

Neumann, Michael; Müller, Kai-Uwe; Wrohlich, Katharina

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Is The Equal Sharing Of Market Work And Family Duties Hampered By Financial Means Or Constraints? Evidence From A Structural Labor Supply Model With Involuntary Unemployment And Hours Constraints

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Is the equal sharing of market work and family duties hampered by financial means or constraints?

Evidence from a structural labor supply model with involuntary unemployment and hours constraints

Kai-Uwe Müller, Michael Neumann*, Katharina Wrohlich

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Abstract

This paper analyzes the question why desired and actual sharing of market work and family duties among parents with young children in Germany fall apart. Potential explanations include financial incentives favoring the single-earner model, as well as constraints in choosing working hours due to lack of childcare or labor demand restrictions. In order to analyze these explanations, we extend the standard model of labor supply by different types of constraints. We estimate preferences based on desired instead of actual working hours and specify restrictions as a double hurdle model with the first stage representing the risk of involuntary unemployment. The second step pertains the probability of being constrained in specific hours categories. We apply this model to simulate a recent reform proposal that subsidizes parents who both work around 30 hours per week. We find that taking into account constraints in working hours is crucial: The pure incentive effect is almost cut by half. Our approach also allows to simulate the removal of hours constraints which almost triples the labor supply reaction. Hours constraints are thus even more important than adverse incentives in explaining the asymmetric division of work and care within families.

Keywords: Labor supply; Hours restrictions; Involuntary unemployment; Gender

JEL classification: J22; J23; J16; J64

* Corresponding author: German Institute for Economic Research Berlin (DIW Berlin), Mohrenstr. 58, D-10785 Berlin, Tel.: +49 30 89789 353, Fax: +49 30 89789 114, E-mail: mneumann@diw.de

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1 Introduction

As in many industrialized countries the reconciliation of work and family duties for parents of young children is a widely discussed topic in Germany. However, the majority of parents with young children still find it a difficult task. While 60% of all parents with young children state that they wish an equal sharing of market work and family tasks among spouses, only about 14% meet that goal.¹

Besides financial incentives imposed by the tax-transfer system in Germany like joint income taxation, this discrepancy between preferences and reality might particularly be founded in working hours constraints. For example, a lack of sufficient child care facilities could prevent parents from choosing their optimal amount of working time. Restrictions on the labor demand side might be another reason, i.e. employers offering only full-time positions rather than flexible working time arrangements.

Taking such restrictions on the labor market into account, thus, seems to be crucial when evaluating policy proposals which try to foster the reconciliation of work and family duties. However, the majority of empirical labor supply models used for policy evaluation assume the choice of working hours not to be constrained by regulations, institutions, or insufficient labor demand. Observed hours of work are directly interpreted as revealed preferences of individuals or households.

We, therefore, augment a standard discrete choice labor supply model in the tradition of van Soest (1995) by different types of constraints. The empirical framework is based on Euwals and van Soest (1999) who estimate labor supply preferences based on desired working hours as stated by the individuals in the sample. They specify restrictions on the labor market as a double hurdle model with the first stage representing the risk of being involuntarily unemployed. The second step pertains the probability of being constrained in specific hours categories which is directly identified by observed deviations of stated desired and actual hours of work. We extend this framework in several respects to fit our research questions. First, we consider the joint decisions in couple households and the restrictions for both spouses. Second, a newly available and very rich data set on families in Germany allows us to put structure into the constraints part of the model distinguishing different channels for constraints on labor market participation and working hours that are

¹Source: Own evaluation of the survey “Families in Germany”, see section 3 for more details.

related to observed variables. Third, we allow for a correlation between labor supply preferences and various constraints caused by unobserved characteristics.

We apply this empirical framework to analyze the labor supply effects of a recent policy proposal for which restrictions on the choice set are crucial. The *family working time benefit* (FWTB) is targeted at couple households and designed to improve the financial incentives for a more equal distribution of market work and family duties among spouses: conditional on both partners working around 30 hours per week (equal to 80% of a conventional full-time job) the (hypothetical) income difference to their full-time income is partially compensated. The replacement rate varies with the household income.

