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**Abstract**

We estimate the labour supply elasticity for a large number of groups on the Dutch labour market. We exploit a large administrative household panel data set for the period 1999-2005. The idenfication of the parameters benefits from the large 2001 Dutch tax reform that led to substantial exogenous variation in household budget constraints. For couples we find that men have much smaller elasticities than women, in particular when children are present. Furthermore, cross elasticities of men's wages on women's labour supply in couples are non-negligible. When they are single, men and women have similar labour supply elasticities. The elasticity is relatively high for single parents with small children, but much lower for single parents with children in secondary school. Low skilled singles and single parents have much higher labour supply elasticities than their high skilled counterparts. Differences by skill are less pronounced for couples. For all groups, the decision whether to participate or not is much more responsive to financial incentives than the hours per week decision.

**JEL classification codes**: C25, C52, H31, J22
**Keywords**: labour supply elasticity, discrete choice models, the Netherlands

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# 1 Introduction

In setting taxes and transfers policymakers face the fundamental trade-off between equity and efficiency (Mirrlees, 1971). Redistribution from rich to poor households generates a more equitable income distribution but discourages labour supply.[1] The response of labour supply to changes in financial incentives, traditionally measured by the wage elasticity of labour supply, plays a key role in the efficiency losses from redistributive taxes and transfers. Furthermore, policymakers also need to know the labour supply elasticity for a large number of subgroups (high skilled vs. low skilled, single individuals vs. individuals in couples), and for different decision margins (extensive/participation vs. intensive/hours per week), to optimize taxes and transfers given their preferences for redistribution.

In this paper, we provide a comprehensive overview of the relevant labour supply elasticities in the Netherlands. We exploit a large recent administrative panel data set on Dutch households for the period 1999-2005, the *Arbeidsmarktpanel* (Labour Market Panel) of Statistics Netherlands (2009). The size of the data set allows us to precisely estimate preferences over income and leisure and the corresponding labour supply elasticities for a large number of subgroups. Many of these subgroups are not present in related studies or have to be pooled in the regressions because of insufficient data. Furthermore, the data period covers the large tax reform of 2001. This reform generates large exogenous changes in financial incentives which strengthens the identification of the structural parameters.

We use a discrete choice model to estimate the preferences over income and leisure and the corresponding labour supply elasticities. Discrete choice models have become popular in labour supply analysis because they simplify the analysis of labour supply decisions when there are kinks and non-convexities in the budget set. Furthermore, the discrete choice approach does not require the global imposition of quasi-concavity of preferences, this can be checked ex post. Studies using continuous labour supply choices and piecewise linear budget constraints need to impose global quasi-concavity ex ante, which may have led to upward biased estimates of labour supply elasticies in these studies (MaCurdy et al., 1990).

Our main findings are as follows. Men and women have similar labour supply elasticities when they are single. Single parents with small children have larger elasticities, while single parents with children in secondary school have lower elasticities. When men and

[1] A related strand of literature studies the elasticity of taxable income to measure the distortionary effects of taxation, see *e.g.* Saez et al. (2012). The elasticity of taxable income also captures other responses to changes in tax rates, like changes in effort and tax evasion. However, there is an active academic debate to what extent the elasticity of taxable income is a sufficient statistic to measure the distortions from taxation, see *e.g.* Chetty (2009) and Piketty et al. (2011).

women form a couple, men have much smaller elasticities than women, in particular when children are present. We also find that cross elasticities of men's wages on women's labour supply in couples are non-negligible. Low skilled singles and single parents have much higher labour supply elasticities than their high skilled counterparts, whereas differences between skill types are less pronounced for couples. Finally, for all subgroups we find that responses on the so-called extensive or participation margin are much more important than responses on the so-called intensive or hours per week margin.

We build on a large body of literature using structural discrete choice models to study labour supply responses to changes in financial incentives (Van Soest, 1995; Keane and Moffitt, 1998; Aaberge et al., 1999; Blundell et al., 2000; Bargain et al., 2011). The contribution of this paper is in the scope of the analysis. This is made possible by the large administrative household panel data set we use. With this data set we are able to study a large number of subgroups, a number of which have received little attention in labour supply analysis, like singles and in the Dutch case also single parents.[2] Furthermore, previous studies rely on one cross-section or repeated cross-sections from a period when there was hardly any change in the tax system, hence the identification comes only from cross-sectional differences in financial incentives due to non-linearities in the tax-benefit system. We use seven years of data, with a large tax reform in the middle. This strengthens our identification as this generates large exogenous variation in the budget constraints of households over time. Also, the tax-benefit calculator of CPB we use to determine the discretized budget constraint for households is arguably more sophisticated than the tax-benefit calculators used in previous studies on Dutch data. Indeed, it is the official tax-benefit calculator of the government used to assess the budgetary and income effects of policy changes. We further provide an extensive sensitivity analysis, to *e.g.* changes in the functional form, the inclusion of unobserved preferences heterogeneity, and changes in labour supply elasticities over age groups and time. Finally, the dataset also allows for an external validation of the structural models (Todd and Wolpin, 2006; Hansen and Liu, 2011). We compare our structural estimates with the (preliminary) findings of two quasi-experimental studies of tax reforms using the same dataset (Bosch and Jongen, 2012; Bettendorf et al., 2013). The findings of these quasi-experimental studies are in line with the findings of our structural estimates.

The outline of the paper is as follows. In Section 2 we outline the structural models

[2] Bargain et al. (2011) consider many of the subgroups we consider, but their limited number of observations (763 singles and 1,806 couples) forces them to pool the observations for singles and single parents and for couples with and without children. Due to our much larger sample size we are able to estimate preferences for all these groups separately allowing for more heterogeneity in preferences.

for the empirical analysis. Section 3 presents the data set we use. Section 4 gives the empirical results for preferences and the corresponding labour supply elasticities. Section 5 compares these results with the findings of related studies. Finally, Section 6 considers options for future research and concludes.[3]

## 2 Structural model

We consider the two most popular specifications for preferences in discrete choice models: i) a (log) quadratic specification (used in *e.g.* Van Soest, 1995, Blundell *et al.*, 2000, and Bargain *et al.*, 2011), and ii) a Box-Cox specification (used in *e.g.* Aaberge *et al.*, 1999, Aaberge and Colombino, 2009, and Blundell and Shephard, 2011). The Box-Cox specification is less flexible than the (log) quadratic function, but guarantees that marginal utilities of income and leisure are always positive. When the marginal utility of income is negative the optimization problem is not well defined. Theory does not put a priori restrictions on the marginal utility of leisure though. Below we will see if the quadratic model generates negative marginal utilities of income, and whether or not the Box-Cox model gives a poorer fit than the quadratic models.

First consider the quadratic specification. We consider the specification for couples, the specification for singles is similar but without the partner variables. The choice of working hours of both partners is a co-ordinated decision between the two adult household members $m$ (male) and $f$ (female).[4] The partners maximize household utility[5] by choosing the utility maximizing combination of working hours $\{h_m, h_f\}$. Individual working hours are chosen from a discrete set $\mathcal{H} = \{h_0, ..., h_Z\}$, which is the same for all individuals. Household utility depends on household disposable income $y$[6], leisure of the male $l_m$ (we use the normalization of Blundell and Shephard (2011) $l_m = 1 - h_m/\overline{L}$, where $\overline{L}$ denotes total time available for work and leisure), leisure of the female $l_f$, fixed costs of work for

[3] In the Supplementary material we give descriptive statistics of the dataset, the wage estimations we use to impute wages for non-employed, and some further robustness checks on the labour supply elasticities.

[4] In the estimations we drop same sex households.

[5] Samuelson (1956) shows that in a unitary model individual utilities can be aggregated to obtain a household utility function.

[6] We abstract from a savings decision, and use disposable household income for consumption.

the male $\beta_{fc_m}$ and fixed costs of work for the female $\beta_{fc_f}$[7]

$$\begin{aligned} U(y, h_m, h_f; \boldsymbol{X}, \boldsymbol{\varepsilon}, \boldsymbol{\epsilon}) &= u(y, h_m, h_f; \boldsymbol{X}, \boldsymbol{\varepsilon}) + \epsilon_{h_m h_f} \\ &= \beta_y(\boldsymbol{\varepsilon})y + \beta_{l_m}(\boldsymbol{X})l_m + \beta_{l_f}(\boldsymbol{X})l_f + \beta_{yy}y^2 \\ &\quad +\beta_{l_m l_m}(l_m)^2 + \beta_{l_f l_f}(l_f)^2 + \beta_{yl_m}yl_m + \beta_{yl_f}yl_f + \beta_{l_m l_f}l_m l_f \\ &\quad +\mathbf{1}(h_m > 0)\beta_{fc_m}(\boldsymbol{X}) + \mathbf{1}(h_f > 0)\beta_{fc_f}(\boldsymbol{X}) + \epsilon_{h_m h_f}. \end{aligned} \tag{1}$$

Household disposable income is a function of working hours of the male $h_m$ and the female $h_f$, their respective gross hourly wages $w_m$ and $w_f$, and the tax system $T$ which depends on observable individual and household characteristics $\boldsymbol{X}$

$$y(w_m h_m, w_f h_f, T) = w_m h_m + w_f h_f - T(w_m, h_m, w_f, h_f; \boldsymbol{X}). \tag{2}$$

We assume that gross hourly wages do not vary with hours worked. Since we do not have data on fixed costs of work, we remain agnostic about them and simply include dummies in utility metric.[8] We allow the linear terms in leisure and the fixed costs to depend on observable individual and household characteristics

$$\begin{aligned} \beta_{l_m}(\boldsymbol{X}) &= \boldsymbol{X'_{l_m}\beta_{l_m}}, \\ \beta_{l_f}(\boldsymbol{X}) &= \boldsymbol{X'_{l_f}\beta_{l_f}}, \\ \beta_{fc_m}(\boldsymbol{X}) &= \boldsymbol{X'_{fc_m}\beta_{fc_m}}, \\ \beta_{fc_f}(\boldsymbol{X}) &= \boldsymbol{X'_{fc_f}\beta_{fc_f}}. \end{aligned}$$

In the data section below we consider the demographic characteristics we include for males and females in leisure and fixed costs respectively. Furthermore, in an extension we allow for random preference heterogeneity in the linear income term[9,10]

$$\beta_y(\boldsymbol{\varepsilon}) = \beta_y + \varepsilon_y.$$

Finally, to reproduce heterogeneous choices for otherwise similar households, each labour supply option has a unique 'error' term $\boldsymbol{\epsilon}$ that captures unobserved household-option

[7]As shown by *e.g.* Van Soest (1995) fixed costs are necessary to reproduce the low share of individuals that work only few hours per week.

[8]Furthermore, Heim and Meyer (2004) show that it is inconsequential whether one puts fixed costs into income or leisure for both positive and normative analyses, as long as fixed costs do not change.

[9]This is sometimes referred to as quasi-random effects. This is where we account for the panel element of our data.

[10]Other studies sometimes also include quasi-random effects into the marginal value of leisure (and fixed costs). However, choices depend on the marginal rate of substitution between leisure and income, and therefore including quasi-random effects in only of them is enough to account for them in the decision process.

specific utility components. $\boldsymbol{\epsilon}$ is assumed to follow a Type-I extreme value distribution, resulting in the convenient multinomial logit specification for predicted frequencies (Creedy and Kalb, 2005; McFadden, 1978). The log-quadratic specification is the same as the quadratic specification, but with income and leisure replaced by log income and log leisure respectively.

