Combining micro- and macroeconomic approach to simulate labour tax wedge cut in Italy[1]

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Abstract

The overall tax burden on labour is high in Italy as compared to the EU average. A high marginal labour tax inevitably causes disincentives to work, especially among the lower paid whose labour market participation choices are typically highly responsive to marginal tax rates. In 2014/2015 Italy undertook measures to lower its tax wedge on labour, a key element of which was the introduction of a refundable in-work tax credit of EUR 80 per month for low-income earners.

In this paper we study the effects of the abovementioned reform, combining the advantages of the microsimulation model with these of an overlapping generations (OLG) model. This allows us to take advantage of both the detailed, disaggregated information at the micro level and the behavioural responses of economic agents at the macro level, providing a broader analysis of the reform than either of the two methodologies in isolation.

The simulation can be split into three components: (i) the static microsimulation effects, (ii) the microsimulation effects with the labour supply response, and (iii) the dynamic macroeconomic consequences. The static microsimulation using the standard EUROMOD version shows the first-round effects by individual worker (in the EU-SILC data), which is aggregated to show the impacts by household categories. First-round effects have been recently analysed in Astarita, Maestri and Schmitz (2016). The second step is to incorporate the labour supply response in the microsimulation model, which provides a partial picture of the impact on employment of the policy. The final stage, using the OLG model, addresses the long-run dynamic macroeconomic consequences, including relaxing the assumption of unchanged GDP (a core contribution of the dynamic scoring approach). Of particular interest to this study is the labour demand response to the policy reform.

The results are split into the three methodological components.

The static microsimulation shows that the policy improves equity outcomes as it is focused on low paid workers. Nevertheless when aggregated to the household level, a fair portion of the benefits go to higher income households where the second income earner is low paid. The tax revenue loss at this stage can be considered an overestimate as the behavioural responses are believed to act to reduce the loss. Using only the macro model we ignore detailed information on individuals'

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responsiveness to the fiscal policy reform. When we simulate lower labour tax using only the OLG model, we in fact run a very different shock than using the OLG model and the microsimulation model. The response of the labour supply and consumption and output is positive in the long run.

On the other hand, when we benefit from using both the microsimulation model and the discrete choice labour supply model and then the OLG model that allows us taking into account of the richness of individuals' distinct characteristics and differences in their responsiveness to the relevant shock, we get negative overall labour supply response.

This surprising result arises from the estimated discrete choice model. This model accounts not only for the choice to enter the labour market (total participation in the labour market increases with the reform), but also the choice of hours worked, which on aggregate falls sufficiently to cause a reduction in total labour supply. The striking differences in simulating a fiscal policy measure using only macroeconomic model and using both micro and macro models clearly points out at the need of integrating the microeconomic characteristics of individuals into the OLG model.

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Keywords: overlapping generation model, fiscal policy reform, combining microsimulation and general equilibrium model

1 Introduction

The overall tax burden on labour is high in Italy as compared to the EU average. A high marginal labour tax inevitably causes disincentives to work, especially among the lower paid whose labour market participation choices are typically highly responsive to marginal tax rates. In 2014/2015 Italy undertook measures to lower its tax wedge on labour, a key element of which was the introduction of a refundable in-work tax credit of EUR 80 per month for low-income earners.

In this paper we study the effects of the abovementioned reform, combining the advantages of the microsimulation model with these of an overlapping generations (OLG) model. This allows us to take advantage of both the detailed, disaggregated information at the micro level and the behavioural responses of economic agents at the macro level, providing a broader analysis of the reform than either of the two methodologies in isolation.

The paper is structured as follows. In section 2 we describe our methodology and models used, in section 3 we discuss the effects of the fiscal policy shock applied and in section 4 we conclude.

2 Methodology

In this paper we benefit from two complementary approaches: a microsimulation and a macroeconomic approach. To study the effects of the policy shock we combine the EUROMOD tax benefit microsimulation model and the macroeconomic overlapping generations model.

Main advantage of the EUROMOD microsimulation model is its very detailed information on taxes and benefits of the individuals. Thus it enables to determine how a specific fiscal policy shock would affect each individual or predefined class of individuals e.g. distinguished by income, labour skills etc. This class of models determine only static responses to the shocks meaning that they cannot provide an adjustment path of an economy following the shock.

Overlapping generations models differ from the microsimulation static models in that they allow the study of both the reform-induced adjustment path and long-run macroeconomic effects of labour supply, saving and investment as well as redistributional effects of reforms across and within generations (Diamond and Zodrow, 2013). Although the EUROMOD model can determine labour supply response to the policy shock, it cannot provide insights about the macroeconomic feedback effects. The OLG model should complement the microsimulation perspective with the macroeconomic perspective by taking into account the intertemporal nature of household reactions to fiscal policy changes and the impact of these reactions onto the rest of the economy.

To study the effects of the abovementioned tax wedge reduction in Italy we first introduce the shock into the microsimulation tax-benefit model (EUROMOD) and then we take the response of the labour supply and introduce it into an OLG model. The simulation can be split into three components: (i) the static microsimulation effects, (ii) the microsimulation effects with the labour supply response, and (iii) the dynamic macroeconomic consequences. We choose not to run the models iteratively, as it is not necessarily advantageous to do so when dealing with a dynamic macro model (due to aggregation consistency, data measurement errors, and so on).[3]. Instead, we apply the bottom-up strategy under which the information from the micro model (labour market parameters, tax rates) are used in the macro model. Then to run the simulation in the OLG model we take the change in the labour supply from the discrete choice labour supply model and use it as an exogenous variable for the OLG model. In addition to that to better illustrate differences between

[3] The challenges of linking micro and *static* macro models are discussed for example in Peichl (2009) and Colombo (2010).

using only a macro model and using both macro and micro model we run a shock of a reduction of an implicit labour tax rate derived from the microsimulation model in the OLG model with endogenous labour supply.

Below we provide the description of the two models: in section 2.1 of the microsimulation model and in section 2.2 of the macroeconomic model.

2.1 EUROMOD model

EUROMOD is the European Union tax-benefit microsimulation model (Sutherland, 2007; Sutherland and Figari, 2013). The model is a static tax and benefit calculator that makes use of representative micro data from the harmonised EU Statistics on Income and Living Conditions survey (EU-SILC) and from national statistics on income and living conditions surveys, to simulate individual tax liabilities and social benefit entitlements according to the rules in place in each Member State. Its main distinguishing feature is that it covers all 28 European countries within the same framework allowing for flexibility of the analysis and comparability of the results. Starting from gross incomes contained in the survey data, EUROMOD simulates most of the direct tax liabilities and non-contributory benefit entitlements. While demographic and labour market characteristics remain the same, uprating factors are used to bring the income values from the survey reference period up to the level of the year in which the tax and benefit system is coded.