Explicitly modeling working hours constraints not only allows to answer the research question of how men and women in couple households would adjust their working behavior following the introduction of the FWBT, but also: How large is the pure incentive effect induced by this new benefit? By how much is this effect reduced when constraints are taken into account? Do the employment effects get significantly larger when existing restrictions on working hours are reduced or even removed by such a reform? Hence, we provide insights about the relative importance of financial incentives and constraints on the labor market in explaining the discrepancy between preferences and reality when it comes to an equal sharing of market work and family duties. Thereby, we are also able to analyze the value added of incorporating working hours constraints into structural labor supply models when evaluating policies which change the budget set in a non-linear way. This paper, thus, contributes to the empirical literature on labor supply elasticities in the presence of institutional or labor demand constraints.

The problem of hours restrictions has been acknowledged already by Moffitt (1982) who extends a Tobit model to account for institutional restrictions on part time work. Van Soest et al. (1990) augment a Hausman (1980) type labor supply model with piecewise linear convex budget constraints to model hours restrictions. Tummers and Woittiez (1991) utilize a similar model and also make the wage rate dependent on the number of working hours. Bloemen (2000) relates the labor supply model to the job search literature and considers different specifications for the job offer distribution that put constraints on the labor supply decision. Jobs are characterized by a combination of a wage and a number of weekly working hours.

Our most important finding is that modeling constraints in working hours is crucial when evaluating a reform like the FWTB. The behavioral reaction to the pure incentive effect is almost cut by half if hours constraints are taken into account. We also show that the standard labor supply based on actual hours gives an upward biased labor supply reaction. Moreover, our approach allows us to additionally simulate the removal of hours constraints, which could for example be interpreted as the introduction of a strictly enforced legal entitlement to work 30 hours for all employees. In this case, the labor supply reaction almost triples compared to the pure effect of financial incentives. We therefore conclude that hours constraints play a very important role in explaining why parents are not able to realize their desired sharing of market work and family duties.

The remainder of the paper is in five parts. We outline the potential consequences of the FWTB reform for the incentives to work and the restrictions on working in a extended part time jobs in section 2. Section 3 describes our data set and presents some descriptive findings on the discrepancy of desired and actual working hours for couples in our sample. We discuss the econometric model in section 4. Empirical results are presented in section 5. The final section discusses the findings and concludes.

2 Design of the FWTB

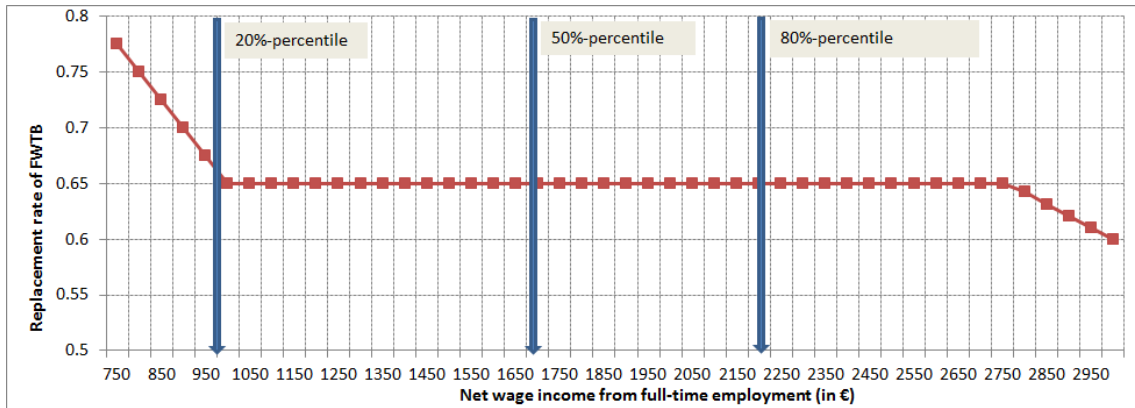
The German tax and transfer system provides strong incentives for an uneven share of market work and family duties between mothers and fathers, in particular through joint taxation of married spouses and free health insurance for non-working spouses. The mothers employment rate and average working hours for those employed are significantly lower compared to fathers (see section 3 for details). The basic idea of the *family working time benefit* (FWTB) is to improve the incentives for a more equal distribution of employment within families and to increase the amount of mothers working with jobs in the vicinity of a ‘regular’ full-time contract. The subsidy targets families with children aged at least 15 and at most 48 months. It is thus tied in with the parental leave scheme that covers the first 14 months after birth.