Next, the Box-Cox specification for household utility is given by

$$\begin{aligned} U(y, h_m, h_f; \boldsymbol{X}, \boldsymbol{\varepsilon}, \boldsymbol{\epsilon}) &= u(y, h_m, h_f; \boldsymbol{X}, \boldsymbol{\varepsilon}) + \epsilon_{h_m h_f} \\ &= \exp(\gamma_y(\boldsymbol{\varepsilon})) \left( \frac{y^{\delta_y} - 1}{\delta_y} \right) \\ &\quad + \exp(\gamma_{l_m}(\boldsymbol{X})) \left( \frac{(l_m)^{\delta_{l_m}} - 1}{\delta_{l_m}} \right) + \exp(\gamma_{l_f}(\boldsymbol{X})) \left( \frac{(l_f)^{\delta_{l_f}} - 1}{\delta_{l_f}} \right) \\ &\quad + \mathbf{1}(h_m > 0)\gamma_{fc_m}(\boldsymbol{X}) + \mathbf{1}(h_f > 0)\gamma_{fc_f}(\boldsymbol{X}) + \epsilon_{h_m h_f}, \end{aligned} \tag{3}$$

with

$$\begin{aligned} \gamma_{l_m}(\boldsymbol{X}) &= \boldsymbol{X'_{l_m} \gamma_{l_m}}, \\ \gamma_{l_f}(\boldsymbol{X}) &= \boldsymbol{X'_{l_f} \gamma_{l_f}}, \\ \gamma_{fc_m}(\boldsymbol{X}) &= \boldsymbol{X'_{fc_m} \gamma_{fc_m}}, \\ \gamma_{fc_f}(\boldsymbol{X}) &= \boldsymbol{X'_{fc_f} \gamma_{fc_f}}. \end{aligned}$$

Below we will refer to this specification as Box-Cox 1. We also consider a Box-Cox specification where we add an interaction term between income and leisure, following Dagsvik and Strom (2006), for singles and single parents, with coefficient $\gamma_{yl}$.[11] Below we refer to this specification as Box-Cox 2. Finally, in an extension we again allow for random preference heterogeneity in the income term

$$\gamma_y(\boldsymbol{\varepsilon}) = \gamma_y + \varepsilon_y.$$

To estimate the preferences we use simulated maximum likelihood. The likelihood function is given in the Supplementary material. For workers we use actual wages, for non-workers we impute wages from an estimated wage equation that includes quasi-fixed effects. The estimated wage equations are given in the supplementary material. We take 10 draws from the estimated wage distribution for each non-worker, and average the likelihood over these draws. In the extension with random preference heterogeneity we also take 10 draws of the estimated random preference distribution and average over these draws for all households. For the random draws we use Halton sequences which give even

[11] For singles we do not use the subscript $m$ and $f$.

coverage over the domain of the sampling distribution and generate negative correlation over observations which reduces the variance of the simulated function (Cameron and Trivedi, 2005; Train, 2003).

## 3 Data

We use data from a large recent administrative panel data set on Dutch households for the period 1999-2005, the *Arbeidsmarktpanel* (Labour Market Panel) of Statistics Netherlands (2009). This data set combines information from the *Gemeentelijke Basisadministratie* (data from municipalities) on individual and household demographic characteristics (*e.g.* the age of the adults and the children in the household, and their ethnicity), from the *Sociaal Statistisch Bestand* (Social Statistical Panel) on income from various sources (*e.g.* wages, benefits, profits, but not capital income), the number of contractual working hours (per month and per year) and the industry the individual is working in (relevant for *e.g.* calculating premiums), and the *Enquête Beroepsbevolking* (Labour Force Survey) on the level of education.

From this data set we drop all individuals under 20 years old and over 57 years old. The maximum age is set at 57 years old because we do not want outcomes to be influenced by the changes in early retirement benefits in the data period. This would require a dynamic tax-benefit calculator, and a dynamic discrete choice model, which we do not have at the moment. We also drop students. We further drop households for which we have incomplete demographic information and households for which we have incomplete partner information (like the wages of the partner). When there is a timegap for a household we only keep the longest period. This leaves us with 320 thousand individuals and over one million observations. We use this sample to estimate the wage equations. Descriptive statistics and estimation results for wages are given in the supplementary material. For the estimation of the structural parameters we use a random subsample, to limit the computational burden.

We calculate disposable household income corresponding to the gross incomes of the two partners in each labour supply option with the help of the MIMOSI model of CPB (Romijn et al., 2008). MIMOSI is, among other things, a very detailed (non-behavioural) tax-benefit calculator for the Netherlands. It takes into account all (national) taxes and transfers for individuals in households.[12] This includes the standard tax brackets and the associated tax rates, numerous tax credits targeted at specific groups (like tax credits

[12]The incomes we obtain are yearly numbers, division by 52 gives weekly incomes corresponding to the weekly hours we seek to explain. Income is then divided by 100 again for computational reasons.

for families with children and additional tax credits for single parents) and a number of income dependent subsidies (like subsidies for health care costs and subsidies for families with children). In line with the tax and transfer system, disposable household income can not fall below the social assistance level. This is particularly relevant for singles and single parents, as working only a few days per week generates little additional revenue for this group. For simplicity we treat all premiums as taxes.[13]

We experimented with a number of discretizations, an interval of 8 hours (a normal working day in the Netherlands) running from 0 to 40 hours per week gave a good fit of the data and worked well in the estimations.[14] For single men and women we then have 6 discrete options, and for couples we have 6x6 = 36 discrete options.

# 4 Estimation results

We seek to recover the preferences that best explain the labour supply choices households make, given their set of disposable household incomes and given the functional form of the utility function. We estimate the preference parameters for the following key groups on the labour market: i) singles, ii) single parents, iii) couples without (dependent) children and iv) couples with children. We discuss the results for each group in turn. For each group we first present the estimated preference parameters of the different functional forms. Subsequently we consider the fit of the model and finally we simulate the relevant labour supply elasticities. In a discrete choice model the labour supply elasticities have to be simulated (Creedy and Kalb, 2005).

## 4.1 Singles

First consider the results for singles. We started with estimating preferences for single men and women separately. This yielded very similar results, therefore we decided to pool the data for single men and single women. Below we present the results for the pooled regressions. Furthermore, we use a large random subsample of the full data set, estimates with larger data sets generated similar results.[15] Table 1 gives the estimated preference parameters for different preference specifications for singles.

[13] Hence, we ignore that part of the premiums are deferred payments. Indeed, there is often a direct link between the individual premiums paid and the individual benefits received.

[14] We allocate individuals working [0,5) hours to 0 hours, individuals working [5,13) hours to 8 hours, individuals working [13,21) hours to 16 hours, individuals working [21,29) hours to 24 hours, individuals working [29,37) hours to 32 hours, and individuals working 37 hours or more to 40 hours.

[15] Details available on request.

Table 1: Estimated preference parameters: singles

| Variable | Parameter | Quadratic | Log-quadratic | Parameter | Box-Cox 1 | Box-Cox 2 |
|---|---|---|---|---|---|---|
| Income | $\beta_y$ | 0.650 | 4.292$^{***}$ | $\gamma_y$ | 1.617$^{***}$ | 1.478$^{***}$ |
| | | | | $\delta_y$ | –0.062 | 0.069 |
| (Income)$^2$ | $\beta_{yy}$ | –0.058$^{***}$ | –2.100$^{***}$ | | | |
| Leisure | $\beta_l^c$ | 127.3$^{***}$ | –22.29$^{***}$ | $\gamma_l^c$ | –43.43 | –36.36$^{***}$ |
| x (Age – 38)/10 | $\beta_l^a$ | 1.064$^{***}$ | 1.084$^{***}$ | $\gamma_l^a$ | 0.278$^{***}$ | 1.170$^{**}$ |
| x (Age – 38)$^2$/100 | $\beta_l^{aa}$ | 2.027$^{***}$ | 1.626$^{***}$ | $\gamma_l^{aa}$ | –0.009 | –0.445$^{*}$ |
| | | | | $\delta_l$ | –178.1 | –148.1 |
| (Leisure)$^2$ | $\beta_{ll}$ | –80.03$^{***}$ | –97.54$^{***}$ | | | |
| Income x leisure | $\beta_{yl}$ | 0.851 | –16.53$^{***}$ | $\gamma_{yl}$ | | –36.28$^{***}$ |
| Fixed costs of work | $\beta_{fc}^c$ | –4.169$^{***}$ | –4.245$^{***}$ | $\gamma_{fc}^c$ | –2.386$^{***}$ | –2.373$^{***}$ |
| x **1**(Lower educated) | $\beta_{fc}^e$ | –0.814$^{***}$ | –0.808$^{***}$ | $\gamma_{fc}^e$ | –0.747$^{***}$ | –0.755$^{***}$ |
| x **1**(Native) | $\beta_{fc}^n$ | 0.920$^{***}$ | 0.886$^{***}$ | $\gamma_{fc}^n$ | 0.831$^{***}$ | 0.833$^{***}$ |
| Observations | | 24,000 | 24,000 | | 24,000 | 24,000 |
| Log likelihood | | –5,691 | –5,655 | | –5,687 | –5,687 |
| Akaike information criterion | | 11,402 | 11,330 | | 11,392 | 11,394 |
| Chosen options with ${U^d}'_y < 0$ | | 0% | 1% | | 0% | 0% |
| Chosen options with ${U^d}'_l < 0$ | | 38% | 52% | | 0% | 0% |

Note: * denotes significant at 10% level, ** at 5% level and *** at 1% level.

The first column gives the results for the quadratic utility function. We find positive but diminishing marginal utility of income, the linear term is positive and the quadratic term is negative. For none of the chosen options in the data we find negative marginal utility of income, as required for the optimisation problem to be well defined. We also find positive and diminishing marginal utility of leisure. The coefficient of the interaction term between leisure and (age – 38) suggests that older singles have a higher marginal utility of leisure than younger individuals workers, whereas the interaction term between leisure and (age – 38)$^2$ tilts the marginal utility of leisure up at both ends of the age distribution. For 38% of the chosen options we find a negative marginal utility of leisure. However, this is not a problem per se, theory does not require it to be positive. Working more hours may have benefits beyond income. Furthermore, with fixed costs of work, it is not straightforward to interpret the marginal value of leisure (Bargain et al., 2011). The coefficient on the interaction term between income and leisure is positive (though not signficantly different from zero). The coefficient on fixed costs of work, a dummy that equals 1 when individuals are working, is negative. Fixed costs of working are higher for lower educated singles[16], and for individuals born outside the Netherlands. Overall, we can conclude that the quadratic utility function yields plausible preference parameters from an economic point of view.

The second column gives the results for the log-quadratic utility function. Again we find positive but diminishing marginal utility of (log) income. Both the linear and quadratic term of log leisure are now negative, resulting in more individuals having a negative marginal value of leisure in the chosen options. Older workers again have a higher marginal value of leisure, as do the youngest and the oldest singles in the sample. For the log-quadratic specification the interaction term of income and leisure has a negative sign, and is significantly different from zero. Fixed costs of working again reduce the utility from working, and the more so for lower educated singles and immigrant singles.

