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Reduction of child poverty in Serbia: Improved cash-transfers or higher work incentives for parents?

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Abstract

Based on the 2013 Serbian Survey of Income and Living Conditions (SILC) and on the Serbian version of the EUROMOD platform, we evaluate the poverty and distributive effects on children of various reform (benefit and employment) strategies concerning the two major social benefit programs in Serbia: child allowance and social monetary assistance. Both the first and second-order effects of the proposed reforms are considered. For the second-round impacts, a structural labour supply model on parents has been estimated. Our results show that a benefit strategy (which also combats fiscal evasion) is preferred to an employment strategy which aims at raising the work incentives by parents.

JEL: J22, J13, J18

Keywords: child poverty, tax and benefit reforms, labour supply, Serbia

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I. Introduction and context

Child poverty has important and long lasting negative effects on child development (Pollitt, 1994; Dubow & Ippolito,1999; UNICEF, 2000; Duncan, Ziol-guest & Kalil, 2010). Poverty during childhood considerably increases the risk of poverty throughout adulthood, with significant intergenerational pass-through effects. Parents raised in poverty are more likely to raise their children in poverty too (Atkinson, Maynard & Trinder, 1983; Harper, Marcus & Moore, 2003).

Child poverty rates in Serbia are well above the average poverty rates for the general population, with both the total poverty rate and the child poverty rate being considerably higher than the EU average. According to the 2012 Survey on Income and Living Conditions (SILC), the at-risk-of-poverty rate of the total population in Serbia equalled 24.6%, while among children it reached 30%. At the same time, the EU average child at-risk-of-poverty rate amounted to 19% (Council of Europe, 2014).

Child poverty can mainly be tackled by two categories of government policies (Sutherland, 2000): *i*) direct financial support to poor families with children (means-tested cash transfers, e.g. child allowance); *ii*) policies aimed at promoting poor children's parents to work (e.g. in-work benefits or conditional child tax credits)[1]. Effectiveness of government tax and benefit policies in tackling child poverty depends on the amount of resources invested in these programs, but also on the structure of the programs (Levy, Lietz & Sutherland, 2005).

Total non-contributory social benefits spending in Serbia amounts to 2.1% of GDP, thus being slightly higher compared to the Eastern Europe average (World Bank, 2012). However, the structure of non-contributory spending is rather unfavourable in terms of poverty reduction, since the share of means-tested benefits (monetary social assistance and child allowance) is rather low[2]. Despite the fact that as a result of several waves of the

[1] Another category of government policies would be policies aimed at reducing the child poverty before government intervention via a tax-benefit system (e.g. teenage pregnancy reduction measures, raising the basic standards of literacy and numeracy, tackling school truancy and exclusions, etc.). Nevertheless, this category of policies is not discussed in this paper.

[2] A significant share of funds is dispersed through non-means tested transfers (wage compensation during maternity leave, birth grants, war veterans' benefits, etc.)

reforms, and due to the impact of the crisis, total spending on the means-tested benefits increased to approximately 0.6% of GDP, it is still significantly below the EU average of 1.1. % of GDP (World Bank, 2012; Matkovic & Mijatovic 2009).[3]

Empirical studies have shown that the high poverty rate among children in Serbia is not only the consequence of the low spending on child related benefits, but also the consequence of poor design of major benefit programmes. Both the coverage and targeting of child allowance in Serbia are found to be weak –almost 60% of poor children do not receive child allowance, while more than half of those who receive child allowance do not live in poor families (World Bank 2006; Matkovic, Stanic & Mijatovic, 2012; Matkovic & Mijatovic, 2012).

In addition to the low spending on child-reduction policies and their ineffective parameterization, the weak labour market performances also contribute considerably to the high total and child poverty rate.[4] According to the 2015 Labour Force Survey data, the working age (15-64) population labour market participation rate equalled 63%, which was approximately 10 percentage points lower than the EU-28 average. At the same time, unemployment stood at 16.7%, which was two-thirds higher than the EU average. An additional peculiarity of the Serbian labour market is related to its high informality rate. These indicators suggest that labour market effects need to be considered when evaluating child-poverty reduction policies.

In this study we propose different reform strategies concerning the two main means-tested social protection programs (monetary social assistance and child allowance), which were in place at the time of the study. In a time of austerity, our proposals aim to improve the targeting and coverage of these programs, as well as acting on the incentives to work by the parents for the benefit of children in poverty. Based on the 2013 Serbian SILC data, we used the microsimulation tax-benefit model for Serbia to estimate the first-order effects. Also, to simulate the second-order effects, we developed a structural multi-sector discrete choice labour supply model that allowed individuals to choose both hours of work and the

[3] Child allowance was a quasi-universal benefit prior to these reforms. An income test was applied to the first two children, whereas third and subsequent children were entitled to the benefit regardless of income conditions. Reforms abolished universal features of the benefit and introduced a means test instead of an income test.

[4] This is a well-established empirical fact (see Whiteford & Adema, 2007)

sector (formal or informal). This is the first use of such a model on Serbian data. Our results suggest that in order to obtain the largest poverty reduction among children per RSD spent, the benefit reform strategy (complemented with interventions to combat fiscal evasion) should be preferred to an approach that increases work incentives for parents.

The paper is organized as follows: Section 2 provides a brief overview of the literature. Section 3 presents the survey data and stylized facts on child poverty profile and performance indicators for major means-tested benefit programs. Section 4 describes the methodology and proposed benefit reform scenarios. Section 5 presents the results and offers discussion. The last section concludes and offers policy recommendations.

II. Literature review

Empirical literature suggests that child benefits play a major role in tackling child poverty in Europe, but that their poverty-reduction impact differs greatly between countries, depending on generosity and design of the benefit system (Lancker, Ghysels & Cantillon, 2003). For instance, UNICEF (2000) found that in some countries, tax-benefit policies reduced child poverty by 20 percentage points (pp), while in other countries, it was as little as 5 pp. While most of the literature suggests that the amount of spending on child benefit programs is an important determinant of the efficiency of these programs, there are different findings regarding the efficiency of universal versus means-tested benefits. Notten and Gossmann (2008) suggest that universal benefits (in Russia) tended to have a larger impact on child poverty reduction than means-tested benefits. At the same time, Lancker and Van Mechelen (2014) found that the redesign of the means-tested benefits (by enhancing eligibility criteria) could trigger further reduction of child poverty, with the same fiscal costs.

Child poverty can be tackled not only by redesigning family cash benefits (benefit strategy), but also through implementation of policies aimed at increasing the labour supply of parents (work strategy). The first strategy relies on the direct impacts of transfers on family income, while the second strategy relies not only on direct impacts, but also on second round effects; that is, the indirect impact of labour activation on family income

(Whiteford & Adema, 2007; Björklund, 2006; Immervoll, Sutherland & De Vos, 2001; Thévenon & Luci, 2012). At the same time, there is considerable interplay between the strategies, in the sense that a benefit strategy, via its impact on the disposable family income, also has an effect on work incentives, and this should also be taken into account.

Child poverty reduction policies focused on the benefit strategy face implicit equity-efficiency trade-offs (Duncan & Giles, 1996; Blundell, Duncan, Mccrae & Meghir, 2000; Adam & Browne 2010; Jara & Tumino, 2013). As confirmed in many studies, policies aimed at providing direct support to low-income families trigger the reduction of child poverty (Blundell 2006; Immervoll, Kleven, Kreiner & Saez, 2007), but at the same time discourage the labour supply of parents, particularly of the second earners, and thus harm economic efficiency, as well encourage long-term poverty (Blundell 2001; Immervoll et al., 2007; Whiteford & Adema, 2007; Immervoll et al., 2001; Laroque & Salanie, 2008; Kornstad & Thoresen, 2007; Haan & Wrohlich, 2011). Although the equity-efficiency trade-off is usually associated with anti-poverty policies, the scale of the trade-off is not constant, but rather dependent on the design of the policy. Immervoll et al. (2007) found that "the efficiency implications of welfare reform depend crucially on who is targeted by the reform, the poor or the working poor" (p.26). The empirical literature surveyed in Immervoll et al. (2007) suggests that unconditional transfers made to the poor tend to trigger larger efficiency losses (in terms of labour supply) than the conditional policies targeted on the working poor cohort. Therefore, welfare policies in developed countries increasingly focus on employment-conditional programs, which is why 16 out of 30 OECD countries have implemented some form of employment-conditional benefit schemes (or in-work benefits), and several other countries are actively considering their introduction (Immervoll & Pearson, 2009). In-work benefits are effective tools for alleviating the poverty of families with children, since many empirical studies suggest that the labour supply effects of these benefits are concentrated on the low-earning families with children (CBPP, 2014; De Lucca, Rossetti & Vuri, 2012; Nichols & Rothstein, 2015). The labour supply mechanism, included in the in-work benefit programs, may play an important role in the efficacy of other means-tested programs in tackling child poverty, since more generous means-tested benefits may discourage working. Although in-work benefits seem to balance the need to tackle poverty without harming labour supply, this does not imply that they should replace the standard

child benefit programs (Van Mechelen & Bradshaw, 2012). Therefore, in this paper, in order to determine what is best in reducing child poverty – a benefit or a work strategy - we do not introduce structural changes to the child benefit design; we leave it largely as it is, only making it more generous. On the other hand, we introduce changes to the design of the monetary social assistance benefit by introducing the logic of an in-work benefit program.

III. Data and stylized facts

We used the 2013 SILC data to analyse the performance of the existing child-related means-tested benefits, as well as to estimate the child-poverty effects of redesigning these programs.[5] The SILC is, in fact, the most comprehensive and detailed survey in Serbia on individuals' income, labour market status, as well socio-economic features, thus, enabling the microsimulation of different reform options and detailed evaluation of the contribution of each parameter to the overall performance of the particular benefit program. This is also why SILC is commonly used for the evaluation of the effects of tax-benefit policies across Europe, which makes it possible to compare the results.

SILC 2013 was conducted by the Statistical Office, on a representative sample of 6,501 households (20,069 individuals). This survey is based on the EU-SILC methodology developed by Eurostat. The data are collected at the household and the individual level, depending on the content. The dataset also includes respective weights assigned to each unit, thus enabling the macro extrapolation of the results.

According to the 2013 SILC survey, the at-risk-of-poverty rate[6] of the total population in Serbia (at 60% of median income) equalled 24.6% while that for children was 30.7%. It was also much higher than that of the EU for children (19%). Households with children faced a considerably higher at-risk-of-poverty rate (28%) than childless households (22.3%). When poverty line is set at 30% of median income, the poverty rate is again higher among

[5] The SILC survey was conducted by the Statistical Office of Serbia in 2013, the income data being related to 2012.

[6] The share of people with an adult equalized disposable income (after social transfers and taxes) below the at-risk-of-poverty threshold, which is set at 60 % of the national median equalized disposable income after social transfers

children (11.7%) than in the general population (9.6%). For the estimations shown below, we use the poverty line set at 30% of median income[7].

Table 1: Overall and child at-risk-of-poverty rates based on different thresholds

	Total Population	Children	Childless HHs.	HHs. with children
60% of median income per adult equivalent	25.6	30.7	22.3	28.0
30% of median income per adult equivalent	9.6	11.7	8.2	10.6

Source: Authors' calculation based on the 2012 SILC data

In Serbia there are two anti-poverty means-tested benefits – child allowance (CA) and monetary social assistance (MSA). A marginal estimation shows that the child allowance reduces the poverty rate among children by about 4 pp, whereas monetary social assistance reduces it by about 3 pp.

