Analyzing female labor supply – Evidence from a Dutch tax reform

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Abstract

Among OECD countries, the Netherlands has an average female labor force participation, but by far the highest rate of part-time work. This paper investigates the extent to which married women respond to financial incentives. We exploit exogenous variation caused by a substantial Dutch tax reform in 2001. Our main conclusion is that the positive significant effect of the tax reform on labor force participation dominates the negative insignificant effect on working hours. The latter contradicts the common empirical finding of positive wage elasticities. Our preferred explanation is that women respond more to changes in tax allowances than to changes in marginal tax rates.

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1 Introduction

Since Heckman (1974) female labor supply has been an important topic for economic research. A major contribution to this literature has been made by Blundell, Duncan and Meghir (1998), who show that changes in tax rules can be used to estimate wage elasticities. They investigate a series of modifications in marginal tax rates over a relatively long observation period. A related literature focuses on the importance of financial incentives, such as earned income tax credits, on labor force participation decisions (e.g. Eissa and Hoynes, 2004; and Eissa and Liebman, 1996). We contribute to these literatures by investigating the effects of a very substantial Dutch tax reform in 2001.

In 2001, labor force participation rates of prime-age women in the Netherlands were close to those in the UK or US. However, part-time work among women is much more common in the Netherlands than in any other OECD country. Whereas, on average, in the OECD about 25% of the prime-age working women work less than 30 hours per week, this is over 55% in the Netherlands (OECD, 2004). The high rate of part-time work allows substantial room for increasing labor supply. It is generally believed that female labor supply is more responsive to financial incentives than male labor supply (e.g. Meghir and Phillips, 2010). Therefore, Dutch policymakers have a strong interest in stimulating female labor supply. This could increase economic growth and contribute towards dealing with the costs of an ageing society. Indeed, one of the most important motivations for the Dutch tax reform in 2001 was to make work financially more attractive for women.

The key elements of the tax reform were the reduction of marginal tax rates, and the replacement of tax allowances by tax credits. Both elements might affect the force participation decision and hours of work decision. The second element, however, is more likely to affect the participation decision due to the elimination of perverse disincentives to work (particularly for women with a high-income partner). Tax allowances and tax credits are both transferable between partners. Whereas the tax credit is a fixed amount, the benefit of the tax allowance depends on the marginal tax rate of the partner. For non-working women with a high-income partner, transferring the tax allowance to the partner is more beneficial than starting working at a low income. The reason is that when working (and earning more

than 4000 euro annually), women had to use their own allowance at a low marginal tax rate, while when not working it would be transferred to their partner with a higher marginal tax rate. The change from allowance to tax credit can be considered as a reduction in the fixed costs of working. Saez (2002) stresses the importance of financial incentives for the decision to participate in the labor force. There are two relevant margins to investigate, labor force participation (extensive margin) and hours of work (intensive margin).

In the empirical analysis, we focus on prime-age women who are either married or cohabiting. Our empirical model is similar to the model used in Blundell, Duncan and Meghir (1998). However, we study a much shorter time period with a substantial tax reform rather than a series of smaller tax modifications. Tax reforms provide useful natural experiments to study the effect of financial incentives on female labor supply (see Blundell and MaCurdy, 1999; Eissa, 1995; and Eissa and Hoynes, 2004). Because the tax reform generates exogenous variation in after-tax wages, it allows to deal with the simultaneity of working hours and after-tax wages. This simultaneity can arise, for example, because unobserved preferences or ability affect both wages and working hours, or because working hours have a direct effect on after-tax wages due to the progressive tax system. Obviously, the tax reform does not depend on individual characteristics, past choices and working hours. In the empirical model, the after-tax marginal wage will be instrumented using the tax reform. Since the tax reform was introduced at one specific moment, we should control for trends in working hours. Furthermore, we exploit the fact that the tax reform affected different groups differently to deal with self selection into employment.

In the empirical analysis, we use the Dutch Labor Force Survey collected by Statistics Netherlands, which is a repeated cross-section containing information on (weekly) working hours, and detailed information on the socioeconomic structure of the household. We link this to the Social Statistical Database on Jobs, which contains administrative information on jobs and gross income. Finally, we add taxable income registered by the tax offices. The overlapping period of the three databases is from 1999 to 2005.

Within our parameterized selection model we find that the estimated uncompensated wage elasticity is about -0.13, but not significantly different from zero. This suggests that the tax reform which increased after-tax hourly wages did not increase female labor supply.

However, the tax reform had a substantial positive effect on labor force participation, which we attribute to the shift from allowance to tax credit. Female labor force participation increased by 2.4 percentage-points. Simulations with our estimated model show that the positive effect on labor force participation dominates the negative effect of wages. Whereas working women, on average, reduced weekly working hours by 0.04 hours, average working hours increased by 0.37 in the full population. The effect of the tax reform is highest for the lowest-educated women and decreases in level of education.

Our empirical results contradict earlier studies finding that the uncompensated wage elasticity is between 0 and 0.3 (see Meghir and Phillips, 2010; for a survey). In particular, our results differ from those found in Blundell, Duncan and Meghir (1998). As a sensitivity analysis we apply their grouping estimator, which gives a positive and significant uncompensated wage elasticity in the same order as found in Blundell, Duncan and Meghir (1998). The grouping estimator might be less appropriate in our setting since our observation period contains a single tax reform. In that case it is only necessary to distinguish between the period before and after the tax reform, which can be done by a single instrument. The grouping estimator uses many instrumental variables of which in our case many are insignificant in the first-stage regression. In our setting the grouping estimator suffers from a weak instruments problem. The grouping estimator might perform better in situations in which there are a series of tax modification rather than one substantial reform.

The outline of this paper is the following. Section 2 provides details about the Dutch tax reform of 2001. Section 3 introduces the empirical model. In Section 4, we discuss our data. Section 5 presents the estimation results. And Section 6 concludes.

2 The Dutch tax reform

In this section, we provide details about the Dutch tax system. We mainly focus on elements relevant for this study, and particularly on changes which occurred during the tax reform in 2001.

The Dutch tax system is an individualized progressive tax system, with the exception of some tax credits and allowances which can be transferred between partners. Prior to 2001

Table 1: Main characteristics of the tax system.

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
General allowance* (in €)	4674	4646					
Tax credit** (in €)			1731	1752	1715	1881	1916
Marginal tax rates in % (including national insurance premiums)							
Lowest income bracket	35.75	33.9	32.35	32.35	32.35	33.4	34.4
Income bracket 2	37.05	37.95	37.6	37.85	37.85	40.35	41.95
Income bracket 3	50	50	42	42	42	42	42
Highest income bracket	60	60	52	52	52	52	52

Explanatory notes:

* The general allowance reduces taxable income.