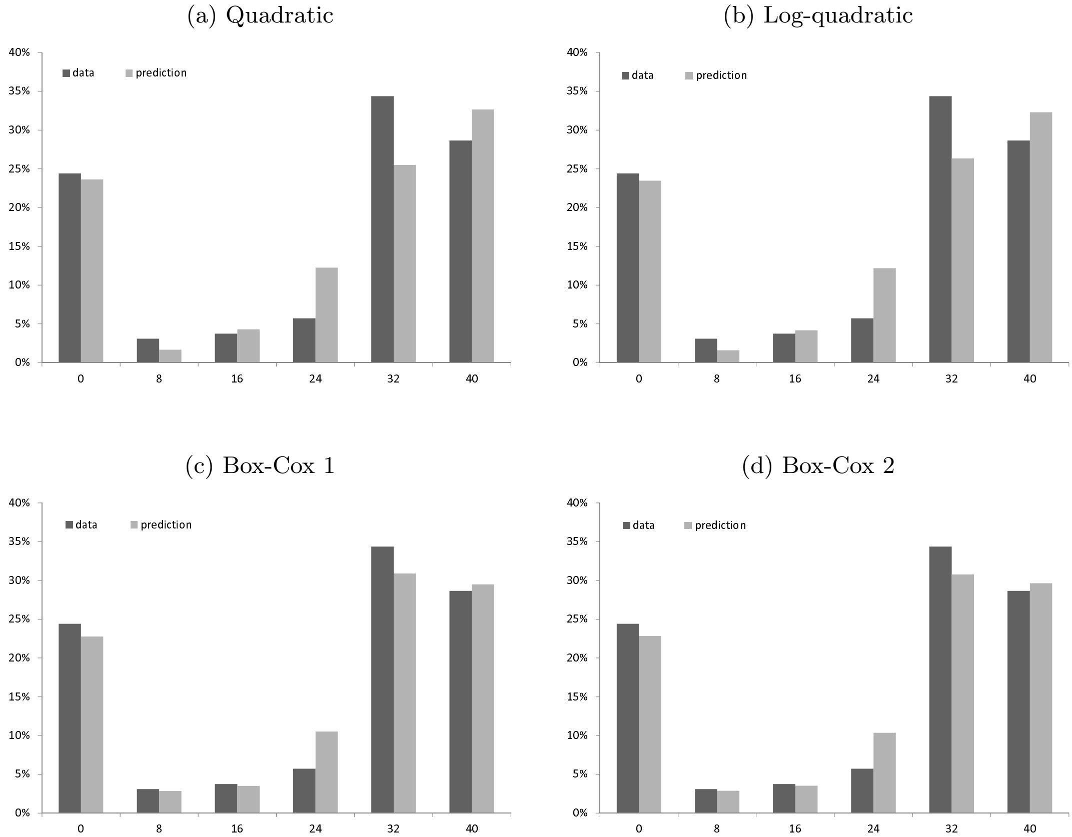
The third column gives the results for the Box-Cox 1 specification. This specification restricts the marginal utility of both income and leisure to be positive. We find that the parameter $\delta_y$ is very close to 0. In this case, the Box-Cox 1 specification converges to the log specification in income. The $\gamma_l^c$ parameter of leisure (in the exponential term in front of leisure) has a very large negative number (–43.43). This shows that the Box-Cox specification forces the marginal value of leisure to stay positive. Fixed costs of working again reduce the utility fom working, and the more so for lower educated and immigrants.

Finally, in the fourth column we add some flexibility to the Box-Cox specification by adding an interaction term between leisure and income, the Box-Cox 2 specification, and this interaction term turns out to be significant. The results for the other parameters are rather similar to the results from the Box-Cox 1 specification. Again, $\gamma_l^c$ is a big negative number, and the results for fixed costs are quite similar as well.

Figure 1 gives the respective fit of the four models in Table 1. The quadratic model fits the data quite well. Due to the fixed costs parameters, the model reproduces the low frequencies at few working hours. At high working hours the frequency in the data levels off, and the quadratic specification predicts too many singles at 40 hours and too few singles at 32 hours. However, also at high working hours the differences are not big. Overall, the quadratic specification does quite well in predicting the observed frequencies. The fit for the log-quadratic model is quite similar to the fit of the quadratic model. Despite differences in estimated parameters for leisure and the interaction term of leisure and income between the two models they still lead to similar predictions. The Box-Cox specifications also do well in terms of fit. Furthermore, they better predict the frequencies at 32 and 40 hours in the aggregate. However, we can see that the Box-Cox specification is more restrictive for subgroups, as it restricts the marginal value of leisure to remain

[16]Lower educated have lower vocational training (VMBO) or less.

Figure 1: Predicted and observed frequencies hours classes: singles




positive. Cameron and Trivedi (2005) suggest using the Akaike information criterion to compare the goodness-of-fit across non-nested discrete choice models[17], with a lower value indicating a better fit. According to this criterion, and given that none of the models produces (a significant share of) negative marginal utilities of income, the log-quadratic specification is to be preferred.

Table 2 gives the simulated labour supply elasticities for the different models and for a number of subgroups. Furthermore, we present the total hours worked elasticity ('Total'), the participation or extensive margin elasticity ('Ext.') and the hours per employed or

[17]The value of the Akaike information criterion is given by -2 * log likelihood + 2 * number of parameters. Two other popular measures for the goodness-of-fit, the Bayesian information criterion and the pseudo $R^2$, result in the same ordering of the goodness-of-fit as the Akaike information criterion in all models for all household types.

Table 2: Labour supply elasticities: singles

| | Quadratic | | | Log-quadratic | | | Box-Cox 1 | | | Box-Cox 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.43 | 0.35 | 0.07 | 0.43 | 0.36 | 0.07 | 0.59 | 0.49 | 0.10 | 0.58 | 0.48 | 0.09 |
| Male | 0.39 | 0.32 | 0.06 | 0.39 | 0.33 | 0.06 | 0.54 | 0.45 | 0.09 | 0.53 | 0.44 | 0.08 |
| Female | 0.46 | 0.37 | 0.08 | 0.47 | 0.39 | 0.08 | 0.64 | 0.52 | 0.11 | 0.62 | 0.52 | 0.10 |
| Lower educated | 0.79 | 0.66 | 0.12 | 0.92 | 0.78 | 0.13 | 1.17 | 0.98 | 0.18 | 1.14 | 0.96 | 0.17 |
| Higher educated | 0.33 | 0.26 | 0.06 | 0.30 | 0.24 | 0.06 | 0.43 | 0.35 | 0.08 | 0.42 | 0.34 | 0.08 |
| First quartile | 0.58 | 0.44 | 0.13 | 0.83 | 0.67 | 0.14 | 1.06 | 0.85 | 0.19 | 1.02 | 0.82 | 0.18 |
| Second quartile | 0.50 | 0.41 | 0.09 | 0.52 | 0.44 | 0.08 | 0.74 | 0.61 | 0.12 | 0.72 | 0.60 | 0.11 |
| Third quartile | 0.35 | 0.28 | 0.07 | 0.32 | 0.26 | 0.05 | 0.47 | 0.38 | 0.08 | 0.46 | 0.38 | 0.08 |
| Fourth quartile | 0.27 | 0.23 | 0.04 | 0.20 | 0.17 | 0.03 | 0.29 | 0.24 | 0.04 | 0.28 | 0.24 | 0.04 |
| Age 20 – 28 | 0.46 | 0.36 | 0.10 | 0.53 | 0.42 | 0.10 | 0.71 | 0.56 | 0.14 | 0.68 | 0.54 | 0.13 |
| Age 29 – 40 | 0.31 | 0.25 | 0.06 | 0.32 | 0.27 | 0.06 | 0.54 | 0.45 | 0.09 | 0.52 | 0.44 | 0.08 |
| Age 41 – 57 | 0.47 | 0.41 | 0.06 | 0.44 | 0.38 | 0.06 | 0.55 | 0.46 | 0.08 | 0.54 | 0.46 | 0.07 |

Simulated labour supply elasticities following an increase of 10% in gross hourly wages. 'Total' is the elasticity of total working hours, 'Ext.' is the participation elasticity, 'Int.' is the hours per employed elasticity.

intensive elasticity ('Int.'). These labour supply elasticities are simulated by comparing the predicted frequencies with base gross hourly wages and the predicted frequencies when gross hourly wages are 10% higher than in the base.

For the total group of singles, we find a labour supply elasticity for total hours ranging from 0.43 for the quadratic specification to 0.59 for the Box-Cox 1 specification. For all preference specifications the extensive margin is much more important than the intensive margin. The former ranging from 0.35 to 0.49, the latter ranging from 0.07 to 0.10. Hence, the decision to participate is much more responsive to financial incentives than the hours per week decision.

Turning to the subgroups, we see that single men have a somewhat lower elasticity than single women.[18] This is mostly due to a difference in the extensive margin elasticity, which, as we will see below, explains most of the differences across other subgroups as well. Lower educated singles have a much higher labour supply elasticity than higher educated singles, and a similar pattern arises when we look at income quartiles where the bottom quartile has a labour supply elasticity up to four times as large as the upper quartile. Finally, when looking at three age groups (20 – 28, 29 – 40, 41 – 57), we find for most

[18]Note that preferences for men and women are assumed to be the same, differences arise due to differences in wages and personal characteristics.

specifications that younger workers have a higher elasticity than middle aged workers, whereas older worker have an elasticity comparable or somewhat higher than middle aged workers.[19]

Some additional sensitivity analysis for the log-quadratic specification is given in the supplementary material. First, we calculate standard errors on the labour supply elasticities by simulating multiple draws from the parameter space and bootstrapping the means of the resulting elasticities. We show that the standard errors are rather small, in the order of 0.01. Second, we calculate the labour supply elasticity for an impulse in net income rather than gross wages. The tax system generates differences in marginal gross and net income. When we increase net income in all options with positive hours of work by 10% we find a somewhat larger labour supply elasticity of 0.54, compared to 0.43 in the baseline where we increase gross wages by 10%. Changing net income rather than gross income is closer to the elasticity concept relevant in theory. However, almost all discrete choice studies report simulated elasticities using an impulse in gross wages, hence for comparability we present results for an impulse in gross wages in the main text. Third, we calculate the labour supply elasticities for 1999 and 2005 rather than for the whole period 1999-2005. We find a drop of only –0.02 in the elasticity over this (admittedly relatively short) period.[20]

## 4.2 Single parents

Next we consider the results for single parents. Table 3 gives the estimated preferences for the same four models, where now we include an interaction term for the value of leisure and the fixed costs of working with the age of the youngest child. We group single parents into having a youngest child 0 to 3 years old (before primary school), 4 to 11 years old (in primary school) and the base group 12 to 17 years old (in secondary school).

Both the quadratic and log-quadratic specification do rather poorly in economic terms. The linear term in (log) income is negative. The quadratic term is positive but for a large group of individuals this is insufficient to generate positive marginal utility of income. Indeed, 33% and 79% of the single parents has a negative marginal utility in the chosen options in the data in the quadratic and log-quadratic specification respectively. Since these results are inconsistent with utility maximisation we skip the discussion of the other coefficients and turn to the Box-Cox specifications instead.

[19] Note that we exclude individuals aged 58 and over. Labour supply elasticities close to retirement might be higher again, see *e.g.* Blundell et al. (2011).

[20] Heim (2007) shows that the female labour supply elasticity has fallen dramatically over the past decades in the US.