As an extension to EUROMOD, we also estimate a structural discrete choice labour supply model as in Bargain, Orsini, and Peichl (2014) using the microsimulation model EUROMOD and EU-SILC household data. Households are assumed to maximize utility and thereby face the standard consumption-leisure trade-off. In contrast to the classical “continuous choice” approach, we estimate a discrete choice model where agents can choose from a limited number of discrete alternatives, i.e. households have the option to work half-time (20 hours), full-time (40 hours), over-time (60 hours), or remain inactive (not participate in the labour market, i.e. supply zero hours). In this way, the choice covers both the extensive and intensive margins. Econometrically, our methodology entails the specification and estimation of consumption-leisure preferences, and the evaluation of utility at each discrete alternative. Utility consists of a deterministic part which is a function of observable variables (household characteristics and characteristics of the hours category), and an error term which can reflect optimization errors of the household, measurement error concerning the explanatory variables, or unobserved preference characteristics. For the moment, the model does not account for labour demand restrictions.

2.2 The Overlapping Generations (OLG) model

The benefits of OLG models trace back to work by Allais (1947), Samuelson (1958) and Diamond (1965), who focused on more stylised models to highlight intergenerational aspects of economic policy.[4] A major step forward in the use of applied, computable OLG models came with the publication of *Dynamic Fiscal Policy* (Auerbach and Kotlikoff, 1987), which made full use of the newly available computing power to solve more complex and detailed models. Most applied OLG models used today still recognise the Auerbach-Kotlikoff model as an important aspect of their heritage, despite the fact that such models have been extended and expanded across many dimensions since then (see Gorry and Hassett, 2013, for an overview of the impact of the Auerbach-Kotlikoff model and Diamod and Zodrow, 2013 for an overview of the tax policy analysis using overlapping

[4] For example, Samuelson (1958) was concerned with the determination of interest rates.

generations models). The practice of combining micro- and macro-models, as is done here, is a core component of the dynamic scoring (for example, see Gravelle, 2014).

2.2.1 OLG model – data and calibration

We use World Input Output Database (WIOD) data accompanied with detailed EUROSTAT data for general government accounts. Consistent with the WIOD 2016 release, the base year in our model is 2014. Since the Socioeconomic Accounts data (SEA) 2016 release were not available at the time the paper has been written, we use KLEMS data for the value added decomposition as well as for calculation of the implied depreciation rate for physical capital in Italy in 2014. For population composition according to age we use United Nations (UN) data (United Nations, 2015). In order not to introduce additional shock for the fiscal policy measure simulation we aim at assuming zero population growth.[5] To do so, we assume that generations aged 20 to 50 are equally populated on the average levels over this age span. It means that we are assuming no changes in population across generations aged 20 to 50 (no migrations, no deaths) and across time (zero population growth). We only assume that generations aged 60 or more die in line with the implied by UN's data mortality rates.

The model is calibrated under the steady-state assumption.

In order to calibrate the parameters describing the consumer behaviour we jointly determine consumption by generation ($Con0_g$), assets by generation ($Ast0_g$), preference parameter for leisure by generation ($Gamma0_g$), interest rate ($rint0$), discount rate ($discr0$), rental price for capital ($Rent0$), and the lump-sum tax-transfer $\left(Lump0\_g_g\right)$ which is needed to provide the balanced government budget.[6] These variables are determined by the similar equations as in the model (see section 2.2.2), the only difference being the lack of time dimension here since it is base year values calibration.

The labour income profiles are calibrated consistently with EUROMOD EU-SILC data for 2014. The consumption profiles are at this stage simulated by the model as described above, but with future model developments they will be calibrated based on the EUROMOD model micro-data.[7]

On the government side we capture 3 types of taxes: consumption tax (mainly VAT tax), labour income tax (mainly PIT) and capital taxes (mainly CIT) as well as social contributions. On the expenditure side we cover government expenditures on goods and services (government consumption), old-age pension expenditures, social benefits other than old-age pensions and social benefits in kind. The revenue side covers ca. 81% of actual general government revenues and ca. 92% of expenditures. In calibration we keep the value of public debt fixed at the 2014 level,[8] meaning that the adjustment variable to ensure the balanced government budget is the abovementioned lump-sum tax-transfer ($Lump0\_g_g$).

Having determined the (steady state) interest rate value in line with consumer behavioural parameters we can calculate implied initial capital stock ($Kstock0$) in the base year as in Rasmussen and Rutherford (2001) and Paltsev (2004), using data on the depreciation rate ($depr0$; 4.4% annually) and on capital compensation in 2014 ($Capcomp0$):

[5] In further model developments we plan to proceed with the dynamic calibration of population projections, i.e. relaxing the steady-state assumption for calibration and use the UN's projections to get in 2014 (the base year) the actual values.

[6] As we are not covering all general government revenues and expenditures, this is not exactly equal to the general government deficit.

[7] Including exogenous consumption profiles into the OLG model requires some changes in the calibration procedure, like for example time-varying endogenous discount rates – see Rasmussen and Rutherford (2001).

[8] To keep the consistency of the flow-stock relations, we divide the public debt value of 2014 by 10, i.e. the number of years equivalent to a single period in the model.

$$Kstock0 = \frac{Capcomp0}{rint0 + \delta 0}$$

Then we calculate the implied investment according to the formula ($gpop0$ is assumed steady-state growth of the economy):

$$Inv0 = (gpop0 + \delta 0) * Kstock0$$

As the so calculated investment value differs from the actual investment value for Italy in 2014 we adjusted the aggregate consumption accordingly to keep the aggregate demand-aggregate supply balance.
In Table A.1 in the Appendix we provide base year values for calibration.

2.2.2 OLG model structure

The OLG model we use for an applied analysis in this paper is the closed economy model for Italy, inspired by Auerbach and Kotlikoff (1987) and Merette and Georges (2010).[9]

In every period seven overlapping generations are alive: g20s, g30s, g40s, g50s, g60s, g70s and g80s. The decision whether to work or not is taken by an individual based on his preference for consumption and leisure. Thus we are modelling individuals by decades, meaning that every single period in the model is equivalent to 10 years. Each individual enters the labour market at the age of 20, then work until the retirement and at the end of age 89 he dies with certainty. We assume that individuals at the age of 70 or more are fully retired, but that they can work up to the age of 69 in line with their preferences. The date of retirement is distinct from the initial age at which benefits are received which we set at 60 (this age might be interpreted as minimum age for retirement in our model).