** The tax credit reduces the amount of tax paid.

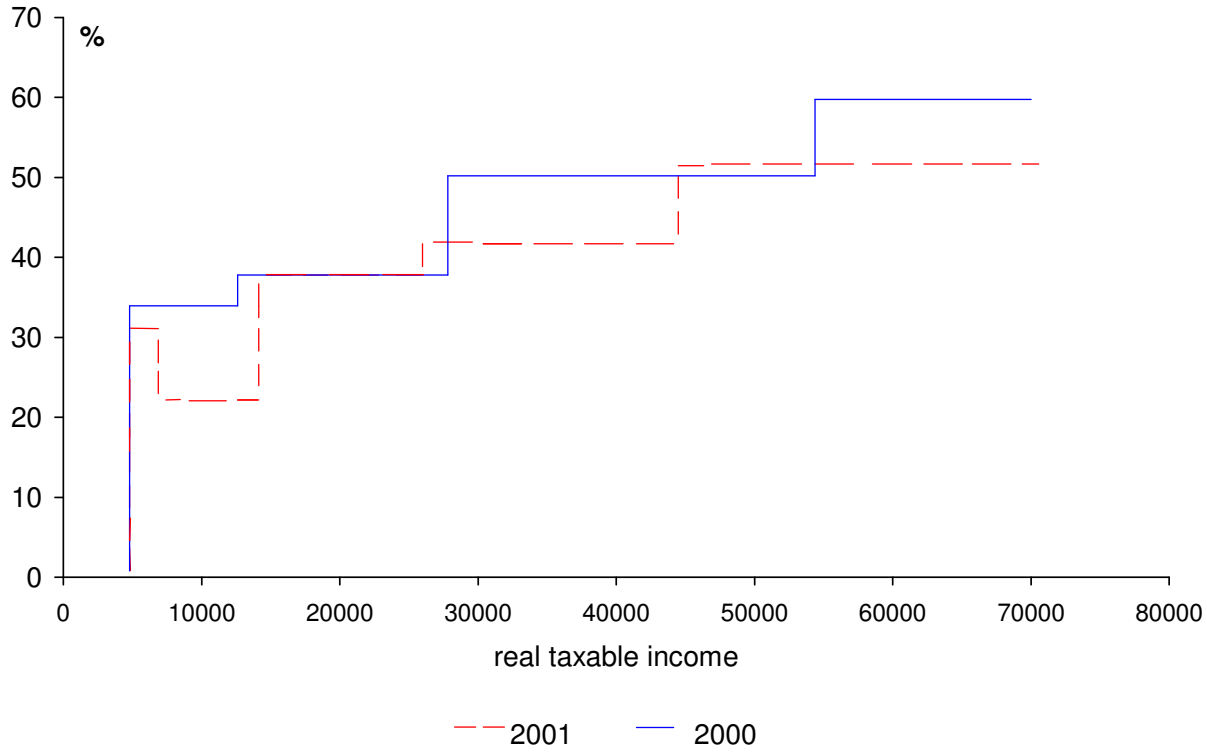
all individuals had a general allowance and individuals only paid taxes on income above the allowance. There are also additional allowances for working and parenting, which we discuss below. Income above the allowances is taxed according to four income brackets with increasing marginal tax rates (including national insurance premiums). The tax allowances thus yield a higher tax reduction for high-income individuals with a higher marginal tax rate.

An important feature of the general allowance is that if the allowance can not be fully used, the allowance is transferred to the partner.[1] Transferring the allowance is particularly beneficial if the partner's income falls in a bracket with a higher marginal tax rate. So working at a low income is financially relatively unattractive for women with a high-income partner.

The tax reform of 2001 replaced the general allowance by a tax credit. A tax credit is a fixed reduction on the total amount of taxes that an individual should pay. Like the general allowance, the tax credit is transferable between partners. However, if a woman increases labor supply, the total tax reduction to the family due to the credits remains the same. The tax reform removed some fixed costs of working, because the tax credit does not impose any disincentive effects of working at a low income.

[1]Married and cohabiting couples have the same status in the Dutch tax system. If a partner has an annual income above 4000 euro, the allowance can not be transferred.

Figure 1: Effective marginal tax rates before and after the tax reform of 2001.

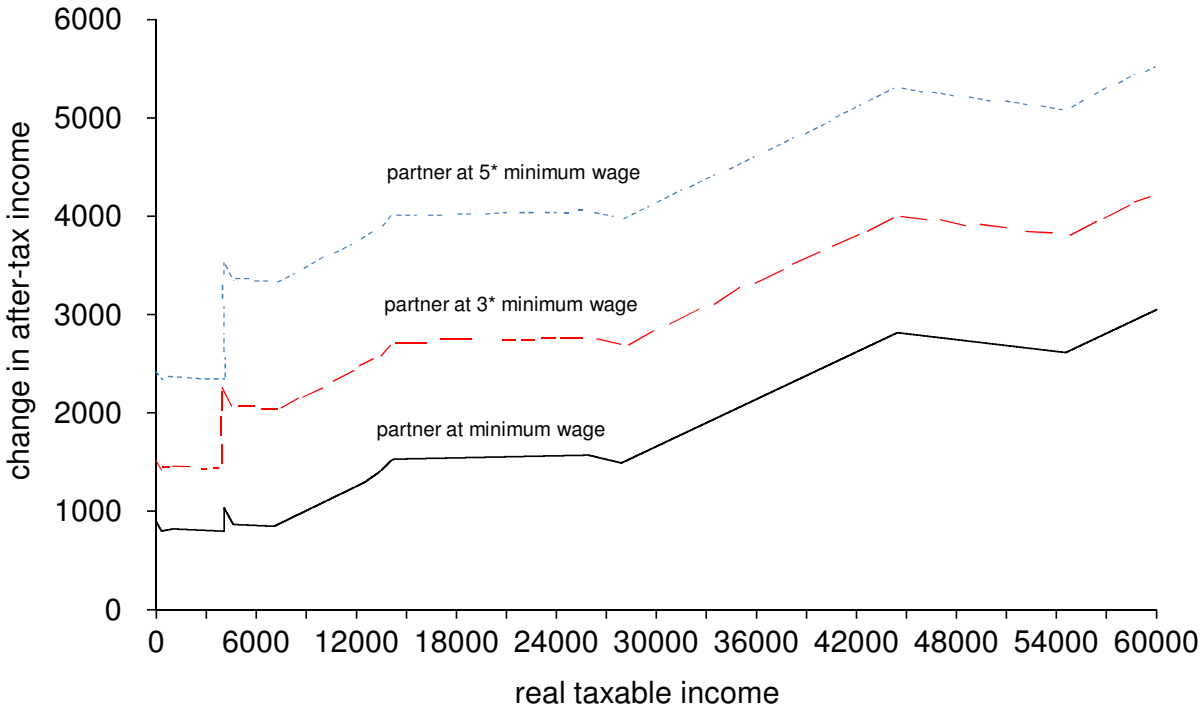


Note: Only nontransferable allowances and tax credits are taken into account.

The tax reform in 2001 also included a reduction of marginal tax rates. Table 1 shows for each year the marginal tax rates for the four different income brackets in the Dutch tax system. The most substantial reduction occurred in the highest two brackets, where marginal tax rates were reduced by eight percentage-points. However, not only the marginal tax rates changed, also the cut-off points of the brackets shifted (see Figure 1).

The tax reform of 2001 not only replaced the general allowance by a tax credit, but also introduced new tax credits for parenting and the combination of working and parenting. The tax credit for parenting is transferable, but amounts to only 138 euro annually. The tax credit for working is more substantial, but not transferable. If an individual earns up to 50 percent of the annual (full-time) minimum wage, the tax credit increases by 150 euro per year. Above this, the tax credit further increases to 900 euro at an income level equal to the annual (full-time) minimum wage. Figure 1 shows the effective marginal tax rates at different taxable incomes in 2000 and 2001. When computing the effective marginal tax rates

Figure 2: Change in after-tax household income due to tax reform of 2001.