Table 3: Estimated preference parameters: single parents

| Variable | Parameter | Quadratic | Log-quadratic | Parameter | Box-Cox 1 | Box-Cox 2 |
|---|---|---|---|---|---|---|
| Income | $\beta_y$ | –2.714$^{***}$ | –5.559$^{***}$ | $\gamma_y$ | 1.713$^{***}$ | 1.185$^{***}$ |
| | | | | $\delta_y$ | –0.452 | –0.019 |
| (Income)$^2$ | $\beta_{yy}$ | 0.116$^{***}$ | 2.636$^{***}$ | | | |
| Leisure | $\beta_l^c$ | 233.6$^{***}$ | –55.91$^{***}$ | $\gamma_l^c$ | –50.96 | –54.75$^{***}$ |
| x (Age – 38)/10 | $\beta_l^a$ | –3.387$^{***}$ | –2.999$^{***}$ | $\gamma_l^a$ | –0.260$^{***}$ | –0.729$^{***}$ |
| x (Age – 38)$^2$/100 | $\beta_l^{aa}$ | 2.685$^{***}$ | 2.327$^{***}$ | $\gamma_l^{aa}$ | 0.016 | –0.137 |
| x **1**(Youngest child 0 – 3) | $\beta_l^{03}$ | 4.823$^{***}$ | 3.914$^{***}$ | $\gamma_l^{03}$ | 0.399$^{**}$ | 11.77$^{***}$ |
| x **1**(Youngest child 4 – 11) | $\beta_l^{411}$ | 5.752$^{***}$ | 4.841$^{***}$ | $\gamma_l^{411}$ | 0.405$^{***}$ | 11.72 |
| | | | | $\delta_l$ | –206.9 | –175.7 |
| (Leisure)$^2$ | $\beta_{ll}$ | –148.6$^{***}$ | –111.6$^{***}$ | | | |
| Income x leisure | $\beta_{yl}$ | 2.202$^{**}$ | 7.129$^{**}$ | $\gamma_{yl}$ | | –43.13$^{***}$ |
| Fixed costs of work | $\beta_{fc}^c$ | –5.373$^{***}$ | –5.011$^{***}$ | $\gamma_{fc}^c$ | –1.036$^{***}$ | –1.035$^{***}$ |
| x **1**(Lower educated) | $\beta_{fc}^e$ | –1.649$^{***}$ | –1.659$^{***}$ | $\gamma_{fc}^e$ | –1.399$^{***}$ | –1.400$^{***}$ |
| x **1**(Native) | $\beta_{fc}^n$ | 0.465$^{***}$ | 0.469$^{***}$ | $\gamma_{fc}^n$ | 0.464$^{***}$ | 0.467$^{***}$ |
| x **1**(Youngest child 0 – 3) | $\beta_{fc}^{03}$ | –0.283 | –0.373 | $\gamma_{fc}^{03}$ | –1.613$^{***}$ | –1.600$^{***}$ |
| x **1**(Youngest child 4 – 11) | $\beta_{fc}^{411}$ | 0.679$^{***}$ | 0.608$^{***}$ | $\gamma_{fc}^{411}$ | –0.379$^{***}$ | –0.378$^{***}$ |
| Observations | | 24000 | 24000 | | 24000 | 24000 |
| Log likelihood | | –5,157 | –5,152 | | –5,378 | –5,374 |
| Akaike information criterion | | 10,342 | 10,332 | | 10,782 | 10,776 |
| Chosen options with ${U^{d'}}_y < 0$ | | 33% | 79% | | 0% | 0% |
| Chosen options with ${U^{d'}}_l < 0$ | | 72% | 72% | | 0% | 0% |

Note: * denotes significant at 10% level, ** at 5% level and *** at 1% level.

In the Box-Cox 1 specification we restrict the marginal value of income and leisure to be positive, and despite the interaction term for income and leisure, we also find only positive numbers for the marginal value of income and leisure for the Box-Cox 2 specification. For the Box-Cox 2 specification we further see that $\delta_y$ is close to 0, hence close to the log specification. The coefficient on the exponent in front of leisure $\gamma_l^c$ is a large negative number, bringing the exponent term close to zero. Here, we can really see that the Box-Cox specification forces marginal utility of leisure to stay positive. The value of leisure falls somewhat in age. Having a youngest child 0 to 3 years of age increases the value of leisure time, and the same holds for a (youngest) child between 4 and 11 years of age. The interaction term between income and leisure in Box-Cox 2 is negative. Fixed costs of working reduce utility, and even more so when the single parent is lower educated or an immigrant, in line with the results for singles. Having a small child also raises the fixed costs of working, in particular when the youngest child is 0 to 3 years of age.

Figure 2: Predicted and observed frequencies hours classes: single parents

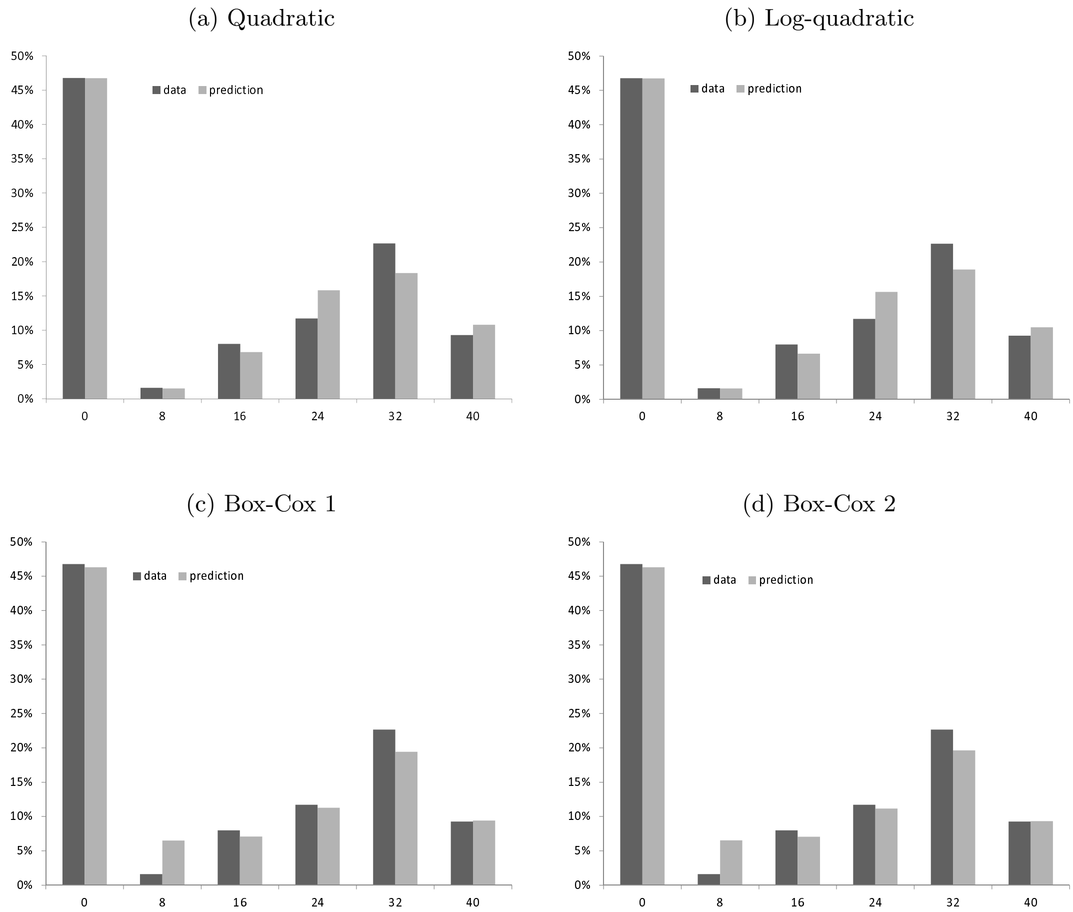



Figure 2 gives the fit of the models for single parents. The first two panels show that a poor economic model can still give a good fit. More importantly, the panels for the Box-Cox models show that these still give a good fit of the data, though they overpredict individuals at the 8 hours option to some extent. According to the Akaike information criterion, the Box-Cox 2 model is preferred over the Box-Cox 1 model, the interaction term between income and leisure generates enough of an improvement for the Box-Cox 2 model over the Box-Cox 1 model.

Table 4 gives the labour supply elasticities for single parents for the different specifications. We find small and even negative labour supply elasticities for some subgroups when we look at the quadratic and log-quadratic specification. However, since these es-

Table 4: Labour supply elasticities: single parents

| | Quadratic | | | Log-quadratic | | | Box-Cox 1 | | | Box-Cox 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.06 | 0.02 | 0.04 | 0.23 | 0.19 | 0.04 | 0.59 | 0.42 | 0.17 | 0.60 | 0.42 | 0.17 |
| Male | 0.19 | 0.09 | 0.10 | 0.14 | 0.14 | 0.00 | 0.43 | 0.31 | 0.11 | 0.45 | 0.32 | 0.12 |
| Female | 0.04 | 0.01 | 0.03 | 0.24 | 0.19 | 0.05 | 0.62 | 0.43 | 0.18 | 0.62 | 0.43 | 0.18 |
| Lower educated | –0.08 | –0.07 | –0.01 | 0.31 | 0.22 | 0.09 | 1.00 | 0.72 | 0.26 | 0.97 | 0.70 | 0.25 |
| Higher educated | 0.11 | 0.06 | 0.06 | 0.17 | 0.16 | 0.01 | 0.45 | 0.30 | 0.14 | 0.46 | 0.31 | 0.15 |
| First quartile | –0.10 | –0.08 | –0.02 | 0.37 | 0.26 | 0.11 | 1.07 | 0.77 | 0.28 | 1.04 | 0.75 | 0.27 |
| Second quartile | –0.05 | –0.04 | –0.01 | 0.29 | 0.21 | 0.08 | 0.88 | 0.62 | 0.24 | 0.86 | 0.61 | 0.23 |
| Third quartile | 0.05 | 0.02 | 0.03 | 0.22 | 0.18 | 0.04 | 0.54 | 0.35 | 0.18 | 0.54 | 0.35 | 0.18 |
| Fourth quartile | 0.17 | 0.09 | 0.09 | 0.12 | 0.14 | –0.01 | 0.37 | 0.26 | 0.11 | 0.39 | 0.27 | 0.12 |
| Age 20 – 28 | –0.06 | –0.05 | –0.01 | 0.46 | 0.31 | 0.14 | 1.02 | 0.75 | 0.25 | 1.01 | 0.74 | 0.25 |
| Age 29 – 40 | 0.04 | 0.01 | 0.03 | 0.28 | 0.22 | 0.06 | 0.68 | 0.48 | 0.19 | 0.68 | 0.48 | 0.19 |
| Age 41 – 57 | 0.08 | 0.03 | 0.05 | 0.19 | 0.16 | 0.03 | 0.51 | 0.35 | 0.15 | 0.51 | 0.35 | 0.16 |
| Youngest child 0 – 3 | 0.13 | 0.07 | 0.06 | 0.35 | 0.31 | 0.05 | 0.97 | 0.80 | 0.16 | 1.00 | 0.82 | 0.17 |
| Youngest child 4 – 11 | 0.06 | 0.02 | 0.04 | 0.24 | 0.19 | 0.05 | 0.61 | 0.43 | 0.17 | 0.61 | 0.43 | 0.18 |
| Youngest child 12 – 17 | 0.04 | 0.01 | 0.03 | 0.20 | 0.16 | 0.03 | 0.50 | 0.33 | 0.17 | 0.50 | 0.33 | 0.17 |

Simulated labour supply elasticities following an increase of 10% in gross hourly wages. 'Total' is the elasticity of total working hours, 'Ext.' is the participation elasticity, 'Int.' is the hours per employed elasticity.

timated models are not consistent with utility maximisation we should not give much weight to these elasticities. Therefore we turn to the elasticities for the economically more meaningful Box-Cox models.

The total labour supply elasticity of single parents is 0.59–0.60 for the Box-Cox specifications. The extensive margin is again more important than the intensive margin, as with singles, however the intensive margin elasticity of 0.17 is bigger in size than the 0.07 to 0.10 for singles. We find somewhat larger elasticities for single mothers than for single fathers.[21] Lower educated single parents again have a much higher labour supply elasticity than higher educated single parents, and the same pattern is visible in the elasticities by income quartiles. We further find a monotonically declining age pattern. Finally, we find much higher elasticities for single parents with a youngest child up to 3 years of age.

