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Tax and Transfer Policies and the Female Labor Supply in the EU

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ABSTRACT

Tax and Transfer Policies and the Female Labor Supply in the EU*

This study contributes to the female labor supply responsiveness literature by measuring the effect of tax-benefit policies on female labor supply based on a broad sample of 26 European countries in 2005-2010. The tax-benefit microsimulation model EUROMOD is used to calculate a measure of work incentives at the extensive margin – the participation tax rate, which is then used as the main explanatory variable in a female employment equation. This allows me to deal with the endogeneity of income in a new way by using a simulated instrumental variable based on a fixed EU-wide sample of women. Results suggest that a 10 percentage point increase in the participation tax rate decreases the female employment probability by 2 percentage points. The effect is higher for single mothers, for women in the middle of the skills distribution, and in countries that have lower rates of female employment.

JEL Classification: C25, H24, H31, J22

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* This research was financially supported by grant GB14-36154G from the Czech Science Foundation and by an ERSTE Foundation Fellowship for Social Research 2012/2013. The results presented here are based on EUROMOD version F6.0+. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex, in collaboration with national teams from the EU member states. EUROMOD relies on micro-data from 27 different countries. These are EU-SILC UDB datasets made available by Eurostat; Spanish SILC 2008 data made available by the Spanish Statistical Office; Italian SILC 2008 data made available by the Italian Statistical Office; Austrian SILC 2008 data made available by Statistics Austria; and United Kingdom Family Resources Survey 2008 data made available by the UK Data Archive. All errors remaining in this text are the responsibility of the author.

1 Introduction

The impact of tax–benefit systems on female labor supply has important consequences for an optimal design of tax and transfer policies. Labor supply elasticities have been widely studied in the economic literature, with a major challenge of this literature being the endogeneity of income.[1] The literature on the responsiveness of labor supply decisions to tax and benefit changes can be separated into three main groups: structural models, reduced–form estimation, and grouped data estimation. Most labor supply elasticity estimates come from the structural literature that builds on a family labor supply model (see e.g. Bargain, Orsini, & Peichl, 2014; Blundell, Duncan, McCrae, & Meghir, 2000; Hoynes, 1996; van Soest, 1995). A second group of studies uses a specific tax or transfer reform in the reduced–form estimation of labor supply responsiveness (see e.g. Eissa & Liebman, 1996; Meyer & Rosenbaum, 2001; Saez, Matsaganis, & Tsakloglou, 2012). Finally, the grouped data literature identifies the labor supply elasticities by estimating group–average regressions over a long time period (see e.g. Blau & Kahn, 2007; Causa, 2009; Blundell, Duncan, & Meghir, 1998; Devereux, 2004).

Researchers usually seek for exogenous variation in income provided by tax and transfer reforms or by non–linearities in tax–transfer schedules. However, modeling tax–benefit systems for more than one country in a harmonized way has been largely limited by the complex nature of tax and transfer schedules. Therefore, the literature is highly concentrated on the US, the UK, and other developed economies of Western Europe, while there is little evidence for other countries, including the new EU member states. Moreover, the estimated magnitudes of female labor supply elasticities vary greatly across studies (for a survey, see Blundell & Macurdy, 1999; Keane, 2011; Meghir & Phillips, 2008).

This study brings several contributions to the female labor supply elasticity literature. Using the tax–benefit microsimulation model EUROMOD, I estimate the effect of tax–benefit policies on female labor supply based on a sample of 26 European countries in 2005–2010.

[1] Both labor and non–labor income are potentially endogenous to the labor supply. People have different unobserved characteristics (taste for leisure, ability, willingness to work hard, etc.) that affect their probability of being employed, their wages, and the size of non–labor income.

This allows me to study the female labor supply responsiveness across countries and groups of women in a comparable way and at the same time control for both time–invariant and time–varying country–level unobserved factors. Further, this paper uses a new approach to deal with the endogeneity of income by using a group–level simulated instrumental variable based on a fixed EU–wide sample of women.

This study focuses on the extensive margin of female labor supply, because the responsiveness of female labor supply was found to be driven mainly by participation choices (Blundell et al., 1998; Keane, 2011).[2] Unlike previous literature, which uses net wage and non–labor income as the main explanatory variables, the main explanatory variable in this study is a measure of the extensive margin work incentives—the participation tax rate (PTR). The PTR is defined as a proportion of lost earnings that is compensated for by lower taxes and higher benefits when not in paid work, and it thus describes the (dis)incentives provided by the tax–transfer system for the participation decision. The use of the PTR allows me the capture of the joint effect of taxes and transfers on female participation decisions and to deal with the endogeneity and measurement error in income by using a simulated instrumental variable.[3]

The instrumental variable for the PTR used in this study exploits variation in the PTR driven by changes in tax–transfer policies, while it eliminates the variation in the PTR caused by behavioral responses to these tax–transfer changes. In particular, the individual–level PTR is instrumented with a group–level measure of tax and transfer systems that is created based on a fixed EU–wide sample of women. This sample is created from a pooled dataset of all EU countries by taking a random sample of approximately 27,000 women. The instrumental variable for a woman with given characteristics,[4] living in country c and year t is calculated as an average PTR of women from the fixed EU–wide sample who have the same characteristics and whose PTR is computed based on the tax–transfer system of country c in year t. Therefore, the only variation in the IV stems from differences in tax and transfer policies across

[2]In accordance with previous literature, I refer to the decision of working or not as the participation decision (see, e.g. Meghir & Phillips, 2008). It should not be confused with labor force participation (being in a labor force or not, including the unemployed).

[3]Note that the use of the participation tax rate in the labor supply equation itself does not solve the problem of income endogeneity, because the PTR is a function of family income.

[4]Characteristics include education level, the presence of children of different ages, and marital status.

EU countries, over time, and across groups of women. This instrumental variable approach builds on the simulated IV approach used in the health economics literature (Currie & Gruber, 1996; Cutler & Gruber, 1996), but is also related to the simulated IV of Moffitt and Wilhelm (2000), Gruber and Saez (2002), or Dahl and Lochner (2012)[5] and to the grouped data literature.

This paper takes advantage of recent developments in multinational microsimulation models that allow researchers to model the tax and benefit systems for a large set of countries in a comparable way. It uses the EU–wide microsimulation model EUROMOD[6] to calculate participation tax rates at the individual level for 26 EU countries in 2005–2010. The rich structure of the data enables the studying of the heterogeneity in female labor supply responsiveness across countries and groups of women while controlling for time–invariant country–specific characteristics (such as culture and informal institutions), but also for time–varying country–level unobserved factors (such as country–level economic shocks, changes in preferences for work or family policies).