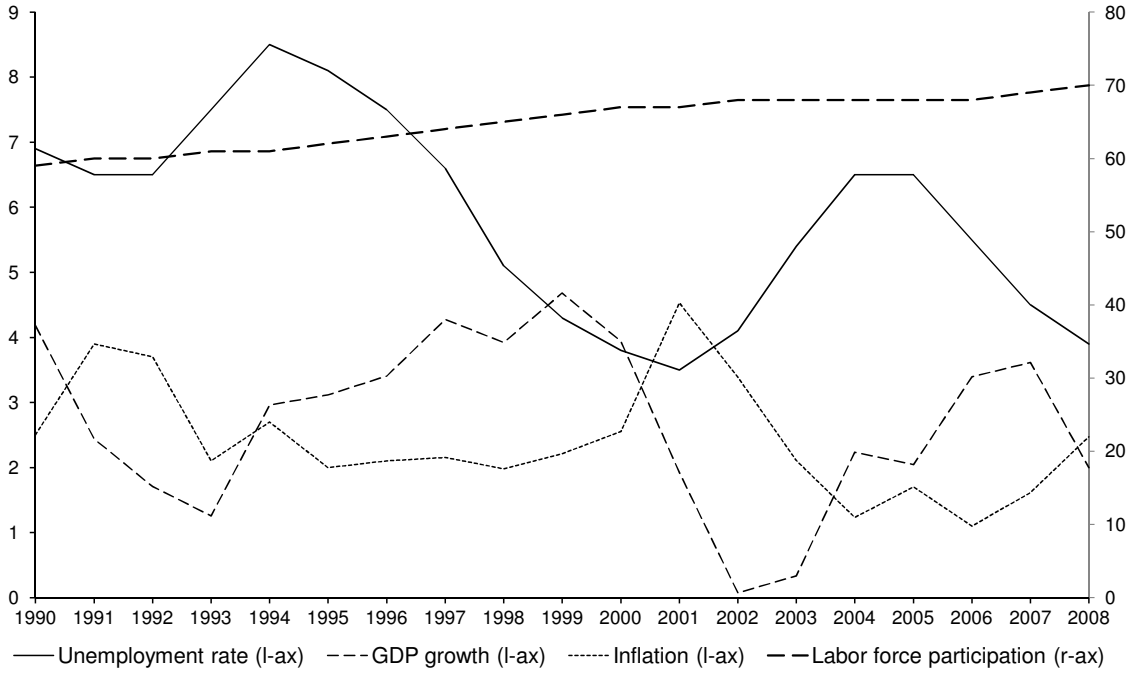


in the figure we take the nontransferable allowances and tax credits into account, but ignore the transferable allowances and tax credits. Taking account of the transferable allowances and tax credits would cause that the effective marginal tax rates at low incomes are not zero but dependent on the partner's income. The impact of the tax credit for working causes the drop in effective marginal tax rates between 8000 and 16,000 euro shown in Figure 1. The average annual taxable income of working women is about 15,000 euro.

The tax reform of 2001 reduced labor tax for all individuals. As can be seen in Figure 2 the after-tax income was higher after the reform, and even more so for women with a high-income partner. However, some deductions were abolished. To compensate for the reduction in labor tax, the government increased value added tax from 17.5 to 19 percent leading to a higher inflation rate in 2001 (see Figure 3).[2] The decision on the tax reform was made in 1999, when the economy was booming. After that, economic growth slowed to almost zero in the first quarter of 2002. Around the same time the unemployment rate started to increase

[2]The value added tax on some essential goods, such as food, is only six percent.

Figure 3: Macroeconomic variables.



for the first time since 1994. Figure 4 shows the unemployment rate by level of education. It is clear that individuals with a lower level of education are more likely to be unemployed than individuals with a higher level of education. The trend in the unemployment rate between groups is, however, very similar. For all groups the unemployment rate declined from around 1994 to 2001, increased until 2005 and declined again afterwards.

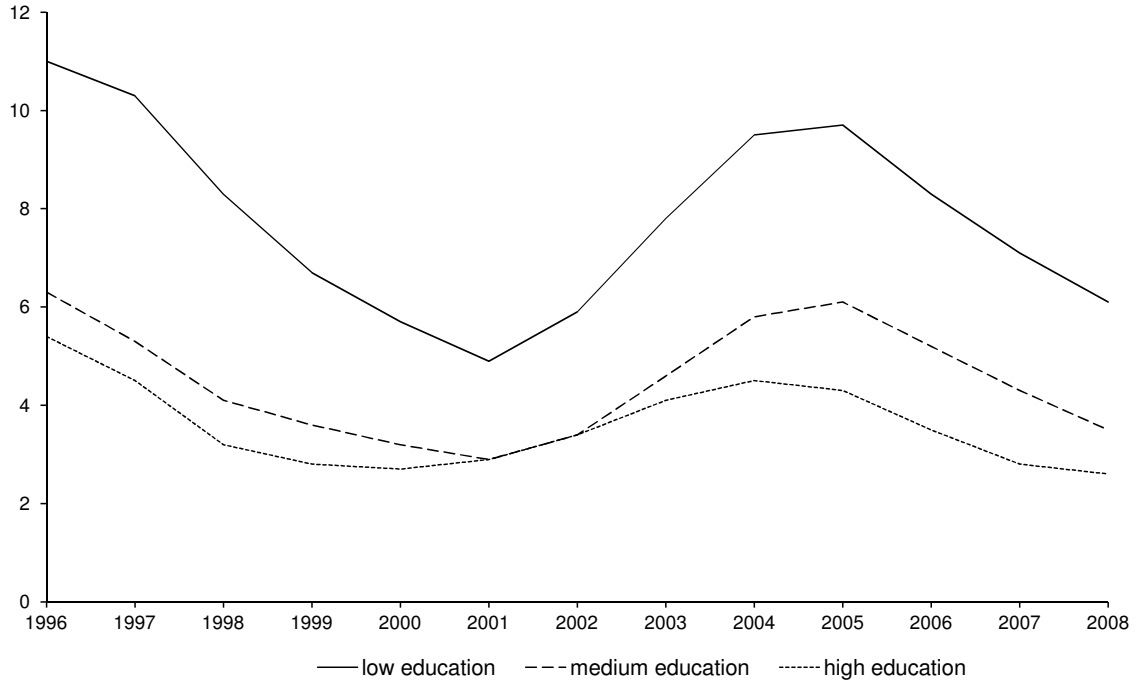
3 Empirical model

This section presents our empirical model. The model describes weekly working hours and has strong similarities with the model used in Blundell, Duncan and Meghir (1998).

We focus on how the after-tax marginal hourly wage w_{it} of woman i in year t causally affects her weekly working hours h_{it}. Therefore, we investigate the traditional labor supply model (e.g. Heckman, 1974)

$$h_{i,t} = \beta_0 + \beta_1 \log(w_{i,t}) + x_{i,t}\beta_2 + \xi_t + \varepsilon_{i,t} \tag{1}$$

Figure 4: Unemployment rate by educational level.



The vector $x_{i,t}$ contains observed individual characteristics such as demographic variables, cohort dummies, level of education, etc. These variables are used to control for heterogeneity between women, no causal interpretation should be given to the coefficients in β_2. The function ξ_t describes common macroeconomic trends in female labor supply. Usually, the labor supply model also includes a term describing other income. We only consider women with a working partner and they are not entitled to benefits and subsidies, other than child subsidies. The latter depend on the household composition which is included in $x_{i,t}$.

The traditional labor supply model considers individual labor supply decisions and does not take intra-household decision making into account. However, our data describe married women with a working husband and within a household the labor supply decisions of partners may be interrelated. Chiappori (1992) extends the labor supply model to a model of collective household decision making. The extension of the collective model is that there is first sharing of non-labor income. Fortin and Lacroix (1997) reject the alternative unitarian model. Blundell, Chiappori, Magnac and Meghir (2007) consider the case in which men choose between working full time or not working, while women can choose their working hours.

Within this framework they reject the unitarian model, but cannot reject the collective model. They discuss the empirical content of the collective model. We only consider women with a working husband. Following Blundell, Chiappori, Magnac and Meghir (2007) this implies that $x_{i,t}$ should include the husband's earnings.