Again, some additional sensitivity analysis, now for the Box-Cox 2 model, are given in the supplementary material. Bootstrapped standard errors on the labour supply elas-

[21]Note that single mothers are by far the largest group of single parents, over 80% of single parents is female in the Netherlands. Children of divorced parents typically go and live with their mother for most of the time.

ticities are rather small again, in the order of 0.01. When we increase net income in all options with positive hours of work by 10% we find a larger labour supply elasticity of 0.90, compared to 0.60 in the baseline where we increase gross wages by 10%. Over the period 1999–2005 we find a drop in the elasticity of –0.06.

### 4.3 Couples without children

Moving from singles to couples, we first turn to couples without children. For the couples without children the Box-Cox specifications did not converge. Therefore, we only present results for the quadratic and log-quadratic specification. This is not a problem per se, because these specifications are more flexible than the Box-Cox specifications, and it turns out that with the quadratic specifications we do not run into trouble with marginal utility of income. Table 5 gives the estimation results for the quadratic and log-quadratic specifications. The functions now distinguish between leisure of the male and leisure of the female, and between fixed costs of the male and the female. Furthermore, we allow for an interaction term of leisure of both partners.

First consider the results for the quadratic specification. The linear term in income is slightly negative, and so is the quadratic term in income, but this is dominated by the positive interaction term with leisure. In the end, all chosen options have positive marginal utility of income. The linear term in leisure is positive both for males and females. However, the quadratic term is negative, which results in a negative marginal value of leisure for the majority of chosen options. However, this is not at odds with utility maximization, and the fixed costs may capture part of the difference in utility due to a difference in leisure between working and not working. Age plays an important role in the marginal utility of leisure for women, but much less so for men. The interaction term of leisure for couples without children is positive, suggesting they prefer to spend more time together ceteris paribus. The interaction terms of income and leisure are quantitatively unimportant. For both men and women we find significant fixed costs of working. As with singles and single parents, fixed costs of work are higher when the person is lower educated and when the person is an immigrant.

The log-quadratic specification also has a negative linear income term, but a positive quadratic term and a large positive interaction term with leisure. Again, all chosen options in the end have positive marginal utility of income. The linear and quadratic terms in leisure are negative for both partners, all chosen options have negative marginal utility of leisure. Clearly, it is unlikely that all individuals have a negative marginal utility of leisure. However, note that part of the marginal utility of leisure in the decision of whether or not to work is captured by the fixed costs of work dummy. Age again seems important

Table 5: Estimated preference parameters: couples without children

| | Parameter | Quadratic | Log-quadratic |
|---|---|---|---|
| Income | $\beta_y$ | –0.116 | –9.730$^{**}$ |
| (Income)$^2$ | $\beta_{yy}$ | –0.000 | 1.993$^{***}$ |
| Leisure male | $\beta^{c_m}_{l_m}$ | 94.97$^{*}$ | –134.2$^{***}$ |
| x (Age male – 38)/10 | $\beta^{a_m}_{l_m}$ | 0.268 | 0.313 |
| x (Age male – 38)$^2$/100 | $\beta^{a_m a_m}_{l_m}$ | –0.491 | –0.302 |
| (Leisure male)$^2$ | $\beta_{l_m l_m}$ | –91.21$^{***}$ | –24.03 |
| Leisure female | $\beta^{c_f}_{l_f}$ | 207.0$^{***}$ | –90.48$^{***}$ |
| x (Age female – 38)/10 | $\beta^{a_f}_{l_f}$ | 5.966$^{***}$ | 4.869$^{***}$ |
| x (Age female – 38)$^2$/100 | $\beta^{a_f a_f}_{l_f}$ | 2.187$^{***}$ | 2.120$^{***}$ |
| (Leisure female)$^2$ | $\beta_{l_f l_f}$ | –137.7$^{***}$ | –46.70$^{***}$ |
| Income x leisure male | $\beta_{y l_m}$ | 0.197$^{*}$ | 12.74$^{***}$ |
| Income x leisure female | $\beta_{y l_f}$ | –0.008 | 4.521 |
| Leisure male x leisure female | $\beta_{l_m l_f}$ | 28.08$^{**}$ | 5.248$^{***}$ |
| Fixed costs male | $\beta^{c_m}_{fc_m}$ | –8.134$^{***}$ | –7.623$^{***}$ |
| x **1**(Lower educ. male) | $\beta^{e_m}_{fc_m}$ | –0.381$^{*}$ | –0.291 |
| x **1**(Native male) | $\beta^{n_m}_{fc_m}$ | 1.199$^{***}$ | 1.337$^{***}$ |
| Fixed costs female | $\beta^{c_f}_{fc_f}$ | –3.869$^{***}$ | –3.244$^{***}$ |
| x **1**(Lower educ. female) | $\beta^{e_f}_{fc_f}$ | –0.384$^{*}$ | –1.006$^{***}$ |
| x **1**(Native female) | $\beta^{n_f}_{fc_f}$ | 0.814$^{***}$ | 0.337$^{***}$ |
| Observations | | 72,000 | 72,000 |
| Log likelihood | | –4,999 | –4,930 |
| Akaike information criterion | | 10,036 | 9,898 |
| Chosen options with ${U^{d}}'_y < 0$ | | 0% | 0% |
| Chosen options with ${U^{d}}'_{l_m} < 0$ | | 96% | 100% |
| Chosen options with ${U^{d}}'_{l_f} < 0$ | | 57% | 100% |

Note: * denotes significant at 10% level, ** at 5% level and *** at 1% level.

for the marginal utility of leisure of females, but much less so for men. Partners prefer to spend time together ceteris paribus, and there is a positive relation between income and leisure for both partners. For both men and women we again find significant fixed costs of working, which are higher for lower educated and immigrants.

Next, we consider the fit of the models. As we now have one extra dimension, labour supply by the partner, we present predicted and observed frequencies in a table rather a graph, see Table 6 and Table 7. The quadratic specification gives a good fit, the notable exceptions being the {32,32} and {24,40} combination for women and men. Here the density is close to 4%-points short of what is observed in the first cell, and close to 3%-points too high for the second cell. The same is true for the log-quadratic specification,

Table 6: Predicted and obs. (in brackets) freq. quadratic model: couples w/o children

| | | Hours males | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 32 | 40 |
| | 0 | 3.7 | 0.0 | 0.3 | 2.1 | 8.4 | 18.8 |
| | | (4.0) | (0.3) | (0.6) | (0.5) | (9.6) | (18.7) |
| | 8 | 0.2 | 0.0 | 0.0 | 0.2 | 0.9 | 2.1 |
| | | (0.1) | (0.0) | (0.2) | (0.1) | (1.1) | (1.9) |
| Hours females | 16 | 0.5 | 0.0 | 0.1 | 0.7 | 2.8 | 6.3 |
| | | (0.4) | (0.1) | (0.1) | (0.2) | (4.1) | (7.7) |
| | 24 | 0.6 | 0.0 | 0.2 | 1.3 | 5.2 | 11.5 |
| | | (0.4) | (0.1) | (0.3) | (0.3) | (5.6) | (8.1) |
| | 32 | 0.7 | 0.0 | 0.2 | 1.5 | 5.7 | 12.5 |
| | | (0.8) | (0.2) | (0.5) | (0.6) | (10.0) | (12.4) |
| | 40 | 0.4 | 0.0 | 0.1 | 0.9 | 3.6 | 8.1 |
| | | (0.6) | (0.0) | (0.2) | (0.2) | (2.9) | (8.4) |

Table 7: Predict. and obs. (in brackets) freq. log quadr. model: couples w/o children

| | | Hours males | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 32 | 40 |
| | 0 | 3.7 | 0.0 | 0.3 | 2.0 | 8.9 | 18.2 |
| | | (4.0) | (0.3) | (0.6) | (0.5) | (9.6) | (18.7) |
| | 8 | 0.2 | 0.0 | 0.0 | 0.2 | 1.1 | 2.1 |
| | | (0.1) | (0.0) | (0.2) | (0.1) | (1.1) | (1.9) |
| Hours females | 16 | 0.4 | 0.0 | 0.1 | 0.7 | 2.9 | 5.8 |
| | | (0.4) | (0.1) | (0.1) | (0.2) | (4.1) | (7.7) |
| | 24 | 0.6 | 0.0 | 0.2 | 1.3 | 5.4 | 11.1 |
| | | (0.4) | (0.1) | (0.3) | (0.3) | (5.6) | (8.1) |
| | 32 | 0.7 | 0.0 | 0.2 | 1.4 | 6.1 | 13.1 |
| | | (0.8) | (0.2) | (0.5) | (0.6) | (10.0) | (12.4) |
| | 40 | 0.4 | 0.0 | 0.1 | 0.8 | 3.5 | 8.3 |
| | | (0.6) | (0.0) | (0.2) | (0.2) | (2.9) | (8.4) |

Table 8: Labour supply elasticities couples without children: quadratic utility

| | Male own | | | Female cross | | | Female own | | | Male cross | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.05 | 0.05 | –0.01 | 0.04 | 0.04 | 0.00 | 0.22 | 0.17 | 0.05 | –0.02 | 0.00 | –0.02 |
| Lower educated | 0.07 | 0.08 | 0.00 | 0.06 | 0.06 | 0.00 | 0.26 | 0.19 | 0.05 | 0.00 | 0.01 | –0.01 |
| Higher educated | 0.04 | 0.04 | –0.01 | 0.04 | 0.04 | 0.00 | 0.21 | 0.17 | 0.05 | –0.03 | –0.01 | –0.02 |
| First quartile | 0.06 | 0.06 | 0.00 | 0.05 | 0.05 | 0.00 | 0.19 | 0.14 | 0.04 | –0.01 | 0.00 | –0.01 |
| Second quartile | 0.04 | 0.05 | 0.00 | 0.04 | 0.04 | 0.00 | 0.21 | 0.16 | 0.05 | –0.02 | 0.00 | –0.02 |
| Third quartile | 0.04 | 0.05 | –0.01 | 0.04 | 0.04 | 0.00 | 0.22 | 0.17 | 0.05 | –0.03 | –0.01 | –0.02 |
| Fourth quartile | 0.04 | 0.04 | –0.01 | 0.04 | 0.04 | 0.00 | 0.28 | 0.22 | 0.06 | –0.03 | –0.01 | –0.02 |
| Age 20–28 | 0.03 | 0.03 | 0.00 | 0.02 | 0.01 | 0.00 | 0.10 | 0.05 | 0.05 | –0.03 | –0.01 | –0.02 |
| Age 28–40 | 0.03 | 0.04 | –0.01 | 0.02 | 0.02 | 0.00 | 0.13 | 0.08 | 0.06 | –0.05 | –0.02 | –0.03 |
| Age 40–57 | 0.05 | 0.06 | –0.01 | 0.07 | 0.06 | 0.01 | 0.35 | 0.27 | 0.07 | –0.01 | 0.00 | –0.01 |

Simulated labour supply elasticities following an increase of 10% in gross hourly wages. 'Total' is the elasticity of total working hours, 'Ext.' is the participation elasticity, 'Int.' is the hours per employed elasticity. For the male own and female cross elasticity we use the education and age of the male, for the female own and male cross elasticity we use the education and age of the female.