Child allowance is the benefit for children from low and lower middle income families. The income census for receiving benefit is 7,250 RSD per family member. For a two-parent family with two children, this amounts to 29,000 RSD, which is 50% higher than the net minimum wage. The benefit is set to 2,280 RSD per child which represents 32% of the poverty line (30% median of equivalent income). A fixed amount of benefit is given to the first four children in the family (aged 0-19), which is conditional on the means test and school enrolment for children over 7 years of age.

Child allowance covered 370,000 children in 2012, or around 29% of those in the 0-19 age bracket, which is quite low compared to similar programs in other EU countries. The total expenses of the benefit amounted to 0.4% of Serbian GDP. Most of the beneficiaries (almost one half) were households with two children, followed by households with only one child.

[7] Poverty line set at 60% of the median income is too high in Serbia given that, according to this line, a quarter of the population is at risk of poverty. In this study we use the relative poverty line set at 30% of the median because it is closer to the administrative eligibility threshold for the monetary social assistance benefit. Additionally, poverty rate at 30% median income is approximately equal to the poverty rate from Household Budget Survey (8.7% in 2012), calculated on consumption and absolute poverty line (based on the consumer basket using nutritional standards and the assessed proportion of non-food item).

Monetary social assistance is the last resort social assistance program for individuals (living alone), or families (including those with children), who meet the eligibility criteria[8]. The income threshold for MSA was set to 7,628 RSD per adult equivalent in 2012, amounting to 16,000 RSD for a two-parent family with two children[9], which represents 82% of the net minimum wage. The threshold is almost two times lower than for the child allowance, which indicates that MSA is directed towards the poorest members of the population.

The amount of the benefit equals the difference between the household-specific threshold and the average monthly income of the household during the last three months. Therefore, the benefit aims to increase the equivalent household income over 7,628 RSD, which is approximately equal to the poverty line used in this paper.

According to the administrative data in 2012, approximately 3.5% of the population received the MSA, triggering fiscal costs of 0.3% of GDP, which was below EU average spending (0.5% of GDP). According to both administrative and SILC data, households with children made up half of all recipient households.

IV. Methodology

The objective of this paper is to evaluate the effects of two tax-benefit policy reforms on incomes, labour participation and child poverty. This is achieved through a micro-simulation approach. In the first stage, micro-simulation was only used in an accounting manner (day-after or static). Disposable income of a representative sample of the population is calculated before and after a reform using a tax and benefit calculator (Levy et al., 2005; Salanauskaite and Verbist, 2011; Levy, Morawski & Myck, 2009; Immervoll et al., 2000, De Lathouwer, 1996; Popova, 2013). In the second stage, labour supply behaviours were added to the analysis using a structural discrete choice model.

[8] Full list of criteria can be found in Arandarenko et al., 2013

[9] The equivalence score for this type of family is 2.1 (1 for the head of the household + 0.5 for the second adult + 2*0.3 for two children in the household).

4.1. Tax and benefit micro simulation model

The tax and benefit micro-simulation model for Serbia, SRMOD, is based on the EUROMOD platform[10]. Similar to other micro-simulation models, SRMOD is a tax and benefit calculator based on micro-data. Using the data disclosed in the 2013 SILC (earnings, non-labour incomes, and various socio-demographic features) and the tax-benefit rules, SRMOD enables the computation of taxes and the main means-tested benefits (including child allowance and monetary social assistance) for each individual in a household. The main outputs of the model were disposable income and the amounts of taxes, social contributions and benefits attributed to each individual and household. This output could then be used to calculate poverty indicators. If for some individuals in the dataset, relevant data required for simulation of a particular benefit were missing, the reported amount of benefit was used instead. Finally, SRMOD allows the evaluation of short-term effects of a reform by calculating the disposable income before and after a reform, which can be used to estimate the changes in child poverty.

4.2. Labour supply model

Labour supply behaviours were estimated using a structural labour supply model with discrete labour choice and linking it to SRMOD (Van Soest, 1995; Aaberge et al., 1999). It was necessary to use a structural model instead of a reduced form since the policies we wished to analyse had not been implemented. We then had to use a Random Utility Maximisation (RUM) model that allows for *ex ante* analysis. A RUM labour supply model is based on the assumption that a person/couple can choose among a finite number of working hours, depending on his, her, or their income-leisure preferences. Discretising working hours into categories allowed us to overcome nonlinearities in the budget constraint. It also allowed us more flexibility in the stochastic structure (random parameters and correlation among them). Aaberge and Colombino (2015) discuss in more detail the

[10] EUROMOD is the tax and benefit micro-simulation model for the European Union (Randjelovic & Zarković-Rakić, 2013). Being developed on the EUROMOD platform, SRMOD is to very large extent comparable to EUROMOD, in terms of data sources (SILC), the simulated policies (income taxes, social contributions and the main benefits), user interface and the output data format

advantages of the RUM model as well as its possible competitors. Bargain et al. (2013) also show how labour supply elasticities varied across European countries using RUM models. By adopting such an approach, we hypothesized that the reform options proposed in this study would not generate full general equilibrium effects.

Following standard practice, the sample for the labour supply model was constructed after excluding persons under 18 and over 64 years of age, students, pensioners, persons with disabilities and women on maternity leave from the data due to the fact that their labour supply was not flexible. Additionally, we excluded agricultural workers and unpaid family members[11]. The final sample for the labour supply model estimation included 8,639 individuals (4,016 single people and 4,622 people living in couples).

We split the sample and defined separate models for singles[12] and couples. For singles, we assumed that the person could choose not to work or to work from 10 to 60 hours (with 10 hour-intervals[13]) in the formal sector, or to work from 10 to 60 hours in the informal sector[14],[15]. According to the empirical distribution of hours worked for couples, we decreased their number of hour alternatives to 0, 20, 40 and 50 hours[16] (so allowing for just 4 hour alternatives rather than 7 as for singles), where positive hours worked could be either in the informal or formal sector. For simplicity, only the model for couples is presented here (documentation about the model for singles is available on request). The

[11] This is also a standard practice in the labour supply modelling given that it is reasonable to assume that for employees and the self-employed (outside of agriculture), sector and working hours decisions were the channels through which they responded to tax and benefit reforms, while for agricultural workers and unpaid family members, hours of work were not the important margin of response. Therefore, their labour supply behaviour may indeed be rather different from other workers and would have required a different modelling strategy. Agricultural workers represented 10% of the population. However, although they were dropped from the labour supply estimations, they were included in the poverty analysis.

[12] We label this group as "singles", although it includes all the cases where there is only one person within the family belonging to the sample for the estimation of the labour supply model. Besides single people, it also includes married individuals whose partners were excluded from the sample (agricultural workers, disabled individuals, pensioners, etc.). Rather than excluding them, we considered their partner's income as exogenous and estimated their labour supply response with singles, with marital status included as a variable in the preferences estimation.

[13] Observed working hours were grouped to working hours alternatives according to the following rule: (0,5) = 0; [5,14) = 10; [15,24) = 20; [25,34) = 30; [35,44) = 40; [45, 54) = 50; [55, -) = 60.

[14] Therefore, a person chose between 13 alternatives: nonparticipation and 12 working options: 6 hours options (from 10 to 60 hours, with 10 hour-intervals) times two sector options (informal and formal work).

[15] Informal employment was mostly involuntary, correlated with wage disadvantages, poverty and social exclusion (Krstić & Sanfey, 2011).

[16] Observed working hours were grouped to working hours alternatives according to the following rule: (0,5) = 0; [5,34) = 20; [35,44) = 40; [45, -) = 50.

model for singles is a simplified version of the model for couples where there is only one adult who chooses their hours of work (leisure).

More formally, a couple maximizes the (trans-log) utility function with the following form (*m* and *f* are the subscripts for male and female variables and coefficients, while *i* stands for a couple):

$$U_{ji} = a_{i1}DI_{ijk}\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) + \beta_1 DI_{ijk}^2\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) + a_{i2f}L_{jf} + \beta_{2f}L_{jf}^2 + a_{i2m}L_{jm} + \beta_{2m}L_{jm}^2 + \beta_{3f}DI_{ijk}\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) * L_{jf} + \beta_{3m}DI_{ijk}\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) * L_{jm} + a_{3f}I\left(NP_f\right) + a_{3m}I(NP_m) + a_{i4f}I\left(Inf_f\right) + a_{i4m}I(Inf_m),$$

$$i = 1, 2, \ldots n.\ j = 0, 20, 40, 50;\ k = NP, Inf, For$$

under a budget constraint:

$$DI_{ijk}\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) \leq w_{ikf} * H_{jf} + w_{ikm} * H_{jm} + Y_i + B\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) - T\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right) \quad (1)$$

and a time constraint:

$$L_{jk} \leq 80 - H_{jk}, \qquad k = f, m.$$

where $DI_{ijk}\left(w_{ikf} * H_{jf}, w_{ikm} * H_{jm}, Y_i, X_i\right)$ represents household disposable income, calculated in SRMOD for each person, as the sum of female ($w_{ikf} * H_{jf}$,) and male wages ($w_{ikm} * H_{jm}$) and non-labour income Y_i, (pensions, remittances, etc.) and social transfers $B\left(w_{ik} * H_j, Y_i\right)$, minus taxes and contributions $T\left(w_{ik} * H_j, Y_i\right)$. X_i are socio-economic variables that affect social transfers (size of the household, age of children, education status, etc.). Social transfers as monetary social assistance and child allowance are alternative specific since their receipt and the amount, depend on wages and other household income. L_j *i*s the leisure variable defined as the difference between 80 hours and number of working hours chosen, while *I(NP)* and *I(Inf)* are the indicator variables indicating sector choice (non-participation and work in informal sector respectively)[17].

[17] The third sector choice variable for formal employment was omitted to avoid perfect multicolinearity. Therefore, the coefficients for indicator variables should be interpreted in comparison to formal employment sector.

We used both level and second order preference parameters for income (a_{i1f}, a_{i1m}, β_{1f}, β_{1m}) and leisure (a_{i2f}, a_{i2m}, B_{2f}, B_{2m}). Parameters a_{3f} and a_{3m} represent the reverse of fixed working costs. Additionally, due to the high unemployment rate, this parameter also accounts for the labour demand restrictions on the labour market. Finally, parameters a_{i4f} and a_{i4m} represent the marginal utility of informal employment. As some previous research has shown, in Serbia, ceteris paribus, informal work is less preferred than formal (Randjelovic et al., 2016)[18]. We put subscript *i* next to the coefficients for income, leisure and informal employment, as they were treated as random parameters in the estimation procedure. Other parameters were treated as fixed.

Observed heterogeneity in preference was also taken into account by introducing some interaction terms of the main variables (income, leisure, informal and non-participation) with the observed family characteristics (e.g. presence of children below 6 years, age, etc; See Table A6 and A7 for a complete list of interaction terms). The theoretical framework for couples is a unitary one, that is, we did not consider intra-household bargaining between spouses.