Multinational microsimulation models have so far been used mainly to describe the differences in the tax and transfer systems across countries, and to my knowledge, Bargain et al. (2014) is the only study that uses a multinational microsimulation model in the labor supply elasticity estimation, and is thus closest to the present study. They use the microsimulation models TAXSIM and EUROMOD to compare labor supply elasticities of men and women in the U.S. and 17 European countries. Compared to Bargain et al. (2014), this study takes advantage of a newer version of the EUROMOD model, which includes a larger sample of countries (mainly from the post–communist countries) and a much longer time span, while I also take a different estimation approach. My methodology is based on a reduced–form estimation combined with an instrumental variable approach, while Bargain et al. (2014) use

[5]These studies simulate instrumental variables based on the pre–reform characteristics of the affected individuals to which they apply the post–reform tax and transfer schedules. My instrumental variable works in a similar way, but I apply the tax and transfer schedules to the fixed sample of individuals with similar characteristics in order to minimize the effect of composition changes across countries and time. See Section 2.2 for details.

[6]EUROMOD is a tax–benefit microsimulation model for all EU member states. In this paper, EUROMOD version F6.0+ is utilized. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex, in collaboration with national teams from the EU member states. See https://www.iser.essex.ac.uk/euromod.

a structural model. An advantage of the present study over the structural models is that it does not require any assumptions on preferences (including the form of utility function and the choice set for working hours). However, it does require a sufficient amount of changes in the tax and transfer policies for identification. In Section 2.2, I argue that there was indeed enough policy variation in the EU countries between 2005 and 2010.

My results suggest that a 10 percentage point increase in the participation tax rate decreases the female employment probability by 2 percentage points. The implied participation elasticity with respect to the PTR is 0.08—a 10% increase in the participation tax rate decreases the female employment rate by 0.8%. I also analyze the heterogeneity of the response across groups of women with different characteristics and find that the effect is substantially higher for women with secondary education (an elasticity of 0.16, compared to an elasticity of 0.04 for primary and tertiary–educated women) and women with small children. Consistent with previous findings, the highest elasticity is found for single mothers (0.32). Finally, the use of a multinational microsimulation model allows for a comparison of female participation elasticities across groups of countries in a harmonized way. I find that the responsiveness does differ substantially across countries, and that the countries with the lowest female employment rates have the highest participation elasticity.

2 Methodology

2.1 The participation tax rate

This section introduces basic notation and explains the role of the participation tax rate in female participation decisions. Let's assume that each woman has a fixed earnings potential e_w^p and fixed costs of work q_w (including a disutility from work, a value of lost home production, child care costs, etc.). She chooses between working ($e_w = e_w^p$) and not working ($e_w = 0$) to maximize the household's utility.[7]

[7]Married and cohabiting women are assumed to be secondary earners; their labor force participation decisions follow their spouses' decisions, while single women are the primary and only potential earner in a household. I also assume here that spouses pool their resources, which is a standard assumption of a unitary model. While some studies question this assumption, the unitary model is still widely used in the labor supply literature (see e.g. Blundell, Pistaferri, & Saporta-Eksten, 2012) and some recent empirical studies supported

The effect of taxes and transfers on family income is captured by a tax–transfer function $T(e_m, e_w, \rho)$, which represents net taxes paid as a function of both spouses' earnings (e_m denotes earnings of the woman's spouse) and parameters of the tax–transfer system (ρ). Therefore, the female participation decision is based on a comparison of costs of work and net gain from entering the labor market, which is defined as gross earnings less net taxes that the woman has to pay while in paid work on top of net taxes that she pays out of work. Therefore, the woman decides to enter the labor market if:

$$q_w \leq e_w^p - [T(e_m, e_w^p, \rho) - T(e_m, 0, \rho)]. \tag{1}$$

The participation decision can then be expressed in terms of the participation tax rate:

$$PTR \equiv \frac{[T(e_m, e_w^p, \rho) - T(e_m, 0, \rho)]}{e_w^p} \leq \frac{e_w^p - q_w}{e_w^p}, \tag{2}$$

where the PTR describes the proportion of lost earnings that is compensated by lower taxes and higher benefits when not in paid work.

2.2 Estimation approach

The model from the previous section provides a basis for the estimation approach used in this paper. I estimate the effect of a widely used work incentive measure—the participation tax rate—on the labor supply decisions of women. The participation equation has the following form:

$$Empl_{ict} = \alpha PTR_{ict} + \beta' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + \epsilon_{ict}, \tag{3}$$

where $Empl_{ict}$ is the employment dummy, PTR_{ict} is the participation tax rate, and X_{ict} represents the set of observable characteristics including age, education, marital status, number of household members, dummy variables for the presence of spouse, for children of certain ages (children aged 1, 2, 3, 4–5, 6–9, 10–15, and no children below 16), and for elderly

the validity of a unitary model (see, e.g. Bargain et al., 2014).

in the household, and characteristics of spouse if present (education and economic status). I also include country fixed effects (γ_c) and year fixed effects (γ_t), while in most specifications all country–year fixed effects (γ_{ct}) are included. Therefore, I allow for changes in the country–specific fixed effects, which capture unobserved country–specific tastes for work, cultural norms, gender–role attitudes, labor market conditions, or family policies.

I deal with possible endogeneity and measurement error in the PTR by using a simulated instrumental variable.[8] The instrument for the PTR represents a group–level measure of the tax–transfer work incentives which is created based on a fixed sample of women from the whole EU. This method builds on the simulated instrument approach used in the health economics literature (Currie & Gruber, 1996; Cutler & Gruber, 1996), but is also related to the simulated IV used in the literature on responsiveness towards tax and transfer changes (Dahl & Lochner, 2012; Gruber & Saez, 2002; Moffitt & Wilhelm, 2000).

The instrumental variable for the PTR is created in three steps. First, I take a random sample of 27,000 women (denoted by a subscript j) from the pooled sample of the 26 EU countries in 2007.[9] The first step provides a sample of women with fixed demographic characteristics and fixed income distribution. Second, I calculate the participation tax rate PTR_{jct} for each woman j from this fixed EU–wide sample applying country c and year t's tax and transfer system. I repeat this PTR calculation for each country–year cell. Therefore, for each woman in the fixed EU–wide sample, I have 126 calculated PTRs, where each PTR corresponds to one country–year cell.[10] To avoid problems with income–level differences across the EU countries which might negatively affect the calculated PTR_{jct}, I adjust incomes of women from the fixed EU–wide sample to correspond to the level of incomes in country c.[11]

[8] The participation tax rate is a function of a woman's and her husband's income (see equation 2). Therefore, it can be affected by the standard endogeneity and measurement error problems of income in the labor supply equation.