Obviously, the key parameter of interest in β_1. It is, however, well known that using OLS to estimate equation (1) yields inconsistent estimators for β_1. The logarithm of the after-tax marginal hourly wage may be correlated to the error term $\varepsilon_{i,t}$ for a number of reasons. First, there may be reverse causality. Working more hours increases annual taxable income and individuals enter an income bracket with a higher marginal tax rate because of the progressity of the tax system. Second, the vector $x_{i,t}$ probably does not capture all relevant heterogeneity in individual preferences or ability. If there is unobserved ability and more able individuals earn higher wages and have a stronger preference for work, then there is a direct relation between $\log(w_{i,t})$ and $\varepsilon_{i,t}$.

We use the tax reform of 2001 to deal with endogeneity of $\log(w_{i,t})$. The tax reform provides some exogenous variation in after-tax marginal hourly wage. Therefore, we add the first-stage regression

$$\log(w_{i,t}) = \alpha_0 + \alpha_{i,1} \cdot I(t \geq 2001) + x_{i,t}\alpha_2 + \zeta_t + V_{i,t} \tag{2}$$

The indicator function $I(t \geq 2001)$ describing the period after the tax reform acts as instrumental variable. We allow the effect of the tax reform on wages $\alpha_{i,t}$ to be different for different types of individuals. In particular, we allow for separate $\alpha_{i,1}$ for different educational groups. The indicator $I(t \geq 2001)$ is only a relevant instrumental variable if common macroeconomic trends ξ_t and ζ_t are smooth functions over calendar time. Our identifying assumption is that between 2000 and 2001 there are no general abrupt shocks in female labor supply other than due to the tax reform. This also implies that the tax reform should not be the response of policymakers to a sudden change in female labor force decisions or shifts in preferences. Although there was no unexpected change in female labor supply in the period prior to the tax reform, an important goal of the tax reform was to stimulate female labor force participation.

A second important issue is that the composition of working women might have changed over time and due to the tax reform. Recall that the tax reform included a shift from an allowance to a tax credit, which reduced the fixed costs of working. Furthermore, there is an increasing trend in employment rates among women. Finally, the decision to work might directly be related to unobserved preferences and ability. The self selection into work is most likely not random and cannot be ignored. To control for selective labor force participation $P_{i,t}$ we add a probit model

$$\Pr(P_{i,t} = 1) = \Phi\left(\gamma_0 + \gamma_{i,1} \cdot I(t \geq 2001) + x_{i,t}\gamma_2 + \psi_t\right) \tag{3}$$

Again we allow the tax reform to have a differential impact on the labor force participation of women with different educational degrees. And we allow for a smooth trend ψ_t in female labor force participation.

We follow the estimation procedure of Blundell, Duncan and Meghir (1998), which is a control function approach. First, we estimate the wage equation (2) using OLS on the sample of employed women, and the participation equation (3) using maximum likelihood estimation on the full sample. This provides us the residuals $\hat{V}_{i,t}$ from the first-stage regression for wages and the inverse Mills ratios $\hat{\lambda}_{i,t} = \frac{\phi\left(\hat{\gamma}_0+\hat{\gamma}_{i,1}\cdot I(t\geq 2001)+x_{i,t}\hat{\gamma}_2+\hat{\psi}_t\right)}{\Phi\left(\hat{\gamma}_0+\hat{\gamma}_{i,1}\cdot I(t\geq 2001)+x_{i,t}\hat{\gamma}_2+\hat{\psi}_t\right)}$ from the participation probit. We add these as regressors to equation (1), which gives the second-stage equation

$$h_{i,t} = \beta_0 + \beta_1 \log(w_{i,t}) + x_{i,t}\beta_2 + \xi_t + \beta_3\hat{V}_{i,t} + \beta_4\hat{\lambda}_{i,t} + U_{i,t} \tag{4}$$

Estimating this model using OLS on the sample of working women provides consistent parameter estimates for β_1. Because equation (4) includes two additional terms to control for selective labor market participation and endogenous wages, at least two exclusion restrictions are required. We achieve this by not restring to have the same impact for all women on the after-tax marginal hourly wage and labor force participation (i.e. $\alpha_{i,1}$ and $\gamma_{i,1}$ are allowed to be different for women with different levels of education). We return to this issue in Subsection 4.2 when we discuss the impact of the tax reform. Finally, we have already discussed including the after-tax income of the husband in the vector of regressors $x_{i,t}$. Intra-household decision making is not the only reason for taking account of the husband's income. The tax

reform affects the income of the husband as well. If female labor supply decisions are related to the husband's after-tax income which is most likely the case, ignoring the husband's income causes a direct correlation between the error terms $\varepsilon_{i,t}$ and the tax reform $I(t \geq 2001)$. This would violate the validity condition for using the tax reform as instrumental variable.

The parameter of interest β_1 should be interpreted as the uncompensated wage coefficient. This can be translated into the uncompensated wage elasticity of labor supply by dividing by working hours. In particular, we divide by mean working hours of employed women $\bar{h}$, so the uncompensated wage elasticity is $\frac{\beta_1}{\bar{h}}$. The wage elasticity includes both the substitution and the income effect. A positive value of β_1 implies that the substitution effect dominates the income effect.

4 Data

4.1 Sample

In the empirical analysis, we use a data set constructed from three separate databases. The Dutch Labor Force Survey collected by Statistic Netherlands is a repeated cross-section containing detailed information on socioeconomic and demographic characteristics of households. This database contains information on employment status and weekly working hours, but lacks wages and income. Therefore, we use a unique identification code to merge the Dutch Labor Force Survey with the Social Statistical Database on Jobs. This database contains information reported by employers on gross annual earnings and annual working hours for about a random one-third of the working population. We link a third database containing taxable income registered by the tax office. The three databases share the observation period from 1999 until 2005.

We restrict the data to married or cohabiting women between age 20 and 50 whose education level is observed. In total, this includes 147,696 women. Women should have an employed husband with a taxable income above 9000 euro and for whom we observe the level of education. This reduces the sample size by 25,065 women.[3] There are no differences

[3]We also exclude women with a self-employed husband.

in employment rates of married men around the reform. The income restriction is made to avoid complications with husbands transferring tax allowances and tax credits to their working wives. Furthermore, if the husband works, the wife is not entitled to means-tested welfare benefits. In total 122,631 women in the Labor Force Survey satisfy the criteria above.

The employment status of women reflects the timing of the survey. We drop women whose employment status in Social Statistical Database and Labor Force Survey diverge and those who are self-employed. This excludes 18,849 women. If a woman is employed, she is asked to report her weekly working hours. Individuals should report their contractual hours, or if they are working without a contract the average number of hours they work during a week. In total 75 percent of the women are employed, and they work, on average, 25 hours per week.