For each family (single or couple) *i* and each alternative *j* we added a random disturbance v_{ji}, to correct for the imperfect prediction of the choice of the utility function. Therefore, the total utility for each family was:

$$V_{ji} = U_{ji}\big(DI_{ij}, L_j, I(Inf), I(NP)\big) + v_{ji}$$

where for each family and alternative random terms v_{ji} are type I extreme value distribution with IID, and independent from the utility function.

Family *i* chooses the alternative for which the total utility V_{ji} function is the largest. The probability of each alternative to be selected is:

$$P\big(V_{ij} \geq V_{il}, for\ all\ l\big) = \frac{\exp(U\left(DI_{ij}, L_j, I(Inf), I(NP)\right))}{\sum_{l=1}^{m} \exp(U\left(DI_{ij}, L_j, I(Inf), I(NP)\right))}.$$

Where *m* is the number of alternatives available (13 for singles, 49 for couples).

[18] Informal income in the model was assumed to be a perfect substitute to regular income, that is, in the model we did not account for informal employment being risky. This is because in Serbia there are no regular inspections, so the probability of being caught and fined is low. The indicator variable for the work in the informal economy to a certain extent takes into account costs of working in the informal economy.

Estimation procedure

Given that informal and formal hourly wages for non-participants, as well as formal wages for informal workers, and informal wages for formal workers, were not observed, we followed Bourguignon et al. (2007) to predict wages[19]. Following Löffler et al. (2014), we also introduced the stochastic component in the wage prediction. The stochastic component was estimated by drawing randomly from a normal distribution with the observed variance. We then used the predicted wages, and multiplied them by hours of work in each sector, and SRMOD to calculate the disposable income for each family and each alternative.

Following Train (2009), the mixed logit model was used to estimate the parameters of the utility function for both singles and couples, since it did not require the Independence of Irrelevant Alternatives (IIA) assumption. We used *mixlogit* procedure in Stata[20] to estimate the coefficients. We assumed log-normal distribution of unobserved heterogeneity for income (a_{i1}) and leisure (a_{i2}) coefficients, and a normal distribution for the informal sector (a_{i4}) coefficient. The variance matrix of random coefficients (Ω) for income, leisure and the informal sector (a_{i1}, a_{i2f}, a_{i4f} and etc.) was estimated using 100 Halton draws. Correlations across all random terms were allowed (ρ_{21}, ρ_{41}, ρ_{42}, …). For couples, the variance matrix (Ω^c) was wider since there are two individuals:

$$\Omega^c = \begin{pmatrix} \sigma^2_{a_1} & & & & \\ \rho_{2f1} & \sigma^2_{a_{2f}} & & & \\ \rho_{4f1} & \rho_{4f2} & \sigma^2_{a_4} & & \\ \rho_{2m1} & \rho_{2m2f} & \rho_{2m4f} & \sigma^2_{a_{2m}} & \\ \rho_{4m1} & \rho_{4m2f} & \rho_{4m4f} & \rho_{4m2m} & \sigma^2_{a_{4m}} \end{pmatrix}$$

The correlation matrix for singles was the first three lines of the correlation matrix for couples.

Unobserved heterogeneity in preferences was then considered using maximum simulated likelihood (MSL) for couples following this equation:

[19] To do that, we used the Stata command *selmlog* (developed by Gurgand & Fournier, 2007).
[20] The mixlogit Stata command was developed by Hole (2007).

$$\tilde{P}(V_{ij} \geq V_{il}, for\ all\ l)$$
$$= \frac{1}{100}\sum_{r=1}^{100} \frac{\exp\left\{U\left(DI_{ij}, L_j, I(Inf), I(NP) \middle| \varepsilon_{a_1}^r, \varepsilon_{a_{2f}}^r, \varepsilon_{a_{4f}}^r, \varepsilon_{a_{2m}}^r, \varepsilon_{a_{4m}}^r\right)\right\}}{\sum_{l=1}^{m} \exp\left\{U\left(DI_{ij}, L_j, I(Inf), I(NP) \middle| \varepsilon_{a_1}^r, \varepsilon_{a_{2f}}^r, \varepsilon_{a_{4f}}^r, \varepsilon_{a_{2m}}^r, \varepsilon_{a_{4m}}^r\right)\right\}},$$

where $\varepsilon_{a_1}^r, \varepsilon_{a_{2f}}^r, \varepsilon_{a_{4f}}^r, \varepsilon_{a_{2m}}^r, \varepsilon_{a_{4m}}^r$ are the r[th] draws of the random components from the unobserved heterogeneity distribution of $a_{i1}, a_{i2\mathrm{f}}, a_{i4f}, a_{i2\mathrm{m}}$, and a_{i4m}.

Based on the utility parameters, we estimated the deterministic part of the utility function for each of the choices under the pre-reform and post-reform. Following Bourguignon et al. (2001), the stochastic part of the utility function (v_{ij}) was simulated after the estimation of the structural parameters using 200 Halton draws, in order to correct the imperfect prediction of the choice. We then calculated the total utility as the sum of the deterministic and stochastic parts.

For each draw and for each family, we computed the dummy variable which took the value 1 to mark the alternative with the highest total utility, and value 0 otherwise. We then calculated the probability of choosing each alternative as the average of the dummy variables representing the choice with the highest utility.

We estimated labour supply effects of the reform by comparing the predicted probabilities of the alternatives under the pre-reform (current tax-benefit system), and post-reform conditions.

Furthermore, to estimate the labour supply effects on the household disposable income and poverty, we calculated the expected income for each family for pre-reform and post-reform conditions. The expected income was calculated as the product of the probability of the alternative and the disposable income for that alternative. The expected income for pre-reform and post-reform conditions was then used to calculate the changes in the poverty indicators as a consequence of the reform.

V.Reform scenarios

5.1. Child Allowance

Analysis of SILC data suggests that 41.5% of all child allowance recipient households had income from informal employment. The same data further suggest that for 12,500 households (or 8% of the total number of recipient households), informal income only was high enough to push them beyond the eligibility threshold. In essence, what mainly distinguished benefit recipients in the first and higher income quintiles was the possession of income from informal employment.[21] This is due to the fact that in our baseline scenario we assumed that the households did not declare any informal income when they were means-tested for the child allowance[22]. For instance, administrative workers in the capital, Belgrade, estimates that around 10% of child benefit recipients work in the informal economy and would not be eligible for the benefit if their income from unregistered activity were to be included in the means test. [23]

In our reform scenario, on the other hand, we imposed more stringent eligibility criteria by imputing information on income from informal employment in the means test for child allowance[24]. Obviously, this kind of income is not easily observable and, in the case of monetary social assistance, it was estimated by frequent home visits to verify information reported by benefit applicants, in order to evaluate their true social situations.

[21]According to the latest Labour Force Survey data, the informal employment rate in Serbia stands at a very high 23.4% while the shadow economy is estimated at 30.1% of GDP (Krstic & Schneider (eds.), 2015). The definition of informal employment includes: employed and self-employed workers with no social contributions paid; (2) people employed in a private unregistered firm; and (3) unpaid family members. Also, we believe that informal income is well captured in the SILC, since the non-response rate for informal income is relatively low (7.7%). We assumed that underreporting of informal incomes was not significantly higher as compared to formal incomes, given that the probability of detection of informal workers and the probability of being penalized if detected is very low in Serbia, according to the enterprise survey data (*ibid.*).

[22] Namely, the current Law on financial support for families with children stipulates that income from unregistered activity is to be included in the means test. However, it is not estimated and imputed in the means test by the municipality administrative workers, but depends on the willingness of the benefit claimant to report his or her true income.

[23] http://www.novosti.rs/vesti/beograd.74.html:401760-Sve-vise-zahteva-za-decji-dodatak

[24] In practice, social workers would estimate income from informal activity and impute it in the income test. How such an imputation would be made goes beyond the scope of this paper, but we believe that this could be done as it is under social monetary assistance, which has proven to be quite successful in terms of the correct declaration of incomes from informal employment.

Social workers also used external data bases to check standards of living of benefit applicants. In a first reform scenario, we assumed that the full income from informal employment was declared and then considered for the means test. In a second, and probably more plausible, reform only 70% of informal income was included in the means test.

In the next step, following proposals suggested by Matkovic, Stanic and Mijatovic (2012, p.62), we introduced other changes to the child allowance design. They were mainly motivated by the need to change some old fashioned elements of benefit design. First, we replaced the eligibility threshold based on the mean family monthly income, per family member, with the mean family monthly income per adult equivalent[25]. This was done to take into account economies of scale present in each household[26].

The introduction of a new OECD scale would reduce the number of eligible households given that their equivalent income would be higher than for households of equal size, but with more adults. Thus, as a third proposal, to roughly maintain the current number of households, the income threshold in the reform scenario was increased from the current 20% to 30% of the average wage per adult equivalent.

Finally, in the last step, we increased the benefit amount in order to spend all the money that was being saved after the inclusion of the informal income in the means test, that is, to reach the current level of spending on the child allowance programme. However, one should bear in mind that trying to capture informal income is costly Grosh et al. (2008, p. 94) report that targeting costs for similar programs in the neighbouring countries of Albania, Bulgaria and Romania amount to an average 6% of total program costs. Therefore, using the same share, in each reform scenario we added the amount of targeting costs to the total expenditures.

[25] The equivalence scale factor comes from the OECD: 1 for the first adult in the family, 0.7 for the subsequent adult and 0.3 for children up to 18 years of age.
[26] The beneficiary of the child allowance is the family (a part of the household).

5.2. Monetary social assistance

As mentioned earlier, the maximum amount of the benefit for a two-parent family with two children was around 16,000 RSD, which is at the level of 82% of the minimum wage. Once any person from a household finds a job, the benefit is withdrawn for the entire amount of earned income. However, a 100% withdrawal rate makes formal jobs an unattractive option.

In order to increase the working incentives for parents, in our reform scenario, we reduced the social assistance withdrawal rate with the intention of increasing the difference between incomes in and out of formal work. For a two-parent family with two children, in the case of a 50% withdrawal rate, when a person from the household finds full time job at the minimum wage level, the disposable income increased by 6,275 RSD (32% of the net minimum wage)[27]. Furthermore, there was a greater difference between disposable income when working part time and full time[28]. We also simulated the labour supply effects when the withdrawal rate was reduced to 0.25, making the disposable income higher by 11,138 RSD (57% of the net minimum wage)[29].

VI. Discussion of results

6.1. Labour supply model

The estimated coefficients used to predict wages, are presented in Tables A4 and A5 in the Appendices. The coefficients have the expected signs: for both men and women, informal and formal wages rose with years of education and working experience, and were higher if a person lived in urban areas, and in the Belgrade region (capital). Furthermore, the wages in both sectors were affected by the sector selection biases (see Table A5).

[27] This is equal to the amount of benefit available after the reform. Calculated as a difference between the full amount of the benefit for this family type (16,000 RSD) and 50% of the minimum net wage (50%*19,450).
[28] Summary of all proposed changes to the benefits' design are given in the Table A1 in Appendix 1.
[29] This is equal to the amount of the benefit available after the reform. Calculated as a difference between the full amount of the benefit for this family type (16,000 RSD) and 50% of the minimum net wage (25%*19,450).