[9] A sample of 27,000 women seems to be sufficiently large as to provide a reasonably strong IV and EUROMOD is not meant to work with much larger samples. I have also conducted a robustness check with a substantially smaller sample of 17,000 women, but the results were largely unchanged.

[10] There are 126 country–year cells used in the estimation, because not all 26 countries are observed for all 6 years between 2005 and 2010. For details, see Section 3.1.

[11] I assign each woman in the fixed EU–wide sample a quantile in the income distribution of her own country, and then change her income to correspond to the average income in that quantile, but in the income distribution of country c. I create very detailed income distributions with 400 income quantiles in each country. I also adjust incomes of all household members the same way, because their incomes potentially affect the PTR computation as well.

Third, the instrumental variable for a woman i from group g, country c, and year t is constructed as an average PTR_{jct} of women from the fixed EU–wide sample who belong to group g.[12] Therefore, the only variation in this group–level IV stems from variation in tax and transfer systems across EU countries, over time, and across groups of women. The possible endogeneity and measurement error in the PTR are filtered out using the sample of women with fixed characteristics and fixed income distribution.

The simulated instrument is used in a 2SLS estimation described by the following equations:

$$PTR_{ict} = \lambda PTR\_IV_{ict} + \theta' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + u_{ict}, \tag{4}$$

$$Empl_{ict} = \delta \widehat{PTR}_{ict} + \phi' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + e_{ict}, \tag{5}$$

where PTR_IV_{ict} is the instrumental variable for the PTR, $\widehat{PTR}_{ict}$ denotes the predicted PTR from the first stage regression, and δ denotes the coefficient of interest.

The identification of female labor supply elasticities in this paper is based on tax and transfer changes that took place in the 26 EU countries between 2005 and 2010. Indeed, there were several reforms of tax and transfer schedules in this time period including some major reforms of tax systems—tax base allowances reform in Belgium in 2008, a flat tax reform in the Czech Republic in 2008, tax system changes in Denmark in 2010, an increase in the number of tax brackets in Spain in 2007, etc. Benefit schedules in the EU countries also underwent several important changes including the introduction of an allowance for school children in Belgium in 2006, reforms of housing and child benefits in the Czech Republic in 2007 and 2008, increased generosity of the universal child benefit and the reform of education benefits in Germany in 2008 and 2009, extensions to the large family benefit in Greece in 2006 and 2008, the introduction of a Solidarity labor income benefit in France in 2009, the reform of child benefit in Lithuania in 2009, etc.

[12] There are in total 30 groups that are defined based on three educational categories (primary, secondary, and tertiary education), five categories according to the presence of children of various ages (children aged 1–3, 4–5, 6–9, 10–15, and no children below 16) and two categories by marital status (married and unmarried). Therefore, the IV for a married childless woman with tertiary education living in Germany in 2008 is calculated as an average PTR of women from the fixed EU–wide sample who are also married, childless, and tertiary educated, and whose PTR is calculated based on the German tax–transfer system in 2008.

3 Data and microsimulation of taxes and benefits

3.1 Data and sample selection

The empirical analysis makes use of the tax–benefit microsimulation model EUROMOD, version F6.0+. The EUROMOD model is largely based upon harmonized EU–SILC data[13] (that are further adjusted for microsimulation purposes) combined with a detailed tax–benefit calculator. The model utilizes detailed information on household composition, characteristics of household members, and their incomes from the micro data, and creates common definitions of income concepts and assessment units to allow for a very detailed and harmonized micro–level calculation of taxes and benefits (for details on the EUROMOD project, see Sutherland & Figari, 2013). This makes EUROMOD a very suitable instrument for computing participation tax rates in a harmonized way for the EU countries.

The EUROMOD model covers all 27 countries of the EU, but I exclude Malta from the analysis, because the Maltese data have serious shortcomings.[14] I utilize tax–transfer schedules that were in force in 2005 to 2010 and are available in the EUROMOD, version F6.0+. The EUROMOD model covers some countries only for 2006–2010 and some countries only for 2007–2010. Moreover, while EUROMOD computes taxes and transfers for all the above mentioned years, the EUROMOD input data are available only for selected years. Computation of taxes and transfers for the years that do not have the corresponding input data is based on data from previous years with updated incomes. An overview of country–year cells, for which the tax–transfer computations are available and for which the EUROMOD input data are available, is provided in Appendix Table A.1.[15]

These country–year combinations, which have tax–transfer computations in EUROMOD

[13]For most countries EU–SILC UDB data are used for microsimulation, but for some countries national SILC data are utilized, while the Family Resource Survey data are used for the UK.

[14]Maltese data does not include exact age information, but report age only in 5–year age bands, which is a serious limitation for female labor supply analysis, mainly because we cannot identify the exact age of children in a family.

[15]Official country abbreviations are used throughout the paper: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Germany (DE), Denmark (DK), Estonia (EE), Spain (ES), Finland (FI), France (FR), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), Slovakia (SK), United Kingdom (UK).

but do not have the input data available, cannot be directly used in the estimation, because actual participation decisions of women for these country–year cells are not observed. However, the EUROMOD can be used to calculate the participation tax rates for all available country–year combinations, and then these participation tax rates can be assigned to individuals in the EU–SILC data, where the participation decisions are available. Participation tax rates computed within the EUROMOD are imputed to the EU–SILC data based on reported incomes and household characteristics using propensity score matching.[16] The imputation should be very precise given the fact that the PTR is merely a function of incomes and other observable characteristics of individuals in a household.

Nevertheless, the quality of matching is examined in Section 4.3, where estimation results based on the EUROMOD data are compared to those based on the EU–SILC data with imputed participation tax rates. Since the quality of matching is indeed good, the main results presented in the paper are those based on the EU–SILC data with the imputed PTR. This allows me to take advantage of all available country–year cells in EUROMOD and substantially improves the identification strategy.

I restrict the sample to prime–aged women (aged 25–55), and I exclude women in full–time education, pensioners, disabled, women with a new–born child (younger than 1 year of age),[17] and those with missing values for education. I also exclude the self–employed from the analysis (all women who have more than 30% of their work income from self-employment), because the quality of reporting of self–employment income in the micro–data sources is generally limited and varies largely across countries (Immervoll, 2004). Excluding self–employed women is a common practice in a majority of the female labor supply elasticities papers (see, e.g. Bargain et al., 2014). The analysis includes both women living in couples (married or cohabiting) and single women.

