdrawal rate	40%	40%		24%	30%
Disregarded amount	2,513	2,513		2,061	2,990
Age limit	10	9		9	9
Work requirements	none	as in 1998	work ≥ 6FT	as in 1998	work ≥ 6FT
Average cost	€2,634	€3,163	€1,920	≤ €3,163	≤ €1,920

Notes: a lone mother, in order to be eligible for the benefit, is required to work part-time, seek work or be in training (case 1); a lone mother, in order to be eligible for the benefit, is required to work for a given amount of time (case 2).

In order to find the optimal policies, under revenue neutrality, I vary the maximum amount of the benefit, the withdrawal rate, the disregarded amount, the age limit and, only for case 2, the working requirements. In order to find the parameters of the reform I proceed with a two-step maximization procedure[16]. The results are shown in Table 6. If we consider the case where working requirements are implemented as in 1998 with the possibility of training and seeking work (case 1), with an average expenditure of €3,163 per lone mother, we observe a further decrease in poverty to 7.2%. Comparing the parameters of the benefit between the "actual reform" and the "optimal policy", we see that the

[16] In the first step, I widen the interval around each parameter in turn to try all possible combinations of the parameters, until I cannot find any additional combination that gives a lower level of poverty. When I arrive to this stage, the policy parameters' intervals are: maximum amount: 6,672–13,344 (case 1), 3,336–10,008 (case 2), withdrawal rate: 0–64 % (case 1), 16–48 % (case 2), disregarded amount: 1,005–5,026 (case 1), 0–8,042 (case 2); age limit: 7–10 (case 1, case 2); working requirements: 0–8 equivalent full time months of work (case 2). In the second step, within the above intervals for each parameter I try all the possible combinations considering small variation in the parameters each time, in order to find the "optimal" solutions which minimize poverty.

reduction in poverty is a consequence of the reduction of the withdrawal rate and of the disregarded amount, while the maximum amount and age limit are the ones observed, respectively, in the pre and post reform period. In the second scenario (case 2), we also observe a decline in poverty which is now equal to 9.0%. Also in this case, the withdrawal rate is the parameter which is more distant from the observed one. The maximum amount is still around €8,000 per year while, the disregarded amount has increased. In this scenario, I allowed the required time of work to vary. However, the optimal one is confirmed to be 6 months a year (part time). Also the age limit is confirmed to be 9 years old.
Could they have reformed the transitional benefit in a more efficient way investing the same amount of public resources? Yes, the paper shows that this would have been possible, not by increasing the generosity of the benefit, but through a reduction of the withdrawal rate so that decision to work could have been more attractive, leading to higher income, and lower poverty.

7 Conclusions

In this paper, I compare the effect of the 1998 Norwegian welfare reform on lone mothers' earnings estimated using a triple-difference model and a discrete choice model of earnings and welfare participation decisions. The reform increases the maximum amount of the transitional benefit, introduces new working requirements and changes time limits in order to be eligible for it. A first contribution of the paper is to compare two different ways of doing policy evaluation. From both the evaluation methods, we observe a positive effect on lone mothers' earnings, driven by behavioural responses of lower and medium educated women. The two strategies help the understanding of the policy impact in a complementary way: while the focus of the triple-difference model is to measure what really happened, the challenge of the discrete choice model is to predict what potentially can happen. Both aspects are important from a policy point of view. The fact that predictions provided by the discrete choice model track the results of the triple-difference analysis gives credibility to both the approaches. From a policy point of view, the availability of structural models gives policy makers the opportunity to plan how to use rationally the resources at disposal to pursue their social objects. The main contribution of the paper is to suggest what would work better for fighting lone mothers' (and their children) poverty. In the studied case, we observe that – under revenue neutrality – lone mothers' poverty could be more efficiently reduced by lowering the withdrawal rate. This would give women the incentive to work and earn more, and to reach a level of income beyond the poverty-line threshold.

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Appendix

Table A1: Earnings Equation

	Beta	St err
Hourly wage		
Tertiary education	7.066***	0.908
Secondary education	2.605***	0.655
Lower education		
Work experience	0.431***	0.112
Work experience sq.	-0.007***	0.002
Part time job	-0.021	0.255
Constant	6.700***	2.164
Selection		
Tertiary education	1.163***	0.120
Secondary education	0.518***	0.108
Lower education		
Work experience	0.162***	0.011
Work experience sq.	-0.003***	0.000
Married/cohabitant	0.260***	0.084
Dependent children	-0.182***	0.070
Household income	-0.026***	0.006
Living in a city	0.000	0.058
Constant	-1.508***	0.146
Lambda	1.051	1.462
Rho	0.21	
Observations	2,667	

Notes: Heckman regression; *** significant at 1% level, ** significant at 5% level, *significant at 10% level. Hourly wage is expressed in € - 1998. Source: EU-SILC (2004).

Table A2: Sensitivity Analyses

	All women	Low educated	Medium educated	High educated
Random coefficients: Time (Table 3)				
Reform	450	788	516	-176
Increased generosity	-835	-907	-861	-665
Age limit	115	15	156	130
Activity requirements	916	1,071	1,030	390
No random coefficients				
Reform	797	1,328	846	-34
Increased generosity	-1,034	-1,034	-1,117	-797
Age limit	207	314	204	74
Activity requirements	1,431	1,945	1,537	459
Random coefficients: time, income, welfare				
Reform	416	704	482	-145
Increased generosity	-833	-894	-853	-698
Age limit	119	30	165	104
Activity requirements	915	1,079	1,034	365

Notes: simulated effects of the reform when using different econometric specifications of the discrete choice model. The top part of the Table reports the estimates shown in Table 3, the middle part of the Table reports the estimates without unobserved heterogeneity, the bottom part of the Table reports the estimates when allowing unobserved heterogeneity in time of work, income and welfare participation.