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

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Abstract

The growing microsimulation literature suggests that effective tax rates on women are inefficiently high in many countries. However, there is no consensus in the economic literature about the female labor supply consequences of these high effective tax rates. This study uses a tax–benefit microsimulation model EUROMOD to estimate the effect of tax and transfer policies on the female labor supply. A main contribution lies predominantly in the rich structure of the data, which cover the EU–27 countries for 2005–2009. Moreover, this study uses a novel way to deal with the endogeneity of taxes and benefits at the individual level. I create a group–level instrumental variable based on a fixed sample of women drawn from the whole EU that serves as a behaviorally-neutral measure of work incentives. Results of the instrumental variable estimation suggest that a 10 percentage point increase in the participation tax rate decreases female employment probability by 2 percentage points. The effect is higher for more educated women and differs substantially across countries.

Keywords: female labor supply, tax and benefit system, cross–country study, instrumental variable

JEL classification: J21, H24

*This research is supported by the 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. We are indebted to the many people who have contributed to the development of EUROMOD and to the European Commission for providing financial support for it. 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 Spanish Statistical Office (INE); Italian SILC 2008 data made available by Italian Statistical Office (ISTAT); Austrian SILC 2008 data made available by Statistics Austria; United Kingdom Family Resources Survey 2008 data made available by UK Data Archive. The results and their interpretation are the author's exclusive responsibility.

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Introduction

The impact of tax–benefit policies on female employment has been widely studied in the economic literature. However, due to the complicated nature of the tax and benefit systems, most of the studies focus on one country only. Moreover, the estimated magnitudes of female labor supply elasticities vary greatly across studies and most of the research is concentrated on the developed economies of Western Europe, while there is very little evidence for the new EU member states (for a survey see Meghir & Phillips, 2008 or Keane, 2011).

Recent developments in the cross–country microsimulation models allowed researchers to model tax and benefit systems for more than one country in a comparable way. Microsimulation models have been used to describe the differences in the tax–and–transfer treatment of men and women across countries, and several microsimulation studies point to the negative correlation between the relative taxation of women (as compared to men) and their labor force participation (Immervoll & O'Donoghue, 2002; Immervoll, Kleven, Kreiner, & Verdelin, 2009). However, these studies provide no evidence about the causal effect of tax–and–transfer policies on female labor supply.

This study aims to combine the two streams of literature by using the tax–benefit microsimulation model to estimate the effect of tax and transfer policies on the female labor supply. The main contribution is threefold.

First, this study uses a wider source of policy variation than was used in most of the previous literature. The microsimulation model EUROMOD[1] provides simulations of taxes and benefits at the individual level for EU–27 countries for 2005–2009. Rich structure of the data also enables to control for time–invariant unobserved country–specific characteristics (such as culture and informal institutions), but also for time–varying country–level unobserved factors (such as country–level economic

[1] EUROMOD is a tax–benefit microsimulation model for all EU member states. In this research, 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.

shocks or changes in family policies).

Second, I use a measure of extensive margin work incentives—the participation tax rate (PTR)—as the main explanatory variable.[2] PTR is defined as a ratio of the difference between net taxes in work and out of work to the gross wage, and it thus describes the extent to which tax–and–benefit systems replace lost earnings if an individual moves out of work. This approach is in contrast to most of the studies on labor supply elasticities, which estimate participation elasticities with respect to net wages. PTR allows to capture the effect of both taxes and transfers on the labor force participation decision,[3] and to deal with possible endogeneity of the decision by using an instrumental variable.

Third, I apply the simulated IV strategy to deal with possible endogeneity of the participation tax rate. This strategy allows me to exploit only the variation in the participation tax rate due to changes in policies and not due to changes in individual behavior.[4] I instrument the individual–level participation tax rates with a group–level measure of tax and transfer systems that is created based on a fixed sample of women from the whole EU. The instrumental variable for a woman from group g,[5] country c, and year t is calculated as an average PTR of the fixed sample of women who belong to the group g, and whose PTR is simulated based on tax–transfer system of country c and year t. Therefore, the only variation in the IV stems from the variation in tax and transfer policies across EU countries, over time, and across groups of women. This method builds on the simulated instrument approach used in the health economics literature (see Currie & Gruber, 1996, Cutler & Gruber, 1996), but it is also related to the simulated IV of Gruber and Saez (2002) or Moffitt and Wilhelm (2000).

[2]Throughout the paper, I focus on the extensive margin of labor supply, because the responsiveness of female labor supply was found to be driven by labor force participation, not by hours worked of the working (Blundell, Duncan, & Meghir, 1998).

[3]As Immervoll (2004) pointed out, focusing only on taxes and ignoring the transfer system in evaluation of redistribution schemes' incentives can be very misleading.

[4]This is a standard problem of income endogeneity, which here transfers to potential endogeneity of the participation tax rate, because individual labor supply decisions might affect the level of participation tax rate.

[5]Groups are defined based on age intervals, education levels, the presence of children of different ages, and marital status.

To my knowledge, Bargain, Orsini, and Peichl (2012) is the only paper that uses microsimulation model in the labor supply elasticity estimation, and is thus closest to the present study. They use microsimulation models, EUROMOD and TAXSIM, to estimate labor supply elasticities of men and women in Europe and the U.S. Compared to Bargain et al. (2012), this study takes advantage of a newer version of the EUROMOD model, which includes more countries and a longer time span, while I also take a different estimation approach. My methodology is based on reduced–form estimation combined with an instrumental variable approach, while Bargain et al. (2012) use a structural model. Moreover, I estimate elasticities with respect to participation tax rates, while Bargain et al. (2012) estimate responsiveness to net wages and other household income. Therefore, a direct comparison of my results with Bargain et al. (2012) is rather difficult. Nevertheless, both studies have found a substantially smaller female labor supply elasticities than what was found in most of the previous literature (see e.g. Callan, van Soest, & Walsh, 2009; or van Soest, Das, & Gong, 2002).

I have found a significant effect of participation tax rate on the employment decisions of women in the EU, but the magnitude of estimated coefficients implies that a 10 percentage point increase in the participation tax rate decreases female employment probability by 2 percentage points only. I also investigate the heterogeneity of the effect across groups of women and across countries, and I conclude that the effect is higher for more educated women and differs substantially across countries. This is consistent with results of Bargain et al. (2012), who also found substantial heterogeneity of labor supply elasticities across countries, which is most likely driven by differences in formal and informal institutions.

1 Related literature

There is extensive literature that uses the microsimulation approach to describe differences in work incentives across countries and across different groups of individuals (Immervoll & O'Donoghue, 2002; Figari, Immervoll, Levy, & Sutherland, 2007; Immervoll, Kleven, Kreiner, & Saez, 2007; Immervoll et al., 2009). These studies simulate work incentive measures for a representative sample of population, and describe how the tax–benefit system applies to the existing population. However, by analysing the work incentives of the population in a given country, cross–country comparisons can hardly separate the effect of tax–benefit system itself from the effect of demographic composition and income distribution in the country. This might be potentially important if we want to assess the effects of tax–benefit systems alone (setting apart the effect of demographic composition). Moreover, these studies are merely descriptive; they do not aspire to evaluate the role that the work incentives measures play in labor supply decisions. In this study, I will use the microsimulation model, but the analysis applied here will allow me to separate the effect of demographic composition from the effect of tax–benefit systems and evaluate the role of work incentives in actual labor supply decisions.

The literature assessing the responsiveness of labor supply decisions to tax and benefit changes can be separated into three main groups—structural models, reduced–form, and grouped data estimation. Most labor supply elasticity estimates come from the structural literature. Female labor supply elasticities are usually estimated using a family labor supply model (see e.g. van Soest, 1995; Hoynes, 1996; Blundell, Duncan, McCrae, & Meghir, 2000). Due to the complicated nature of tax and benefit systems that need to be incorporated into the model, most of these studies focus on one country only (usually the U.K. or the U.S.). However, recent developments in the cross–country microsimulation models of tax and benefit systems allowed researchers to estimate labor supply elasticities for more than one country in a comparable way. Bargain et al. (2012) is the first study to use the two most developed microsimulation models, EUROMOD and TAXSIM, for a large scale labor supply elasticities comparison across Europe and the U.S. Compared to Bargain et al. (2012), this study takes advantage of a newer version of the EUROMOD model, which includes more countries and a longer time span, while I also take a reduced–form approach combined with an instrumental variable (Bargain et al., 2012 estimates labor supply elasticities using a structural model).

The second group of studies uses a specific tax or transfer reform in the reduced–form estimation of labor supply elasticities (see e.g. Eissa & Liebman, 1996; Meyer & Rosenbaum, 2001; Saez, Matsaganis, & Tsakloglou, 2012). Similarly to the structural literature, most of these studies provide evidence for one country only. Moreover, these studies usually report estimates specific to the examined reform without providing comparable measures of the labor supply elasticities. Finally, grouped data studies identify the labor supply elasticities by estimating group–average regressions over a long time series (see e.g. Blundell et al., 1998; Causa, 2009; Devereux, 2004; Blau & Kahn, 2007). Their approach is in a sense generalization of the reduced–form approach using one specific reform. The identification is based on the fact that different groups of individuals are affected by tax reforms differently over time.