[16]The propensity score matching procedure matches women in the EUROMOD data with those in EU–SILC within each country–year cell based on their income, marital status, income of the partner (if present), dummy variables for presence of children of various ages (children aged 1, 2, 3, 4–5, 6–9, 10–15, and no children below 16) and a dummy for elderly household members. Each woman in the SILC data is assigned a closest neighbor from the EUROMOD data and the corresponding PTR is imputed. To maintain consistency, the PTR is imputed to the EU–SILC data even for those years for which the EUROMOD input data are available.

[17]Children aged 0 are dropped from the EUROMOD dataset in order to align demographic variables with the income reference period for the computation of benefits (in most countries, the income reference period of the data is the calendar year preceding the survey).

3.2 Participation tax rate calculations

The participation tax rate is defined as the difference between net taxes paid when the woman works and when she does not work over her gross wage, while the economic status and incomes of all other household members are fixed. Therefore, to calculate the PTR, I need to compute taxes and benefits for all household members for two hypothetical scenarios—when the woman works and when she does not work. For the non–working women, this requires some assumptions about their potential earnings. I impute monthly wages for all women (both working and non–working) using Heckman's two step procedure.[18]

EUROMOD is then used to calculate monthly income taxes, social security and health contributions paid, and welfare benefits received for all household members for the situation of the woman working (based on predicted wage) and not working (zero wage). Benefits included in the PTR computations consist mainly of social assistance benefits (targeted to very low income households), child–related benefits, and housing benefits.[19] Computed taxes, contributions, and welfare benefits and imputed monthly wages are then used in the PTR calculation (see equation 2). The same procedure is applied to calculate the PTR for the fixed EU–wide sample of women.

Sample summary statistics of the employment rate, the PTR and the IV for the PTR by country are reported in Table 1. There are in total over 433,000 women from 26 countries in the sample. The average employment rate of prime–aged women in the sample is 82.5%, but there are large differences across countries with Scandinavian countries having an employment rate over 90% and Southern Europe with very low employment rates (close to 60% or 70%). The average participation tax rate in the sample is 30.2%, but again the PTR differs greatly across countries with Belgium, Denmark, and Slovenia having the highest average participation tax rates (over 40%), and Cyprus, Greece, and Spain having the lowest average

[18] The wage regression adjusted for selection term is run for each country and year separately to allow for different determinants of wages across countries and over time. The selection term is identified using dummies for the presence of children of different ages in the household. Other explanatory variables in the monthly wage regression include education, age, marital status, and nationality.

[19] Public pension benefits are ignored in the present study, because the focus is on prime–aged women. I also exclude maternity and parental leave benefits and unemployment benefits from the PTR computation, because the EUROMOD model includes these benefits only in few countries (eligibility for these benefits often depends on employment history, which is not available in the data). Moreover, unemployment benefits represent only a temporary income replacement, and I am more interested in medium to long term work incentive effects.

PTR not exceeding 20%. The within–country variations in the PTR are also substantial and are mainly caused by the presence of means-tested benefits and progressive income tax.[20]

Table 1: Summary statistics of employment rate and the PTR by country

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment rate		PTR		IV for PTR		Observations
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
AT	0.838	0.368	0.367	0.132	0.404	0.080	9,840
BE	0.835	0.371	0.423	0.105	0.404	0.063	14,689
BG	0.901	0.298	0.242	0.135	0.236	0.065	8,781
CY	0.775	0.418	0.109	0.152	0.106	0.071	5,385
CZ	0.837	0.370	0.308	0.116	0.350	0.053	22,042
DE	0.844	0.363	0.389	0.118	0.368	0.059	20,234
DK	0.981	0.136	0.468	0.136	0.550	0.066	9,550
EE	0.895	0.306	0.234	0.106	0.245	0.030	13,917
ES	0.732	0.443	0.175	0.091	0.165	0.054	34,864
FI	0.954	0.210	0.309	0.074	0.260	0.040	14,613
FR	0.905	0.294	0.330	0.126	0.347	0.088	21,315
GR	0.625	0.484	0.115	0.098	0.050	0.032	13,364
HU	0.825	0.380	0.326	0.109	0.365	0.094	20,729
IE	0.712	0.453	0.235	0.160	0.260	0.041	5,969
IT	0.684	0.465	0.249	0.087	0.165	0.048	46,606
LT	0.894	0.308	0.250	0.084	0.242	0.042	11,780
LU	0.740	0.439	0.394	0.183	0.427	0.063	9,585
LV	0.904	0.294	0.298	0.050	0.299	0.027	11,185
NL	0.886	0.318	0.316	0.102	0.367	0.049	22,220
PL	0.783	0.412	0.311	0.090	0.309	0.034	26,860
PT	0.818	0.386	0.270	0.139	0.375	0.091	9,373
RO	0.706	0.456	0.313	0.097	0.304	0.027	11,245
SE	0.963	0.189	0.334	0.106	0.324	0.036	13,848
SI	0.953	0.213	0.418	0.060	0.484	0.062	25,195
SK	0.905	0.293	0.327	0.181	0.347	0.067	14,643
UK	0.825	0.380	0.348	0.176	0.230	0.049	15,775
Total	0.825	0.380	0.302	0.138	0.299	0.123	433,607

Notes: The sample includes women aged 25–55, who are not in full–time education, are not pensioners, disabled, or self–employed, and do not have a child younger than 1. The number of observation for each country differs due to differences in sample sizes, but also due to the different number of years covered in different countries (see Appendix Table A.1).
Source: EUROMOD and EU–SILC data (2005–2010), own calculations.

[20]For example, there are means-tested child benefits, education benefits, and social assistance benefits in Germany, which in combination with progressive income tax system that treats married couples jointly (thereby increasing marginal tax rates of secondary earners) creates a system with quite high and much dispersed participation tax rates for women. Lithuania provides a good example of a country with a participation tax rate that has low variance. Lithuania applies a flat tax rate system to personal income, and the only means–tested benefit is the social assistance benefit for very low income households.

Summary statistics of the instrumental variable for the PTR are reported in columns 5 and 6 of Table 1. The mean of the IV follows quite closely the mean of the PTR in each country, which confirms that the IV captures most of the cross–country variation in the participation tax rates. The instrumental variable for the PTR has substantially smaller standard deviations than the PTR, because the IV varies only at group–level (while the PTR has an individual–level variation).