Next, we use the Social Statistical Database on Jobs to compute the gross hourly wage, which is the gross annual wage divided by annual working hours. Because the Social Statistical Database on Jobs contains a random one-third of the working population, we get three subsamples: (*i*) working women with observed hourly wages, (*ii*) working women without observed wages and (*iii*) non-working women. To reduce measurement errors in wages, we transfer women from subsample (*i*) to subsample (*ii*) if the gross hourly wage is below 90 percent of the mandatory minimum wage or above 200 euro per hour.[4]

We add taxable income to our data set, and apply the existing tax rules to transform taxable income into after-tax income. The taxable income data is collected by the tax office for all employees. Information on annual working hours is retrieved from the Social Statistical Database on Jobs containing information for a random one-third of the employees. Therefore, we can compute the average after-tax hourly wage for one-third of the working population. In our empirical model the relevant wage rate is not the average after-tax hourly wage, but the marginal after-tax hourly wage. To obtain the marginal tax rate we increase taxable income by 10 euro. Next, we transform taxable income again into after-tax income and divide the increase in after-tax income by 10. To remove further outliers from the data,

[4]In the Netherlands, the minimum wage is the same for all workers above age 23 and is formulated in terms of gross hourly wages. Below age 23 the minimum wage is age dependent. The minimum wage is corrected for inflation twice a year. In 2000 the minimum wage for those above age 23 was 6.41 euro per hour.

we transfer women from subsample (i) to subsample (ii) if their after-tax hourly wage is below 54 percent of the gross minimum wage or above 200 euro per hour. Finally, women reporting to work over 48 hours, which is the legal maximum number of working hours per week, and women having an annual taxable income above 150,000 euro are transferred from (i) to (ii). In addition, we transfer 3731 women from (i) to (ii) because the marginal tax rate could not be calculated, for example because they had multiple jobs. We observe wage information for in total for 38,367 women. However, recall that in the estimation we also take into account the remaining women, who are either not working or employed but without an observed wage. We have corrected wages for inflation. This takes account of the increased consumer tax in 2001.

In our baseline empirical analysis, we focus on the years 1999 until 2003, which reduces the sample size by 31,183 women. This has the advantage that the data describe two years before and two years after the 2001 tax reform, and that we do not have to deal with the minor changes in the tax rules implemented in 2004. In Subsection 5.3 we also provide results on all observations including the years 2004 and 2005. So the baseline analysis use a sample of 72,599 women for which we observe their employment status and for 24,935 women we also observe wage information. Individual characteristics are obtained from the Labor Force Survey. Table 2 provides summary statistics both for working and non-working women. Working women are, on average, slightly younger, have less often (young) children and are higher educated. Also the partners of working women are slightly younger and, on average, higher educated. However, the after-tax annual income of partners with working women is, on average, more than 2000 euro lower.

Table 3 reports some labor market outcomes. Female labor force participation rates steadily increased from 70 percent in 1999 to 78 percent in 2003, and remained relatively constant afterwards. During most of the period in which participation rates increased, average working hours decreased. This suggests that those women who newly enter the workforce, work relatively few hours. Both average and marginal after-tax hourly wages show a substantial increase in 2001. This is the result of the tax reform, because as can be seen the marginal tax rate reduced substantially, while the taxable hourly income did not fluctuate much. In 2004, marginal tax rates started to increase again, which is the result of

Table 2: Weighted summary statistics of the data set describing 1999-2003.

	Working	**Non-working**
Age (in years)	35.9	38.8
No children (in %)	44	24
One minor child (in %)	22	22
Two minor children (in %)	26	35
Three or more minor children (in %)	8	19
Presence youngest child 0-3 (in %)	22	30
Presence youngest child 4-11 (in %)	21	30
Presence youngest child 12-17 (in %)	12	15
Highest completed level of education		
Primary + lower secondary (in %)	23	49
Higher secondary (in %)	49	40
College or university (in %)	28	11
Age partner (in years)	38.4	41.5
Highest completed level of education partner		
Primary + lower secondary (in %)	24	35
Higher secondary (in %)	45	41
College or university (in %)	32	24
After-tax annual income partner (in €)	18,126	20,732
Observations	56,295	16,304

Table 3: Female labor market outcomes.

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Participation (in %)	70	72	74	76	78	78	79
Weekly working hours	25.6	25.1	24.9	25.5	25.1	24.7	24.9
Average after-tax hourly wage (in €)	9.46	9.64	10.27	10.46	10.44	10.68	10.43
Marginal after-tax hourly wage (in €)	7.79	7.89	8.49	8.63	8.60	8.74	8.49
Before tax hourly wage (in €)	12.4	12.5	12.8	13.0	13.0	13.3	13.1
Marginal tax rate (in %)	37.1	36.9	33.5	33.7	33.9	34.5	35.3

Explanatory note: Weekly working hours and hourly wage are the average for employed women. Wages are corrected for inflation.

the changes in the tax system implemented in 2004.

Table 4 shows some characteristics of the distribution of working hours by year for the different educational groups. First, higher-educated women are more likely to work and also more likely to work more than 32 hours. For all groups there is a negative trend in the percentage not working, however, the fraction of women working more than 24 hours per week remains constant.

4.2 Impact of tax reform on wages and participation

This subsection investigates the impact of the tax reform on after-tax wages and on labor force participation. First, we provide some descriptive evidence. Next, we focus on estimating the reduced-form models for the logarithm of the after-tax marginal hourly wages and labor force participation (equations (2) and (3) respectively).

Table 5 summarizes the marginal tax rate, the after-tax marginal hourly wage and the participation rate for each year. Recall from Section 2 that the tax reform has different impacts on marginal tax rates at different parts of the income distribution. Therefore, we distinguish between low-educated, medium-educated and high-educated women. For all three groups marginal tax rates are substantially reduced due to the tax reform. The impact of the tax reform is, however, smallest for the highest educated women.

The drop in marginal tax rates due to the tax reform causes a substantial increase in after-tax marginal hourly wage for all groups. Participation rates steadily increase during the

Table 4: Percentage of women with particular working hours by year and educational level.

	No work	**$\leq$ 16 hours**	**16-24 hours**	**24-32 hours**	**$>$ 32 hours**
			Low education		
1999	44	13	20	10	13
2000	42	14	20	9	14
2001	39	13	22	10	15
2002	36	15	22	12	15
2003	37	13	21	12	18
			Medium education		
1999	26	11	24	14	25
2000	25	11	25	16	24
2001	22	13	26	15	24
2002	22	13	28	16	21
2003	21	12	27	18	22
			High education		
1999	16	5	21	19	39
2000	15	6	21	19	38
2001	14	6	22	21	38
2002	13	6	23	20	38
2003	11	6	21	21	41

Table 5: Impact of the tax reform.

	marginal tax rate (in %)	**marginal wage** (in €)	**participation rate** (in %)
	Low education		
1999	34.0	6.71	56
2000	33.0	6.90	58
2001	29.4	7.47	61
2002	29.4	7.33	64
2003	29.7	7.45	64
1999-2000	33.5	6.81	57
2001-2003	29.5	7.41	63
change	−4.0	0.61	6
	Medium education		
1999	36.1	7.48	74
2000	36.0	7.61	75
2001	32.1	8.27	78
2002	32.4	8.48	78
2003	32.5	8.34	79
1999-2000	36.0	7.55	75
2001-2003	32.3	8.37	79
change	−3.7	0.82	4
	High education		
1999	40.2	8.85	84
2000	40.5	8.86	85
2001	37.8	9.42	86
2002	38.0	9.56	87
2003	38.0	9.50	89
1999-2000	40.4	8.85	85
2001-2003	38.0	9.50	87
change	−2.4	0.64	3

Table 6: Estimation results for the reduced-form equations.

	participation		**log hourly wage**	
instrumental variables				
low education post reform	0.103	(0.037)	0.073	(0.018)
medium education post reform	0.091	(0.033)	0.071	(0.010)
high education post reform	0.058	(0.058)	0.061	(0.011)
F-test for instruments	16.17		33,31	
Observations	72,599		24,935	

Explanatory note: Standard errors in parentheses. Controls added for education, cohort, calendar time, household situation, education and income of partner (see Table 10 for all parameter estimates).

observation period, but show a jump in 2001 for the low and medium educated. The impact of the tax reform seems to be different for different educational groups. As we argued earlier the tax reform is not correlated to individual preferences or unobserved ability. However, it is not only necessary that the instrument variables are not correlated to the error terms in the labor supply equation (1), but they should also be relevant. The latter implies that the instruments should have a sufficiently large impact on wages and labor force participation.