At the beginning of age 20 an individual chooses his consumption and leisure levels over the life cycle in order to maximize a CES type intertemporal utility function taking into account the lifetime endowments he has at his disposal. Since this is a perfect foresight model and individuals know the future the optimizing decision is made only once, at the beginning of the economic life of an individual.

$$U = \frac{1}{1-\frac{1}{\sigma}} \begin{bmatrix} \left(\left(Con_{t7,g1}\right)^{1-\frac{1}{\rho}} + \gamma_g \left(Lsr_{t7,g1}\right)^{1-\frac{1}{\rho}} \right)^{\frac{\rho}{(\rho-1)(1-\sigma)}} + \\ + \frac{1}{1+\theta} \left(\left(Con_{t8,g2}\right)^{1-\frac{1}{\rho}} + \gamma_g \left(Lsr_{t8,g2}\right)^{1-\frac{1}{\rho}} \right)^{\frac{\rho}{(\rho-1)(1-\sigma)}} + \\ + \frac{1}{(1+\theta)^2} \left(\left(Con_{t9,g3}\right)^{1-\frac{1}{\rho}} + \gamma_g \left(Lsr_{t9,g3}\right)^{1-\frac{1}{\rho}} \right)^{\frac{\rho}{(\rho-1)(1-\sigma)}} + \dots + \\ + \frac{1}{(1+\theta)^6} \left(\left(Con_{t13,g7}\right)^{1-\frac{1}{\rho}} + \gamma_g \left(Lsr_{t13,g7}\right)^{1-\frac{1}{\rho}} \right)^{\frac{\rho}{(\rho-1)(1-\sigma)}} \end{bmatrix}$$

where: U – lifetime utility (time-separable), $Con_{t,g}$ – consumption level by generation at time t, $Lsr_{t,g}$ – leisure level by generation at time t, θ – discount rate, σ – intertemporal elasticity of substitution, ρ – intratemporal elasticity of substitution, γ_g – preference parameter for leisure.

The dynamic budget constraint makes distinction between the labour income, capital income, old-age pensions, other than pensions social benefits and social benefits in kind. In addition, the

[9] Although Merette and Georges (2010) model is multiregional one and our model is a single economy model, the remaining structure is very similar.

consumer (apart from the last generation) is receiving the lump-sum tax-transfer from the government.

$$(1+ctxr_t) * Con_{t,g} + \Delta Ast_{t+1,g+1} = \\ (1-wtxr_t-contr_t) * Wage_t * Lab_t * EP_g * (1-Lsr_{t,g}) + rint * (1-ktxr_t) * Ast_{t,g} \\ +(1-wtxr_t) * Pens_{t,g} + OthSocBen_{t,g} + SocBenKind_{t,g} + Lump\_g_{t,g}$$

where: $ctxr_t$ – consumption tax rate at time t, $Ast_{t,g}$ – assets by generation at time t, $wtxr_t$ – labour income tax rate at time t, $contr_t$ – social contribution rate at time t, $Wage_t$ – wage index at time t (equal to one in the base case), Lab_t – scaling factor at time t (correcting the difference between observed labour compensation and aggregated labour earnings on the basis of the earnings profile), EP_g – earnings profile through the life cycle, $rint$ – real interest rate, $ktxr_t$ – capital tax rate at time t, $Pens_{t,g}$ – old-age pension benefit (average for generation) at time t, $OthSocBen_{t,g}$ – social benefit other than old-age pensions (average for generation) at time t, $SocBenKind_{t,g}$ – social benefit in kind (average for generation) at time t, $Lump\_g_{t,g}$ – lump-sum tax-transfer by generation at time t, Δ – first difference operator; other variables as above.

As a result of the intertemporal utility maximization under the abovementioned household budget constraint the optimal consumption path can be determined (the Euler equation) as follows: [10]

$$\frac{Con_{t+1,g+1}}{Con_{t,g}} = \left[\left(\frac{1+rint_{t+1}(1-ktxr_t)}{1+\theta}\right)\left(\frac{1+ctxr_t}{1+ctxr_{t+1}}\right)\right]^{\sigma}.$$

Labour supply is endogenous, i.e. it depends on consumer's choice upon leisure. Effective labour supply takes into account the individual's age-dependent earning profile which are defined as a cubic function of age.

$$Lsup_t = \sum_g \left(Pop_{t,g} * Lab_t * EP_g * (1-Lsr_{t,g})\right)$$

where: $Lsup_t$ – effective labour supply at time t, $Pop_{t,g}$ – population of generation g at time t; other variables as above.

Leisure to consumption ratio in each period is a result of an intratemporal utility maximization problem subject to a constraint that $0 \leq Lsr_{t,g} \leq 1$. As a result we obtain the functional form for leisure to consumption ratio (which in fact is a labour supply function) being determined by the leisure preference parameter, γ_g, divided by the reservation wage. It is also governed by the intratemporal elasticity of substitution parameter, ρ as follows:

$$\frac{Lsr_{t,g}}{Con_{t,g}} = \left[\left(\frac{\gamma_g}{(1-wtxr_t-contr_t) * Wage_t * Lab_t * EP_g + \mu_{t,g}}\right)\right]^{\rho}.$$

[10] This form of the Euler equation rests on the assumption that the intertemporal elasticity of substitution, σ is equal to the intratemporal elasticity of substitution, ρ. Implied by the assumed leisure preference parameter and elasticity of labour supply with respect to wage taken from the discrete choice labour supply model we obtain $\rho = 1.5$. Since we do not have any strong beliefs that the intertemporal elasticity of substitution, σ should be greater or smaller than intratemporal one, we assume they are both equal. If $\sigma \neq \rho$, then we should multiply the right hand side of the above Euler equation form by $\frac{V_{t+1,g+1}}{V_{t,g}}$, where $V_{t,g} = \left(1+{\gamma_g}^{\rho} * {reservation\_wage_{t,g}}^{1-\rho}\right)^{\frac{\rho-\sigma}{1-\rho}}$.

The reservation wage equals the net marginal wage per unit of leisure foregone augmented with μ, the lagrangian multiplier of an additional constraint that $0 \leq Lsr_{t,g} \leq 1$, which we add into the model's equations as follows:

$$\mu_{t,g} = \mu_{t,g} * Lsr_{t,g}.$$

By definition, this multiplier can only differ from zero if no labour is supplied ($Lsr_{t,g}$= 1). Assuming $Lsr_{t,g}$= 0 the model equations reduce to exogenous labour supply system, i.e. with no labour-leisure choice.