In this study, I built upon the reduced–form approach, but I use all tax and transfer reforms in the EU countries between 2005 and 2009 as a source of policy variation. The present study is also related to the grouped data literature, because it uses a group–level instrumental variable. Grouped data estimation has been shown to be equivalent to using group–level instruments, but my instrumental variable allows not only getting rid of the income endogeneity problem, but also disentangling the effect of tax and transfer policies from other factors like demographic composition and income distribution. But the main contribution to the existing literature lies in the novel approach to estimating labor supply elasticities. I estimate elasticities with respect to participation tax rates, while previous literature analysed responsiveness to net wages and other household income. My approach allows me to simulate the instrumental variable for the participation tax rate, and thus deal with endogeneity of labor supply decisions and measurement error in the imputed wages (see the next section).

2 Empirical approach

2.1 Simple model of family labor supply

In this section, I set up a simple extensive labor supply model, which gives basis for my empirical strategy. Similar labor supply models have been used in the labor supply literature (e.g. Eissa & Hoynes, 2004), but I mainly build the model based on Immervoll et al. (2009) paper. This model describes the extensive margin decision of labor supply, because that is the focus of this paper. Therefore, each woman faces a decision whether to work or not, while the working hours conditional on working are fixed at full–time work (40 hours a week). Let me first consider single women and married/cohabiting women separately before I build a common framework to study their participation decisions.

Labor supply of single women

Single women are the primary and also the only potential earner in a household. Each woman has a fixed earnings potential e_w^p, so that the participation choice e_w is between $e_w = e_w^p$ and $e_w = 0$. The participation decision depends on heterogeneous costs of work (including disutility from work, value of lost home production, child care costs etc.) and earnings potential. All women share a quasi–linear utility function of the form:

$$u = e_w - T(e_w, \rho) - q_w \times 1(e_w > 0) \tag{1}$$

where q_w denotes costs of work that are present only if the woman works ($e_w > 0$). The effect of taxes and transfers is captured by the tax–transfer function $T(e_w, \rho)$, which represents net taxes paid by the woman (taxes paid less benefits received). The ρ term is a parameter representing features of the tax–transfer system. Each woman chooses between $e_w = e_w^p$ and $e_w = 0$ to maximize her utility. This specification does not allow for income effect, which considerably simplifies the analysis, so that this assumption is used in many labor supply studies (Immervoll et al., 2009; Blundell et al., 1998). Moreover, income elasticities have been found to be extremely small in the previous literature (Bargain et al., 2012; Blundell et al., 2000).

The 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. The woman decides to enter the labor market if:

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

Labor supply of married/cohabiting women

Married and cohabiting women are assumed to be secondary earners; their labor force participation decision follows their spouse's decision. The participation decision of these women depends on the costs of work and the earnings potential of each individual woman, but also on the earnings potential of their partner. I also assume that spouses pool their resources, and the utility function is defined at the household level:

$$u = e_m + e_w - T(e_m, e_w, \rho) - q_m \times 1(e_m > 0) - q_w \times 1(e_w > 0), \tag{3}$$

where e_m denotes man's earnings, e_w denotes woman's earnings, q_m and q_w their respective costs of work, and $T(.)$ is a tax–transfer function of both spouse's earnings.[6] Each woman again chooses between $e_w = e_w^p$ and $e_w = 0$ to maximize the household utility taking her partner's earnings as given. Therefore she again compares the costs of work with the net gain from work, which is defined as her earnings less the difference in net taxes paid by the household in case she works over the net taxes paid if she does not work. She decides to participate on the labor

[6]Notice that the earnings of the two spouses can interact in the tax–transfer function, as it is the case in many systems where the earnings of one of the spouses affect the taxes of the other—e.g. in joint taxation systems or in individual taxation systems with the tax credit for non–working spouse.

market if:

$$q_w \leq e_w^p - [T(e_m, e_w^p, \rho) - T(e_m, 0, \rho)]. \tag{4}$$

Clearly, the only difference between single and married/cohabiting woman's decision to work (comparison of equations 2 and 4) is in the fact that the spouse's earnings enter the tax–transfer function of the household. Therefore, it is quite easy to built a common framework for the participation decision of single and married/cohabiting women.

The participation tax rate

The participation decisions of both women in couples and single women (equations 2 and 4) can be expressed in terms of the participation tax rate:

$$PTR \equiv \frac{[T(e_m, e_w^p, \rho) - T(e_m, 0, \rho)]}{e_w^p} \leq \frac{e_w^p - q_w}{e_w^p} \tag{5}$$

where e_m (spouse's income) is not present in the tax–transfer function for single women. Participation tax rate (PTR) describes the proportion of lost earnings that is compensated by lower taxes and higher benefits when not in paid work. It summarizes the (dis)incentives provided by the tax–transfer system for the extensive margin decision of labor supply. Consequently, we can define the participation elasticity as follows:

$$\epsilon_w \equiv \frac{\partial Empl}{\partial [e_w(1 - PTR)]} \frac{[e_w(1 - PTR)]}{Empl}, \tag{6}$$

where *Empl* is a participation dummy.

2.2 Estimation and identification

The model from the previous section provides a basis for a reduced form estimation technique applied 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:

$$Empl_{ict} = \alpha PTR_{ict} + \beta' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + \epsilon_{ict}, \tag{7}$$

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, children of certain ages, and elderly in the household, 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 some specifications all country–year interactions (γ_{ct}) are included. Therefore, I allow for unobserved country–specific fixed effects, which capture all country–level policies that affect women in different countries differently (like maternity and parental leave policies, child care provision) and also the unobserved country–specific tastes for work, cultural norms, gender–role attitudes, or labor market conditions.

However, even though I use imputed wages to construct the PTR (see the Participation tax rate simulations section below), the level of tax rate can be influenced by individual labor supply decisions and by measurement error in the imputed wages. I deal with this possible endogeneity of the participation tax rate by using a simulated instrument for the PTR. The instrument represents a group–level measure of the tax–transfer work incentives that 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 (see Currie & Gruber, 1996, Cutler & Gruber, 1996), but it is also related to the simulated IV used in the labor supply elasticities literature (Gruber & Saez, 2002, Moffitt & Wilhelm, 2000).

The instrumental variable for PTR is created in three steps. First, I take random sample of women ($j = 1, ..., J$) from the pooled sample of EUROMOD data for all EU countries in year 2007.[7] This provides a fixed sample of women with given

[7] I take random sample of 30,000 households, which gives me a sample of almost 17,000 women.

demographic characteristics and income distribution. Second, I calculate the participation tax rate PTR_{jct} for woman j (from the fixed sample of women) applying country c and year t's tax and transfer system. I repeat this simulation for each woman in the fixed sample and for each country–year combination.[8]

Third, the instrumental variable for a woman from group g, country c, and year t is constructed as an average of PTR_{jct} of women from a random sample who belong to group g.[9] 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 behavioral part of PTR and the effect of measurement error are filtered out using the fixed sample of women. Moreover, this IV gives a clear and comparable measure of tax–transfer treatment that is purified from the effect of different demographic composition of income distribution across countries.

The simulated instrument is then used in the 2SLS estimation, where the IV is used to predict the actual participation tax rate. The 2SLS estimation is based on the following equations:

$$PTR_{ict} = \lambda PTR\_IV_{ict} + \theta' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + u_{ict}, \tag{8}$$

$$Empl_{ict} = \delta \widehat{PTR}_{ict} + \phi' X_{ict} + \gamma_t + \gamma_c + (\gamma_{ct}) + e_{ict}, \tag{9}$$

where PTR_IV_{ict} is the instrumental variable for PTR, $\widehat{PTR}_{ict}$ denotes the pre-

[8]There are 102 country–year cells used in the estimation (for details on the sample selection, see next section). Therefore, for each woman in the fixed sample, I have 102 simulated PTRs, where each simulated PTR_{jct} corresponds to the tax–benefit system in a country c and year t. To avoid problems with income–level differences across countries of EU, I calculate these PTRs for the fixed sample of women based on adjusted incomes. I assign each woman in the sample a quantile in the distribution of income in her country of origin, and then change her income to correspond to the average income in the same quantile, but in the income distribution of country c. I create a very detailed wage 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 simulations as well.

[9]Groups are defined based on three age categories (25–34, 35–44, 45–55), three educational categories (primary, secondary, and tertiary education), seven categories according to the presence of children of various ages (children aged 1, 2, 3, 4–5, 6–9, 10–15, and no children below 16), and two categories by marital status (single and married). Therefore, the IV for a married childless woman aged 26 with tertiary education living in Germany in 2008 is calculated as an average PTR of women from the fixed sample who are also married, childless, aged 25–34, and tertiary educated, and whose PTR is calculated based on tax–transfer system in Germany in 2008.

dicted PTR from the first stage regression, and δ denotes the coefficient of interest.