The parameter estimates for the utility function are presented in Tables A6 and A7 in the Appendix 1. The results for both singles and couples suggest a positive and decreasing marginal utility of income[30] and leisure, a large positive marginal utility of non-participation (indicating high fixed costs of working and labour demand restrictions), and a negative marginal utility of informal employment (indicating that formal employment was, ceteris paribus, preferable to informal). The preferences show observed heterogeneity, as they depend on age, gender, and the number of children in the household.

Additionally, estimated unobserved heterogeneity was significant for informal employment for singles and men in couples, as well as for the income for couples. Furthermore, the coefficients for informal employment were correlated with both leisure and income coefficients for singles. For couples, coefficients for income were correlated with both male and female leisure coefficients, while male and female informal employment coefficients were correlated with female leisure coefficients.

Starting from the estimated utility functions, we calculated the predicted probabilities of all alternatives and conditional[31], and unconditional[32] formal employment elasticities (Table 2).

Table 2: Employment elasticities (%)

	Conditional formal employment elasticity		Unconditional formal employment elasticity	
	Singles	**Couples**	**Singles**	**Couples**
Total	0.063	0.242	0.166	0.932
Male	0.063	0.203	0.182	1.052
Female	0.062	0.285	0.154	0.836

[30] In order to assess whether income in the utility function was a normal good we performed a quasi-concavity test, which indicated that the income was a normal good for 98,8% of singles and 100% of the couples. More details on the normality testing are available in Appendix 2.

[31] Conditional formal employment elasticity represents the increase of the probability of formal employment, conditional on being employed in any of the sectors (either formal or informal), if the wages in formal sector increase by 1%.

[32] Unconditional formal employment elasticity represents the increase of the probability of formal employment, compared to all other choices (informal employment or non-participation), if the wages in formal sector increase by 1%.

Both elasticities were positive for both singles and couples, meaning that wage increases in formal employment would trigger a transfer to formal employment from both non-participation, and informal employment.

Conditional formal employment elasticity was higher for women in couples than for men, implying that married women were more prone than men to switch from the informal to the formal economy when the wages rise in the formal sector. On the other hand, unconditional employment elasticity was lower for single women and those in couples, suggesting that due to wage rises in the formal sector, the probability of switching from non-participation or informal employment to formal sector employment was lower for women.

Bargain et al. (2013) provide a comprehensive cross-country (17 European countries and the US) comparison of labour supply elasticities. They found large variation in labour supply elasticities across the countries, the higher elasticities being reported in countries with lower labour market participation (e.g. Italy). Estimated labour supply elasticities in Serbia were higher than the average elasticities captured in other European countries, at the same time being closer to the results for southern Europe. This is in accordance with the mentioned stylized fact that labour supply is more sensitive to changes in wages when participation rates are low, and in Serbia they are among the lowest in Europe.

6.2. Reform of the child allowance

Informal income, being part of disposable income, makes households better off, and pushes them into higher income quintiles. However, if an administrative worker does not try to estimate and impute informal income in the means test, some of these not-so-poor households become eligible for child allowance benefit. Henceforth, in the first change to the current child allowance benefit system we assumed that income from informal activity was imputed in the means test.

In Table 3, the baseline system refers to the simulated child allowance in the SRMOD according to current law provisions[33]. In the first reform scenario, R1, we assumed that the entire income from the informal economy could be estimated and included it in the means test for child allowance. This reduced the number of eligible households to 175,000 and the government would save RSD 305 million; that is, 0.1% of GDP (compared to the baseline, Table 3). If we adopt the assumption that only 70% of the informal income can be estimated, the government would save around 219 million dinars; that is, 0.07% of GDP.

Table 3: Child benefit reform scenarios

	Number of HHs receiving CA	Average amount of CA	Total CA expenditure (in million RSD)	Total CA expenditure (in % of GDP)
Baseline	256,278	4,229	1,083	0.36
R1: 100% of informal income included in the means test	175,379	4,441	778	0.26
R2: Introducing new OECD scale	181,839	4,526	823	0.28
R3: Increased benefit amounts	181,839	5,895	1,071	0.36
R1: 70% of informal income included in the means test	197,478	4,379	864	0.29
R2: Introducing new OECD scale	201,770	4,504	908	0.30
R3: Increased benefit amounts	201,770	5,312	1,071	0.36

Note: R2 scenario includes changes already introduced in R1 scenario, while R3 scenario includes the changes from both in R1 and R2 scenarios. All amounts are in monthly terms.

In the R2 scenario, we imputed informal income and we replaced the eligibility threshold based on income per family member with the income per adult equivalent, and we increased the income threshold from 20 to 30% of the average wage per adult equivalent.

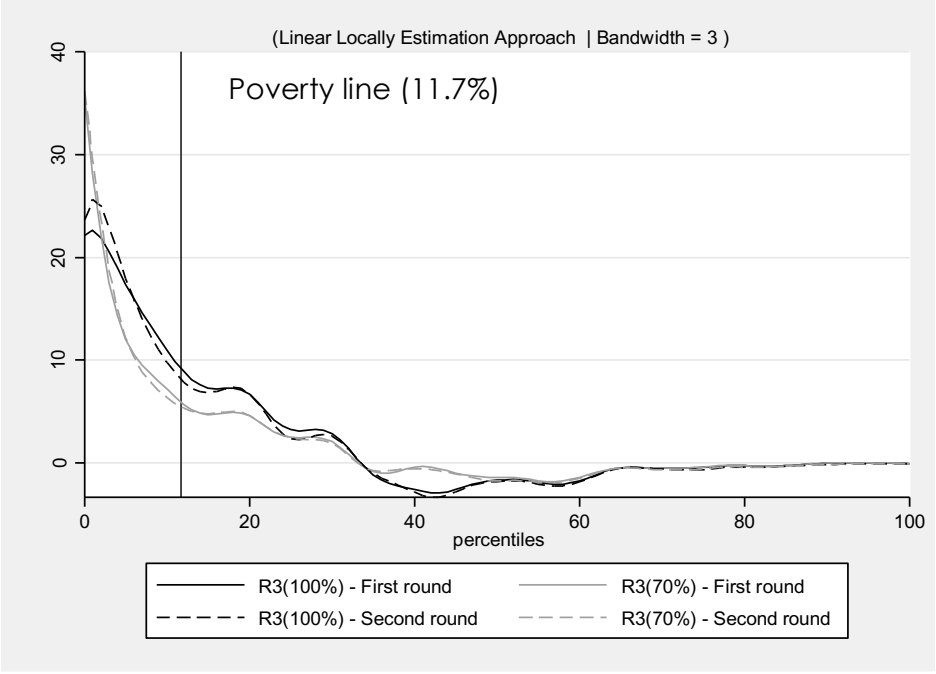
Finally, in the last step, in the R3 scenario, we increased the benefit amount in order to spend all the money that was being saved after the inclusion of the informal income in the means test; that is, to reach the level of spending on child allowance programme in place at the time of this study. This amounted to a 30% and 18% increase for 100% and

[33] The number of recipient households, according to our simulations, is 20% higher when compared to the administrative data showing that the average number of beneficiary household per month was 203,294 in 2012. The higher number of households according to simulations can be explained by the fact that there were poor households that qualified for the benefit but simply did not claim it.

70% of the informal income included in the means test, respectively. R3 scenarios were then budget neutral reforms. As a consequence of the reforms, the poverty rate was reduced by 1.8 pp, from 11.7% to 9.9% (to 10.3% in the case of 70% of the informal income being included in the means test). The poverty gap was reduced from 4.8% to 4.0% (to 4.3% when 70% of the informal income was included in the means test). The results were fairly robust to changes in the poverty line (see Figure A1 in Appendix 1). However, at the level of the official at-risk-of-poverty rate (60% median equivalent income, i.e. twice as high as the one reported in Table 4) the poverty rate was only reduced by 0.7 pp (see Table A12 in Appendix 1).

Figure 1 reports the growth incidence curves and shows changes in the household disposable income per adult equivalent that occur after reform R3 along the overall distribution of children. The largest reform effects were in the first income percentiles where income grew more than 10%. The positive, albeit smaller, income growth was present until the 35th percentile. Between the 35th and 65th percentile, disposable income decreased slightly as a consequence of the reform because households with large informal income were no longer eligible for the benefit.

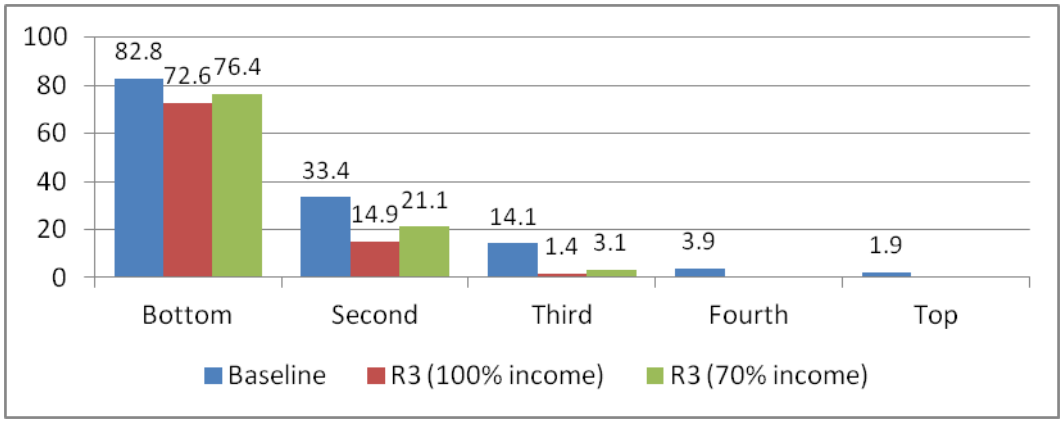
Figure 1: Changes in the disposable income per adult equivalent per percentiles



Note: The sample used to construct the graph includes children only. Percentiles are calculated using the baseline household disposable income per adult equivalent for each child.

In Figure 2 we notice that, due to the introduction of the R1-R3 reforms, coverage was reduced across all income quintiles, with the reduction being larger for higher income quintiles. This is primarily driven by the inclusion of informal income in the means test. After the reforms, there were no more recipients in 4th and top income quintiles, there were negligible numbers in the 3rd quintile, while the number of households with children belonging to the second income quintile was reduced by 18.5 pp (12.3 pp when 70% of the informal income was included in the means test). Given more stringent eligibility criteria, the number of eligible households from the 1st quintile was also reduced, by 10.2 pp (6.4 pp when 70% of the informal income was included in the means test). Overall, the coverage performance improved in terms of less leakage of resources to not-so poor households[34].