The decision to retire is endogenous in the model, although we assume that individuals can only make this decision with respect to age 60 up to 69, then they are all retired. In our model we make the date of retirement distinct from the initial age at which benefits are received which we set at 60 implying that individuals might combine working with receiving pension benefits. Old-age pension benefits ($Pens_{t,gr}$) are proportional to the lifetime labour earnings of the last working generation (EP_{gwl}) and the fraction coefficient ($bnfr$) is defined by a pension replacement rate that is calculated based on the Italian data for 2014.

$$Pens_{t,gr} = bnfr * Wage_t * Lab_t * EP_{gwl} * (1 - Lsr_{t,gwl})$$

Pension expenditures are covered by the social contributions collected from the labour income of working generations.

$$\sum_{gr} \left(Pop_{t,gr} * Pens_{t,gr}\right) = contr_t * \sum_{g} \left(Pop_{t,g} * Wage_t * Lab_t * EP_g * (1 - Lsr_{t,g})\right)$$

where $Pop_{t,gr}$ is population of retired persons; other variables as above.

On the supply side, firms maximise profits generated from the production of a single good. Government collects revenues from taxes on consumption, labour and capital which are used to finance spending on public consumption and transfer payments to different generations. The production technology is described by a Cobb-Douglas function.

$$Y_t = A_t * Kdem_t^{\propto} * Ldem_t^{(1-\propto)}$$

where Y_t – output at time t, A_t – scaling parameter for production (total factor productivity) at time t, $Kdem_t$ – capital demand by firm at time t, $Ldem_t$ – labour demand by firm at time t and $\propto$ - share of capital in the output.

As a result of the profit maximization problem given the above production technology frontier, formulas for factor demands are as follows:

$$Kdem_t * Rent_t = \propto * Y_t * PY_t$$

$$Ldem_t * Wage_t = (1 - \propto) * Y_t * PY_t$$

where PY_t – producer's price index, other variables as above.

The rental price for capital ($Rent$) is determined as:

$$Rent = Rint - (1 - \delta)$$

where $Rint = 1 + rint$.

The evolution of the capital is determined using the standard law of motion formula:

$$Kstock_{t+1} = Inv_t + (1 - \delta) * Kstock_t$$

where $Kstock_t$ – stock of physical capital at time t, Inv_t – investment at time t; other variables as above.

Government collects revenues from taxes on consumption, labour and capital which are used to finance spending on public consumption, debt servicing and transfer payments to different generations. The government budget might be balanced every period or intertemporally. To close the gap between revenues and expenditures that are captured in the model, the lump-sum tax-transfer variable is introduced. This is described with the following equation:

$$\sum_g \{Pop_{t,g} * [(wtxr_t + contr_t) * Wage_t * Lab_t * EP_g * (1 - Lsr_{t,g}) + ctxr_t * Con_{t,g} + ktxr_t * rint * Ast_{t,g}]\} + \Delta Bond_{t+1} = GovC_t + rint * Bond_t + + \sum_g \{Pop_{t,g} * (Pens_{t,g} + OthSocBnf_{t,g} + SocBnfKind_{t,g} - Lump\_g_{t,g})\}$$

where: $Lump_t$ – lump-sum tax-transfer at time t, $\Delta Bond_{t+1}$ – change in public debt from time *t+1* to time t, $GovC_t$ – government consumption at time t, $Bond_t$ – public debt at time t; other variable as above.

Since OLG model is a general equilibrium model, all markets must clear. On the goods market output must be equal to aggregate demand (domestic and foreign). The identity is as follows:

$$Y_t = \sum_g \{Pop_{t,g} * Con_{t,g}\} + Inv_t + GovC_t + Exp_t - Imp_t$$

where: Exp_t – export at time t (exogenous), Imp_t – import at time s; other variables as above.

On the labour market, total labour supply must be equal to labour demand by firm:

$$Lsup_t = Ldem_t.$$

Similarly, total capital stock must be equal to capital demand by firm:

$$Kstock_t = Kdem_t.$$

Equilibrium on the capital market requires that total assets be equal to physical capital, government bonds and foreign assets:

$$\sum_g \{Pop_{t+1,g+1} * Ast_{t+1,g+1}\} = Kstock_{t+1} + Bond_{t+1} + \frac{(Imp_{t+1} - Exp_{t+1})}{rint_{t+1}}$$

where $\frac{(Imp_{t+1} - Exp_{t+1})}{rint_{t+1}}$ defines foreign assets of Italy.

We assume perfect substitution between physical capital and government bonds meaning that the interest rates for these two types of assets are equal.

3 Simulation results of the labour tax wedge reduction in Italy

In the remaining part of the paper we discuss effects of the introduction of a refundable in-work tax credit of EUR 80 per month for low-income earners in Italy. To better account for a value added of different modelling strategies we split presentation of the results into the following parts: (i) the static microsimulation effects based on the EUROMOD model (ii) the microsimulation effects with the labour supply response, and (iii) the dynamic macroeconomic consequences of a reduction in the labour tax wedge using the change in the labour supply based on the microsimulation model for the OLG model. In addition to that to better illustrate differences between using only a macro model and using both macro and micro model we run a shock of a reduction of an implicit labour tax rate derived from the microsimulation model in the OLG model with endogenous labour supply.

The simulation strategy is similar to the bottom-up approach used by Peichl (2009).[11] As described in section 2, we apply the bottom-up approach under which we use the information from the micro model both for calibration (labour market parameters, tax rates) and determination of the size of shocks for the OLG model. As discussed above in section 2 for further versions of the OLG model we aim at integrating the microeconomic characteristics of consumers based on EU-SILC data into the OLG model.

3.1 The static microsimulation effects using EUROMOD

In May 2014 a refundable in-work tax credit (known as "80 euro bonus") has been introduced in Italy, with the aim of reducing the labour tax wedge (particularly at the lower end of the income distribution) and of boosting consumption. This measure has been made permanent as of 2015, resulting in a tax credit of EUR 960 per year (i.e. 80 euro per month) granted to employees with annual taxable income between EUR 8,173 and EUR 24,000. The amount linearly decreases up to a maximum taxable income of EUR 26,000. In addition, the tax credit depends on the number of days worked over the year (Ceriani et al., 2015).

Although the reform was introduced in May 2014, in our analysis we simulate the introduction of the tax credit as of January 2014 to replicate the annual effect (thus raising the maximum annual amount for 2014 from EUR 640 to EUR 960).

As a result of an introduction of the in-work tax credit, revenues from personal income taxes (at national and regional level) decrease by almost 5%, from EUR 164 bn to EUR 156 bn, while total tax revenues (which include, in addition, taxes on property, private pensions, investment and rental income) fall by approx. 4.3%. This is a first round effect of the reform without any behavioural response. In the next step, the labour supply response will be simulated.