3 Data and microsimulation of taxes and benefits

3.1 Data and sample selection

The empirical analysis makes use of the EU–wide tax–benefit microsimulation model EUROMOD. EUROMOD is largely based upon harmonized EU–SILC data[10] (that are further adjusted for microsimulation purposes) combined with a detailed tax–benefit simulator. 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 simulation of taxes and benefits (for details on EUROMOD project, see Sutherland, 2007). This makes EUROMOD a very suitable instrument for computing participation tax rates in a comparable way for different countries.

Current version of the EUROMOD model simulates tax–benefit systems for all 27 countries of the EU, but I exclude Maltese data from the analysis, because they have serious shortages.[11] I utilize EUROMOD simulations of tax–transfer rules that were in force in years 2005 to 2009. However, not all countries have tax–benefit simulations available for all years as some countries joined the EUROMOD project only in 2006 and some in 2007.[12] Moreover, while EUROMOD simulates tax and transfer rules for all above mentioned years, the input data are available only for selected years (microsimulation of the tax and benefit systems for the years that do not have corresponding input data in EUROMOD is based on data from previous

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

[11]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.

[12]Microsimulations for year 2005 are available only for Belgium, the Czech Republic, Estonia, Greece, Spain, Italy, and Lithuania. In 2006, there were 11 more countries joining the EUROMOD project: Cyprus, France, Hungary, Ireland, Latvia, Netherlands, Poland, Portugal, Sweden, Slovenia, and Slovakia. Simulations for year 2007 are already available for all EU–27 countries.

years with adjusted incomes). The overview of available country–year combinations is provided in Table A.1 in the Appendix.

These country–year combinations, which are simulated within EUROMOD 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, EUROMOD can be used to simulate participation tax rates for all available country–year combinations (even for those that do not have input data for the particular year available), and then the simulated participation tax rates can be assigned to individuals in the EU–SILC data, because EU–SILC data are available for all years between 2005 and 2009. Participation tax rates computed within EUROMOD are assigned to women in the EU–SILC data based on their income and household characteristics (using propensity score matching procedure).[13] This approach is based on the fact that participation tax rate is merely a function of incomes and other observable characteristics of individuals in a household. The quality of assignment of participation tax rates from women in EUROMOD to women in SILC is examined in the next section, where estimation results using original EUROMOD output are compared to the ones using the EU–SILC data with assigned participation tax rates. Since the quality of assignment is indeed good, I present as the main results those based on the EU–SILC data with assigned PTRs. This allows taking advantage of all available country–year cells of tax and transfer simulations in EUROMOD (see Table A.1 in the Appendix).

I restrict the sample to the prime–aged women (aged 25–55). I exclude women in full–time education and disabled, those receiving pension, having a new–born child (younger than 1 year of age),[14] and those with missing values for education. I also exclude self–employed from the analysis (all women who have more than 30%

[13]The propensity score matching procedure matches women in EUROMOD 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, and elderly household members. Each woman in SILC data is assigned a closest neighbor match from the women in EUROMOD, and is assigned her participation tax rate.

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

of their work income from self-employment), because the quality of self-employment income variables in the micro–data sources is generally limited and most literature thus focuses on simulations for employees only (Immervoll, 2004). The analysis includes both women living in couples (married or cohabiting) and single women.

3.2 Participation tax rate simulations

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 PTR I need to simulate taxes and benefits for all household members for two hypothetical scenarios—when the woman works and when she does not work. Moreover, I calculate participation tax rates not only for the working, but also for the non–working women, which requires some assumptions on their potential earnings. I predict monthly wages for all women (both working and non–working) using Heckman's two step procedure.[15] This is a standard procedure used in the literature (Bargain et al., 2012, Eissa & Hoynes, 2004, Immervoll & O'Donoghue, 2002), which also reduces some of the bias caused by measurement error in wages.

EUROMOD is then used to calculate monthly income taxes, social security and health contributions, and welfare benefits for all household members for the two situations of the woman working (based on predicted wage) and not working (zero wage). Simulated taxes, contributions, and welfare benefits and predicted monthly wages are used in PTR calculation (see equation 5). The same procedure is applied to calculate PTR for a fixed sample of women , who are used to construct the instrumental variable.

EUROMOD simulates both universal and means–tested benefits, and creates common definitions of benefit types, which allows harmonizing benefits types used

[15]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 presence of children of different ages in the household and the dummy for single mothers. Other explanatory variables in wage regression include education, age, marital status, regional dummies, and nationality.

in the participation tax rate simulations. Benefits included in the PTR simulations consist mainly of social assistance benefits (targeted to very low income households), child benefits (benefits targeted to families with children), and housing benefits (aimed at partially compensating housing costs for low income households). 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 simulations, because EUROMOD simulates these benefits only in few countries (micro data usually do not include information on employment income history, which is often necessary for simulating these benefits), and I do not want to create variation in the PTR given merely by the fact that the same benefit type is simulated in one country and not in other.[16]

Summary statistics for the sample of women used in the analysis are reported in Table 1. There are in total over 385,000 women in the sample from 26 countries covering years 2005 to 2009.[17] Average employment rate of prime–aged women in the sample is 79 %, but there are big differences across countries with Scandinavian countries having employment rate close to 100% and Southern Europe with very low employment rates (close to 60% or 70%). Average participation tax rate in the sample is 30%, but again the PTR differs a lot across countries with Denmark, Belgium and Germany having the highest average participation tax rates (over 40%), and with Cyprus, Greece, and Spain having the lowest average PTR not exceeding 20%.

Finally, summary statistics of the instrumental variable for PTR (PTR_IV) are reported. Clearly, the mean of the instrument follows quite closely the mean of the PTR in each country, which confirms that most of the cross–country variation in the participation tax rates is driven by differences in the tax and transfer systems, and not by differences in demographic composition. The instrumental variable for

[16]Moreover, unemployment benefits represent only a temporary income replacement, not a permanent income guaranteed to all non–workers, and I am more interested in medium to long term work incentive effects.

[17]However, not all countries cover all five years, which is the main reason why the sample sizes differ across countries, for details see Table A.1 in the Appendix.

	Employment rate		PTR		PTR_IV		Observations
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
AT	0.820	0.384	0.402	0.143	0.439	0.092	7780
BE	0.785	0.411	0.441	0.099	0.397	0.073	13568
BG	0.828	0.377	0.229	0.163	0.254	0.108	7419
CY	0.770	0.421	0.116	0.172	0.113	0.078	5592
CZ	0.803	0.398	0.296	0.124	0.367	0.068	20155
DE	0.804	0.397	0.428	0.162	0.453	0.053	16413
DK	0.968	0.175	0.480	0.128	0.564	0.072	7765
EE	0.880	0.325	0.226	0.120	0.249	0.035	12628
ES	0.707	0.455	0.178	0.097	0.160	0.064	33954
FI	0.935	0.247	0.298	0.094	0.269	0.044	12071
FR	0.886	0.318	0.343	0.133	0.373	0.092	18489
GR	0.598	0.490	0.138	0.109	0.046	0.042	13027
HU	0.801	0.399	0.314	0.133	0.373	0.104	17303
IE	0.704	0.457	0.301	0.141	0.292	0.070	6239
IT	0.659	0.474	0.271	0.081	0.163	0.060	43458
LT	0.864	0.343	0.241	0.076	0.246	0.043	10817
LU	0.722	0.448	0.394	0.181	0.442	0.104	7190
LV	0.876	0.330	0.296	0.098	0.291	0.037	9915
NL	0.881	0.324	0.367	0.108	0.391	0.045	18115
PL	0.726	0.446	0.326	0.077	0.312	0.041	24794
PT	0.766	0.424	0.264	0.167	0.376	0.120	8214
RO	0.690	0.463	0.297	0.084	0.301	0.039	8948
SE	0.951	0.216	0.319	0.121	0.339	0.052	11847
SI	0.891	0.312	0.398	0.078	0.491	0.074	23188
SK	0.853	0.354	0.307	0.179	0.343	0.091	13000
UK	0.809	0.393	0.339	0.169	0.241	0.068	13149
Total	0.792	0.406	0.305	0.144	0.305	0.137	385038

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

Source: EUROMOD and EU–SILC data (2005–2009), own calculations.

PTR has a smaller standard deviation than the actual PTR, because part of the cross–country variation in PTR, which is driven by demographic differences across countries, is filtered out, and most importantly, the instrumental variable varies only at group–level (while actual PTR has an individual–level variation). Finally, Table A.2 in the Appendix reports summary statistics by education of woman and by welfare regime, because I investigate in the next section how the PTR effect differs for the groups of women defined by education and welfare regime in which they live.

4 Results

4.1 Work incentives of women in the EU

This section compares the work incentives of tax–transfer systems in the countries of EU. It reports the results of participation tax rate simulations, which are not the main output of this project, but nevertheless provide a unique comparison of work incentives in all countries of the EU (except for Malta). Most of the previous literature provides this comparison for a limited set of countries, the largest set of countries is to my knowledge used in Immervoll et al. (2007) and Immervoll et al. (2009), where the tax–transfer treatment of married couples in EU–15 countries is analysed.