Table 9: Labour supply elasticities couples without children: log-quadratic utility

| | Male own | | | Female cross | | | Female own | | | Male cross | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.07 | 0.07 | 0.00 | –0.03 | 0.00 | –0.02 | 0.27 | 0.22 | 0.05 | –0.02 | –0.01 | –0.02 |
| Lower educated | 0.10 | 0.10 | 0.00 | 0.05 | 0.07 | –0.01 | 0.42 | 0.37 | 0.05 | 0.00 | 0.01 | –0.01 |
| Higher educated | 0.07 | 0.06 | 0.00 | –0.04 | –0.02 | –0.03 | 0.23 | 0.17 | 0.05 | –0.04 | –0.02 | –0.02 |
| First quartile | 0.08 | 0.08 | 0.00 | 0.02 | 0.03 | –0.02 | 0.26 | 0.22 | 0.04 | –0.01 | 0.00 | –0.01 |
| Second quartile | 0.07 | 0.07 | 0.00 | –0.01 | 0.01 | –0.02 | 0.24 | 0.19 | 0.05 | –0.03 | –0.01 | –0.02 |
| Third quartile | 0.07 | 0.07 | 0.00 | –0.03 | 0.00 | –0.03 | 0.26 | 0.21 | 0.05 | –0.03 | –0.01 | –0.02 |
| Fourth quartile | 0.07 | 0.06 | 0.01 | –0.08 | –0.04 | –0.03 | 0.31 | 0.25 | 0.06 | –0.03 | –0.01 | –0.02 |
| Age 20-28 | 0.04 | 0.04 | 0.00 | 0.00 | 0.01 | –0.01 | 0.11 | 0.06 | 0.05 | –0.04 | –0.02 | –0.02 |
| Age 29-40 | 0.06 | 0.05 | 0.00 | –0.02 | 0.00 | –0.02 | 0.14 | 0.08 | 0.06 | –0.05 | –0.03 | –0.02 |
| Age 41-57 | 0.09 | 0.08 | 0.00 | –0.04 | –0.01 | –0.03 | 0.43 | 0.35 | 0.08 | –0.01 | 0.00 | –0.01 |

Simulated labour supply elasticities following an increase of 10% in gross hourly wages. 'Total' is the elasticity of total working hours, 'Ext.' is the participation elasticity, 'Int.' is the hours per employed elasticity. For the male own and female cross elasticity we use the education and age of the male, for the female own and male cross elasticity we use the education and age of the female.

with the same notable exceptions at {32,32} and {24,40}, though the discrepancies with the data are now somewhat smaller. According to the Akaike information criterion, the log-quadratic specification is to be preferred over the quadratic specification.

Finally, Tables 8 and 9 give the labour supply elasiticities for the quadratic and log-quadratic specifications respectively. We consider the own labour supply elasticity of men when we increase their gross hourly wages by 10%, the cross elasticity of women when we increase the gross hourly wage of men by 10%, the own labour supply elasticity of women when we increase their gross hourly wages by 10%, and finally the cross elasticity of men when we increase the gross hourly wage of women by 10%.

The own wage elasticities for all men range from 0.05 to 0.07, which is much lower than for single men, with the intensive margin elasticity close to zero. The own wage elasticities for women are larger, ranging from 0.22 to 0.27, though also lower than for single women, and the intensive margin elasticity is relatively small, 0.05. For the quadratic specification we find a rather surprising positive cross elasticity of men's wages and females' labour supply. However, in our preferred log-quadratic specification cross elasticities are negative (women of lower educated men being the proverbial exception). Lower educated men and women in couples without children have a higher elasticity than their higher educated counterparts[22], but the differences are much less pronounced than for singles and single parents. Also, differences across income quartiles are less pronounced. For both men and women in couples without children, the elasticity rises with age, which is quite different from the pattern we observed for singles and single parents.

In the supplementary material, we show that bootstrapped standard errors are in the order of 0.01 to 0.02 for the labour supply elasticities of couples without children. Elasticities are rather stable over the period 1999–2005, rising by just 0.01.

### 4.4 Couples with children

Finally, Table 10 gives the estimated preference parameters for couples with children. The quadratic and Box-Cox 2 specifications had problems converging, so we only present the log-quadratic and the Box-Cox 1 specification. Again, this is not very restrictive, since the log-quadratic function is the most flexible, and again we do not run into problems with negative marginal utility of income.

For the log-quadratic case we find positive and increasing marginal utility of income. Hence, for all chosen options the marginal utility of income is positive. The linear and quadratic terms of log leisure are negative which results in a negative value for the marginal

[22] For the own wage elasticities of men we report elasticities by the education level of the men, and for the own wage elasticities of the women we report elasticities by the education level of the women.

Table 10: Estimated preference parameters: couples with children

| | Parameter | Log-quadratic | Parameter | Box-Cox 1 |
|---|---|---|---|---|
| Income | $\beta_y$ | 3.415 | $\gamma_y$ | 2.264*** |
| | | | $\delta_y$ | –0.168* |
| (Income)$^2$ | $\beta_{yy}$ | 0.253 | | |
| Leisure male | $\beta_{l_m}^{c_m}$ | –67.81*** | $\gamma_{l_m}^{c_m}$ | –43.43*** |
| x (Age male – 38)/10 | $\beta_{l_m}^{a_m}$ | 2.342*** | $\gamma_{l_m}^{a_m}$ | 9.758*** |
| x (Age male – 38)$^2$/100 | $\beta_{l_m}^{a_m a_m}$ | –1.506** | $\gamma_{l_m}^{a_m a_m}$ | –4.752** |
| x **1**(Youngest child 0 – 3) | $\beta_{l_m}^{03}$ | 1.150 | $\gamma_{l_m}^{03}$ | –12.68 |
| x **1**(Youngest child 4 – 11) | $\beta_{l_m}^{411}$ | 0.575 | $\gamma_{l_m}^{411}$ | –16.06 |
| | | | $\delta_{l_m}$ | 9.589*** |
| (Leisure male)$^2$ | $\beta_{l_m l_m}$ | –89.72*** | | |
| Leisure female | $\beta_{l_f}^{c_f}$ | –20.97 | $\gamma_{l_f}^{c_f}$ | 1.236*** |
| x (Age female – 38)/10 | $\beta_{l_f}^{a_f}$ | 0.176 | | |
| x (Age female – 38)$^2$/100 | $\beta_{l_f}^{a_f a_f}$ | 1.653*** | | |
| x **1**(Youngest child 0 – 3) | $\beta_{l_f}^{03}$ | 3.545*** | | |
| x **1**(Youngest child 4 – 11) | $\beta_{l_f}^{411}$ | 3.774*** | | |
| x **1**(Higher educ. male) | | | $\gamma_{l_f}^{e_m}$ | 0.100 |
| x **1**(Native female) | | | $\gamma_{l_f}^{n}$ | 0.342** |
| | | | $\delta_{l_f}$ | –12.48*** |
| (Leisure female)$^2$ | $\beta_{l_f l_f}$ | –109.3*** | | |
| Income x leisure male | $\beta_{y l_m}$ | 5.314 | | |
| Income x leisure female | $\beta_{l_f l_f}$ | –0.711 | | |
| Leisure male x leisure female | $\beta_{l_m l_f}$ | –0.082 | | |
| Fixed costs male | $\beta_{fc_m}^{c_m}$ | –8.368*** | $\gamma_{fc_m}^{c_m}$ | –4.948*** |
| x **1**(Lower educ. male) | $\beta_{fc_m}^{e_m}$ | –0.024 | | |
| x **1**(Native male) | $\beta_{fc_m}^{n_m}$ | 1.520*** | | |
| x **1**(Youngest child 0 – 3) | | | $\gamma_{fc_m}^{03}$ | –1.382 |
| x **1**(Youngest child 4 – 11) | | | $\gamma_{fc_m}^{411}$ | –1.811* |
| x (Age female – 38)/10 | | | $\gamma_{fc_m}^{a_f}$ | 0.728*** |
| x (Age female – 38)$^2$/100 | | | $\gamma_{fc_m}^{a_f a_f}$ | –0.098 |
| Fixed costs female | $\beta_{fc_f}^{c_f}$ | –2.931*** | $\gamma_{fc_f}^{c_f}$ | –2.087*** |
| x **1**(Lower educ. female) | $\beta_{fc_f}^{e_f}$ | –0.817*** | | |
| x **1**(Native female) | $\beta_{fc_f}^{n_f}$ | 0.414*** | $\gamma_{fc_f}^{e_f}$ | 0.661*** |
| x **1**(Higher educ. male) | | | $\gamma_{fc_f}^{e_m}$ | –0.790*** |
| Observations | | 72,000 | | 72,000 |
| Log likelihood | | –5,113 | | –5,203 |
| Akaike information criterion | | 10,272 | | 10,446 |
| Chosen options with ${U^{d'}}_y < 0$ | | 0% | | 0% |
| Chosen options with ${U^{d'}}_{l_m} < 0$ | | 49% | | 0% |
| Chosen options with ${U^{d'}}_{l_f} < 0$ | | 50% | | 0% |

Note: * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 11: Predicted and obs. (in brackets) freq. log quadr. model: couples with children

| | | Hours males | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 32 | 40 |
| | 0 | 5.6 | 0.0 | 0.2 | 1.8 | 9.4 | 22.1 |
| | | (6.9) | (0.2) | (0.5) | (0.3) | (10.4) | (21.9) |
| | 8 | 0.6 | 0.0 | 0.0 | 0.5 | 2.3 | 4.8 |
| | | (0.1) | (0.0) | (0.1) | (0.1) | (2.3) | (3.7) |
| Hours females | 16 | 0.7 | 0.0 | 0.2 | 1.3 | 5.4 | 10.4 |
| | | (0.8) | (0.2) | (0.1) | (0.4) | (8.0) | (12.7) |
| | 24 | 0.9 | 0.0 | 0.2 | 1.7 | 6.4 | 11.5 |
| | | (0.6) | (0.2) | (0.4) | (0.7) | (7.4) | (8.5) |
| | 32 | 0.7 | 0.0 | 0.2 | 1.0 | 3.5 | 5.9 |
| | | (0.8) | (0.3) | (0.4) | (0.3) | (4.2) | (4.8) |
| | 40 | 0.2 | 0.0 | 0.0 | 0.2 | 0.8 | 1.3 |
| | | (0.3) | (0.1) | (0.1) | (0.1) | (1.0) | (2.1) |

Table 12: Predicted and obs. (in brackets) freq. Box-Cox 1 model: couples with children

| | | Hours males | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 32 | 40 |
| | 0 | 5.7 | 0.1 | 0.4 | 2.0 | 8.1 | 22.9 |
| | | (6.9) | (0.2) | (0.5) | (0.3) | (10.4) | (21.9) |
| | 8 | 0.7 | 0.0 | 0.1 | 0.7 | 2.6 | 6.7 |
| | | (0.1) | (0.0) | (0.1) | (0.1) | (2.3) | (3.7) |
| Hours females | 16 | 0.6 | 0.0 | 0.2 | 1.3 | 4.2 | 10.0 |
| | | (0.8) | (0.2) | (0.1) | (0.4) | (8.0) | (12.7) |
| | 24 | 0.7 | 0.0 | 0.3 | 1.6 | 4.9 | 10.9 |
| | | (0.6) | (0.2) | (0.4) | (0.7) | (7.4) | (8.5) |
| | 32 | 0.7 | 0.0 | 0.3 | 1.2 | 3.3 | 7.0 |
| | | (0.8) | (0.3) | (0.4) | (0.3) | (4.2) | (4.8) |
| | 40 | 0.2 | 0.0 | 0.1 | 0.3 | 0.7 | 1.5 |
| | | (0.3) | (0.1) | (0.1) | (0.1) | (1.0) | (2.1) |