Table 1. Aggregate personal income taxes and total simulated revenues (EUR)

	Baseline	Reform	Difference		95% confidence interval		
	Total	Total	Total	Standard error	Lower bound	Upper bound	% of baseline
PIT	164,069,338,912	155,677,956,335	-8,391,382,578	194,944,290	-8,773,529,614	-8,009,235,541	-5.1
Total taxes	**193,915,049,011**	**185,523,670,693**	**-8,391,378,319**	**194,943,888**	**-8,773,524,567**	**-8,009,232,071**	**-4.3**

Source: Own calculations

3.2 The microsimulation effects using EUROMOD with labour supply response

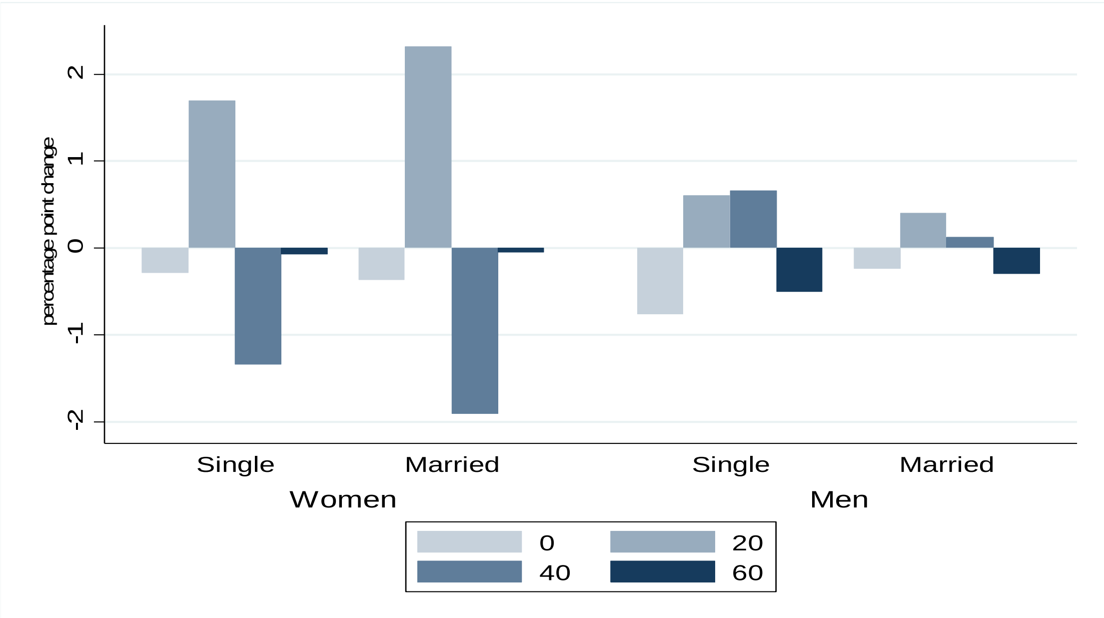
Figures 1 and 2 show the impact of the tax credit on labour supply by gender, marital status and age category, reporting the percentage points change in the share of people out of work, working part-

[11] Peichl (2009) uses a static CGE macro model, and is able to link interatively the micro and macro models. As we are using a dynamic OLG macro model, we do not follow the latter parts of the approach.

time (20 weekly hours), full-time (40 weekly hours) or overtime (60 weekly hours) in the baseline and reform scenario.

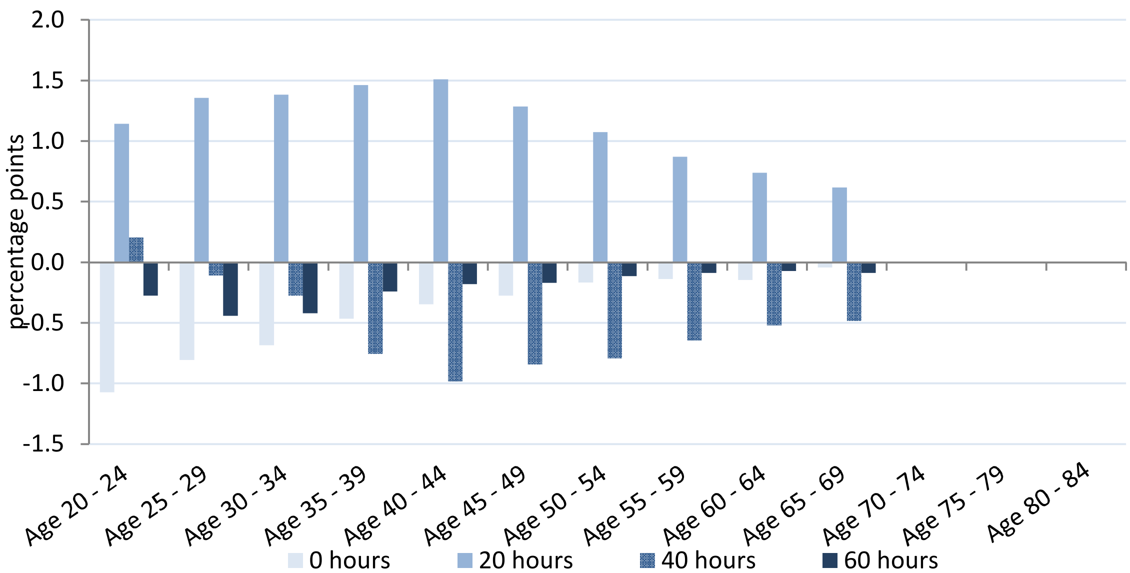
The reform slightly raises labour market participation, while increasing the incentive to shift from full-time to part-time work. The incentive of the new tax credit on taking-up a job (extensive margin) is stronger for single men (almost 0.75% are entering the labour market) and, to a lesser extent, for women and married men. On the intensive margin, individuals working full or over time are also affected, but in opposite directions. For women, the reform creates an incentive to provide less hours of work. This is particularly the case of married and single women working 40 hours (2.3% and 1.7%, respectively, shift to a part-time schedule). The impact of the tax credit on women working overtime is, however, negligible. As far as men are concerned, there is a stronger tendency for those working overtime to reduce their hours of work as compared to women. However, the shift is not only to part-time, but to the full-time schedule as well (especially for single men).