Figure 1 illustrates the distribution of participation tax rates for women in the countries of EU (EU–27 except Malta) in the year 2007 by income decile. Clearly, the participation tax rates for women differ a lot across countries in both levels and dispersions. The variation in PTR is mainly caused by presence of means-tested benefits and progressive income tax. 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 participation tax rate that has both low level and 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.

Moreover, we can see that the participation tax rates do not differ much across income deciles. The participation tax rate increases slightly with income in some countries like Belgium, Denmark, Hungary, Portugal, and others, but in general it is quite flat across income deciles. This can be explained by presence of means–tested benefits for low–income households and progressive income tax system or by

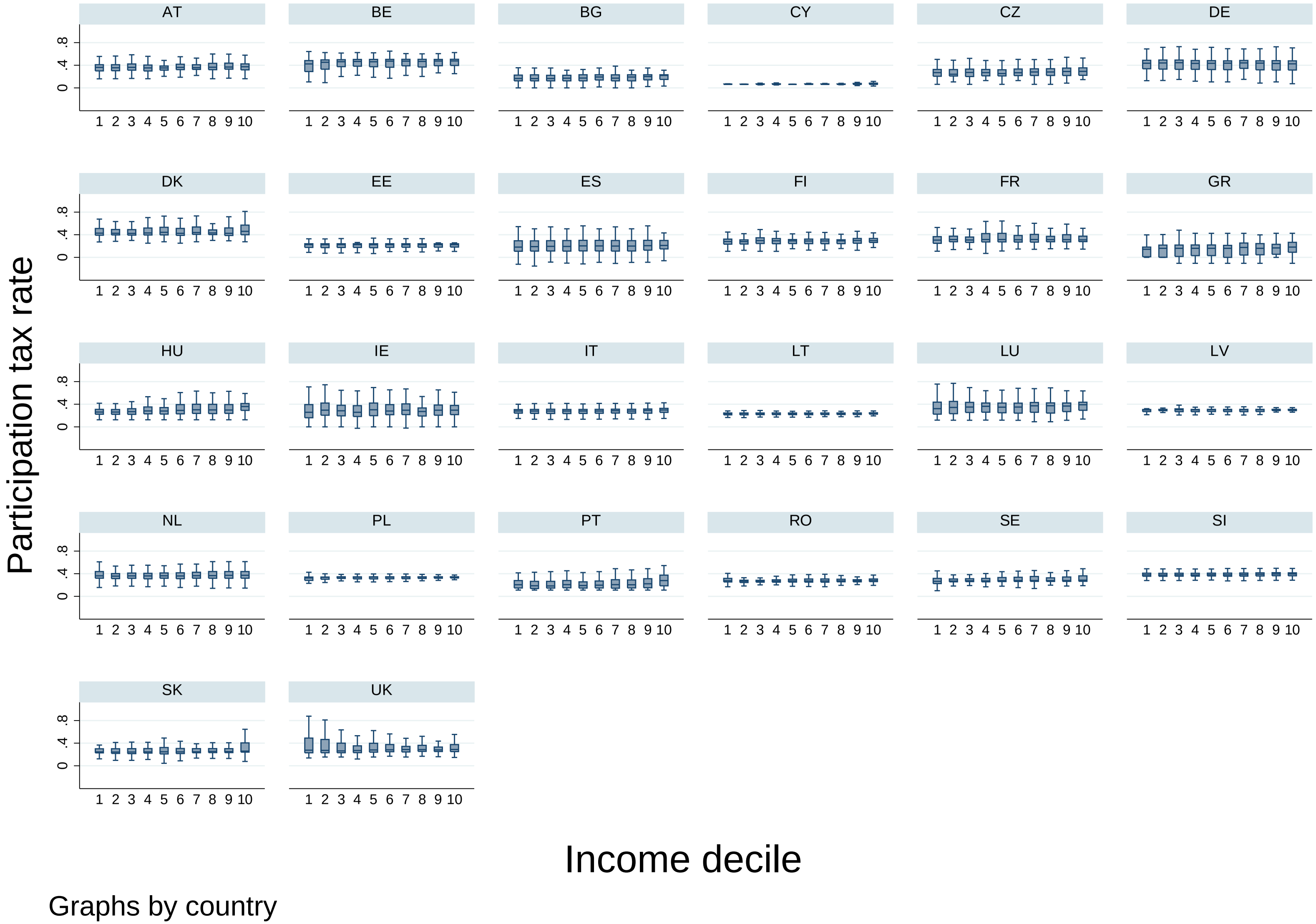

Figure 1: Box plot of PTR for women in the EU in 2007 by income decile.

Note: 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 datum still within 1.5 interquartile range of the lower quartile and the highest datum still within 1.5 interquartile range of the upper quartile (the ends of the whiskers).
Source: EUROMOD model, own calculations.

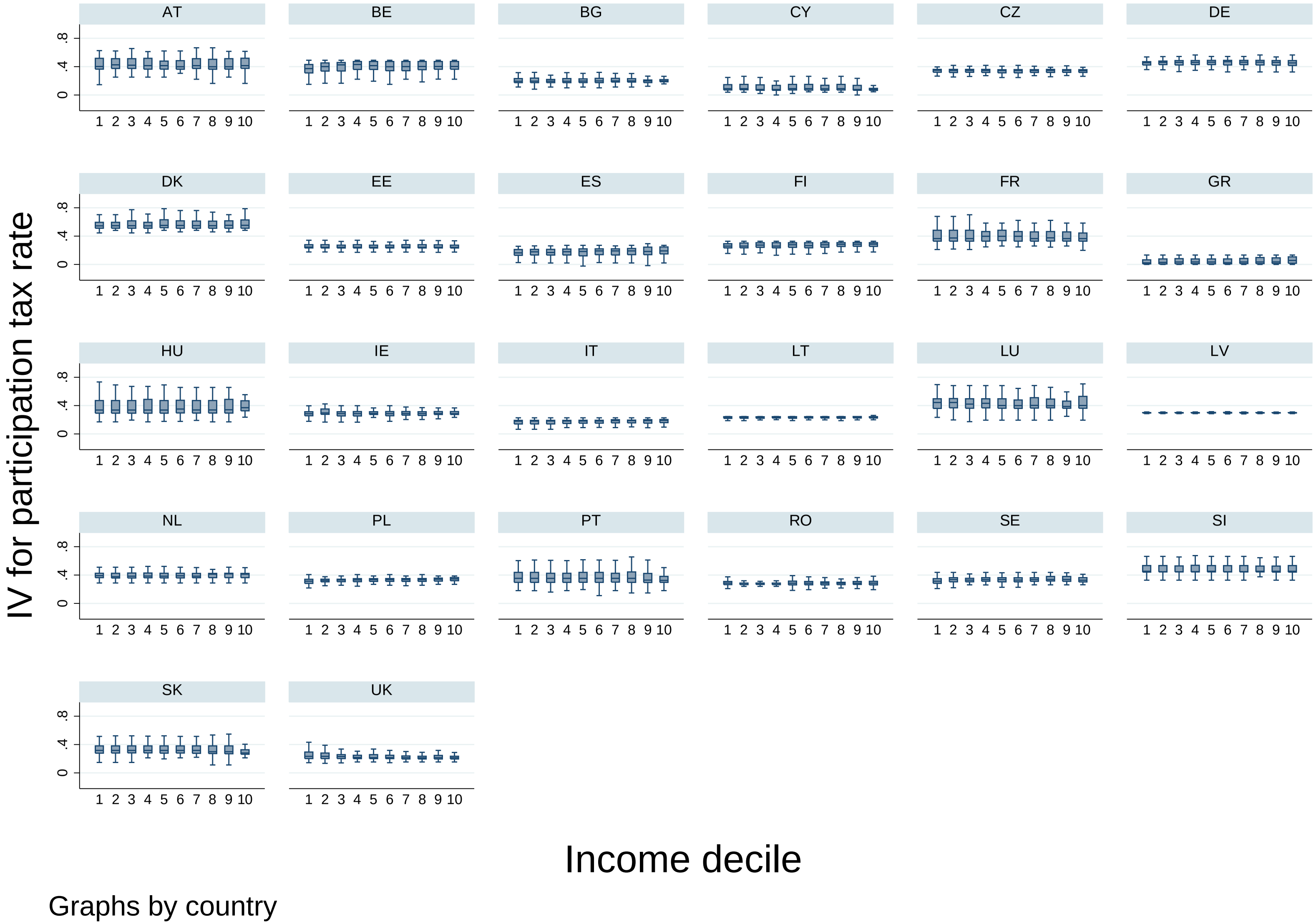

Figure 2: Box plot of instrumental variable for PTR for women in the EU in 2007 by income decile.

Note: 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 datum still within 1.5 interquartile range of the lower quartile and the highest datum still within 1.5 interquartile range of the upper quartile (the ends of the whiskers).
Source: EUROMOD model, own calculations.

presence of very little means–tested benefits and flat income tax system, which both in combination create virtually flat tax rate system. Strikingly flat participation tax rates were found for the EU–15 countries also in the Immervoll et al. (2007) study.