Figure 2: Coverage across quintiles



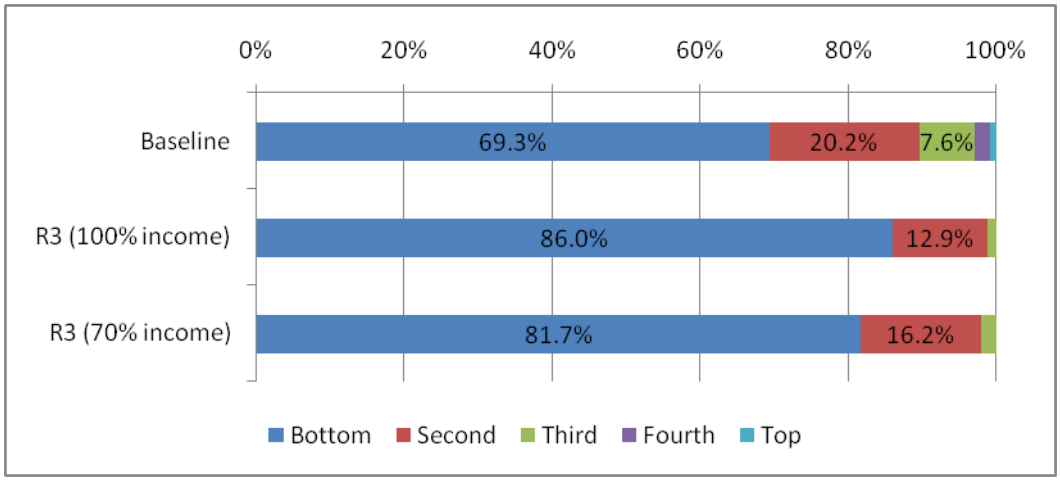
Note: Baseline refers to simulated values of child allowance. R3 scenario includes changes already introduced in R1 and R2 scenarios. The percentages represent the share of households which receive CA over the total number of the households with children in each quintile.

At the same time, reforms improved the targeting given that expenditures on child allowance going to the first quintile of the income distribution increased by 16.7 pp. Following the assumption that 70% of informal income was included in the means test, expenditures on child allowance going to the first quintile increased by 12.4 pp (see Figure

[34] It should be noted that the receipt of the benefit depends on the household size.

3). In the reform scenarios, there were less public resources devoted to individuals in the second and higher income quintiles.

Figure 3: Targeting across quintiles



Note: Baseline refers to simulated values of child allowance. R3 scenario includes changes already introduced in R1 and R2 scenario.

The previous analysis is mainly concerned with the day after effects of the child allowance reform, which are mostly of distributional nature. However, the proposed reform could, in the long run, also have labour supply effects. These effects were estimated using the abovementioned labour supply model.

For both singles and couples, results (Tables A8 and A9 in Appendix 1) show that non-participation and part time working arrangements became more attractive after the child allowance reforms, whereas in the formal and informal sectors, the probability of full time and overtime work was reduced. This is due to the fact that, when not working or working part-time, a person earns zero or a lower wage, respectively, and is more likely to be eligible for the child allowance (i.e. passes the means test) than in the case of full-time, or over-time work. After the reform, due to the higher child benefit amount, the disposable income for non-participation, or part time working option increased, while it remained unchanged for the full-time, or over-time options. For singles, the likelihood of non-participation would increase by 0.26%, and by 0.21%, when total informal income and 70% of the informal income was estimated and imputed in the means test, respectively. This is driven by a reduced probability of full-time, or over-time employment in the formal sector, while the part-time working options were more probable than before the reform. There was also a reduction in the probability of working in the informal sector by 0.2%, and

0.08%, when total informal income and 70% of the informal income was estimated and imputed in the means. Results for couples followed almost the same pattern of changes in the labour market statuses, although at smaller magnitudes.

Based on the changes in the probabilities of the choices, we calculated the changes in the expected income as second round reform effects. Reduction of formal employment and increase of parents' inactivity increased the child poverty rate from 9.9% to 10.1% when 100% income was imputed in the means test (and from 10.3% to 10.4% when 70% of informal income was included, see Table 4). This shows that, in the long term, a more generous benefit would not have large negative effects on labour market activity, and poverty. The same was true in the case of a higher poverty line at 60% of the median equivalent income. As shown in Figure 1, the first and second round curves overlapped for most of the percentiles, except for few cases just above and below the poverty line, where the inclusion of the changes in the labour supply by parents slightly reduced the direct positive effects of the reform.

Table 4: Child poverty rates and gaps: baseline and reform scenarios

		Poverty rate	Number of poor children	Poverty gap
Baseline		11.7%	166,053	4.8%
R3: 100% of informal income	First round effects	9.9%	141,016	4.0%
	Second round effects	10.1%	142,799	4.1%
R3: 70% of informal income	First round effects	10.3%	146,023	4.3%
	Second round effects	10.4%	147,128	4.3%

6.3. Results of monetary social assistance reform

Reducing the withdrawal rate for the monetary social assistance benefit to 50% increased the number of eligible households by 30%, and budgetary expenses by 12% (R4 scenario). If benefit recipients were allowed to retain a higher portion of their employment income, that is, if the benefit withdrawal rate were further reduced to 25%, then the number of eligible household increased more than twofold, as well as expenditures (R5 scenario, Table 5).

Table 5: Monetary social assistance reform scenarios

	Number of HHs receiving MSA	Average amount of MSA	Total MSA expenditure (in million RSD)
Baseline	107,578	6,993	752
R4: withdrawal rate 50%	131,781	6,443	849
R5: withdrawal rate 25%	233,659	5,737	1,340

Poverty rates were reduced to 11.5% and 11.4% in the case of the first and second scenario, respectively (Table 6). The changes were statistically significant, although this result was not fully robust to changes of the poverty line (Figure A2 in Appendix 1). From Figure 4, we can see that the biggest changes in incomes due to the reform were from the 15th to 40th percentile of the income distribution. Children living in the poorest households were not affected by the first round effect since they were already receiving MSA, or were not eligible for MSA under the new rules, as they were living in jobless households. The effects were slightly higher at the 60% of the median equivalent income poverty rate, as poverty was reduced by 0.6%.

Table 6: Child poverty rates and gaps: baseline and reform scenarios

		Poverty rate	Number of poor children	Poverty gap
Baseline		11.7%	166,053	4.8%
R4: withdrawal rate 50%	First round effects	11.5%	163,729	4.8%
	Second round effects	11.4%	162,032	4.8%
R5: withdrawal rate 25%	First round effects	11.4%	161,145	4.8%
	Second round effects	10.9%	155,065	4.6%

Note: Poverty line is set on 30% of the median simulated disposable income before all social cash transfers.

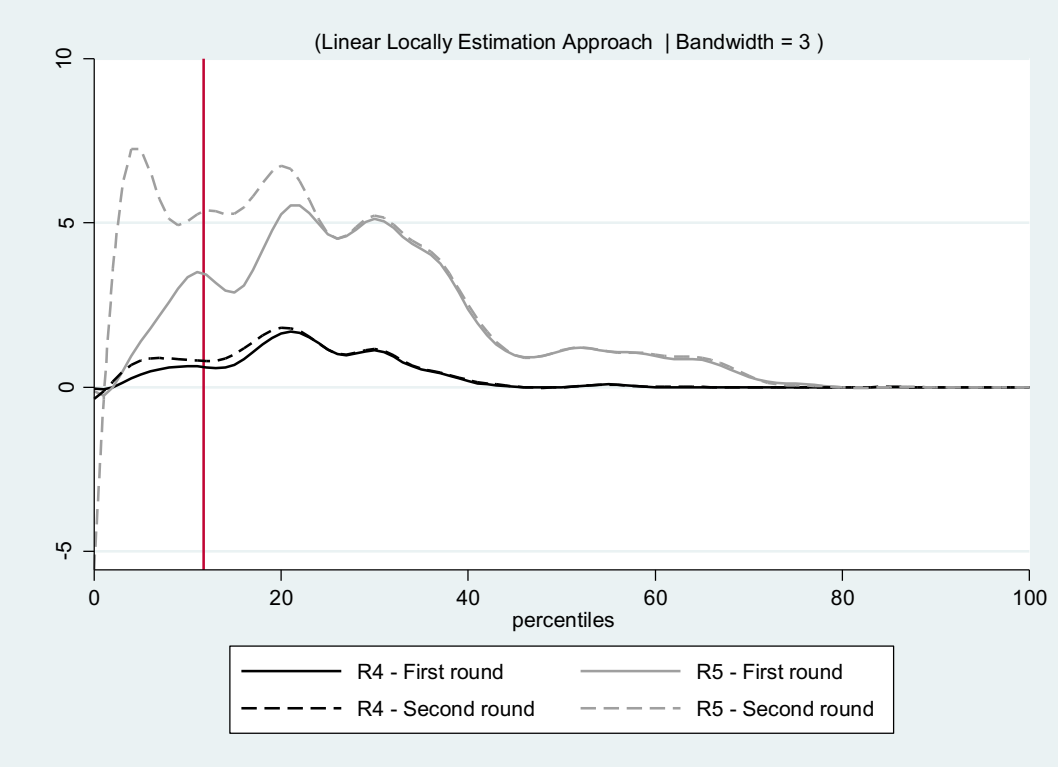
The labour supply model was used to estimate the effects of the reduction of monetary social assistance withdrawal rate. Labour supply effects of the reform were estimated by comparing the predicted probabilities of the alternatives under the pre-reform (current tax-benefit system), and post-reform conditions. Results, given in Tables A10 and A11 in the Appendix 1, show that for singles, the likelihood of non-participation would drop by 0.06%, and 0.2% in the case when the withdrawal rate was reduced to 0.5

and to 0.25, respectively. The drop in the non-participation was due to an increase in formal employment, which became a more attractive alternative after the reform. Results for couples followed a similar pattern, with the likelihood of non-participation dropping by 0.05%, and 0.44% in the case when the withdrawal rate was reduced to 0.5 and to 0.25, respectively.

Taking into account the changes in the expected income, we calculated the second round effects of the reform on the poverty indicators. As a consequence of the increase in formal employment and decrease of the inactivity of the parents, the child poverty rate further decreased to 11.4% in case of R4, and 10.9% in the case of the R5 scenario. The poverty gap followed the same pattern (Table 6).

Furthermore, as presented in Figure 4, the increase of the expected income was most prominent among the families with children from the poorest households, and in the case of a withdrawal rate of 25%. Thus, reducing the withdrawal rate to 25% would create some substantial incentives to move to formal employment for the poorest 20th. Such a mechanism, through a multiplier effect, further reduces child poverty.

Figure 4: Changes in the disposable income per adult equivalent per percentiles



Since the proposed reforms concerning the MSA were not budget neutral, in order to make the overall reforms comparable in terms of the budgetary costs, we calculated how much each of the reforms would contribute to the cut in the poverty rate per million of Serbian dinars (see Table 7). The most cost-effective reform option was the child allowance where 100% of informal income was included in the means-test, followed by the case where 70% of informal income was added. Given significant increase in the budgetary costs when the withdrawal rate of monetary social assistance was reduced to 0.25%, its potential for poverty reduction was the lowest one per million of dinars spent.

Table 7: Marginal poverty impact:
Poverty rate and gap decrease by one million RSD

	Increase of the total expenditure (in million RSD)	Poverty rate decrease (in percentage points)	Poverty rate decrease by one million RSD (in percentage points)	Poverty gap decrease (in percentage points)	Poverty gap decrease by one million RSD (in percentage points)
CA reform (R3 100%)	53	1.4	0.0264	0.6	0.0113
CA reform (R3 70%)	53	1.3	0.0245	0.6	0.0110
MSA reform 1 (R4)	97	0.3	0.0031	0.1	0.0010
MSA reform 2 (R5)	588	0.8	0.0014	0.2	0.0003

Notes: the poverty rates with second-order effects have been in the estimations above.