Figure 1. Labour supply effect of the refundable in-work tax credit (by gender and marital status)



Source: Own calculations

Figure 2. Labour supply effect of the refundable in-work tax credit (by age category)



Source: Own calculations

Looking into the impact of the refundable tax credit on different age groups, we notice that the incentive to start working is particularly strong for the younger individuals and decreases with age. The same trend can be observed for the persons working more than 50 hours per week. As per the high preference for part-time jobs, it can be observed across all ages, but it is particularly prominent for the middle-age individuals. It is also this category that mainly reduces its full-time schedule to 20 hours of work per week.

Tables A.2. to A.9 in the Appendix provide more detailed results by number of hours worked, household type and age category. In absolute terms, the reform affects approximately 133,000 women (out of which 89,000 are cohabiting or married). The impact is much milder for men (almost 50,000), particularly for the ones in a couple (ca. 20,000). Overall, 50,000 individuals enter the labour market, while almost 163,000 start working part-time, mainly to the detriment of the 40 hours per week schedule.

Overall the effect of the two reforms is a small reduction in labour supply: the average number of working hours hardly changes in the baseline and reform scenarios (from 32.71 weekly hours in the baseline to 32.55 in the reform scenario). The number of hours worked is calculated based on probabilities of working a specific number of hours for each individual and embeds the effect of both the extensive and intensive margin. This net result is the combined effect of the increase in labour market participation, on the one side, and of the shift from full to part-time work, on the other.

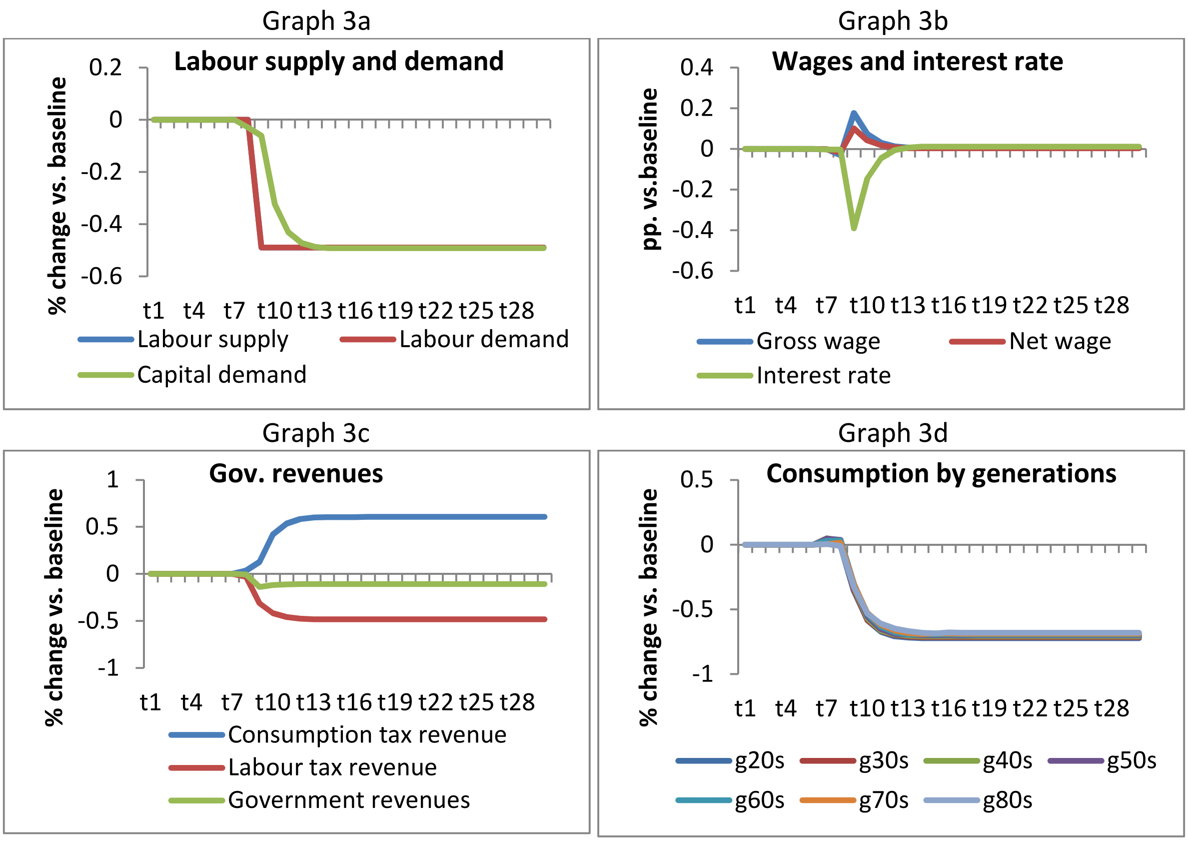
3.3 The dynamic macroeconomic effects using OLG model

The overall change in the labour supply from the discrete choice model due to lowering the labour tax wedge in Italy is small and negative. It is estimated at 0.49% and this value determines the size of the exogenous labour supply shock introduced into the OLG model, which is the total effect of an increase in the number of persons employed and the lower average hours worked (Figure 3, Graph 3a). We assume that consumption tax rate changes in a way to ensure balanced government budget in every period.

Under the negative labour supply shock gross wages go up in the in the first period of the reform to attract employees (Figure 3, Graph 3b). The response of net wages is the same as that of gross wages in qualitative terms; it only differs in magnitude (by definition). Since capital is now abundant relative to labour, interest rate has to decrease to set the new equilibrium level of capital. It continues declining up to the forth period after the introduction of the shock lowering the level of capital until it stabilizes at the new steady-state value. In the long term wages and interest rate stabilise at virtually the pre-shock level consistent with optimal capital to labour ratio. As a consequence of the permanent decrease in labour supply that translates into the equivalent change in labour demand, aggregate tax revenues from labour stays at the lower level in the long run. Labour demand is declining as a result of a decline in aggregate demand due to a decrease in aggregate consumer demand which in turn falls as a result of the increased tax on consumption that is compensating for lower revenues from the tax on labour (Figure 3, Graph 3c). Since overall government expenditure falls due to a fall in transfers to households, the overall government revenues also decline in the long run (by 0.1% with respect to the baseline level). Comparing to the government revenue loss calculated using the static microeconomic model this is a negligible loss. This is a very important feature of designing a policy shock in an OLG model. Since it is a dynamic general equilibrium model to simulate any fiscal policy reform we have to determine the source of financing it as well.

Looking at the consumption by generation we can see that negative labour supply shock coupled with increasing of the consumption tax has relatively strong negative impact on consumption by individuals. For the specific government budget closure the magnitude of the decrease in consumption is virtually the same for all generations (Figure 3, Graph 3d). Nonetheless, what differentiate consumption by generations in the current version of the model are differences in earnings on labour and capital among generations. To further differentiate consumption responses by generations one could incorporate tax functions based on income quantiles and skills.