Table 6 reports the estimation results for the reduced-form equations (2) and (3). The F-test for joint significance of the instrumental variables are 33 and 16, which is above the critical value for weak instruments mentioned by Stock and Staiger (1997). This critical value might not be appropriate in our setting. Stock and Yogo (2005) discuss the case of multiple endogenous regressors and instrumental variables. However, the labor supply model does not fit within their setting, since outcomes are only observed for participants and the first-stage model for labor force participation is non-linear. In the participation equation there are some differential impacts of the tax reform by educational group, but the differences are not significant (the p-value for similarity is 0.81). In the wage equation the coefficients for the different educational groups are very similar and the p-value for similarity equals 0.74.

5 Estimation results

In this section, we first present the estimation results for the labor supply model. Next, we perform simulations with the model. Finally, we discuss some sensitivity analyses.

5.1 Parameter estimates

Table 7 presents the estimation results for the labor supply model. In the full specification of the model (column (1)), the uncompensated wage elasticity equals $\frac{-3.197}{25.00} = -0.13$. This finding does not concur with the literature surveyed by Meghir and Phillips (2010). They mention that most studies find an elasticity between 0 and 0.3. Earlier studies for the Netherlands found large and positive wage elasticities, for example, Van Soest, Woittiez and Kapteyn (1990) estimated the wage elasticity to be 0.45. And Evers, De Mooij and Van Vuuren (2008) conclude, based on surveying the literature, that the wage elasticity for women in the Netherlands should be around 0.5.

Our estimate for the wage elasticity is not significant at any commonly used significance level. The estimate implies that the income effect is about the same size or slightly larger than the substitution effect. It is useful to see our empirical result in the light of recent trends in labor force participation and part-time work in the Netherlands. In the early 1980s labor force participation of prime-aged women was among the lowest within the OECD. In the next two decades female labor force participation increased to about the OECD average, and in this period part-time work was praised by policymakers. Part-time work among prime-aged women was even slightly higher in 2001 than in 1981. Only until a few years ago the attitude towards part-time work changed. In 2008, the Dutch *Committee on Labor Force Participation* stressed the high number of part-time workers as one of the main labor market weaknesses.

In the Netherlands, part-time work is much more institutionalized than in other countries, and relatively high-skilled work can be done part-time (see Bosch, Deelen and Euwals, 2008). In a recent survey Dutch women report being satisfied with their part-time jobs (see Portegijs and Keuzenkamp, 2008; and Portegijs, Cloïn, Keuzenkamp, Merens and Steenvoorden, 2008). Only 4% of the part-time working women indicate that they prefer to work full-time, which

Table 7: Estimation results for the labor supply model.

	(1)		**(2)**		**(3)**		**(4)**	
Log hourly wage	−3.197	(2.821)	−0.994	(2.790)	−0.100	(0.217)	−0.085	(0.217)
Wage residual	3.109	(2.832)	0.912	(2.802)				
Inverse Mills	−4.761	(1.011)			−4.592	(0.999)		
Observations	24,935		24,935		24,935		24,935	

Explanatory note: Robust standard errors in parentheses. Column (1) adds controls for endogenous wages and selective labor force participation. Column (2) and (3) add controls for one of the two, whereas column (4) adds no additional controls and reports the conditional correlation. Furthermore controls are added for education, sector, cohort, calendar time, household situation, education and income of partner (see Table 11 for all parameter estimates).

is much lower than in any other country. The most frequently cited reason for working part-time is taking care of children. Indeed, women usually reduce working hours after their first child is born, but they do not increase working hours when their children become older. Dutch women indicate that financial constraints limit them in working fewer hours much less often than women in other countries.

It is important to stress that the instrumental variables approach measures a local average treatment effect (Imbens and Angrist, 1994). So we estimate the uncompensated wage elasticity at the margin where the tax reform affects the after-tax marginal hourly wage. Recall that the tax reform had two important elements, marginal tax rates were reduced, and allowances were transformed into tax credits. The second element caused work to become financially more attractive for women with high-income partners. Our data show a large degree of assortative matching on education (the correlation in level of education between partners is 0.45). However, if we look at income, the correlation between partners is much smaller, only 0.06 in the period before the tax reform. After the tax reform this correlation increased to 0.08. After the tax reform women with high-income partners started to earn more relative to women with low-income partners. However, we saw in Table 4 that the fraction of women with many working hours remained constant during the observation period. The tax reform thus caused women with high-income partners to enter the labor force, but to work fewer hours. We attribute this mainly to the change from allowance to tax credit, which removed some disincentives for working. Since the women who newly enter the labor market have relatively good skills (due to assortative matching), they can also earn relatively good wages, but devote fewer hours to work than would be expected. This might explain why we estimate the wage elasticity to be negative.

Our interpretation of the results is that the shift from general allowance to tax credit was the part of the tax reform which yields the most substantial incentive. In-work tax credits are often found to have stimulating effects on the labor force participation decision of women (e.g. Aaberge and Flood, 2008; Eissa and Hoynes, 2004; Eissa and Liebman, 1996; and Meyer and Rosenbaum, 2001). If indeed this shift was the key element of the tax reform, the impact of the reform might be different for women with partners with high and low income. Therefore, we added as instrumental variable an interaction between the reform

and the partner's income. However, while having the expected sign the coefficients of this instrument in the first-stage regressions are not significant, and there are no changes in the results of the second-stage regression.

The coefficient for the wage residuals is positive but not significant. Therefore, we cannot reject that the after-tax marginal wage is exogenous. However, ignoring possible endogeneity in wages reduces the wage elasticity to almost 0, i.e. $\frac{-0.100}{25.00} = -0.0$ (see column (3)). The significant coefficient of the inverse Mills ratio (in column (1)) means that there is self selection into work. The negative coefficient of the inverse Mills ratio implies that women who participate in the labor market are also women who are more likely to work relatively many hours. Ignoring selective labor market participation also reduces the wage elasticity (see column (2)). Ignoring both selective labor market participation and endogenous wages has about the same effect as ignoring only endogeneity in wages (column (4)).

In the baseline specification, other exogenous regressors (see Table 11) are almost always significant and have the expected signs. Higher-educated, younger and cohabiting women work more hours. Women with children work less. However, working hours increase in the age of the youngest child, but reduce in the number of children present in the family. Women with a high-income partner work fewer hours. We have tried to include the partner's income squared to capture that the association between female working hours and partner's income might be nonlinear. But this term was not significant and adding this term did not change the main parameters of interest.

5.2 Model simulations

Next, we perform some simulations to get an insight into the effect of the tax reform on female working hours. Table 8 shows the results of these simulations for all women and also separately for low, medium and high-educated women. In the simulations we use all women who are observed in the data in the year 2001.

The first row of the table shows the situation in 2001 (so after the tax reform). The labor force participation model predicts that 77.8 percent of the women have a job. The average after-tax marginal hourly wage is 7.88 euro. Women who are working have, on average, 24.46 working hours per week. However, in the full population the average number

Table 8: Model simulations.