VII. Conclusions and policy implications

A year ago the Government of Serbia introduced a new fiscal consolidation program which relies on cuts in public wages and pensions. Lay-offs in the public sector have also been announced. These measures are expected to trigger further increases in the poverty rates. In many European Union countries, children and their families have been disproportionately affected by the economic and financial crisis, and by austerity measures developed in response to it (Marlier & Frazer, 2014). Therefore, increased efficiency of social policy in protecting the most vulnerable groups in the coming period is seen as a prerequisite for the sustainability of economic reforms, and social stability of the country. This paper aimed to investigate how much child poverty could be reduced by fighting fiscal

evasion and improving the performance of current cash transfers, and/or by introducing policies aimed at increasing parental employment.

We propose a budget neutral reform of the existing child allowance programme. Its impacts on child poverty and parental labour supply were evaluated through a marginal and behavioural framework. Results of our reform scenarios show that both coverage and targeting of child allowance could be improved after the inclusion of the income from unregistered activity in the means test. There would be less leakage of resources to households that are better off, and the number of poor targeted by the benefit would increase. If budgetary resources, saved in this way, were to be spent on higher benefit amounts, the simulated reduction of child poverty rate ranges from 1.2 to 2 percentage points, depending on the ability of the administration to estimate the size of an income from the informal economy.

Apart from these day after effects, a child allowance reform could have an impact on the labour supply of parents, and via this channel, it could also have an impact on child poverty as well. Our results show that for both singles and couples, part time working arrangements would become more attractive after our proposed reform, whereas the probability of full time and overtime work would be reduced, in both the formal and informal sector, due to higher non-labour income. Given that these negative behavioural effects are small, their adverse effect on poverty is also limited.

By trying to increase parental employment, the next reform scenario includes the reduction of the withdrawal rate for monetary social assistance benefit. Currently, the benefit is designed in such a way that once a recipient has any formal income on his/her record, the benefit is almost completely withdrawn. Our results show that allowing benefit recipients to work and keep a larger share of the benefit increases the probability of participation in the formal sector for single parents. For parents in couples there are somewhat larger participation effects (0.44% with a benefit withdrawal rate of 25%). Thus, part time working options become more attractive. In the short term, this reform option reduces child poverty rates by 0.2 and 0.3 percentage points, when the benefit withdrawal rate is reduced to 50% and 25%, respectively. As our results suggest that reducing the withdrawal rate to 25% would create substantial incentives to move to formal employment for the poorest 20th percentile, this could serve as a multiplier effect by further reducing

child poverty in the long term. We should bear in mind, however, that this comes with a rise in this programme's costs by 12% for the 50%, and by 78% for the 25% benefit withdrawal rate.

All in all, the most cost-effective reform (in terms of poverty reduction for each million of RSD spent) proposed in this study is the child allowance in which the full informal income is included in the means-test; the least effective reform is monetary social assistance with a 25% benefit withdrawal rate. We can therefore conclude that the benefit strategy (through the reform of the child allowance program) proposed in this study should be preferred over an employment strategy (through the change in the monetary social assistance policy) which acts on work incentives for parents. To make the latter more effective, interventions that cut the high fixed costs for working, and reduce labour demand restrictions would probably help.

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Appendix 1

Table A1: Proposed changes to benefit design

Current system (baseline scenario)	Proposed reforms
Child allowance	
-income from informal employment not included in the means test	-100% (70%) of income from informal employment included in the means test
- eligibility threshold determined as the ratio of family monthly income and number of family members	-eligibility threshold determined as the ratio of family monthly income and equivalence scale factor obtained from the OECD scale
-income threshold amounts to 20% of the average wage	-income threshold amounts to 30% of the average wage
	-30% (18%) increase of the benefit amount when 100%(70%) of informal income is included in the means test
Monetary social assistance	
-benefit amount is defined as the difference between the amount of benefit household is entitled to and average monthly income of the household during the last three months	-benefit amount is defined as the difference between the amount of benefit household is entitled to and 50% (25%) of the average monthly income of the household during the last three months

Table A2: Descriptive statistics: main variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Years of education	8,639	11.34	2.97	0	20
Working experience	8,639	13.96	11.55	0	45
Settlement (urban==1)	8,639	0.63	0.48	0	1
Age	8,639	41.16	11.82	18	64
Marital status (married==1)	8,639	0.60	0.49	0	1
Number of own children	8,639	0.70	0.92	0	3
Dependancy ratio	8,639	1.47	0.52	1	5
Household status (head==1)	8,639	0.34	0.47	0	1
Regional unemployment rate	8,639	22.36	5.26	13.54	29.85

Table A3: Descriptive statistics: labour market statuses for singles and couples

Singles status	female	%	male	%	total	%
Non-participants	1,021	53.40	834	39.64	1,855	46.19
Informal workers	134	7.01	335	15.92	469	11.68
Formal workers	757	39.59	935	44.44	1692	42.13

Couples status	female	%	male	%	total	%
Non-participants	1,006	43.55	539	23.33	1,545	33.4416
Informal workers	132	5.71	299	12.94	431	9.329
Formal workers	1172	50.74	1472	63.72	2644	57.2294

Table A4: Selmlog procedure, first stage, selection equation

	Informal employment		Formal employment		Informal employment		Formal employment	
VARIABLES	Males		Males		Females		Females	
Secondary (1-3 years, vocational)	0.043	(0.131)	0.719***	(0.114)	0.142	(0.197)	1.082***	(0.125)
Secondary (4 years)	-0.010	(0.133)	1.154***	(0.111)	0.274	(0.169)	1.662***	(0.108)
Post-secondary (1-3 yrs)	-0.681**	(0.304)	1.483***	(0.172)	0.467	(0.288)	2.311***	(0.159)
Tertiary	-0.238	(0.234)	1.995***	(0.153)	0.110	(0.262)	2.655***	(0.134)
Age	0.228***	(0.032)	0.284***	(0.024)	0.247***	(0.046)	0.338***	(0.027)
Age squared	-0.003***	(0.000)	-0.004***	(0.000)	-0.003***	(0.001)	-0.004***	(0.000)
Marital status (2 categories)	-0.026	(0.130)	0.815***	(0.102)	-0.141	(0.167)	0.279***	(0.095)
Preschool children	0.032	(0.138)	0.062	(0.108)	-0.389**	(0.180)	-0.334***	(0.095)
Number of own children	0.147*	(0.087)	0.125*	(0.067)	-0.158	(0.113)	-0.126**	(0.060)
Dependency ratio	-0.036	(0.126)	-0.289***	(0.095)	-0.152	(0.180)	0.077	(0.092)
Household head	0.308**	(0.127)	0.340***	(0.094)	0.432**	(0.193)	0.382***	(0.112)
Regional/urban unemp. rate (%)	-0.041***	(0.009)	-0.044***	(0.007)	-0.005	(0.013)	-0.004	(0.007)
Pensions (adult eq, 000)	-0.040***	(0.009)	-0.005	(0.004)	-0.021**	(0.010)	-0.006	(0.005)
Constant	-3.891***	(0.633)	-4.725***	(0.483)	-5.598***	(0.903)	-7.918***	(0.538)
Observations	4,500				4,339			
Log-likelihood	-3901				-3336			
Pseudo R square	0.11				0.13			

Note: Baseline category is non-participants.
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A5: Selmlog procedure, second stage, wage equation

	Males informal		Females informal		Males formal		Females formal	
VARIABLES	coef	se	coef	se	coef	se	coef	se
Years of highest education	0.040*	(0.020)	0.134***	(0.030)	0.048***	(0.011)	0.045***	(0.012)
Secondary (1-3 years)	-0.072	(0.067)	0.134	(0.106)	-0.051*	(0.027)	-0.096***	(0.031)
Post-Secondary (1-3 years)	-0.180	(0.220)	-0.150	(0.190)	0.118***	(0.045)	0.095**	(0.039)
Tertiary	-0.102	(0.186)	0.071	(0.205)	0.269***	(0.052)	0.329***	(0.053)
Working experience	0.009	(0.011)	0.030**	(0.013)	0.012***	(0.004)	0.009**	(0.004)
Working exp. squared	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)	-0.000	(0.000)
urban	0.185***	(0.067)	-0.016	(0.086)	0.049**	(0.022)	0.074***	(0.020)
Vojvodina	-0.268***	(0.098)	-0.299***	(0.113)	-0.070**	(0.028)	-0.077***	(0.024)
West Serbia	-0.026	(0.097)	-0.160	(0.117)	-0.092***	(0.028)	-0.112***	(0.024)
South-East Serbia	-0.199**	(0.099)	-0.341***	(0.129)	-0.106***	(0.029)	-0.132***	(0.026)
Selection effects								
Non-participation	1.389	(0.900)	2.995**	(1.203)	0.793**	(0.309)	0.277	(0.271)
Informal employment	0.055	(0.248)	-0.154	(0.240)	0.309	(0.289)	0.129	(0.304)
Formal employment	0.753	(1.032)	2.877***	(1.038)	0.361*	(0.192)	-0.001	(0.119)
Constant	5.083***	(0.667)	6.238***	(1.036)	4.607***	(0.175)	4.484***	(0.214)
Sigma2	1.098		3.555		0.436		0.165	
rho1	1.326		1.588		1.202		0.680	
rho2	0.053		-0.082		0.469		0.318	
rho3	0.718		1.526		0.547		-0.003	
Observations	596		258		2388		1927	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Labour supply model, mixlogit estimation for singles

VARIABLES	Coefficient	Standard error
Leisure (ln) [1] [2]	49.675***	(6.727)
*** Female**	5.858**	(2.280)
*** Has preschool children**	-9.847***	(2.872)
*** Age**	0.084	(0.170)
Leisure (ln) squared	-7.243***	(0.935)
*** Female**	-0.680**	(0.293)
*** Has preschool children * Female**	1.505***	(0.381)
*** Age**	-0.008	(0.024)
Income (ln)[1] [2]	0.210**	(0.095)
*** Has preschool children**	0.205	(0.286)
*** Married**	0.008	(0.025)
Income (ln) Squared	0.012	(0.016)
*** Has preschool children**	0.873***	(0.170)
*** Married**	0.002	(0.005)
Non-participation	12.901***	(0.720)
*** Age**	-0.326***	(0.026)
*** Age squared**	0.004***	(0.000)
Informal employment[1]	-1.548***	(0.454)
Standard deviations		
Income (ln)	0.087	(0.135)
Leisure (ln)	0.002	(0.004)
Informal employment	1.270*	(0.671)
Covariation matrix		
	Leisure (ln)	Informal
Income (ln)	0.007	0.012**
	(0.007)	(0.005)
Leisure (ln)		0.222
		(0.158)
Observations	52,208	
ll	-6530	

[1] Mean of the random coefficient.
[2] Coefficients are computed as non-linear point estimates at mean, as they are assumed to have lognormal distribution
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7: Labour supply model, mixlogit estimation for couples

VARIABLES	Coefficient	SE
Leisure (ln) women [1]	119.543***	(12.727)
*** Age**	0.542**	(0.251)
*** Has preschool children**	0.331	(0.530)
Leisure (ln) squared - women	-15.070***	(1.595)
*** Age**	-0.068**	(0.032)
Leisure (ln) men [1]	143.503***	(14.822)
*** Age**	-0.124	(0.215)
*** Has preschool children**	0.385	(0.416)
*** Leisure (ln) women**	-0.940	(0.633)
Leisure (ln) squared men	-18.739***	(1.898)
*** Age**	0.028	(0.028)
Income (ln) [1]	11.401***	(1.386)
*** Leisure - women**	-0.055***	(0.007)
*** Leisure - men**	-0.065***	(0.011)