Figure 3. Macroeconomic effects of the refundable in-work tax credit (exogenous labour supply)



Source: Own calculations

3.4 Effects of the labour tax wedge cut using only macroeconomic (OLG) model

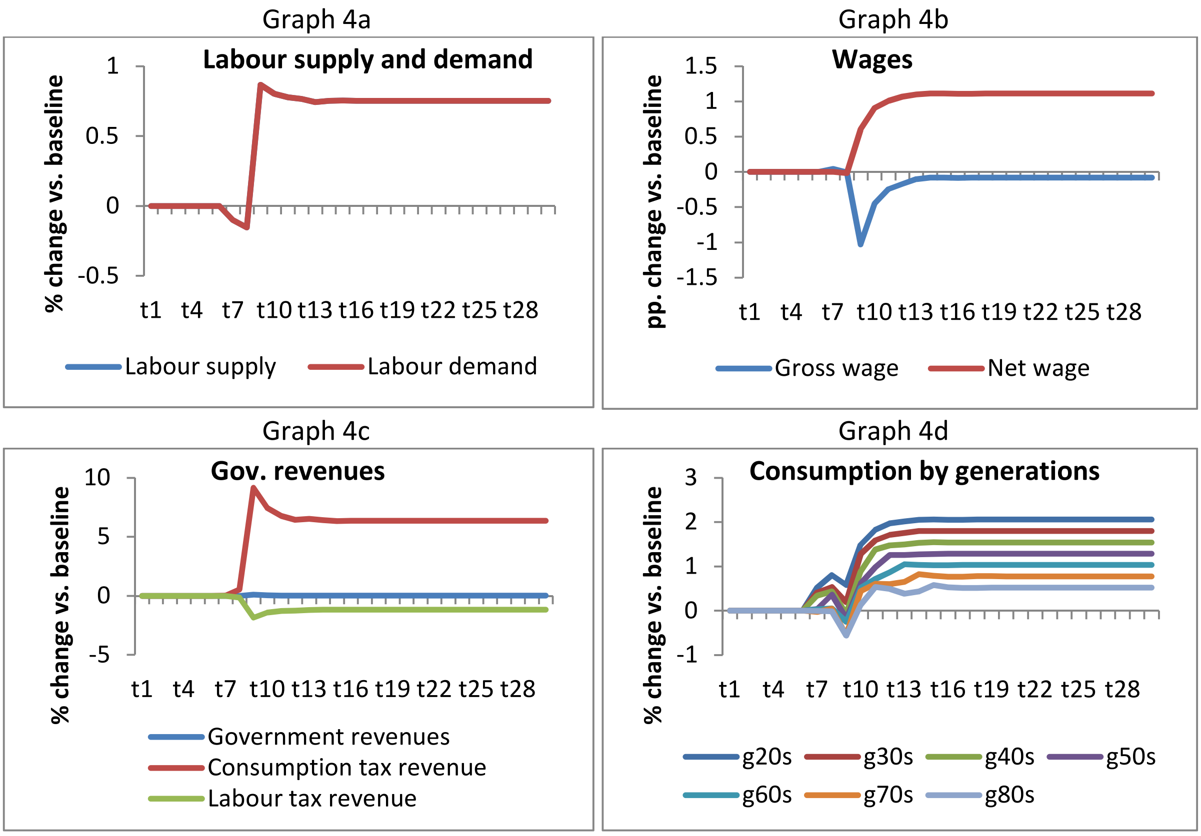
In this section we present the results of simulating the lower labour tax wedge directly with the OLG model. In this setting microsimulation model is only used for calculation of the size of the shock, i.e. by how much the aggregate PIT tax rate (for all tax payers' categories and generations) should be reduced as a consequence of the introduction of in-work tax credit. Based on the microsimulation model the static (i.e. one year, without behavioural response) loss in PIT is estimated at 8.4 bn Euros in total, which translates into -0.94 pp. change in the labour tax rate versus baseline (i.e. no reform) scenario.

In the first period after the introduction of a lower labour tax wedge, net wage increases and the gross wage decreases (Figure 4, Graph 4b) implying increasing both labour supply and labour demand due to reduced cost of labour (Figure 4, Graph 4a). Since we do not model labour market frictions in our OLG model and consequently we do not make a distinction between employment and labour demand, our proxy for employment effects are labour demand effects. Actually, labour supply starts falling two periods before the reform has been introduced as a result of consumers' optimization between today versus future work. Since this is a permanent labour tax wedge shock both labour supply and net wages are higher in the long-term. It should be stressed however that taking into account quite small magnitude of the shock, the macroeconomic effects are not very large in magnitude. As we have now run a shock in a pure macroeconomic setting, the effects on labour supply and the whole economy are positive and totally different as compared with the effects using the response from the discrete choice labour supply model.

The reform is assumed deficit neutral, meaning that government budget is assumed to be balanced every period. The loss in government revenues (Figure 4, Graph 4c) due to lower tax revenues from labour as an immense result of this reform is neutralized by the increase in consumption tax and the overall tax revenues are almost at the baseline level in the long run (the negative change in government revenues with respect to the baseline level is negligible).

An immense effect of a reform is a decline in consumption of individuals at their 50's or older in the first period of an introduction of the reform due to the increase in the consumption tax rate. The fall in consumption is deeper the older is an individual since for the elderly generations there are not so many years left to smooth their consumption. Specifically the eldest generation has no choice but to pay higher consumption tax, so their consumption falls in the first period. Since the labour supply and output are permanently higher, the consumption is so as well. Again, the youngest the individual, the bigger is the change in consumption (Figure 4, Graph 4d).

Figure 4. Macroeconomic effects of the refundable in-work tax credit (endogenous labour supply)



Source: Own calculations

Conclusions

Comparing the two simulation approaches: simulating the lowered labour tax wedge in the macro model directly to get the labour supply response versus simulating the labour supply responses with the discrete choice model and then incorporate labour supply change exogenously into the OLG model we can see the great difference between the two approaches.

First, using only the macro model we ignore detailed information on individuals' responsiveness to the fiscal policy reform. When we simulate lower labour tax using only the OLG model, we in fact run a very different shock than using the OLG model and the discrete choice model of labour supply. The responses of the labour supply and consumption are positive in the long run.

Second, when we benefit from using both the microsimulation model and the discrete choice labour supply model and then the OLG model that allows us taking into account of the richness of individuals' distinct characteristics and differences in their responsiveness to the relevant shock, we get negative overall labour supply response.