Figure 2 reports the distribution of the instrumental variable for PTR by country and income decile. Clearly, most of the variation in participation tax rates for women across countries remains even if we use IV to create the distribution. This provides some evidence for the quality of this instrumental variable, which seems to be quite strong.[18] The within country variation in instrumental variable for PTR is slightly lower than variation in the actual PTR for most countries, because the instrumental variable varies only at group level (it is an average of PTR for women with the same characteristics, for details see the Empirical approach section).

4.2 Regression analysis

In this section, I present the estimated effect of the participation tax rate on employment probability of individual women in the EU countries. OLS results reported in this section are based on equations 7 and 2SLS results utilize equations 8 and 9 (see Empirical approach section). In all specifications, the dependent variables is the dummy variable for being employed, and each regression includes a full set of country dummies to control for unobserved country–specific differences (like preferences, culture, generosity of parental leave policies, or coverage of child care). Therefore, the results are based on the within–country variation in participation tax rates for women in different groups, and based on changes in participation tax rates over time.

In some specifications, the year dummies are also included, and some specifications include a full set of country–year interactions. Controls include observable characteristics like age, education dummies, number of children of certain age (aged 1, 2, 3, 4–5, 6–9, 10–15), dummy variable for cohabiting and married women, num-

[18]Strength of the instrumental variable is further tested using the first stage F statistics in the next section.

ber of household members, dummy for presence of elderly household members, dummies for education of a partner, and dummy variable for the non–working partner (if present).

Before we proceed to the results, the quality of the PTR assignment from EUROMOD data to EU–SILC data is checked by comparing results based on the EUROMOD data and the EU-SILC data (with assigned PTR) for the same set of country–year cells. The comparison of results is provided in Tables A.3 and A.4 in the Appendix. The magnitude of estimated PTR coefficients in the OLS specification is very similar using both original EUROMOD data and the EU–SILC data with assigned PTR (approximately 0.3 based on the EUROMOD data and 0.38 based on the EU–SILC—see columns 1 to 3 in Table A.3), but the estimation using the EU–SILC data provides significant coefficients, while the EUROMOD–based estimation does not. However, the difference between the coefficients from the regressions using the two datasets was tested, and the null hypothesis of significant difference between the coefficients was rejected at 5% level. The 2SLS coefficients of PTR are significantly negative using both datasets, although the estimates based on the EU–SILC data are slightly larger in magnitude (0.18 as opposed to 0.14 in the EUROMOD estimation—see columns 4 to 6 in Table A.3). PTR coefficients interacted with woman's education are compared in Table A.4 in the Appendix, and these further confirm that results based on the EUROMOD data and the EU–SILC data (with assigned PTR) are reasonably similar. Therefore, all results reported in this section are based on the sample of prime–aged women from the EU–SILC data (years 2005 to 2009) with participation tax rates being simulated within the EUROMOD model and assigned to women in the EU–SILC based on their incomes and characteristics (and other household members' incomes and characteristics).

I first report results of the first stage regressions, which confirm the strength of the instrumental variable used in this analysis (see Table 2). The instrumental variable is highly significant in all specification. R^2 exceeds 36% and the first stage F statistic is very high for all specifications, so that the null hypothesis of weak in-

	(1)	(2) PTR	(3)
PTR_IV	0.445***	0.441***	0.429***
	(0.010)	(0.010)	(0.010)
controls	yes	yes	yes
year dummies	no	yes	no
country dummies	yes	yes	no
country-year interactions	no	no	yes
R^2	0.368	0.368	0.371
F	1184.319	1136.492	667.327
Observations	385038	385038	385038

Standard errors in parentheses are clustered at country–year–group level
(* p<0.10, ** p<0.05, *** p<0.01)

Table 2: First stage regression results.

Source: EUROMOD model and EU-SILC data (2005–2009), own calculations.

strument is rejected (test of weak instruments according to Stock, Wright, & Yogo, 2002 has the 5% critical value for the F-statistic equal to 8.96).

Results from the OLS regressions of employment dummy on the participation tax rate and other controls (see equation 7) are reported in the first three columns of Table 3 (full specifications with all controls are provided in Table A.5 in the Appendix). The effect of participation tax rate on employment decision in the OLS specification is negative and significant, and suggests that an increase of PTR by 0.1 (10 percentage points) decreases employment probability by 0.5 percentage points. However, OLS estimates can be biased, because the participation tax rate is a function of potential wage, which is likely to be endogenous to the employment decision. Since women with higher potential wages are more likely to work and are at the same time usually taxed slightly more,[19] the bias is likely to be positive. This is confirmed by the comparison of OLS and 2SLS results in Table 3.

The effect of participation tax rate on employment decision in the OLS specification is negative and significant, but the magnitude of the PTR coefficients is

[19]This holds under the assumption that the tax system is progressive and the effective taxation caused by welfare benefits for low income individuals is not too high. In previous section I have argued that participation tax rates are pretty flat across income deciles, but for most countries indeed increase slightly with income.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	
PTR coef.	-0.054***	-0.053***	-0.052***	-0.197***	-0.190***	-0.195***
	(0.008)	(0.008)	(0.008)	(0.039)	(0.040)	(0.037)
PTR elasticity	-0.021	-0.021	-0.020	-0.076	-0.073	-0.075
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.152	0.152	0.153	0.150	0.150	0.151
Observations	385038	385038	385038	385038	385038	385038

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table 3: OLS and 2SLS regression results.

Source: EUROMOD model and EU-SILC data (2005–2009), own calculations.

almost four times lower than in the 2SLS estimation (columns 4 to 6 of Table 3). The 2SLS regressions capture the effect of tax and transfer policies on the employment probability of women using the variation in tax and transfer policies across different groups of women and over time filtering out the behavioral part of PTR and measurement error in imputed wages. The magnitudes of 2SLS coefficients of PTR suggest that an increase in PTR by 0.1 (10 percentage points) decreases employment probability by almost 2 percentage points. The implied elasticity of labor supply with respect to participation tax rate for the 2SLS estimates is almost -0.08 (10% increase in PTR decreases employment probability by 0.8%). The elasticity for OLS regressions is around -0.02. Both OLS and 2SLS results are very robust towards inclusion of year dummies, and country–year interaction dummies (allowing for time–varying unobserved country fixed effects).

The individual–level variation in the participation tax rate further allows investigating the heterogeneity in the responses towards work incentives across different groups of women. We might expect that women with different levels of education will respond differently towards changes in the tax–transfer system. This may be because they are differently responsive to incentives, or maybe because the level of understanding of how the system affects their work incentives is different.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	
PTR coefficient by woman's education:						
Primary educ.	0.012	0.010	0.009	0.043	0.040	0.033
	(0.028)	(0.028)	(0.027)	(0.065)	(0.065)	(0.064)
Secondary educ.	-0.042***	-0.041***	-0.040***	-0.126***	-0.119**	-0.125***
	(0.010)	(0.010)	(0.010)	(0.045)	(0.046)	(0.043)
Tertiary educ.	-0.101***	-0.100***	-0.099***	-0.442***	-0.437***	-0.446***
	(0.013)	(0.013)	(0.013)	(0.042)	(0.042)	(0.041)
PTR elasticity by woman's education:						
Primary educ.	0.000	0.000	0.000	0.001	0.001	0.001
Secondary educ.	-0.010	-0.009	-0.009	-0.027	-0.028	-0.028
Tertiary educ.	-0.014	-0.014	-0.014	-0.061	-0.061	-0.062
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.152	0.152	0.153	0.148	0.148	0.149
Observations	385038	385038	385038	385038	385038	385038

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table 4: OLS and 2SLS regression results by education of woman.

Source: EUROMOD model and EU-SILC data (2005–2009), own calculations.

Estimated coefficients in Table 4 suggest that the effect of PTR on employment probability indeed differs by education of woman. In both OLS and 2SLS specifications, PTR effect is positive and insignificant for primary educated women, while it becomes negative and significant for secondary and tertiary educated women. Tertiary educated women seem to be the most responsive to changes in tax and transfer systems, the 2SLS results suggest that increase in participation tax rate by 0.1 (10 percentage points) decreases their employment probability by over 4 percentage points. This is consistent with more educated women being more responsive towards incentives and/or having better knowledge of the tax and transfer system and its effect on their work incentives. Table 4 also reports elasticities of employment with respect to PTR by education of woman. These are more less consistent with coefficient estimates, and confirm that the effect is largest for tertiary educated women (almost three times as big in magnitude as for secondary educated).