Table 13: Labour supply elasticities couples with children: log-quadratic utility

| | Male own | | | Female cross | | | Female own | | | Male cross | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.14 | 0.14 | 0.01 | –0.16 | –0.10 | –0.06 | 0.50 | 0.38 | 0.12 | –0.02 | 0.00 | –0.02 |
| Lower educated | 0.24 | 0.23 | 0.01 | –0.07 | –0.02 | –0.05 | 0.68 | 0.55 | 0.12 | 0.01 | 0.03 | –0.01 |
| Higher educated | 0.12 | 0.11 | 0.01 | –0.18 | –0.11 | –0.06 | 0.47 | 0.34 | 0.12 | –0.04 | –0.01 | –0.02 |
| First quartile | 0.20 | 0.20 | 0.00 | –0.11 | –0.06 | –0.06 | 0.62 | 0.48 | 0.13 | 0.00 | 0.02 | –0.02 |
| Second quartile | 0.15 | 0.14 | 0.01 | –0.13 | –0.08 | –0.06 | 0.48 | 0.36 | 0.11 | –0.02 | 0.00 | –0.02 |
| Third quartile | 0.13 | 0.12 | 0.01 | –0.17 | –0.11 | –0.07 | 0.48 | 0.36 | 0.12 | –0.03 | –0.01 | –0.02 |
| Fourth quartile | 0.11 | 0.10 | 0.01 | –0.20 | –0.13 | –0.07 | 0.46 | 0.34 | 0.12 | –0.04 | –0.01 | –0.02 |
| Age 20 – 28 | 0.14 | 0.14 | 0.01 | –0.13 | –0.07 | –0.06 | 0.59 | 0.46 | 0.13 | 0.01 | 0.02 | –0.02 |
| Age 28 – 40 | 0.15 | 0.14 | 0.01 | –0.15 | –0.09 | –0.06 | 0.51 | 0.38 | 0.12 | –0.03 | –0.01 | –0.02 |
| Age 40 – 57 | 0.14 | 0.13 | 0.01 | –0.16 | –0.10 | –0.06 | 0.49 | 0.37 | 0.11 | –0.03 | 0.00 | –0.02 |
| Youngest child 0 – 3 | 0.15 | 0.14 | 0.01 | –0.16 | –0.10 | –0.07 | 0.51 | 0.38 | 0.12 | –0.03 | –0.01 | –0.02 |
| Youngest child 4 – 11 | 0.16 | 0.15 | 0.01 | –0.15 | –0.09 | –0.06 | 0.54 | 0.41 | 0.12 | –0.02 | 0.00 | –0.02 |
| Youngest child 12 – 17 | 0.11 | 0.10 | 0.01 | –0.17 | –0.11 | –0.06 | 0.45 | 0.34 | 0.11 | –0.03 | 0.00 | –0.02 |

Simulated labour supply elasticities following an increase of 10% in the gross hourly wages. ‘Total’ is the elast. of total working hours, ‘Ext.’ is the participation elast., ‘Int.’ is the hours per employed elast. For male own and female cross elast. we use educ. and age of the male, for female own and male cross elast. we use educ. and age of the female.

Table 14: Labour supply elasticities couples with children: Box-Cox 1 utility

| | Male own | | | Female cross | | | Female own | | | Male cross | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. | Total | Ext. | Int. |
| All | 0.19 | 0.16 | 0.02 | –0.29 | –0.18 | –0.11 | 0.52 | 0.40 | 0.12 | 0.00 | 0.02 | –0.02 |
| Lower educated | 0.31 | 0.28 | 0.03 | –0.17 | –0.08 | –0.09 | 0.76 | 0.61 | 0.14 | 0.03 | 0.05 | –0.01 |
| Higher educated | 0.16 | 0.13 | 0.02 | –0.32 | –0.21 | –0.11 | 0.47 | 0.35 | 0.12 | –0.02 | 0.01 | –0.02 |
| First quartile | 0.27 | 0.25 | 0.02 | –0.23 | –0.13 | –0.10 | 0.65 | 0.51 | 0.14 | 0.02 | 0.04 | –0.02 |
| Second quartile | 0.20 | 0.17 | 0.02 | –0.25 | –0.15 | –0.10 | 0.50 | 0.38 | 0.12 | 0.00 | 0.02 | –0.02 |
| Third quartile | 0.16 | 0.14 | 0.02 | –0.31 | –0.20 | –0.11 | 0.50 | 0.37 | 0.12 | –0.01 | 0.01 | –0.02 |
| Fourth quartile | 0.12 | 0.10 | 0.02 | –0.35 | –0.24 | –0.12 | 0.47 | 0.35 | 0.12 | –0.02 | 0.00 | –0.02 |
| Age 20 – 28 | 0.19 | 0.17 | 0.02 | –0.25 | –0.14 | –0.11 | 0.60 | 0.46 | 0.14 | 0.03 | 0.05 | –0.02 |
| Age 28 – 40 | 0.21 | 0.19 | 0.02 | –0.27 | –0.17 | –0.11 | 0.52 | 0.39 | 0.12 | –0.01 | 0.01 | –0.02 |
| Age 40 – 57 | 0.17 | 0.15 | 0.02 | –0.31 | –0.20 | –0.11 | 0.51 | 0.39 | 0.12 | –0.01 | 0.01 | –0.02 |
| Youngest child 0 – 3 | 0.20 | 0.17 | 0.02 | –0.28 | –0.17 | –0.11 | 0.51 | 0.38 | 0.12 | –0.01 | 0.01 | –0.02 |
| Youngest child 4 – 11 | 0.21 | 0.19 | 0.02 | –0.26 | –0.16 | –0.10 | 0.53 | 0.41 | 0.12 | 0.00 | 0.02 | –0.02 |
| Youngest child 12 – 17 | 0.14 | 0.11 | 0.03 | –0.33 | –0.22 | –0.11 | 0.52 | 0.40 | 0.12 | –0.01 | 0.01 | –0.02 |

See footnote Table 13.

utility of leisure for a large fraction of the chosen options. However, having a youngest child 0 to 3 years of age or 4 to 11 years of age raises the value of leisure. The marginal value of leisure depends on age, the linear interaction term is positive and the second order interation term is negative. The interaction term of leisure for the male and the female is negative, hence they do not prefer to spend time together ceteris paribus. For men, leisure is a normal good, whereas the reverse is true for women, the interaction terms between income and leisure are not significant though. For both men and women, we find significant fixed costs of working, which are again higher for lower educated and immigrant males and females.

Turning to the Box-Cox 1 specification, the marginal utility of income is positive, and, given the value of $\delta_y$ close to 0 the income term seems to be close to a log form. The marginal value of leisure for men seems small, $\gamma_{l_m}^{c_m}$ is a large negative number, but we have to be careful given that $\delta_{l_m}$ is large as well. Also for women we see large opposite numbers for $\gamma_{l_f}^{c_f}$ and $\delta_{l_m}$, which suggests a large interdependence between these coefficients.

Fixed costs of working are significant for both men and women, and rise for men when they have a small child (for women these coefficients were insignificant). Fixed costs of working also seem higher for females that form a couple with a higher educated male (education of the female was insignificant).

The fit of the log-quadratic and Box-Cox 1 specifications are given in Table 11 and Table 12 respectively. The log-quadratic specification has a good fit. The largest difference between the predicted and observed frequency is 3%-points, for the option where the man works 24 hours and the woman works 40 hours. The Box-Cox specification also fits the data quite well. However, the Akaike information criterion suggests the log-quadratic specification is to be preferred over the Box-Cox 1 specification.

Table 13 and 14 give the results for the labour supply elasticities of couples with children assuming log-quadratic and Box-Cox 1 preferences respectively. For couples with children, we find larger elasticities for both men and women than for couples without children. The own wage elasticity is much larger for women than for men. There is also a substantial cross elasticity for women, whereas the cross elasticity for men is still close to zero. Indeed, the cross elasticity of women is larger than the own wage elasticity of men, however the total number of hours worked still rises because men work more hours than women. Lower educated have a higher elasticity than higher educated[23], the differences are less pronounced than for singles though, which we also observed for couples without children. The same picture emerges when we look at income quartiles. For men there is

[23]For the own wage elasticities of men we report elasticities by the education level of the men, and for the own wage elasticities of the women we report elasticities by the education level of the women.

no clear relation with age, for women the elasticity seems to fall with age. Most of the response is again on the extensive margin, the intensive margin is small, in particular for men. Furthermore, there is no clear relation with the age of the youngest child, and this holds for both the extensive and intensive margin. This is quite different from the results for single parents.

In the supplementary material we show that for couples with children bootstrapped standard errors are in the order of 0.01 for the own wage elasticities of men and 0.03 for the own wage elasticities of women. There is some change in these elasticities over the period 1999-2005, for men the own wage elasticity rises by 0.03 and for women the own wage elasticity falls by –0.05, indicating that the labour supply behaviour of men and women in couples with children is converging somewhat.

# 5 Comparison with the findings of related studies

Below we consider how our results compare to the findings of related studies. We first compare the results with the findings of related studies using structural models in the Netherlands, and with the (preliminary) findings of two quasi-experimental studies using the same data set. Subsequently we compare our findings with the findings abroad.

## 5.1 The Netherlands

Table 15 gives an overview of structural empirical labour supply studies using Dutch data. For comparability we limit the overview to studies from 2000 onwards, older studies used data from the 1980s, when the participation rate of women was still much lower. This table underscores the value added of our analysis. We use a much larger data set than previous studies, which enables to estimate preferences of subgroups more precisely and enables us to also study singles and single parents which have received little attention in previous studies. Furthermore, previous studies have relied mostly on data from the 1990s (and 1980s), when participation rates were much lower, whereas we use data from the 2000s, which is likely to affect the elasticities to some extent (Bargain et al., 2011). Also, together with Vermeulen (2005) we are the only study to use data from before and after 2001, when there was a large tax reform that generated large exogenous changes in budget constraints, which benefits the identification of the preference parameters.

We compare the results from these studies with our preferred estimates from above. We prefer the estimate for the model that has the best fit as measured by the lowest value for the Akaike information criterion, provided it does not generate negative marginal utility of

Table 15: Estimates of labour supply elasticities in the Netherlands

| Study | Sample | Data period | Observations | Total hours | | Participation | | Hours per worker | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Men | Women | Men | Women | Men | Women |
| This paper | Couples w/o children[a] | 1999-2005 | 72,000 | 0.07 | 0.27 | 0.07 | 0.22 | 0.00 | 0.05 |
| | Couples with children[a] | 1999-2005 | 72,000 | 0.14 | 0.50 | 0.14 | 0.38 | 0.01 | 0.12 |
| | Singles[a] | 1999-2005 | 24,000 | 0.39 | 0.47 | 0.33 | 0.39 | 0.06 | 0.08 |
| | Single parents[b] | 1999-2005 | 24,000 | 0.45 | 0.62 | 0.32 | 0.43 | 0.12 | 0.18 |
| Vlasblom et al. (2001)[c] | Couples | {1985,1992} | 1,856 | | 0.42 | | 0.35 | | |
| Van Soest and Das (2001) | Couples | 1995 | 4,017 | 0.08 | 0.71 | | | | |
| Van Soest et al. (2002)[d] | Couples | 1995 | 1,794 | | 1.04 | | 0.44 | | |
| Vermeulen (2005)[e] | Singles | 1995-2003 | 1,430 | | | | | 0.01 | 0.00 |
| | Couples w/o children | 1995-2003 | 680 | | | | | –0.03 | 0.27 |
| Bloemen and Kapteyn (2008)[f] | Couples | 1985 | 849 | | 0.42 | | 0.25 | | |
| Bloemen (2009)[g] | Unmarried couples w/o children | 1990-2001 | 2,491 | 0.24 | 0.22 | | | | |
| | Married couples w/o children | 1990-2001 | 5,558 | –0.06 | 0.61 | | | | |
| Bloemen (2010)[h] | Couples w/o children | 1990-2001 | 8,049 | | | –0.02 | 0.31 | 0.00 | 0.26 |
| Bargain et al. (2011) | Singles and single parents | 1999 | 763 | 0.08 | 0.16 | 0.08 | 0.11 | 0.01 | 0.02 |
| | Couples | 1999 | 1,806 | 0.06 | 0.32 | 0.06 | 0.20 | 0.01 | 0.13 |

[a] Log-quadratic utility function. [b] Box-Cox 2 utility function. [c] Elasticities are reported in Vlasblom (1998, Table 5.12). [d] Van Soest et al. (2002, Table 2), estimates with second order polynomial for the utility function. The participation elasticity in Van Soest et al. (2002) is the change in percentage points in response to a 1% increase in the wage rate. [e] Vermeulen (2005, Table 7), unitary model for couples (own wage elasticities). [f] Average of the estimation results of the variant with simulated scores and the variant with discrete choices and a third order polynomial utility function, as reported in Bloemen (2010, p. 27). [g] Bloemen (2009, Table 7), reduced form estimates. [h] Bloemen (2010, Table 8), with unrestricted sharing rule and fixed costs.

income in the observed choices in the data.[24] This is the log-quadratic specification for all household types except for single parents. For this group the log-quadratic specification generates negative marginale utility of income in a large part of the observed choices. For this group we prefer the Box-Cox 2 specification, which generates a positive marginal utility of income (and leisure), and has a lower value for the Akaike information criterion than the Box-Cox 1 specification (which does not have the interaction term between leisure and income). We compare the results for the findings for the (own) wage elasticity of total working hours, participation and hours per employed.