The striking differences in simulating a fiscal policy measure using only macroeconomic model and using both microeconomic and macroeconomic models clearly points out at the need of either running the two models iteratively or integrating the microeconomic characteristics of individuals into the OLG model. Future model versions will feature heterogeneous household agents in the OLG model, thus enabling the integration of the microeconomic households' characteristics, like income quantiles, individual tax functions and labour skills into the OLG model.

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Appendix

Table A.1. Base year calibration values for OLG model

Parameter	Description	Value in the OLG model (equivalent to 10 years)	Value on annual basis
rint0	Real interest rate	71.4%	5.5%
$\delta 0$	Depreciation rate	36.5%	4.4%
Rent0	Real rental price for capital	107.9%	9.9%
$\theta 0$	Discount rate	23.9%	2.2%
bnfr0	Replacement ratio for pensions	43.4%	
contr0	Social contribution rate	21.1%	
ctxr0	Consumption tax rate	20.2%	
wtxr0	Labour tax rate	21.7%	
ktxr0	Capital tax rate	6.8%	
Pop20s	Share of population aged 20-29 in total population	12.5%	
Pop30s	Share of population aged 30-39 in total population	15.3%	
Pop40s	Share of population aged 40-49 in total population	19.8%	
Pop50s	Share of population aged 50-59 in total population	18.3%	
Pop60s	Share of population aged 60-69 in total population	15.3%	
Pop70s	Share of population aged 70-79 in total population	11.8%	
Pop80s	Share of population aged 80-89 in total population	6.9%	
Survr0_20s-50s	Assumed survival rate for people aged 60-69	1.00	
Survr0_60s	Implied survival rate for people aged 60-69	0.93	
Survr0_70s	Implied survival rate for people aged 70-79	0.77	
Survr0_80s	Implied survival rate for people aged 80-89	0.59	
Gamma_20s	Preference parameter for leisure for people aged 20-29	1.329	
Gamma_30s	Preference parameter for leisure for people aged 30-39	1.503	
Gamma_40s	Preference parameter for leisure for people aged 40-49	1.402	
Gamma_50s	Preference parameter for leisure for people aged 50-59	1.269	
Gamma_60s	Preference parameter for leisure for people aged 60-69	3.037	

Source: Own calculations

Table A.2. Labour supply reactions of single women

Number of hours worked	Baseline	Reform	Difference
0	410,647	403,304	-7,343
20	307,940	352,097	44,157
40	1,792,417	1,757,410	-35,007
60	95,427	93,619	-1,808
Total	**2,606,430**	**2,606,430**	**0**

Source: Own calculations

Table A.3. Labour supply reactions of married women

Number of hours worked	Baseline	Reform	Difference
0	364,278	350,315	-13,963
20	848,465	937,457	88,992
40	2,564,248	2,491,180	-73,068
60	61,750	59,789	-1,961
Total	**3,838,741**	**3,838,741**	**0**

Source: Own calculations

Table A.4. Labour supply reactions of single men

Number of hours worked	Baseline	Reform	Difference
0	428,485	410,718	-17,767
20	144,182	158,354	14,172
40	1,572,189	1,587,606	15,417
60	190,071	178,249	-11,822
Total	**2,334,927**	**2,334,927**	**0**

Source: Own calculations

Table A.5. Labour supply reactions of married men

Number of hours worked	Baseline	Reform	Difference
0	213,563	204,642	-8,920
20	174,561	190,050	15,490
40	3,133,784	3,138,634	4,850
60	316,833	305,414	-11,419
Total	**3,838,741**	**3,838,741**	**0**

Source: Own calculations

Table A.7. Labour supply reactions of non-working individuals

Age	Baseline	Reform	Difference
Between 20 and 24	15,116	13,605	-1,511
Between 25 and 29	62,292	56,669	-5,624
Between 30 and 34	222,442	211,404	-11,038
Between 35 and 39	269,286	259,181	-10,105
Between 40 and 44	262,610	254,336	-8,273
Between 45 and 49	245,342	238,977	-6,366
Between 50 and 54	168,977	166,010	-2,967
Between 55 and 59	129,048	127,367	-1,682
Between 60 and 64	40,036	39,612	-424
Between 65 and 69	1,824	1,819	-5
Between 70 and 74			
Between 75 and 79			
Between 80 and 84			
Total	**1,416,972**	**1,368,979**	**-47,994**

Source: Own calculations

Table A.7. Labour supply reactions of individuals working part-time

Age	Baseline	Reform	Difference
Between 20 and 24	21,400	23,010	1,610
Between 25 and 29	95,511	104,979	9,467
Between 30 and 34	212,294	234,562	22,268
Between 35 and 39	269,383	301,164	31,780
Between 40 and 44	297,186	333,201	36,014
Between 45 and 49	265,222	295,011	29,789
Between 50 and 54	180,721	199,762	19,042
Between 55 and 59	107,631	118,275	10,643
Between 60 and 64	24,876	27,003	2,126
Between 65 and 69	921	993	72
Between 70 and 74			
Between 75 and 79			
Between 80 and 84			
Total	**1,475,148**	**1,637,959**	**162,811**

Source: Own calculations

Table A.8. Labour supply reactions of individuals working full-time

Age	Baseline	Reform	Difference
Between 20 and 24	99,257	99,546	290
Between 25 and 29	509,330	508,566	-764
Between 30 and 34	1,106,540	1,102,082	-4,458
Between 35 and 39	1,525,350	1,508,926	-16,424
Between 40 and 44	1,700,093	1,676,650	-23,443
Between 45 and 49	1,681,808	1,662,297	-19,511
Between 50 and 54	1,320,144	1,306,083	-14,061
Between 55 and 59	907,254	899,371	-7,883
Between 60 and 64	204,570	203,072	-1,498
Between 65 and 69	8,293	8,237	-57
Between 70 and 74			
Between 75 and 79			
Between 80 and 84			
Total	**9,062,638**	**8,974,830**	**-87,809**

Source: Own calculations

Table A.9. Labour supply reactions of individuals working overtime

Age	Baseline	Reform	Difference
Between 20 and 24	5,082	4,694	-388
Between 25 and 29	30,467	27,388	-3,079
Between 30 and 34	69,459	62,686	-6,773
Between 35 and 39	107,607	102,355	-5,252
Between 40 and 44	124,074	119,776	-4,298
Between 45 and 49	124,202	120,290	-3,913
Between 50 and 54	104,934	102,921	-2,013
Between 55 and 59	79,314	78,236	-1,078
Between 60 and 64	18,264	18,060	-205
Between 65 and 69	679	669	-10
Between 70 and 74			
Between 75 and 79			
Between 80 and 84			
Total	**664,081**	**637,072**	**-27,010**

Source: Own calculations