Income (ln) Squared	0.345**	(0.173)
Non-participation - women	10.436***	(0.506)
*** Has preschool children**	0.476	(0.392)
Non-participation - men	10.669***	(0.640)
*** Has preschool children**	-0.286	(0.337)
Informal employment - women[1]	-5.791**	(2.377)
*** Part time**	3.604***	(0.408)
Informal employment - men[1]	-5.941***	(1.784)
*** Part time**	4.757***	(0.461)

Standard deviations		
Income (ln)	2.225***	(0.392)
Leisure (ln) - women	-0.416*	(0.249)
Leisure (ln) - men	-0.994**	(0.493)
Informal employment - women	3.562**	(1.771)
Informal employment - men	5.194***	(1.824)

Covariation matrix

	Informal men	Income (ln)	Leisure (ln) women	Leisure (ln) men
Informal employment women	1.413*	-1.569**	-2.770***	-1.093
	(0.814)	(0.678)	(0.676)	(1.032)
Informal employment men		-1.056***	0.342	-3.545***
		(0.300)	(0.437)	(0.642)
Income (ln)			1.859***	3.469***
			(0.421)	(0.931)
Leisure (ln) women				0.066
				(0.373)

Observations	113,190
LI	-5900

Notes:[1] Mean of the random coefficient.
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Labour supply effects of the CA reform for singles

	Predicted probability of the choices			Increase of the probability compared to baseline (%)	
	Baseline	100% informal income	70% informal income	100% informal income	70% informal income
Non-participants	**44.97%**	**45.08%**	**45.06%**	**0.26%**	**0.21%**
Informal (10h)	0.62%	0.63%	0.63%	0.03%	0.01%
Informal (20h)	1.49%	1.49%	1.49%	0.05%	0.01%
Informal (30h)	0.98%	0.98%	0.99%	-0.48%	0.05%
Informal (40h)	4.17%	4.15%	4.16%	-0.28%	-0.17%
Informal (50h)	2.79%	2.79%	2.79%	0.02%	-0.02%
Informal (60h)	1.86%	1.86%	1.86%	-0.49%	-0.14%
Total informal employment	**11.92%**	**11.90%**	**11.91%**	**-0.20%**	**-0.08%**
Formal (10h)	0.20%	0.20%	0.20%	0.70%	0.63%
Formal (20h)	0.46%	0.46%	0.46%	0.97%	0.88%
Formal (30h)	0.79%	0.80%	0.79%	1.16%	0.95%
Formal (40h)	28.77%	28.71%	28.72%	-0.21%	-0.19%
Formal (50h)	9.65%	9.62%	9.62%	-0.40%	-0.38%
Formal (60h)	3.24%	3.23%	3.24%	-0.28%	-0.25%
Total formal employment	**43.11%**	**43.02%**	**43.03%**	**-0.21%**	**-0.20%**

Table A9: Labour supply effects CA reform for couples

	Predicted probability of the choices			Increase of the probability compared to baseline (%)	
	Baseline	100% informal income	70% informal income	100% informal income	70% informal income
Non-participants	**32.58%**	**32.60%**	**32.59%**	**0.07%**	**0.04%**
Informal (20h)	1.81%	1.81%	1.81%	0.15%	0.08%
Informal (40h)	3.40%	3.40%	3.40%	-0.01%	-0.02%
Informal (50h)	4.23%	4.22%	4.23%	-0.04%	-0.01%
Total informal employment	**9.43%**	**9.43%**	**9.43%**	**0.01%**	**0.00%**
Formal (20h)	1.04%	1.04%	1.04%	-0.06%	-0.06%
Formal (40h)	38.81%	38.81%	38.82%	0.00%	0.02%
Formal (50h)	18.13%	18.11%	18.11%	-0.13%	-0.10%
Total formal employment	**57.98%**	**57.96%**	**57.97%**	**-0.04%**	**-0.02%**

Table A10: Labour supply effects of the MSA reform for singles

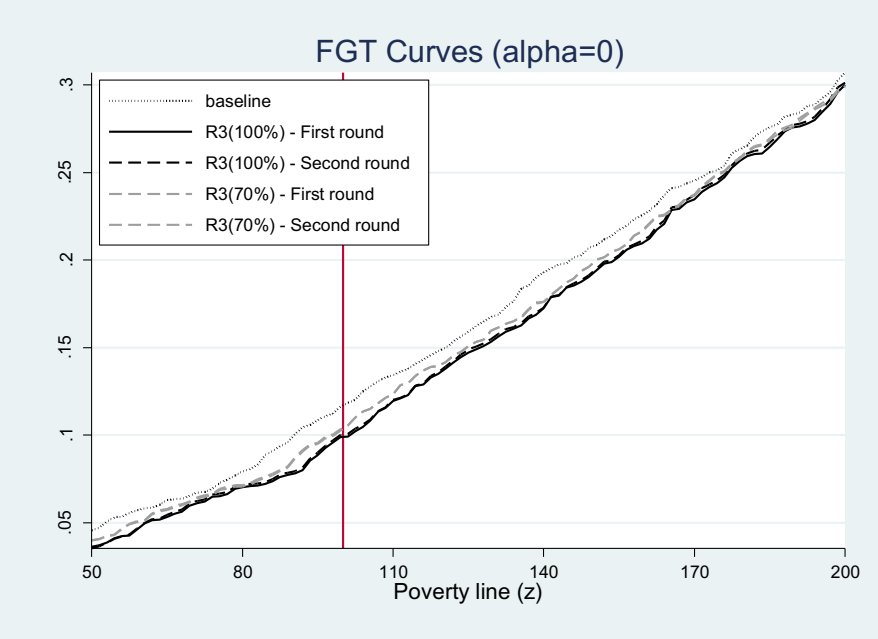
	Predicted probability of the choices			Increase of the probability compared to baseline (%)	
	Baseline	Benefit withdrawal rate 0.5	Benefit withdrawal rate 0.25	Benefit withdrawal rate 0.5	Benefit withdrawal rate 0.25
Non-participants	**44.97%**	**44.94%**	**44.88%**	**-0.06%**	**-0.20%**
Informal (10h)	0.62%	0.62%	0.62%	0.00%	0.00%
Informal (20h)	1.49%	1.49%	1.49%	0.00%	-0.01%
Informal (30h)	0.98%	0.98%	0.98%	0.00%	-0.10%
Informal (40h)	4.17%	4.17%	4.16%	0.00%	-0.01%
Informal (50h)	2.79%	2.79%	2.79%	0.00%	-0.01%
Informal (60h)	1.86%	1.86%	1.86%	0.00%	-0.04%
Total informal employment	**11.92%**	**11.92%**	**11.92%**	**0.00%**	**-0.02%**
Formal (10h)	0.20%	0.20%	0.21%	0.87%	1.31%
Formal (20h)	0.46%	0.46%	0.47%	1.12%	2.87%
Formal (30h)	0.79%	0.79%	0.82%	1.06%	3.93%
Formal (40h)	28.77%	28.78%	28.80%	0.03%	0.12%
Formal (50h)	9.65%	9.66%	9.67%	0.04%	0.13%
Formal (60h)	3.24%	3.24%	3.24%	0.01%	-0.07%
Total formal employment	**43.11%**	**43.14%**	**43.20%**	**0.06%**	**0.21%**

Table A11: Labour supply effects MSA reform, couples

	Predicted probability of the choices			Increase of the probability compared to baseline (%)	
	Baseline	Benefit withdrawal rate 0.5	Benefit withdrawal rate 0.25	Benefit withdrawal rate 0.5	Benefit withdrawal rate 0.25
Non-participants	**32.6%**	**32.6%**	**32.4%**	**-0.05%**	**-0.44%**
Informal (20h)	1.8%	1.8%	1.8%	0.00%	0.00%
Informal (40h)	3.4%	3.4%	3.4%	0.00%	0.00%
Informal (50h)	4.2%	4.2%	4.2%	0.00%	0.00%

Total informal employment	**9.4%**	**9.4%**	**9.4%**	**0.00%**	**0.00%**
Formal (20h)	1.0%	1.1%	1.1%	0.89%	2.63%
Formal (40h)	38.8%	38.8%	38.9%	0.03%	0.31%
Formal (50h)	18.1%	18.1%	18.1%	-0.04%	-0.02%
Total formal employment	**58.0%**	**58.0%**	**58.1%**	**0.03%**	**0.25%**

Figure A1 Poverty rate robustness check - Child allowance



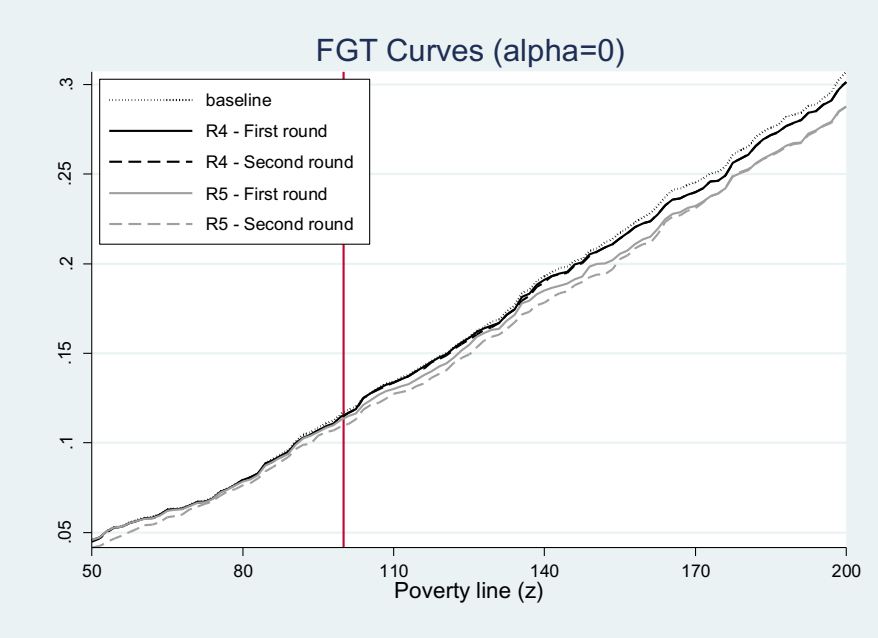
Notes: For both reforms (with first and second round effects), poverty reduction was statistically significant at the poverty rate level (30% of the median disposable income), as well as on the EU-SILC poverty rate level (200% of the poverty line in this paper, i.e. 60% of the median disposable income), although the effects were lower. Except in a few cases, the results were broadly robust along a large range of poverty lines. For R3(100%)-First and second round, poverty reduction was not significant at the level of 198% of the poverty line; for R3(70%)-First round, between 192 and 198% of the poverty line; and for R3(70%)-Second round, between 174 and 180%, and between 192 and 198% of the poverty line. Full results of the robustness testing are available upon request.

Table A12: Child poverty rates and gaps: baseline and reform scenarios

		Poverty rate	Number of poor children	Poverty gap
Baseline		30.7%	435,937	12.9%
R3: 100% of informal income	First round effects	30.0%	426,023	11.8%
	Second round effects	30.0%	425,079	12.1%
R3: 70% of informal income	First round effects	30.1%	427,417	11.9%
	Second round effects	29.9%	424,598	12.1%

Note: Poverty line is set at 60% of the median simulated disposable income per adult equivalent.