	Participation rate (in %)	**After-tax hourly wage** (in €)	**Hours of participants**	**Hours of all women**
	All women			
After tax reform	77.8	7.88	24.46	19.72
Only tax reform on participation	77.8	7.35	24.68	19.89
No tax reform	75.4	7.35	24.50	19.35
	Low educated			
After tax reform	63.7	7.00	22.00	14.53
Only tax reform on participation	63.7	6.51	22.24	14.68
No tax reform	60.0	6.51	21.97	13.89
	Medium educated			
After tax reform	81.2	7.86	24.26	20.23
Only tax reform on participation	81.2	7.32	24.48	20.41
No tax reform	78.9	7.32	24.32	19.89
	High educated			
After tax reform	89.2	9.06	28.17	25.53
Only tax reform on participation	89.2	8.53	28.36	25.70
No tax reform	88.2	8.53	28.29	25.46

of working hours is 19.72 hours per week. The second row of the table describes the case where the tax reform only affects participation, but marginal wages remain unaffected. To some extent this mimics the situation where marginal tax rates remained as in 2000 and the tax reform only included a shift from allowance to tax credit. Of course, participation rates remain at their post reform level, but after-tax marginal hourly wages are lower. Since the wage elasticity is negative, the reduced after-tax marginal hourly wages cause a slight increase in working hours and also of working hours of labor force participants. The third row describes the case in which the tax reform would not have been implemented in 2001. It shows that labor force participation rates are substantially lower and working hours of working women are slightly higher. The last column of the table shows that the labor force participation effect of the tax reform dominates the effect of wages. So the tax reform caused average weekly working hours (in the full population) to increase from 19.35 to 19.72.[5]

The remainder of the table shows the same simulations separately for different education groups. For all three groups the tax reform increases labor force participation, although the effect becomes smaller as the educational level increases (and labor force participation is already higher). In nominal terms the tax reform has about the same impact on after-tax marginal hourly wages of all three groups. However, since low-educated women have, on average, the lowest wages, the relative impact on wages of the tax reform decreases as education increases. The positive effect of the increase in labor force participation dominates the negative effect of higher wages on average working hours in the full population.

5.3 Sensitivity analyses

In this subsection, we present a number of sensitivity analyses. First, we split the sample according to the presence of children. We distinguish three groups of married women. The first group consists of women with at least one child younger than age 12. The second group describes women with the youngest child above age 12 and the third group contains women without dependent children in the household. In the upper panel of Table 9 we show the

[5]Van Soest and Das (2001) estimate a structural model and simulate the tax reform before it was implemented. They predict positive effects on the participation rate (1.48 percent) and working hours (4 percent).

estimation results for these three groups. Only for the group with young children, there do not seem to be problems with weak instruments. For both other groups, the instruments seem particularly weak in the probit model for labor force participation. Furthermore, for all groups we find an insignificant wage elasticity. We take this as evidence that splitting the sample into different groups generates too small subsamples and causes estimators to become imprecise.

Next, we split the sample according to the age of the women. We distinguish between women under age 40 and above age 40. The second panel of Table 9 shows the estimation results by age. Whereas for the younger age group the effect of wages on hour of work is negative and significant, it is positive and significant for the older age group. For younger women both wages and labor force participation are endogenous, while this is not the case for older women. A possible explanation is that older women are less flexible on the labor market, they change jobs less often and have, therefore, fewer possibilities to change working hours (although in the Netherlands there is some regulation that provide workers flexibility to change working hours within their job).

Now, we slightly modify the estimation method. First, we estimate the participation equation. Next, we perform 2SLS on the labor supply equation (and the wage equation) in which we include the inverse Mills ratio as exogenous regressor. The only difference with our baseline approach is that now the inverse Mills ratio is also included in the wage equation. If the inverse Mills ratio would be linear in its index, this estimation procedure would be equivalent to the control function approach used so far. So if the estimated coefficients are very different, this is evidence that important non-linearities in the model are ignored. As is shown in column (6) of Table 9 there is only a very minor difference in the estimated wage elasticity.

Next, we extend the observation period by also including data from 2004 and 2005, and include quadratic terms in the time trends. This improves the predictive power of the instruments in the first-stage regressions. It results in a more negative wage coefficient and because standard errors are reduced, the wage coefficient now becomes significant. Selectivity in labor force participation remains important, but also wages become endogenous.

Finally, we follow Blundell, Duncan and Meghir (1998) and apply the grouping estimator.

Table 9: Sensitivity analyses.

	(1)		**(2)**		**(3)**	
Log hourly wage	−1.510	(4.500)	−2.103	(7.421)	−5.622	(4.046)
Wage residual	1.073	(4.511)	2.207	(7.448)	5.396	(4.067)
Inverse Mills	0.977	(1.893)	−5.965	(4.278)	−17.047	(2.491)
	F-test statistic for instruments					
Wage equation	12.8		6.0		20.5	
Participation	21.9		0.9		5.8	
# of instruments	3		3		3	
Observations	12,240		3170		9525	

Explanatory note: Robust standard errors in parentheses.
(1) Married women with young children (youngest child under age 12)
(2) Married women with older children (youngest child between age 12 and 17)
(3) Married women without dependent children.

	(4)		**(5)**	
Log hourly wage	−11.205	(3.306)	4.880	(0.338)
Wage residual	10.677	(3.318)	−4.812	(5.114)
Inverse Mills	−9.673	(1.163)	−2.162	(2.150)
	F-test statistic for instruments			
Wage equation	21.3		13.1	
Participation	6.9		8.5	
# of instruments	3		3	
Observations	15,109		9826	

Explanatory note: Robust standard errors in parentheses.
(4) Women below age 40.
(5) Women above age 40.

Table 9: (Continued).

	(6)		**(7)**		**(8)**	
Log hourly wage	−3.268	(2.889)	−5.921	(1.269)	10.658	(3.813)
Wage residual			5.852	(1.279)	−9.723	(3.818)
Inverse Mills	−4.899	(1.045)	−4.814	(0.852)	1.151	(1.171)
	F-test statistic for instruments					
Wage equation	31.5		202.8		2.7	
Participation	16.2		164.8		27.35	
# of instruments	3		3		24	
Observations	24,935		38,367		24,935	

Explanatory note: Robust standard errors in parentheses.
(6) Inverse Mills ratio included in wage equation.
(7) Observation extended to 1999-2005 (including quadratic time trends).
(8) Grouping estimator.

As instruments we use education interacted with cohort and year dummies, which yields in total 24 instruments. When applying the grouping estimator wages are endogenous, while there is no longer selective labor force participation. This is similar to what is found by Blundell, Duncan and Meghir (1998), and also our estimated wage elasticity (0.43) resembles their estimated wage elasticity (0.30). The wage residual in the labor supply equation becomes negative (and significant). Women with unobserved characteristics that provide them higher wages, have a lower preference for working many hours. This is not what one would expect if unobservables would capture, for example, motivation, work attitude or unobserved skills. Also Blundell, Duncan and Meghir (1998) do not provide an explanation for this type of endogeneity. A possible explanation for the difference between the results from the grouping estimator and our estimates presented in Table 7 is that the grouping estimator contains many instruments, and that the resulting wage elasticity describes a mixture of many local average treatment effects.

We should also consider the first-stage regressions. Most instruments are not significant in the first-stage regressions. However, the F-test for joint significance of the instruments has both in the wage equation and the labor force participation equation a p-value of less than

0.001 (which is what Blundell, Duncan and Meghir, 1998; report). The F-test statistic is, however, small and indicates problems with weak instruments (e.g. Stock and Yogo, 2005). Extending the observation period by including also 2004-2005 (and thus taking account of the tax modifications in these years) does not solve the weak instrument problem and does not change any of the estimation results.

6 Conclusions

In this paper, we investigate how financial incentives affect female labor supply. We focus on the Netherlands, which has an average female labor force participation, but by far the highest rate of part-time work among women within the OECD. This suggests that women carefully choose their working hours (and within the Netherlands there is regulation that allows for flexibility in adapting hours of work). We exploit exogenous variation from a substantial tax reform in 2001. An important reason for the tax reform was to induce women to increase labor supply. The tax reform included a reduction in marginal tax rates and a change from allowance to tax credit (which are both transferable). The latter removed some disincentives for working. In the empirical analysis we combine three different databases to construct a large data set covering the period around the tax reform. The empirical results show a negative (but insignificant) uncompensated wage elasticity, implying that the income effect dominates the substitution effect. We argue that this might be due to the positive attitude in the Netherlands towards part-time work.