Finally, I investigate the heterogeneity of the effect of PTR on participation 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 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 categorizing of all countries in the sample.[20]

Table 5 indeed confirms that the effect of PTR differs across different welfare regimes. The effect of participation tax rate on the employment probability is highest in the liberal welfare regime (almost 6 percentage point decrease in employment probability with an increase of PTR by 10 percentage points). The effect of PTR on employment probability in the social–democratic and the post–communist countries is approximately half of the effect in the liberal countries, but also highly significant. The effect is much lower and significant only at 10% level in the conservative–corporatist welfare regime countries, and not significantly different from zero in the Southern–European and the former–USSR countries. The Southern–European and the former–USSR countries belong to the countries with lowest participation tax rate in the sample and also with lowest variation in the PTR within each country,

[20] Denmark, Finland, and Sweden belong to the social–democratic welfare regime; Ireland and the United Kingdom belong to the liberal welfare regime; Austria, Belgium, France, Germany, Luxembourg, and Netherlands belong to the conservative–corporatist welfare state; Cyprus, Greece, Italy, Portugal, and Spain belong to the Southern-European welfare regime; Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia to the post–communist welfare regime; and Estonia, Latvia, and Lithuania belong to former–USSR welfare regime.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	
PTR coefficient by welfare regime:						
Social–Democr.	-0.083***	-0.082***	-0.084***	-0.239***	-0.228***	-0.262***
	(0.016)	(0.016)	(0.015)	(0.066)	(0.067)	(0.061)
Liberal	-0.387***	-0.387***	-0.388***	-0.618***	-0.615***	-0.626***
	(0.029)	(0.029)	(0.029)	(0.087)	(0.087)	(0.088)
Conserv.–Corp.	-0.015	-0.014	-0.013	-0.100*	-0.103*	-0.099*
	(0.014)	(0.014)	(0.014)	(0.054)	(0.055)	(0.054)
Southern–Eur.	0.012	0.008	0.005	-0.084	-0.105	-0.110
	(0.019)	(0.019)	(0.019)	(0.065)	(0.066)	(0.067)
Post–Communist	-0.044***	-0.041***	-0.033**	-0.327***	-0.284**	-0.292***
	(0.014)	(0.014)	(0.014)	(0.115)	(0.115)	(0.106)
Former–USSR	0.024	0.034*	0.032	-0.043	0.132	0.287
	(0.020)	(0.020)	(0.019)	(0.145)	(0.162)	(0.222)
PTR elasticity by welfare regime:						
Social–Democr.	-0.003	-0.003	-0.003	-0.009	-0.008	-0.010
Liberal	-0.008	-0.008	-0.008	-0.013	-0.013	-0.013
Conserv.–Corp.	-0.002	-0.002	-0.001	-0.011	-0.011	-0.010
Southern–Eur.	0.001	0.001	0.001	-0.006	-0.008	-0.008
Post–Communist	-0.005	-0.005	-0.004	-0.040	-0.035	-0.036
Former–USSR	0.001	0.001	0.001	-0.001	0.004	0.008
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.153	0.153	0.154	0.150	0.150	0.151
Observations	385038	385038	385038	385038	385038	385038

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table 5: OLS and 2SLS regression results by welfare regime.

Source: EUROMOD model and EU-SILC data (2005–2009), own calculations.

and that is probably the main reason why the effect of PTR in these countries is not significant. Table 5 also reports elasticities of employment to PTR by welfare regime. The estimated elasticity is highest for the post–communist countries, somehow lower for the liberal, the social–democratic, and the conservative–corporatist welfare regime.

Conclusion

This paper investigates the impact of tax and transfer systems in the countries of 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 capturing the effect of both tax and benefit systems on the work incentives of women and to deal with possible endogeneity of the participation tax rate by using an instrumental variable. The simulated 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 changes in individual behavior that might be endogenous.

The results confirm the presence of significant effect of participation tax rate on the employment decisions of women in the EU. The magnitude of estimated coefficients implies that a 10 percentage point increase in the participation tax rate decreases the employment probability by almost 2 percentage points. The effect is higher for more educated women—results suggest that tertiary educated women respond to the 10 percentage point increase in the PTR by decreasing their employment probability by 4 percentage points. This is consistent with more educated women being more responsive towards incentives and/or having better knowledge of the tax and transfer system and its effect on their work incentives.

I also investigate the heterogeneity of responses towards tax and transfer systems across countries. I use a well–known typology of welfare regimes originally proposed by Esping-Andersen (1990). The results indicate that the effect of PTR on employment probability is the highest for the liberal welfare regime (to which Ireland and the UK belong), somehow lower in the social–democratic, the post–communist, and the conservative–corporatist countries, and not significantly different from zero in the Southern–European and the former–USSR countries. This suggests that in some countries (like the countries of Southern Europe), there are other factors than the tax–transfer system which matter for the employment decisions of women (these might include preferences, gender–role attitudes, or child care availability). However, there are other groups of countries, where lowering the tax burden of women might increase the female labor supply significantly—the estimates suggest that decreasing the participation tax rate by 10 percentage points in the liberal countries would lead to an increase in employment rate by 6.2 percentage points.

Comparison of these results with Bargain et al. (2012) is rather difficult, because both studies use different estimation approaches and different explanatory variables (this study estimates elasticities of labor supply with respect to the participation tax rate, while Bargain et al., 2012 use wage rate and unearned income as the main explanatory variables). However, both studies have found a smaller magnitude of the female labor supply elasticities than what was found in most of the previous estimates for European countries (see e.g. Callan et al., 2009; Laroque & Salanié, 2002; van Soest et al., 2002; Arellano & Meghir, 1992). Also, both the present study and Bargain et al. (2012) have found a significant differences across countries in terms of magnitude of labor supply elasticities, which are probably driven by different formal and informal institutions across countries (family policies, child care availability, part–time job availability, but also inherent differences in preferences and gender–role attitudes).

References

Arellano, M., & Meghir, C. (1992). Female labour supply and on-the-job search: an empirical model estimated using complementary data sets. *The Review of Economic Studies*, *59*(3), 537–559.

Bargain, O., Orsini, K., & Peichl, A. (2012). Comparing Labor Supply Elasticities in Europe and the US: New Results. *IZA DP No. 6735*.

Blau, F. D., & Kahn, L. M. (2007). Changes in the Labor Supply Behavior of Married Women: 1980-2000. *Journal of Labor Economics*, *25*(3), 393–438.

Blundell, R., Duncan, A., McCrae, J., & Meghir, C. (2000, March). The Labour Market Impact of the Working Families' Tax Credit. *Fiscal Studies*, *21*(1), 75–104.

Blundell, R., Duncan, A., & Meghir, C. (1998). Estimating labor supply responses using tax reforms. *Econometrica*.

Callan, T., van Soest, A., & Walsh, J. R. (2009, March). Tax Structure and Female Labour Supply: Evidence from Ireland. *Labour*, *23*(1), 1–35.

Causa, O. (2009). The Policy Determinants of Hours Worked across OECD Countries. In *Oecd journal: Economic studies* (Vol. 2009).

Currie, J., & Gruber, J. (1996). Health insurance eligibility, utilization of medical care, and child health. *The Quarterly Journal of Economics*, *111*(2), 431–466.

Cutler, D. M., & Gruber, J. (1996). Does public insurance crowd out private insurance? *The Quarterly Journal of Economics*, *111*(2), 391–430.

Devereux, P. (2004). Changes in relative wages and family labor supply. *Journal of Human Resources*, *39*(3), 696–722.

Eissa, N., & Hoynes, H. W. (2004, August). Taxes and the labor market participation of married couples: the earned income tax credit. *Journal of Public Economics*, *88*(9-10), 1931–1958.

Eissa, N., & Liebman, J. B. (1996). Labor supply response to the earned income tax credit. *The Quarterly Journal of Economics*, *111*(2), 605–637.

Esping-Andersen, G. (1990). *Three Worlds of Welfare Capitalism* (C. Pierson &

F. G. Castles, Eds.). Cambridge: Polity press.

Fenger, H. (2007). Welfare regimes in Central and Eastern Europe: Incorporating post-communist countries in a welfare regime typology. *Contemporary Issues and Ideas in Social Sciences*, *3*(2), 1–30.

Ferrera, M. (1996). The 'Southern model' of welfare in social Europe. *Journal of European social policy*, *6*(1), 17–37.

Figari, F., Immervoll, H., Levy, H., & Sutherland, H. (2007). Inequalities within couples: market incomes and the role of taxes and benefits in Europe. *IZA DP No. 3201*.

Gruber, J., & Saez, E. (2002, April). The elasticity of taxable income: Evidence and implications. *Journal of Public Economics*, *84*(1), 1–32.

Hoynes, H. (1996). Welfare Transfers in Two-Parent Families: Labor Supply and Welfare Participation Under AFDC-UP. *Econometrica*, *64*(2), 295–332.

Immervoll, H. (2004). Average and marginal effective tax rates facing workers in the EU: A micro-level analysis of levels, distributions and driving factors. *OECD Social, Employment and Migration Working Papers No. 19, OECD Publishing*.

Immervoll, H., Kleven, H., Kreiner, C., & Saez, E. (2007). Welfare reform in European countries: a microsimulation analysis. *The Economic Journal*, *117*(516), 1–44.

Immervoll, H., Kleven, H., Kreiner, C., & Verdelin, N. (2009). An Evaluation of the Tax-Transfer Treatment of Married Couples in European Countries. *IZA DP No. 3965*.

Immervoll, H., & O'Donoghue, C. (2002). Welfare benefits and work incentives: An analysis of the distribution of net replacement rates in Europe using EUROMOD, a multi-country microsimulation model. *EUROMOD Working Paper No. EM4/01*.