Finally, an evidence on time variation in the PTR is provided in Appendix Figure A.1. It illustrates changes in the distribution of the PTR over time separately for each country by plotting a box plot of the PTR for each country–year cell. Clearly, the distribution of the PTR changed substantially over time in all countries with the largest changes coinciding with some of the major tax or transfer reforms—a tax base allowances reform in Belgium in 2008, a flat tax reform in the Czech Republic in 2008, tax system changes in Denmark in 2010, the introduction of Solidarity labor income benefit in France in 2009, an increase in the number of tax brackets in Spain in 2007, etc.

4 Results

4.1 Female labor supply responsiveness to tax–transfer changes

First, I report results of the first stage regressions, which indeed confirms the strength of the instrumental variable (see Table 2). The instrumental variable is highly significant in both the specification with and without country–year fixed effects. R^2 exceeds 0.4 and the first stage F statistic is very high (above 700), so that the null hypothesis of a weak instrument is rejected (Stock, Wright, & Yogo, 2002).

The main results of the female participation responsiveness towards the PTR are reported in Table 3. The OLS effect of the participation tax rate on an employment decision is reported in the first two columns of Table 3. The effect is negative and significant at 1% and suggests that an increase of the PTR by 10 percentage points decreases employment probability by 0.6 percentage points. The implied OLS elasticity of participation decision towards the PTR is

Table 2: First stage regression results

	(1)	(2)
	Dependent var.: PTR	
PTR_IV	0.601***	0.602***
	(0.013)	(0.014)
country–year fixed effects	no	yes
R^2	0.400	0.406
F	1107.431	710.403
Observations	433,607	433,607

Notes: All regressions include a full set of country dummies, year dummies, and control variables. Standard errors in parentheses are clustered at country–year–group level, where groups are defined by education, presence of children of various ages, and marital status (* p<0.10, ** p<0.05, *** p<0.01).
Source: EUROMOD model and EU-SILC data (2005–2010), own calculations.

0.02.[21]

The 2SLS approach also implies a significant negative impact of the PTR on employment, but the magnitude of the estimated PTR effect is more than three times higher than in the OLS estimation, which confirms the presence of attenuation bias caused by measurement error and endogeneity of income in the OLS estimation.[22] The 2SLS estimation implies that an increase in the PTR by 10 percentage points decreases employment probability by 2 percentage points (see columns 3 and 4 of Table 3). The implied elasticity of labor supply with respect to the participation tax rate for the 2SLS estimates is 0.08 for the specification with country–year fixed effects (a 10% increase in the PTR decreases employment probability by 0.8%). Both the OLS and 2SLS results are very robust to the inclusion of country–year fixed effects, which allow for country–specific changes in preferences and tastes for work as well as country–level changes in policies. Estimated coefficients of the control variables have the expected signs (see Appendix Table A.3).

[21] All reported elasticities are elasticities at the mean of the independent variables. They are defined as the corresponding PTR coefficient multiplied by the mean of the PTR over the mean of an employment rate.

[22] The income endogeneity in the OLS estimation is also likely to cause a downwards bias. In most countries, the participation tax rate increases with the woman's and her husband's wages, which are both positively correlated to the woman's employment probability (through assortative matching). Therefore, the OLS estimates are likely to be biased downwards, because they include this endogenous positive correlation between the woman's PTR and her employment probability.

Table 3: Estimates of the participation equation

	(1)	(2)	(3)	(4)
	Dependent var.: employment dummy			
	OLS		2SLS	
Panel A. Estimation results				
PTR	-0.060***	-0.061***	-0.188***	-0.208***
	(0.009)	(0.008)	(0.039)	(0.030)
country–year fixed effects	no	yes	no	yes
R^2	0.174	0.175	0.173	0.173
Observations	433,607	433,607	433,607	433,607
Panel B. Elasticity of employment to PTR				
Implied elasticity	-0.022	-0.022	-0.069	-0.076

Notes: All regressions include a full set of country dummies, year dummies, and control variables. Standard errors in parentheses are clustered at country–year–group level, where groups are defined by education, presence of children of various ages, and marital status (* p<0.10, ** p<0.05, *** p<0.01). Panel A reports estimation results of equations 3 (OLS) and 5 (2SLS). Panel B reports the corresponding elasticity of employment to the PTR at the mean of independent variables.
Source: EUROMOD model and EU-SILC data (2005–2010), own calculations.

4.2 Heterogeneity in the labor supply responsiveness

This section investigates the heterogeneity in responsiveness across groups of women by their education, family composition, and by groups of countries. I report how the 2SLS estimates of the PTR effect on female employment differ by woman's education in Panel A of Table 4. The effect of the PTR is largest for the secondary educated women, for whom the 10 percentage point increase in the PTR decreases employment probability by 4.3 percentage points (the corresponding elasticity is 0.16). Both women with primary and tertiary education seem to be much less responsive to tax changes (an elasticity of 0.04 for both groups), but the effect is not significantly different from zero for women with primary education (possibly due to a small sample size). The non–linear relationship between the education and labor supply elasticity might be caused by a combination of two factors. On the one hand, less educated women have a lower employment rate (the means of the dependent variable can be found in the last column of Table 4), which usually implies larger employment elasticity. On the other hand, women with primary education tend to live in households with very low incomes, so that their participation on the labor market might be a necessity.

Panel B of Table 4 illustrates the differences in female labor supply responsiveness according to a woman's marital status and family composition. Married and cohabiting women are overall more responsive to tax and transfer changes than single women, which is a finding consistent with most previous studies (see, e.g. Bargain et al., 2014). The estimated PTR elasticity is 0.08 for married and cohabiting women and 0.06 for single women. However, when splitting the two groups by the presence of small children up to 5 years of age, a slightly different picture emerges. Single women with small children have by far the highest participation elasticity of 0.32, which is consistent with previous findings, where lone mothers are the demographic group with the highest participation elasticity (Meghir & Phillips, 2008). Married and cohabiting women with small children also have a very large participation elasticity of 0.16, while both single and coupled women without small children have a substantially lower responsiveness towards tax and transfer changes (corresponding elasticities of 0.06 and 0.05 for coupled and single women, respectively).

Finally, I investigate the heterogeneity of the effect of the PTR on employment by groups of countries. For this purpose, I use a well–known welfare regime typology by Esping-Andersen (1990) that creates groups of countries based on social policies and organization of work. Esping-Andersen (1990) differentiated between three models of the welfare state: the social–democratic, the liberal, and the conservative–corporatist welfare state. This typology was later extended with the Southern-European welfare regime (Ferrera, 1996), and the European post–communist and former–USSR categories (Fenger, 2007). I use this extended welfare regime categorization of Fenger (2007), which allows the categorizing of all countries in the sample.[23]

Panel C of Table 4 reports the PTR coefficients and elasticities by welfare regime. The participation elasticities are highest in the liberal (0.14), the post–communist (0.11), and the Southern–European (0.10) welfare regimes. These are also the three groups of countries with the lowest female employment. Therefore, the results are consistent with previous find-

[23]See the note below Table 4 for the division of countries into welfare regimes.