Figure A2 Poverty rate robustness check - Monetary social assistance



Notes: For both reforms (both first and second round effects), poverty reduction was statistically significant at the poverty rate level (30% of the median disposable income), as well as on the EU-SILC poverty rate level (200% of the poverty line in this paper, i.e. 60% of the median disposable income). However, the results were not fully robust to the changes of the poverty line. For R4-First round, the poverty reduction was not significant for the levels below 90% and between 104 and 126% of the poverty line; for R5-First round, below 84% of the poverty line; for R4-Second round below 82% and between 104 and 118% of the poverty line. Full results of the robustness testing are available upon request.

Table A13: Child poverty rates and gaps: baseline and reform scenarios

		Poverty rate	Number of poor children	Poverty gap
Baseline		30.7%	435,937	12.9%
R4: withdrawal rate 50%	First round effects	30.1%	427,858	12.7%
	Second round effects	30.1%	427,508	12.7%
R5: withdrawal rate 25%	First round effects	28.8%	408,297	12.3%
	Second round effects	28.8%	408,297	12.1%

Note: Poverty line is set at 60% of the median simulated disposable income per adult equivalent.

Appendix 2

Theorem

The utility function $U(x_1, x_2, \dots, x_n)$ of a structural model is quasi-concave if it is on the nonnegative orthant (Chiang, 1984). The necessary condition to be on the nonnegative orthant is that:

$$|B_1| \leq 0, \quad |B_2| \geq 0, \dots \quad |B_n| \leq 0 \ \text{ if } n \text{ is odd}$$

$$|B_1| \leq 0, \quad |B_2| \geq 0, \dots \quad |B_n| \geq 0 \ \text{ if } n \text{ is even},$$

where $|B|$ is the bordered determinant:

$$|B_1| = \begin{vmatrix} 0 & U_1 \\ U_1 & U_{11} \end{vmatrix} \qquad |B_2| = \begin{vmatrix} 0 & U_1 & U_2 \\ U_1 & U_{11} & U_{12} \\ U_2 & U_{21} & U_{22} \end{vmatrix} \quad \dots \quad |B_n| = |B|$$

And

$$U_i = \frac{\partial U(x_1, x_2, \dots, x_n)}{\partial x_i}$$

$$U_{ij} = \frac{\partial U_i}{\partial x_j}$$

with $i, j \in \{1,2, \dots, n\}$.

A sufficient condition is that

$$|B_1| < 0, \quad |B_2| > 0, \dots \quad |B_n| < 0 \ \ if \ n \text{ is odd}$$

$$|B_1| < 0, \quad |B_2| > 0, \dots \quad |B_n| > 0 \ \ if \ n \text{ is even}.$$

Quasi-concavity test for singles

Assuming a utility function of the structural model with the following form:

$$U(y, l) = \beta_y \log(y) + \beta_{y2} \log(y)^2 + \beta_l \log(l) + \beta_{l2} \log(l)^2 + \beta_{yl} \log(y) \log(l),$$

with

$$\beta_j = \sum_{p=1} \gamma_p X_p + \varepsilon_j, \qquad j \in \{y, l\},$$

and

$$\beta_k = \sum_{p=1} \gamma_p X_p, \qquad k \in \{l2\},$$

and where X_p is a set of socio-demographic variables and ε_j a random preference term. Then, its first derivatives are :

$$U_y = \frac{\beta_y + 2\beta_{y2}\log(y) + \beta_{yl}\log(l)}{y}$$

$$U_l = \frac{\beta_l + 2\beta_{l2}\log(l) + \beta_{yl}\log(y)}{l}$$

Its second derivatives are :

$$U_{yy} = \frac{1}{y^2}\left(2\beta_{y2}[1 - \log(y)] - \beta_{yl}\log(l) - \beta_y\right)$$

$$U_{ll} = \frac{1}{l^2}\left(2\beta_{l2}[1 - \log(l)] - \beta_{yl}\log(y) - \beta_l\right)$$

$$U_{yl} = U_{ly} = \frac{\beta_{yl}}{yl}$$

Now we must test if $U(y, l)$ is on the nonnegative orthant by calculating $|B_1|$ and $|B_2|$:

$$|B_1| = \begin{vmatrix} 0 & U_y \\ U_y & U_{yy} \end{vmatrix} = -U_y^2 < 0,$$

$$|B_2| = \begin{vmatrix} 0 & U_y & U_l \\ U_y & U_{yy} & U_{yl} \\ U_l & U_{ly} & U_{ll} \end{vmatrix} = 2U_y U_l U_{yl} - U_l^2 U_{yy} - U_y^2 U_{ll} > 0.$$

It is easy to see that $|B_1| < 0$ is always respected but $|B_2| > 0$ still need to be tested.

Quasi-concavity test for couples

Assuming a utility function of the structural model with the following form:

$$U(y, l_f, l_h) = \beta_y \log(y) + \beta_{y2}\log(y)^2 + \beta_{l_f}\log(l_f) + \beta_{l_f 2}\log(l_f)^2 + \beta_{l_h}\log(l_h) + \beta_{l_h 2}\log(l_h)^2 + \beta_{l_f l_h}\log(l_f)\log(l_h) + \beta_{y l_f}\log(y)\log(l_f) + \beta_{y l_h}\log(y)\log(l_h),$$

with

$$\beta_j = \sum_{p=1} \gamma_p X_p + \varepsilon_j, \qquad j \in \{y, l_f, l_h\},$$

and

$$\beta_k = \sum_{p=1} \gamma_p X_p, \qquad k \in \{l_f 2, l_h 2\},$$

and where X_p is a set of socio-demographic variables and ε_j a random preference term. Then its first derivatives are:

$$U_y = \frac{\beta_y + 2\beta_{y2}\log(y) + \beta_{yl_f}\log(l_f) + \beta_{yl_h}\log(l_h)}{y}$$

$$U_{l_f} = \frac{\beta_{l_f} + 2\beta_{l_f 2}\log(l_f) + \beta_{yl_f}\log(y) + \beta_{l_f l_h}\log(l_h)}{l_f}$$

$$U_{l_h} = \frac{\beta_{l_h} + 2\beta_{l_h 2}\log(l_h) + \beta_{yl_h}\log(y) + \beta_{l_f l_h}\log(l_f)}{l_h}$$

Its second derivatives are:

$$U_{yy} = \frac{1}{y^2}\left(2\beta_{y2}[1 - \log(y)] - \beta_{yl_f}\log(l_f) - \beta_{yl_h}\log(l_h) - \beta_y\right)$$

$$U_{l_f l_f} = \frac{1}{l_f^2}\left(2\beta_{l_f 2}\left[1 - \log(l_f)\right] - \beta_{yl_f}\log(y) - \beta_{l_f l_h}\log(l_h) - \beta_{l_f}\right)$$

$$U_{l_h l_h} = \frac{1}{l_h^2}\left(2\beta_{l_h 2}[1 - \log(l_h)] - \beta_{yl_h}\log(y) - \beta_{l_f l_h}\log(l_f) - \beta_{l_h}\right)$$

$$U_{yl_f} = U_{l_f y} = \frac{\beta_{yl_f}}{yl_f}$$

$$U_{yl_h} = U_{l_h y} = \frac{\beta_{yl_h}}{yl_h}$$

$$U_{l_f l_h} = U_{l_h l_f} = \frac{\beta_{l_f l_h}}{l_f l_h}$$

Now we must test if $U(y, l_f, l_h)$ is on the nonnegative orthant by calculating $|B_1|$ and $|B_2|$ and $|B_3|$:

$$|B_1| = \begin{vmatrix} 0 & U_y \\ U_y & U_{yy} \end{vmatrix} = -U_y^2 < 0,$$

$$|B_2| = \begin{vmatrix} 0 & U_y & U_{l_f} \\ U_y & U_{yy} & U_{yl_f} \\ U_{l_f} & U_{l_f y} & U_{l_f l_f} \end{vmatrix} = 2U_y U_{l_f} U_{yl_f} - U_{l_f}^2 U_{yy} - U_y^2 U_{l_f l_f} > 0.$$

$$|B_3| = \begin{vmatrix} 0 & U_y & U_{l_f} & U_{l_h} \\ U_y & U_{yy} & U_{yl_f} & U_{yl_h} \\ U_{l_f} & U_{l_f y} & U_{l_f l_f} & U_{l_f l_h} \\ U_{l_h} & U_{l_h y} & U_{l_h l_f} & U_{l_h l_h} \end{vmatrix}$$

$$= -U_y\left[\left(U_y U_{l_f l_f} U_{l_h l_h} + U_{l_h y} U_{l_f} U_{l_f l_h} + U_{l_f y} U_{l_h l_f} U_{l_h}\right) - \left(U_{l_h y} U_{l_f l_f} U_{l_h} + U_y U_{l_h l_f} U_{l_f l_h} + U_{l_f y} U_{l_f} U_{l_h l_h}\right)\right]$$
$$+U_{l_f}\left[\left(U_y U_{y l_f} U_{l_h l_h} + U_{yy} U_{l_h l_f} U_{l_h} + U_{l_h y} U_{l_f} U_{y l_h}\right) - \left(U_{l_h y} U_{y l_f} U_{l_h} + U_y U_{l_h l_f} U_{y l_h} + U_{yy} U_{l_f} U_{l_h l_h}\right)\right]$$
$$-U_{l_h}\left[\left(U_y U_{y l_f} U_{l_f l_h} + U_{yy} U_{l_f l_f} U_{l_h} + U_{l_f y} U_{l_f} U_{y l_h}\right) - \left(U_{l_f y} U_{y l_f} U_{l_h} + U_y U_{l_f l_f} U_{y l_h} + U_{yy} U_{l_f} U_{l_f l_h}\right)\right]$$

$$|B_3| < 0$$

It is easy to see that $|B_1| < 0$ is always respected but $|B_2| > 0$ and $|B_3| < 0$ still need to be tested.

Estimation

Since $U(y, l)$ and $U(y, l_f, l_h)$ contains random preferences, $|B_n|$ depends on ε_y and ε_l for singles and on ε_y, and ε_{l_f}, and ε_{l_h} for couples. $|B_n|$ must then be integrated according to these random preferences.

$$|B_n| = \int \int \left|B_n|\varepsilon_y, \varepsilon_l\right| f(\varepsilon_y) f(\varepsilon_l)\, dy\, dl$$

for singles and

$$|B_n| = \int \int \int \left|B_n|\varepsilon_y, \varepsilon_{l_f}, \varepsilon_{l_h}\right| f(\varepsilon_y) f(\varepsilon_{l_f}) f(\varepsilon_{l_h})\ dy\, dl_f\, dl_h,$$

for couples. $|B_n|$ can be integrated using numerical simulations:

$$\left|\tilde{B}_n\right| = \frac{1}{R}\sum_{r=1}^{R} \left|B_n|\varepsilon_y^r, \varepsilon_l^r\right|$$

for singles and

$$\left|\tilde{B}_n\right| = \frac{1}{R}\sum_{r=1}^{R} \left|B_n|\varepsilon_y^r, \varepsilon_{l_f}^r, \varepsilon_{l_h}^r\right|,$$

for couples.