The tax reform does have a significant effect on labor force participation and we also find significant selection effects. We attribute this to the change from allowance to tax credit. This finding is in agreement with a large literature on earned income tax credits, which finds that the extensive margin of female labor supply is more sensitive to financial incentives than the intensive margin. We performed some simulations with the estimated model and found that the tax reform increased average weekly hours of work by 0.37, which is about 2 percent of average working hours in the population.

The uncompensated wage elasticity and the labor force participation effect are used in many economic models measuring welfare effects of (tax) policies. Nowadays, these models

include a positive wage elasticity, meaning that individuals supply more hours to the market if their after-tax wages increase. Our negative (but insignificant) wage elasticity suggests that lower marginal taxes do not lead to more working hours (intensive margin). We do, however, find that the tax cut induced more women to work (extensive margin). These conclusions are based on a natural experiment and only hold for the part of the labor supply curve affected by the reform. In a recent survey Saez, Slemrod and Giertz (2012) stress the usefulness of the elasticity of taxable income in calculating welfare effects of taxes.

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Table 10: Estimation results for the reduced-form equations.

	participation		**log hourly wage**	
instrumental variables				
low education post reform	0.103	(0.037)	0.073	(0.018)
medium education post reform	0.091	(0.033)	0.071	(0.010)
high education post reform	0.058	(0.058)	0.061	(0.011)
exogenous regressors				
low education and linear trend	0.021	(0.013)	0.006	(0.006)
medium education and linear trend	0.025	(0.012)	0.009	(0.003)
high education and trend	0.053	(0.020)	0.015	(0.004)
coh1949-54. lower education	−0.392	(0.044)	0.021	(0.016)
coh1949-54. medium education	0.199	(0.049)	0.106	(0.013)
coh1949-54. higher education	0.713	(0.060)	0.281	(0.013)
coh1955-64. lower education	0.040	(0.040)	−0.015	(0.014)
coh1955-64. medium education	0.540	(0.044)	0.089	(0.012)
coh1955-64. higher education	0.983	(0.050)	0.220	(0.010)
coh1965-74. lower education	0.106	(0.040)	−0.067	(0.015)
coh1965-74. medium education	0.667	(0.042)	0.039	(0.011)
coh1965-74. higher education	1.031	(0.050)	0.129	(0.009)
coh1975-85. lower education	0.610	(0.050)	−0.194	(0.023)
coh1975-85. medium education	0.891	(0.078)	−0.106	(0.013)
cohabiting. been married	0.196	(0.040)	−0.019	(0.011)
cohabiting. never married	0.300	(0.022)	−0.016	(0.005)
youngest child. 0-3 years	−0.560	(0.020)	0.092	(0.006)
youngest child. 4-11 years	−0.318	(0.021)	0.034	(0.006)
youngest child. 12-17 years	−0.073	(0.021)	−0.018	(0.006)
two minor children	−0.147	(0.016)	0.002	(0.005)
three or more minor children	−0.413	(0.020)	−0.011	(0.008)
presence child 18+	−0.187	(0.018)	−0.036	(0.006)
medium education partner	−0.333	(0.019)	0.018	(0.005)
higher education partner	−0.104	(0.016)	0.039	(0.006)
fiscal net yearly wage partner	−0.890	(0.022)	0.072	(0.007)
public sector			0.032	(0.004)
intercept	9.468	(0.222)	1.176	(0.067)
Observations	72,599		24,935	

Explanatory note: Robust standard errors in parentheses.

Table 11: Estimation results for the labor supply model.

	(1)		**(2)**		**(3)**		**(4)**	
log hourly wage	−3.197	(2.821)	−0.994	(2.790)	−0.100	(0.217)	−0.085	(0.217)
wage residual	3.109	(2.832)	0.912	(2.802)				
Inverse Mills	−4.761	(1.011)			−4.592	(1.000)		
			exogenous regressors					
lower ed. and trend	0.134	(0.119)	0.188	(0.119)	0.052	(0.094)	0.163	(0.091)
med. ed. and trend	−0.113	(0.095)	−0.086	(0.095)	−0.201	(0.051)	−0.113	(0.047)
high ed. and trend	−0.160	(0.106)	−0.123	(0.106)	−0.256	(0.061)	−0.152	(0.057)
coh1949-54. lower ed.	−6.539	(0.659)	−8.812	(0.432)	−6.700	(0.642)	−8.836	(0.426)
coh1949-54. med. ed.	−3.841	(0.536)	−4.905	(0.482)	−4.211	(0.417)	−5.005	(0.374)
coh1949-54. higher ed.	−0.229	(0.872)	−0.771	(0.865)	−1.094	(0.388)	−1.026	(0.389)
coh1955-64. lower ed.	−4.869	(0.460)	−6.122	(0.361)	−4.880	(0.460)	−6.112	(0.359)
coh1955-64. med. ed.	−2.845	(0.402)	−3.269	(0.390)	−3.137	(0.306)	−3.352	(0.301)
coh1955-64. higher ed.	0.783	(0.674)	0.786	(0.675)	0.116	(0.297)	0.585	(0.286)
coh1965-74. lower ed.	−3.940	(0.472)	−4.944	(0.412)	−3.787	(0.450)	−4.887	(0.371)
coh1965-74. med. ed.	−2.556	(0.309)	−2.681	(0.308)	−2.690	(0.285)	−2.720	(0.286)
coh1965-74. higher ed.	1.225	(0.437)	1.364	(0.438)	0.840	(0.264)	1.246	(0.258)
coh1975-85. lower. ed.	−3.688	(0.783)	−4.357	(0.771)	−3.144	(0.599)	−4.185	(0.557)
coh1975-85. medium ed.	−2.381	(0.442)	−2.321	(0.443)	−2.070	(0.335)	−2.228	(0.334)
cohabiting. been married	3.118	(0.338)	3.505	(0.329)	3.187	(0.333)	3.521	(0.326)
cohabiting. never married	1.908	(0.153)	2.253	(0.136)	1.968	(0.143)	2.267	(0.129)
youngest child. 0-3	−6.800	(0.357)	−7.804	(0.296)	−7.112	(0.220)	−7.888	(0.151)
youngest child. 4-11	−6.606	(0.226)	−7.114	(0.202)	−6.727	(0.199)	−7.145	(0.179)
youngest child. 12-17	−3.908	(0.201)	−3.908	(0.201)	−3.853	(0.195)	−3.891	(0.195)
two minor children	−2.159	(0.156)	−2.460	(0.143)	−2.177	(0.155)	−2.463	(0.143)
three or more kids	−2.771	(0.272)	−3.629	(0.199)	−2.768	(0.272)	−3.619	(0.197)
presence child 18+	−1.875	(0.226)	−2.132	(0.219)	−1.775	(0.205)	−2.099	(0.193)
med. ed. partner	−0.189	(0.157)	0.153	(0.141)	−0.228	(0.152)	0.137	(0.132)
high ed. partner	0.751	(0.211)	1.199	(0.189)	0.655	(0.192)	1.165	(0.158)
net yearly wage part	−1.619	(0.435)	−3.219	(0.285)	−1.904	(0.353)	−3.287	(0.194)
public sector	−2.347	(0.137)	−2.406	(0.136)	−2.447	(0.104)	−2.436	(0.104)
intercept	56.834	(4.324)	67.009	(3.751)	53.696	(3.221)	65.956	(1.879)
Observations	24,935		24,935		24,935		24,935	

Explanatory note: Robust standard errors in parentheses. Ed = education, med = medium.