Most studies focus on couples, we consider this group first. We find small elasticities for total hours worked for men in couples, 0.07 for men in couples without children and 0.14 for men in couples with children. This is in line with the other studies. Furthermore, for men in couples we find an intensive margin elasticity close to zero, again in line with the other studies.

We find larger elasticities for women in couples, 0.27 for women in couples without children and 0.50 for women in couples with children. Our results fall in the range of the other studies. In line with the other studies we find substantial extensive margin responses. We find small intensive margin responses for women in couples, the results of the other studies for the intensive margin response are mixed, though they are on average smaller than the extensive margin.

The studies also report information on cross elasticities in couples (not in the table). We find negligible cross elasticities for men and women without children, but sizeable cross elasticities for women with children (–0.2). Van Soest and Das (2001) also find substantial cross elasticities for women in couples (about half of their own wage elasticity), but not for men in couples. Van Soest *et al.* (2002) also report nonnegligible cross elasticities for women in couples (–0.1). Vermeulen (2005) finds nonnegligible cross elasticities on the intensive margin for both men (–0.1) and women (–0.1). Bloemen (2009) finds small cross elasticities for men in couples without children, but somewhat larger cross elasticiteis for women in couples without children (–0.1 for unmarried couples and –0.2 for married couples). Bloemen (2010) also finds small cross elasticities for men and somewhat bigger cross elasticities for women in some specifications.

Only two studies consider singles, using rather small data sets.[25] Vermeulen (2005)

[24]For a significant part of the sample. For singles the log-quadratic specification generates negative marginal utility for 1% of the sample.

[25]Not included in Table 15 is the study by Euwals and Van Soest (1999) on singles and single parents, since it was published before 2000 (and uses data from the 1980s). In the specification that is closest to ours (Euwals and Van Soest, 1999, Table 8, Column 1) they find a (total) labour supply elasticity of 0.15 for single men and 0.19 for single women.

estimates very small intensive margin elasticities for both single men and women (without children), even smaller than our estimates. Bargain *et al.* (2011) is the only other study that also considers singles. They present results for all variables. They also find very small intensive margin responses for this group, but also much smaller extensive margin responses than we do.[26]

We find the highest labour supply elasticities for single parents, 0.62 for single mothers and 0.45 for single fathers, and the intensive margin elasticity of 0.18 and 0.12 is also non-negligible for single mothers and fathers respectively. None of the other studies in Table 15 considers single parents.[27] However, studies abroad also find that single parents are relatively elastic (Meghir and Phillips, 2010).

The relation with education is also of interest. We find much higher labour supply elasticities for lower educated individuals than for higher educated individuals, especially for singles and single parents. Van Soest and Das (2001) also find that lower educated women in couples have somewhat higher labour supply elasticities (0.93 compared to 0.71 for the whole sample of women in couples). With 0.46 the elasticity of lower educated women in couples in Van Soest *et al.* (2002) is also higher than the 0.37 for higher educated women. There is no previous study that considers the elasticities for singles and single parents by level of education.

We can also compare our findings with the findings of two quasi-experimental studies using the same data set. Bosch and Jongen (2012) study the intensive margin elasticity of labour supply, using the 2001 tax reform and the methodology developed in Blundell et al. (1998). For couples they find an intensive margin elasticity of 0.01 for men, in line with the results in Table 15, and of 0.13 for women, which is close to the results for women in couples with children in Table 15 but somewhat larger than the the results for women in couples without children in Table 15, though still relatively small compared to *e.g.* the extensive margin.[28] The intensive margin elasticity of single mothers in Bosch and Jongen (2012) is 0.21, close to the 0.18 reported in Table 15. The intensive margin elasticity of singles of 0.17 is somewhat larger in Bosch and Jongen (2012) than the 0.07 in Table 15, however it

[26]Negative marginal utilities might be a problem in their study. The quadratic term in income is negative, as is the interaction term between income and hours worked and the interaction term between income and age. Individuals with negative marginal utility in income drive simulated elasticities downwards.

[27]Euwals and Van Soest (1999) find a (total) labour supply elasticity of 0.42 for single mothers and 0.18 for single fathers.

[28]Bosch and Van der Klaauw (2012) also find that the intensive margin elasticity of labour supply of women in couples is small, using data from the Labour Force Survey on labour participation and data on income from the Social Statistical Panel. Indeed, in their study the intensive margin elasticity is not significantly different from zero.

is still small compared to the extensive margin elasticity.[29] Bettendorf et al. (2013) study the extensive margin labour supply elasticity of single mothers with a youngest child 12 to 16 years old using the extension of the eligibility of the EITC for single parents to this group in 2002. Using difference-in-differences and regression-discontinuity they show that this reform had a negligible impact on labour participation of single parents, suggesting an extensive margin elasticity for this group close to zero. In our structural model we find an extensive margin elasticity of 0.33 for single mothers with a youngest child 12 to 17 years (Table 4), using our preferred Box-Cox 2 specification. Clearly this is larger than zero, but it is also much smaller than the elasticity for single parents with a small child for which we find an extensive margin elasticity of 0.82 (Table 4). Hence, both methods predict a relatively small elasticity for single parents with a youngest child in secondary school.

## 5.2 Other countries

Next, we compare our estimated labour supply elasticities with estimated labour supply elasticities abroad. Excellent surveys of the labour supply elasticity in a large number of countries can be found in Blundell and MaCurdy (1999) and Bargain et al. (2011). We compare our results with the recent estimates for Europe and the US in Bargain et al. (2011).

Bargain et al. (2011) find that for married women the total hours elasticity ranges from 0.2 to 0.6 across countries. Our estimates for women in couples without and with children of 0.3 and 0.5 respectively fall in this range. For married men the total hours elasticity ranges from 0.05 to 0.15 across countries. Our estimates for men in couples without and with children of 0.07 and 0.14 respectively fall in this range.

For single men Bargain et al. (2011) find a total hours elasticity ranging from of 0.0 to 0.4 and some even higher. Our estimate of 0.4 is on the upper end of this range. For single women they find an elasticity ranging from 0.1 to 0.5 and again some even higher. Our estimate of 0.5 is again on the upper end of this range. They also find that elasticities for single mothers are typically somewhat higher than for single women, which is what we find as well.

Bargain et al. (2011) also find that the extensive margin elasticity is (much) more important than the intensive margin elasticity. Furthermore, they find that labour supply elasticities are lower for the lowest income quintiles than the highest income quintiles,

[29] Furthermore, Bosch and Jongen (2012) consider the elasticity to a change in net rather than gross wages, which typically results in larger elasticities, see *e.g.* Bargain et al. (2011) and the supplementary material.

mostly due to differences in the extensive margin response (in some cases the intensive margin response rises with the income quintile, which is what we find for women in couples without children). They also find that cross elasticities for women in couples are non-negligible and are close to zero for men in couples.

## 6 Conclusion

A large administrative panel household data set has enabled us to estimate the labour supply elasticities for a large number of subgroups on the Dutch labour market. The identification benefits from a large tax reform in the sample that gives substantial exogenous variation in household budget constraints. With this dataset we have been able to show that men and women have similar labour supply elasticities when they are single. Single parents with a small child have larger elasticities than singles without children. In couples, we find that men have much smaller elasticities than women. The difference is particularly strong for couples with children. We also find that cross elasticities of men's wages on women's labour supply in couples are non-negligible. Low skilled singles and single parents have much higher labour supply elasticities than their high skilled counterparts. Furthermore, for all subgroups we find that the extensive or participation margin is much more important than the intensive or hours per week margin. Labour supply elasticities change somewhat over the period 1999-2005 we consider. Indeed, there is an interesting drop in the elasticity of women in couples with children and an interesting counteracting rise in the elasticity of men in couples with children, which suggests that their labour supply behaviour is to some extent converging. Finally, we do not find a clear age pattern for labour supply elasticities, however it is important to note that we only consider individuals aged up to 57 years old.[30] Our results update the findings for couples to a recent period, where participation rates are much higher than in the past, and extend our knowledge to the groups of singles and single parents which have received little attention in previous studies. Our findings are in line with recent findings abroad.

Our findings have a number of important policy implications. When the labour supply of secondary earners responds much more to financial incentives than the labour supply of primary earners, marginal tax rates should be lower for secondary earners than for primary earners (Alesina et al., 2011; Boskin and Sheshinski, 1983). This is in line with the current Dutch tax system. The progressive tax system and specific tax credits for secondary earners reduce the marginal tax rate of secondary earners relative to primary earners. When the extensive margin is much more important than the intensive margin,

[30] Blundell et al. (2011) show that elasticities rise again close to retirement.

participation tax rates should be lower and marginal tax rates can be higher (Saez, 2002). One way to achieve this is to have an earned income tax credit (EITC or 'Arbeidskorting' in Dutch) with a steep phase-in range and subsequently a rather steep phase-out range. The Netherlands has an EITC with a steep phase-in range, but the phase-out range starts at a relatively high income (two and a half times the minimum wage). Targeting the EITC more at low incomes could benefit both efficiency and equity. Indeed, the current government (Rutte-II) has plan to target the EITC more at low incomes (CPB, 2012).

However, the current analysis still has a number of limitations. Statistics Netherlands has recently constructed a new dataset (Statistics Netherlands, 2012). This new dataset has data on the longer period 1999-2009, and also includes information on search behaviour of the unemployed, and the price and use of formal childcare. With this information we can study a number of additional issues. With the new data we can track individuals and households over the longer period 1999-2009, and see whether elasticities change over the period of a decade. We can also distinguish between chance and choice when it comes to labour participation using the job search information, following *e.g.* Bargain et al. (2010). With data on the parental fee and use of formal childcare we can further estimate preferences over income, leisure and the use of formal childcare, and study the impact of changes in the price of formal childcare on labour supply and the choice between formal and informal care, following *e.g.* Kornstad and Thoresen (2006). Finally, we are also studying margins other than labour supply, estimating the elasticity of taxable income in the Netherlands using the same data set (Jongen and Stoel, 2013).

The estimates will be used in the construction of a new microsimulation model at CPB Netherlands Bureau for Economic Policy Analysis to study changes in taxes and transfers, along the lines of *e.g.* the MITTS model for Australia (Creedy et al., 2002) and the IZAΨMOD model for Germany (Peichl et al., 2010).

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