Keane, M. (2011). Labor supply and taxes: A survey. *Journal of Economic Literature*, *49*(4), 961–1075.

Laroque, G., & Salanié, B. (2002). Labour market institutions and employment in France. *Journal of Applied Econometrics*, *17*(1), 25–48.

Meghir, C., & Phillips, D. (2008). Labour supply and taxes. *IZA Working Paper No. 3405*.

Meyer, B., & Rosenbaum, D. (2001). Welfare, the earned income tax credit, and the labor supply of single mothers. *The Quarterly Journal of Economics*, *116*(3), 1063–1114.

Moffitt, R. A., & Wilhelm, M. O. (2000). Taxation and the labor supply decisions of the affluent. In J. Slemrod (Ed.), *Does atlas shrug? economic consequences of taxing the rich* (pp. 193–234). New York: Russell Sage Foundation.

Saez, E., Matsaganis, M., & Tsakloglou, P. (2012, January). Earnings Determination and Taxes: Evidence From a Cohort-Based Payroll Tax Reform in Greece. *The Quarterly Journal of Economics*, *127*(1), 493–533.

Stock, J., Wright, J., & Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics*, *20*(4), 518–29.

Sutherland, H. (2007). EUROMOD - The Tax-Benefit Microsimulation Model for the European Union. In A. Harding (Ed.), *Modelling our future: Population ageing, health and aged care* (pp. 483–488). Emerald Group Publishing Limited.

van Soest, A. (1995). Structural Models of Family Labor Supply: A Discrete Choice Approach. *The Journal of Human Resources*, *30*(1), 63.

van Soest, A., Das, M., & Gong, X. (2002). A structural labour supply model with flexible preferences. *Journal of Econometrics*, *107*(1), 345–374.

Appendix

	2005	2006	2007	2008	2009
Austria			YES	(YES)	(YES)
Belgium	YES	YES	YES	(YES)	(YES)
Bulgaria			YES	(YES)	(YES)
Cyprus		YES	YES	(YES)	
Czech Republic	YES	YES	YES	(YES)	(YES)
Germany			YES	(YES)	(YES)
Denmark			YES	(YES)	(YES)
Estonia	YES	YES	YES	(YES)	(YES)
Finland			YES	(YES)	(YES)
France		YES	(YES)	(YES)	(YES)
Greece	YES	YES	YES	(YES)	(YES)
Spain	YES	YES	YES	(YES)	(YES)
Hungary		YES	YES	(YES)	(YES)
Ireland		YES	YES	(YES)	
Italy	YES	YES	YES	(YES)	(YES)
Lithuania	YES	(YES)	YES	(YES)	(YES)
Luxembourg			YES	(YES)	(YES)
Latvia		YES	YES	(YES)	(YES)
Netherlands		YES	YES	(YES)	(YES)
Poland		YES	YES	(YES)	(YES)
Portugal		YES	YES	(YES)	(YES)
Romania			YES	(YES)	(YES)
Sweden		YES	YES	(YES)	(YES)
Sovenia		YES	YES	(YES)	(YES)
Slovakia		YES	YES	(YES)	(YES)
United Kingdom		(YES)	YES	(YES)	(YES)

Table A.1: Country–year combinations used in the empirical analysis.

Note: "YES" denotes that EUROMOD simulation is available for the particular country and year; "(YES)" indicates that EUROMOD simulation is available, but the input data for that country–year combination are not available (input data from different year are used for simulation of PTR)—these country–year cells can be used in the estimation only after assigning PTR to the EU–SILC data.

	Employment rate		PTR		PTR_IV		Obs.
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
By woman's education:							
Primary	0.506	0.500	0.248	0.165	0.253	0.161	24,738
Secondary	0.761	0.426	0.303	0.145	0.308	0.138	226,727
Tertiary	0.898	0.302	0.318	0.136	0.311	0.127	133,573
By welfare regime:							
Social–Democr.	0.949	0.220	0.350	0.135	0.367	0.128	31,683
Liberal	0.775	0.418	0.327	0.161	0.258	0.073	19,388
Conserv.–Corp.	0.831	0.375	0.392	0.140	0.410	0.081	81,555
Southern–Eur.	0.681	0.466	0.216	0.120	0.161	0.100	104,245
Post–Communist	0.802	0.398	0.323	0.125	0.366	0.104	114,807
Former–USSR	0.873	0.333	0.252	0.105	0.261	0.043	33,360
Total	0.792	0.406	0.305	0.144	0.305	0.137	385,038

Table A.2: Summary statistics by woman's education and by welfare regime.

Note: Denmark, Finland, and Sweden belong to the social–democratic welfare regime; Ireland and the United Kingdom belong to the liberal welfare regime; Austria, Belgium, France, Germany, Luxembourg, and Netherlands belong to the conservative–corporatist welfare state; Cyprus, Greece, Italy, Portugal, and Spain belong to the Southern-European welfare regime; Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia to the post–communist welfare regime; and Estonia, Latvia, and Lithuania belong to former–USSR welfare regime.
Source: EUROMOD and EU–SILC data (2005–2009), own calculations.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	
***Panel A**: Results based on EUROMOD output data (2005-2007).*						
PTR	-0.030	-0.027	-0.031	-0.137**	-0.113*	-0.141**
	(0.020)	(0.020)	(0.020)	(0.066)	(0.065)	(0.063)
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.158	0.158	0.159	0.157	0.158	0.158
Observations	192580	192580	192580	192580	192580	192580
***Panel B**: Results based on matched EU-SILC data (2005-2007).*						
PTR	-0.038***	-0.038***	-0.039***	-0.176**	-0.170**	-0.181***
	(0.011)	(0.012)	(0.011)	(0.069)	(0.069)	(0.063)
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.155	0.156	0.156	0.154	0.154	0.154
Observations	187528	187528	187528	187528	187528	187528

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table A.3: OLS and 2SLS regression results - comparison of basic EUROMOD results and matched EU-SILC results.

Source: EUROMOD data (2005–2007), own calculations.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	

***Panel A**: Results based on EUROMOD output data (2005-2007).*

PTR interacted with woman's education:

	(1)	(2)	(3)	(4)	(5)	(6)
Primary education	0.020	0.021	0.018	0.008	0.022	-0.004
	(0.039)	(0.038)	(0.038)	(0.083)	(0.083)	(0.082)
Secondary education	-0.033	-0.030	-0.033	-0.149**	-0.124*	-0.156**
	(0.024)	(0.024)	(0.024)	(0.069)	(0.068)	(0.066)
Tertiary education	-0.071**	-0.067**	-0.072**	-0.468***	-0.441***	-0.478***
	(0.030)	(0.030)	(0.030)	(0.084)	(0.083)	(0.083)
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.158	0.158	0.159	0.155	0.156	0.155
Observations	192580	192580	192580	192580	192580	192580

***Panel B**: Results based on matched EU-SILC data (2005-2007).*

PTR interacted with woman's education:

	(1)	(2)	(3)	(4)	(5)	(6)
Primary education	-0.037	-0.040	-0.044	0.011	0.008	-0.006
	(0.038)	(0.037)	(0.036)	(0.097)	(0.096)	(0.094)
Secondary education	-0.024	-0.023	-0.024	-0.091	-0.082	-0.094
	(0.015)	(0.015)	(0.015)	(0.079)	(0.079)	(0.073)
Tertiary education	-0.072***	-0.074***	-0.075***	-0.418***	-0.413***	-0.428***
	(0.019)	(0.019)	(0.020)	(0.071)	(0.070)	(0.067)
controls	yes	yes	yes	yes	yes	yes
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.155	0.156	0.156	0.152	0.152	0.152
Observations	187528	187528	187528	187528	187528	187528

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table A.4: OLS and 2SLS regression results by woman's education - comparison of basic EUROMOD results and matched EU-SILC results.

Source: EUROMOD data (2005–2007), own calculations.

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
		employment dummy			employment dummy	
PTR	-0.054***	-0.053***	-0.052***	-0.197***	-0.190***	-0.195***
	(0.008)	(0.008)	(0.008)	(0.039)	(0.040)	(0.037)
secondary education	0.182***	0.181***	0.181***	0.185***	0.184***	0.184***
	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)
tertiary education	0.299***	0.298***	0.298***	0.304***	0.303***	0.303***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
age	0.031***	0.031***	0.031***	0.032***	0.032***	0.032***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
age squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
child 1	-0.080***	-0.080***	-0.080***	-0.079***	-0.079***	-0.079***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
child 2	-0.209***	-0.209***	-0.209***	-0.208***	-0.208***	-0.208***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
child 3	-0.163***	-0.163***	-0.163***	-0.162***	-0.162***	-0.162***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
child 4-5	-0.079***	-0.080***	-0.079***	-0.079***	-0.079***	-0.079***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
child 6-9	-0.059***	-0.059***	-0.059***	-0.058***	-0.058***	-0.058***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
child 10-15	-0.034***	-0.034***	-0.034***	-0.034***	-0.034***	-0.034***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
number of HH members	-0.022***	-0.022***	-0.022***	-0.022***	-0.022***	-0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
presence of elderly	-0.008**	-0.008**	-0.008**	-0.008***	-0.008***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
married	-0.088***	-0.087***	-0.087***	-0.090***	-0.089***	-0.089***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
cohabiting	-0.047***	-0.047***	-0.047***	-0.048***	-0.047***	-0.047***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
inactive partner	-0.059***	-0.059***	-0.059***	-0.058***	-0.059***	-0.058***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
secondary education	0.055***	0.055***	0.054***	0.055***	0.055***	0.054***
of partner	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
tertiary education	0.073***	0.072***	0.072***	0.072***	0.072***	0.071***
of partner	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
year dummies	no	yes	no	no	yes	no
country dummies	yes	yes	no	yes	yes	no
country-year interactions	no	no	yes	no	no	yes
R^2	0.152	0.152	0.153	0.150	0.150	0.151
Observations	385038	385038	385038	385038	385038	385038

Standard errors in parentheses are clustered at country–year–group level (* p<0.10, ** p<0.05, *** p<0.01)

Table A.5: OLS and 2SLS regression results.