Table 4: Estimates of the participation equation: heterogeneity of responses

	Dependent var.: employment dummy			
	2SLS			
	PTR (coeff.)	PTR (elast.)	N	dep. mean
Panel A. The PTR effect by woman's education				
Primary education	-0.093	-0.043	25,322	0.528
	(0.104)			
Secondary education	-0.429***	-0.161	250,280	0.796
	(0.041)			
Tertiary education	-0.125***	-0.043	158,005	0.919
	(0.033)			
Panel B. The PTR effect by family structure				
Married and cohabiting	-0.219***	-0.083	330,216	0.799
	(0.037)			
- with small children	-0.366***	-0.160	74,787	0.694
	(0.071)			
- without small children	-0.176***	-0.064	255,429	0.830
	(0.042)			
Single	-0.180***	-0.059	103,391	0.909
	(0.037)			
- with small children	-0.748***	-0.317	7,909	0.712
	(0.151)			
- without small children	-0.143***	-0.046	95,482	0.926
	(0.037)			
Panel C. The PTR effect by welfare regime				
Social–Democratic	-0.020	-0.007	38,011	0.964
	(0.052)			
Liberal	-0.361***	-0.144	21,744	0.794
	(0.061)			
Conservative–Corporatist	-0.121***	-0.052	97,883	0.854
	(0.046)			
Southern–European	-0.328***	-0.095	109,592	0.708
	(0.067)			
Post–Communist	-0.277***	-0.108	129,495	0.847
	(0.052)			
Former–USSR	-0.132	-0.038	36,882	0.898
	(0.261)			

Notes: The table reports the PTR coefficients from the 2SLS estimation applied separately to each group of women, the corresponding elasticity of employment to the PTR at the mean of independent variables, number of observations (N), and a mean of the dependent variable for each group. All regressions include a full set of country–year fixed effects and control variables. Standard errors in parentheses are clustered at country–year–group level (* $p<0.10$, ** $p<0.05$, *** $p<0.01$). The division of countries into welfare regimes is as following: DK, FI, SE belong to the social–democratic; IE, UK belong to the liberal; AT, BE, DE, FR, LU, NL belong to the conservative–corporatist; CY, GR, IT, PT, ES belong to the Southern–European; BU, CZ, HU, PL, RO, SI, SK belong to the post–communist; and EE, LT, LV belong to the former–USSR welfare regime.
Source: EUROMOD model and EU-SILC data (2005–2010), own calculations.

ings that elasticities are larger in countries where female employment is lower (Bargain et al., 2014; Blau & Kahn, 2007). The responsiveness is substantially lower in the conservative–corporatist welfare regime, and not significantly different from zero in the social–democratic and the former–USSR welfare regimes. This is not very surprising given that the female employment rates in these two groups of countries reach 96.4% and 89.8%, respectively.

Results presented in this section are also in line with Bargain et al. (2014), which is the closest paper to this study. Due to methodological differences and due to the fact that I estimate elasticities with respect to participation tax rates, while Bargain et al. (2014) estimate responsiveness to net wages and non–labor income, a direct comparison of my results with Bargain et al. (2014) is rather difficult. Nevertheless, both studies have found substantially smaller female labor supply elasticities than was found in most of the previous literature (Arellano & Meghir, 1992; Callan, van Soest, & Walsh, 2009; Laroque & Salanié, 2002; van Soest, Das, & Gong, 2002). Both studies also found a substantial heterogeneity of labor supply elasticities across countries (with the UK and the Southern–European countries being among the largest–elasticity countries), and across groups of women (with the largest participation elasticity among single mothers).

4.3 Examining the quality of the PTR imputation

In this section, the quality of the PTR imputation to the EU–SILC data is examined (for details on the imputation, see Section 3.1). To illustrate the impact of the PTR imputation on the estimated coefficients, I compare the results of the participation equation based on the underlying EUROMOD data and based on the EU-SILC data (with the imputed PTR) for the same set of country–year cells. The main difference between the two datasets is that the underlying EUROMOD data include the calculated PTR, while the EU–SILC data only have the imputed PTR. I restrict the sample to all countries, for which the EUROMOD data are available for years 2005–2007.

The comparison of results is provided in Appendix Table A.2. The PTR is highly significant in the 2SLS specification and the magnitude of coefficients is quite similar using both the EUROMOD data and the EU–SILC data with the imputed PTR—the coefficients are -0.52

based on the EUROMOD data and -0.44 based on the EU–SILC in the specification with country–year fixed effects. The elasticities are also quite similar, although again somehow larger in the estimation using the EUROMOD data—elasticity of 0.18 as compared to 0.15 based on the EU–SILC.[24]

The estimated coefficients in the OLS specification are quite different using the EUROMOD data and EU–SILC data. In fact, the results based on the EUROMOD data suggest a positive effect of the PTR on employment probability. Therefore, the magnitude of bias in the OLS estimation seems to be much higher than is suggested by the EU–SILC estimation results (see Appendix Table A.2). Overall, the estimation results based on the EU–SILC data with the imputed PTR thus seem to be somewhat smaller in magnitude than those based on the EUROMOD data suggesting a presence of a downward bias caused by the imputation procedure.[25] Nevertheless, the main findings stay unchanged whether we use the EUROMOD data or the data with the imputed PTR.

Conclusion

This paper investigates the impact of tax and transfer policies in the countries of the EU on the extensive margin of female labor supply. Unlike previous studies, I utilize an indicator of extensive margin work incentives—the participation tax rate—as the main explanatory variable. This allows the capturing of the effect of both tax and benefit systems on the work incentives of women and dealing with possible endogeneity of the participation tax rate by using a simulated instrumental variable. The instrumental variable allows me to exploit only the variation in the participation tax rate due to changes in policies setting aside the variation due to measurement error and endogenous behavioral responses. Further, the rich structure of the data, which cover 26 EU countries in 2005–2010, allows me to control for time–invariant,

[24] The estimated coefficients and elasticities presented here are much larger in magnitude than the estimates presented in Section 4.1. This is because they are based on a selected group of counties for which the EUROMOD data are available for years 2005–2007. This sample selection was mainly driven by the necessity to have a sufficient number of tax and transfer changes in the sample to be able to identify the effect of the PTR on employment decision in the EUROMOD data.

[25] As the imputation procedure increases measurement error in the PTR, the downward bias was to be expected.

as well as time–varying country–level unobserved factors (such as economic shocks, tastes for work, or family policies), and use all policy changes that took place in these countries between 2005 and 2010 for identification.

The results suggest that the participation decisions of women in the EU are indeed negatively affected by the level of effective taxation they face. The comparison of estimates based on the OLS and the IV approaches confirms the presence of attenuation bias caused by the measurement error and income endogeneity. The instrumental variable estimation implies that a 10 percentage point increase in the participation tax rate decreases the female employment probability by 2 percentage points (the corresponding participation elasticity is 0.08). The effect is higher for secondary educated women—results suggest that secondary educated women respond to the 10 percentage point increase in the PTR by decreasing their employment probability by 4.3 percentage points (elasticity of 0.16). Women with primary and tertiary education are substantially less responsive to tax and transfer incentives (elasticity of 0.04 for both groups).

I also investigate the heterogeneity of responses towards tax and transfer systems across groups of women by their marital status and family composition. The results are in line with previous findings (Bargain et al., 2014; Keane, 2011)—the responsiveness is higher for married women than for single women, for women with small children than for those without small children, and the highest elasticities are found for the group of single mothers (participation elasticity of 0.32).

Further, I use the typology of welfare regimes originally proposed by Esping-Andersen (1990) to uncover the heterogeneity of responses across groups of countries. The results indicate that the effect of the PTR on the employment probability is the highest for the liberal welfare regime (to which Ireland and the UK belong), the post–communist and the Southern–European welfare regimes. These are also the three groups of countries with the lowest female employment rate. Therefore, the findings are consistent with previous findings that suggest that the higher the female labor force participation, the lower the female labor supply elasticity (Blau & Kahn, 2007).

Bargain et al. (2014) is to my knowledge the only study that uses multinational tax–benefit microsimulation model in the analysis of female labor supply behavior, and is thus closest to the present study. Similar to Bargain et al. (2014), I find much smaller female participation elasticities than some previous studies, and a substantial heterogeneity of elasticities across groups of women and across countries. In particular, single mothers and women living in Southern Europe and the UK have the largest participation elasticities according to both the present study and Bargain et al. (2014). However, the present study takes a different estimation approach and uses a much longer time span than Bargain et al. (2014). My sample also covers 7 post–communist and 3 former–USSR countries, which have been only rarely studied in the female labor supply literature, and from which Bargain et al. (2014) cover only Estonia, Hungary and Poland. My results suggest that the post–communist countries have one of the highest female participation elasticities, while the former–USSR countries belong to the group of countries with the highest female employment and lowest participation elasticities.

Multinational microsimulation models offer a very useful tool for the study of tax and transfer impact on the labor supply, as they allow for a large scale international comparison as well as a comprehensive analysis of heterogeneity in responsiveness across groups of individuals. However, they have been scarcely used in the labor supply elasticity literature. The main shortcoming of these models is a relatively short time span that they cover so far. Therefore, future research should take advantage of a much richer time variation in policies that will be available in the multinational microsimulation models and use it to further reconcile the persisting controversy over the responsiveness of labor supply to tax and transfer changes.

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Appendix

Table A.1: Overview of country–year cells used in the analysis

	Tax–benefit rules						Input data		
	2005	2006	2007	2008	2009	2010	2005	2006	2007
AT			x	x	x	x			x
BE	x	x	x	x	x	x	x	x	x
BG			x	x	x	x			x
CY		x	x	x				x	x
CZ	x	x	x	x	x	x	x	x	x
DE			x	x	x	x			x
DK			x	x	x	x			x
EE	x	x	x	x	x	x	x	x	x
FI			x	x	x	x			x
FR		x	x	x	x	x		x	
GR	x	x	x	x	x	x	x	x	x
ES	x	x	x	x	x	x	x	x	x
HU		x	x	x	x	x		x	x
IE		x	x	x				x	x
IT	x	x	x	x	x	x	x	x	x
LT	x	x	x	x	x	x	x		x
LU			x	x	x	x			x
LV		x	x	x	x	x		x	x
NL		x	x	x	x	x		x	x
PL		x	x	x	x	x		x	x
PT		x	x	x	x	x		x	x
RO			x	x	x	x			x
SE		x	x	x	x	x		x	x
SI		x	x	x	x	x		x	x
SK		x	x	x	x	x		x	x
UK		x	x	x	x	x			x

Notes: Table illustrates for which country–year cells the EUROMOD tax–benefit computations are available and for which cells the EUROMOD input data are available. The main results are based on all country–year cells, for which the tax–benefit rules are available.

Table A.2: Comparison of results based on EUROMOD data and EU-SILC data with the imputed PTR

	(1)	(2)	(3)	(4)
	Dependent var.: employment dummy			
	OLS		2SLS	
Panel A: Results based on EUROMOD data (2005-2007)				
PTR (coefficient)	0.330***	0.329***	-0.434*	-0.519**
	(0.090)	(0.090)	(0.250)	(0.242)
PTR (elasticity)	0.115	0.115	-0.151	-0.181
country–year fixed effects	no	yes	no	yes
R^2	0.201	0.201	0.179	0.174
Observations	75,928	75,928	75,928	75,928
Panel B: Results based on EU-SILC data (2005-2007)				
PTR (coefficient)	-0.048*	-0.056**	-0.361***	-0.438***
	(0.027)	(0.025)	(0.137)	(0.081)
PTR (elasticity)	-0.016	-0.019	-0.121	-0.147
country–year fixed effects	no	yes	no	yes
R^2	0.181	0.182	0.177	0.175
Observations	75,066	75,066	75,066	75,066

Notes: All regressions include a full set of country dummies, year dummies, and control variables. The sample is restricted to the same set of country–year cells for both samples—to all countries, which have years 2005–2007 covered in the EUROMOD input data. Standard errors in parentheses are clustered at country–year–group level, where groups are defined by education, presence of children of various ages, and marital status (* $p<0.10$, ** $p<0.05$, *** $p<0.01$).
Source: EUROMOD and EU–SILC data (2005–2007), own calculations.