Source: EUROMOD model and EU-SILC data (2005–2009), own calculations.

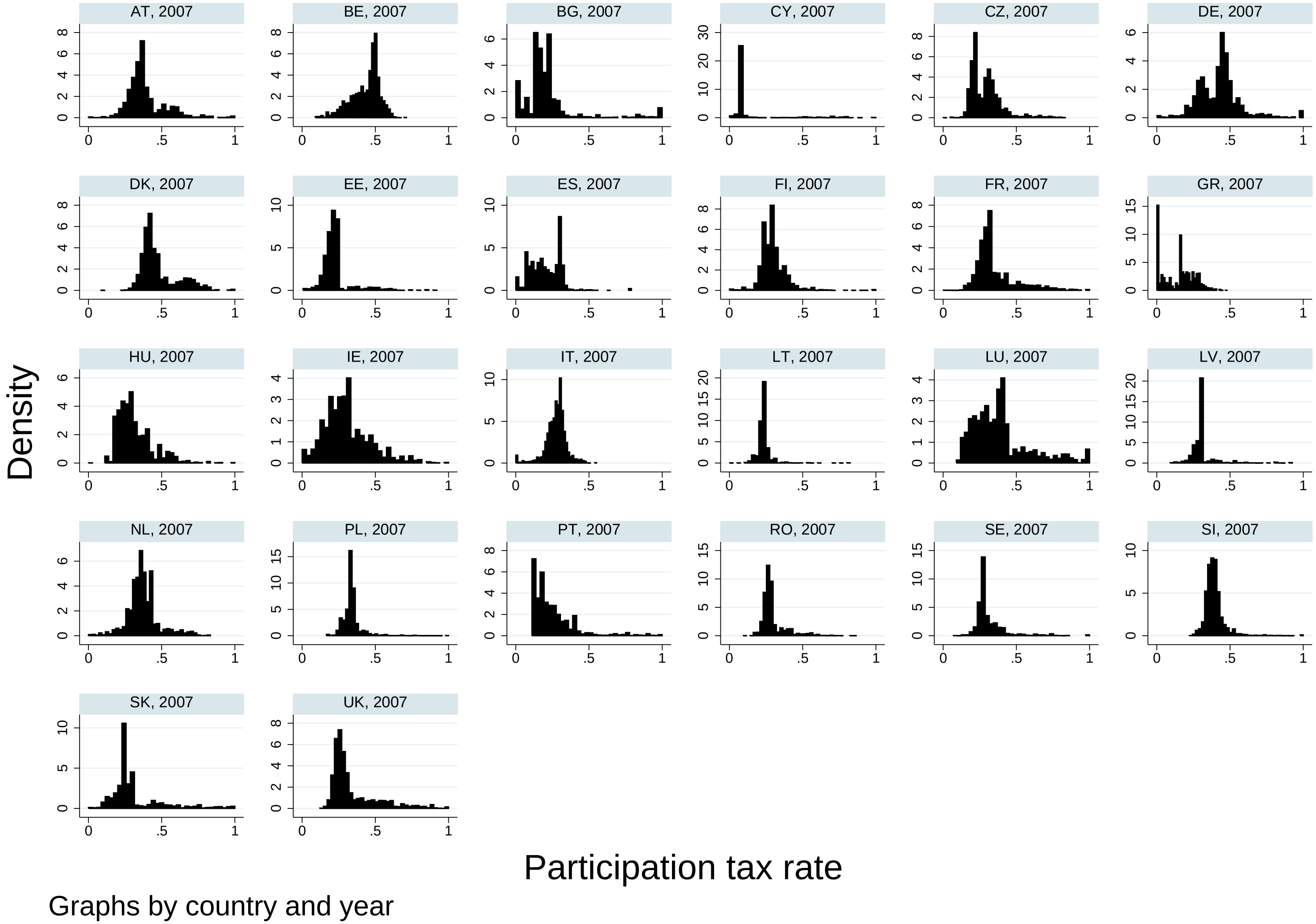

Figure A.1: Distribution of PTR for women in the EU in 2007.

Source: EUROMOD model, own calculations.

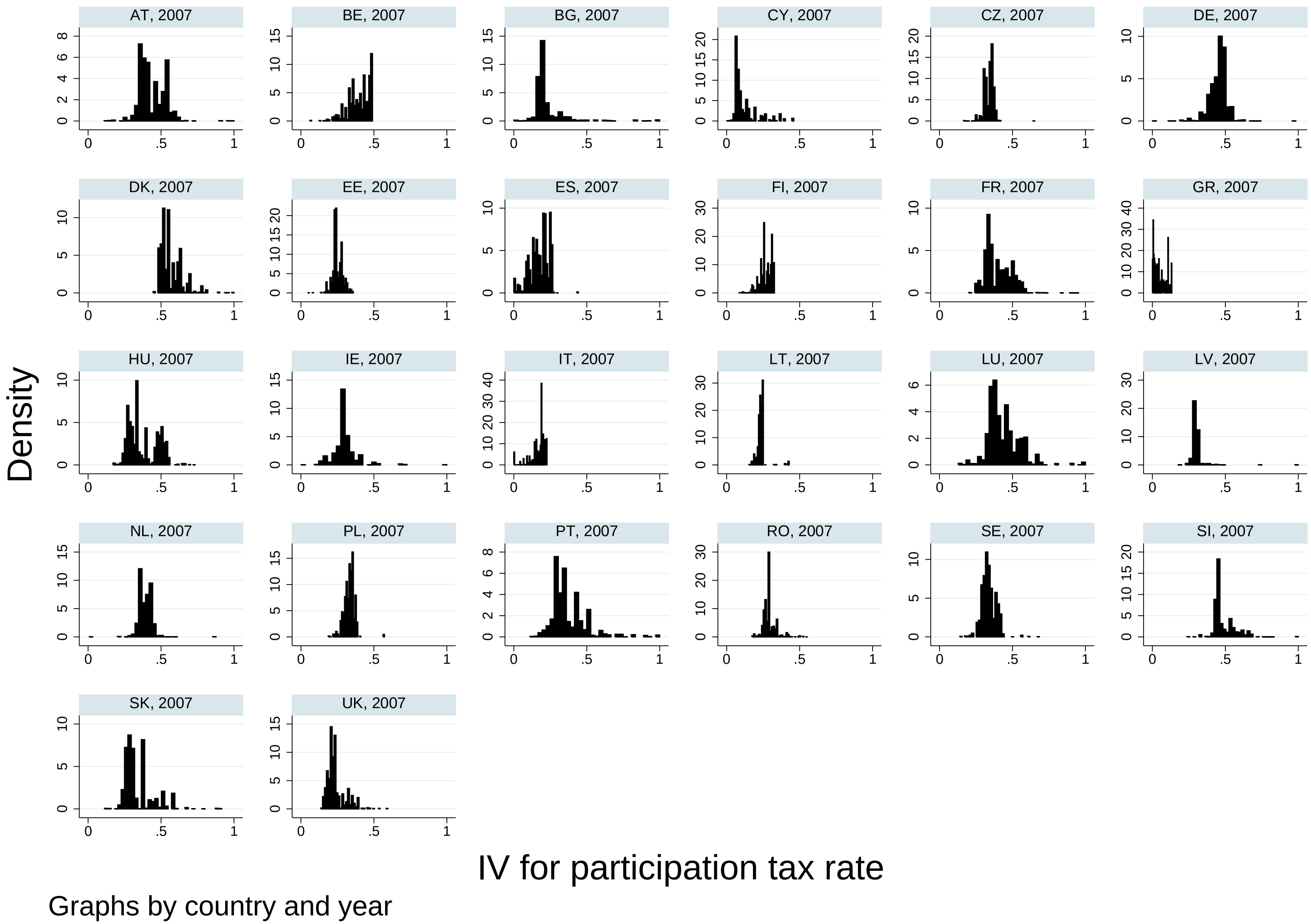

Figure A.2: Distribution of instrumental variable for PTR for women in the EU in 2007.

Source: EUROMOD model, own calculations.