Table A.3: Estimates of the participation equation, full specification

	(1)	(2)	(3)	(4)
	Dependent var.: employment dummy			
	OLS		2SLS	
PTR	-0.060***	-0.061***	-0.188***	-0.208***
	(0.009)	(0.008)	(0.039)	(0.030)
secondary education	0.201***	0.200***	0.202***	0.201***
	(0.009)	(0.009)	(0.009)	(0.009)
tertiary education	0.302***	0.302***	0.306***	0.306***
	(0.008)	(0.008)	(0.008)	(0.008)
age	0.030***	0.030***	0.030***	0.030***
	(0.001)	(0.001)	(0.001)	(0.001)
age squared	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
child aged 1	-0.090***	-0.090***	-0.090***	-0.090***
	(0.006)	(0.006)	(0.006)	(0.006)
child aged 2	-0.222***	-0.222***	-0.222***	-0.222***
	(0.013)	(0.013)	(0.013)	(0.013)
child aged 3	-0.171***	-0.171***	-0.170***	-0.170***
	(0.011)	(0.011)	(0.011)	(0.011)
child aged 4-5	-0.074***	-0.074***	-0.074***	-0.074***
	(0.005)	(0.005)	(0.005)	(0.005)
child aged 6-9	-0.056***	-0.056***	-0.056***	-0.055***
	(0.004)	(0.004)	(0.004)	(0.004)
child aged 10-15	-0.036***	-0.037***	-0.036***	-0.036***
	(0.004)	(0.004)	(0.004)	(0.004)
married	-0.101***	-0.101***	-0.102***	-0.101***
	(0.006)	(0.006)	(0.006)	(0.006)
cohabiting	-0.055***	-0.055***	-0.056***	-0.056***
	(0.005)	(0.005)	(0.005)	(0.005)
number of HH members	-0.021***	-0.021***	-0.022***	-0.022***
	(0.001)	(0.001)	(0.001)	(0.001)
presence of elderly in the HH	-0.003	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
inactive partner	-0.042***	-0.042***	-0.042***	-0.042***
	(0.003)	(0.003)	(0.003)	(0.003)
secondary–educated partner	0.042***	0.042***	0.042***	0.042***
	(0.004)	(0.004)	(0.004)	(0.004)
tertiary–educated partner	0.058***	0.058***	0.059***	0.058***
	(0.004)	(0.004)	(0.004)	(0.004)
country–year fixed effects	no	yes	no	yes
R^2	0.174	0.175	0.173	0.173
Observations	433,607	433,607	433,607	433,607

Notes: All regressions include a full set of country and year dummies. Standard errors in parentheses are clustered at country–year–group level, where groups are defined by education, presence of children of various ages, and marital status (* p<0.10, ** p<0.05, *** p<0.01).
Source: EUROMOD model and EU-SILC data (2005–2010), own calculations.

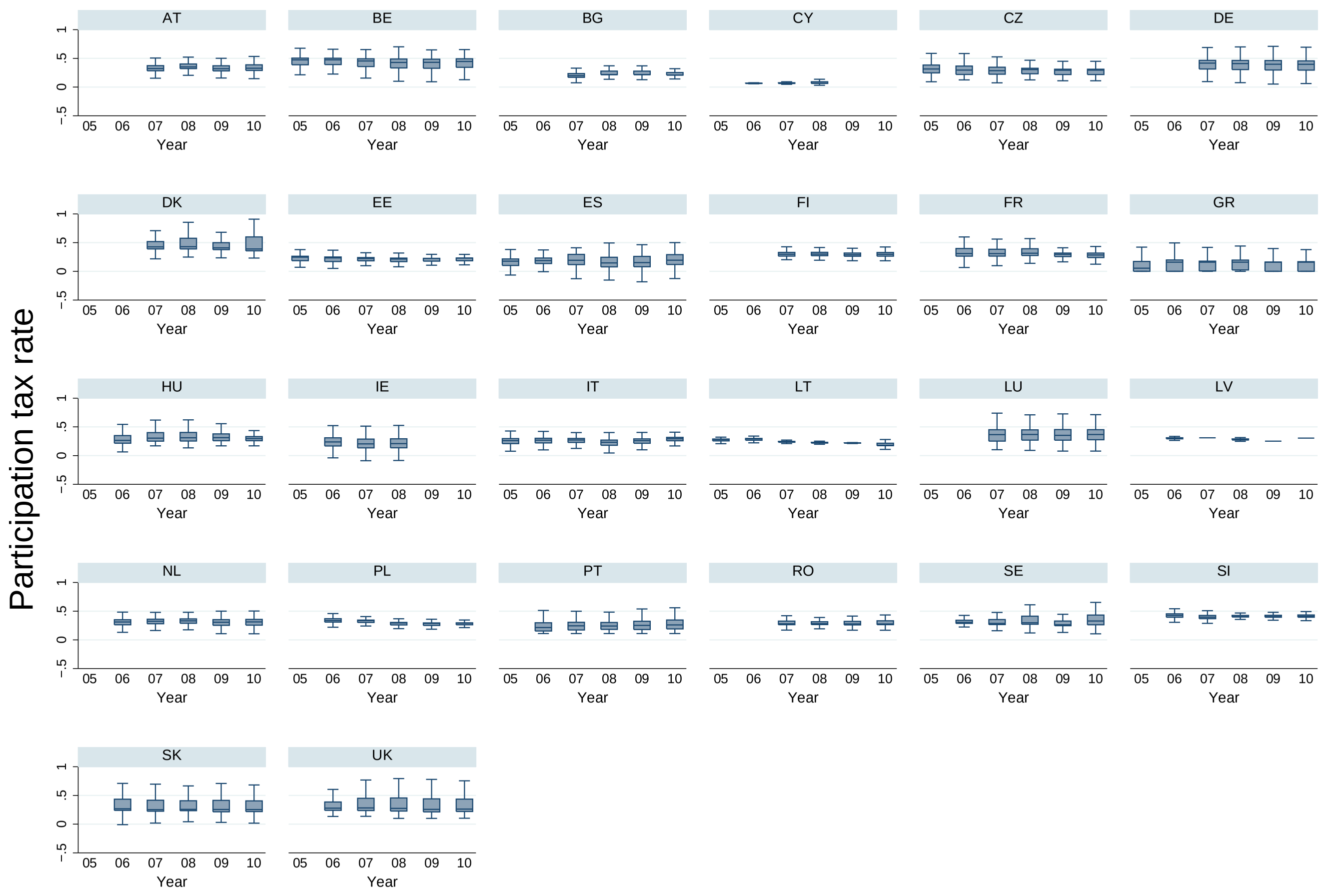

Figure A.1: Evolution of the PTR for women in the EU countries between 2005 and 2010

Notes: Each box plot indicates the 25th and 75th quartile (the bottom and top of the box), the median (the band inside the box), and the lowest (highest) datum still within 1.5 interquartile range of the lower (upper) quartile (the ends of the whiskers).
Source: EUROMOD model and EU–SILC data (2005–2010), own calculations.