The FWBT applies only to couples choosing a 2*0.8-earner model where *both*

spouses work in a part-time position with about 30 hours per week (about 80% of a regular full-time job). It does, e.g., not suffice that only the father reduces his working time. We subsume all individuals observed to work between 25 and 35 hours per week in this ‘extended part-time’ category. The difference in net incomes in comparison to two full-time net earnings is then partially compensated by the FWBT.

The individual amount of the benefit depends on the income difference between full-time work and extended part-time work as well as the replacement rate. In this paper we analyze a version of the FWTB where the replacement rate follows the regulation of the German parental leave scheme.² The replacement rate for net earnings of at least 1,000 € is 65%. It increases for every unit of declining net income at a rate of 0.05 percentage points below this threshold reaching 100% at 300 €. The replacement rate remains constant for incomes above the 1,000 € threshold, but is capped at a maximum amount of 360 € per individual (Figure 1).

Figure 1: Replacement rate for different net incomes



Source: Own calculations.

By conditioning the FWTB on working hours of both partners, it explicitly aims at fostering an equal sharing of work and family duties between mothers and fathers. However, it has been argued in the public debate, that financial incentives will not suffice to make more families choose the 2*0.8-earner model but that constraints on the labor market are equally important. It has thus been discussed to simultaneously introduce a legal claim for part-time work of 30 hours for employees. We will address both issues in section 5.

²See Müller et al. (2013) for alternative models of the FWBT.

3 Data and descriptive results

The empirical analysis is based on the survey “Families in Germany” (FiD, see Schröder et al., 2009). The FiD is a newly available special add-on of the German Socio-Economic Panel (SOEP), a representative survey of German households conducted since 1984 (Wagner et al., 2007). The FiD has a particular focus on families with children born between 2007 and 2010, low income households, families with three or more children, and on lone parents. In total about 4,500 households are surveyed per wave that include about 8,000 children. Like the SOEP the FiD contains information on different sources of income, working time, the previous labor market experience as well as detailed socio-demographic characteristics of the individual and the household. We exploit the first two waves available, which are from the years 2010 and 2011.

In comparison to other household data sets (including the SOEP), the FiD provides more detailed information on potential restrictions for the labor supply decision (e.g. due to the lack of adequate childcare institutions) and – related to that – the discrepancy of desired and actual working hours. As described above, we start from the observation that conditional on participating in the labor market a sizeable proportion of the workforce is restricted from choosing their preferred hours of work. We use the information about those constraints in our data set to estimate rationing probabilities for different hours categories.

FiD respondents are not only asked about their (effective) actual working time, but also whether they are satisfied with these hours worked. The exact wording is: “If you could choose your own number of working hours, taking into account that your income would change according to the number of hours: Would you prefer to decrease, increase or maintain your number of working hours?”. If they prefer a change, they will be asked for their desired working hours.³ There are two possible interpretations to this question (Callan et al., 2007): Respondents might choose their desired hours of work conditional on their partners’ actual working hours (constrained optimization). We deviate from this view and assume here that both

³For non-employed individuals the question on their desired hours of work differentiates only between non-work, part-time and full-time. According to their preferences we assign them randomly a specific hours category, e.g. different lengths of part-time, with the probability weights given by the observed shares for employed people.

spouses can freely choose their desired labor supply (unconstrained optimization of family utility).

The distribution of desired and actual hours for men and women in our sample are cross-tabulated in Table 1. For men the by far most desired hours categories are full-time and overtime. Most of these men actually seem to be able to work their desired amount of hours. This changes significantly for men who desire to work 25 to 35 hours whereof almost 60% are restricted in the sense that desired and actual hours deviate. Virtually all of them are over-employed. Men do generally not desire to or actually work in the lower two hours categories. Approximately 11% of the male sample does not work, less than half of them voluntarily.

Table 1: Joint frequency distribution of desired and actual hours of work

Desired \ Actual							Total
	0	1-14	15-24	25-35	36-40	>40	
Men							
0	105	0	0	1	0	0	106
1-14	5	7	1	1	0	2	16
15-24	1	0	10	1	1	4	17
25-35	5	4	3	104	76	55	247
36-40	65	10	12	36	672	116	911
>40	49	1	2	5	55	648	760
Total	230	22	28	148	804	825	2057
Women							
0	1022	0	0	0	0	0	1022
1-14	62	207	8	2	1	0	280
15-24	7	60	228	18	6	1	320
25-35	24	19	48	166	18	8	283
36-40	15	11	13	9	69	5	122
>40	2	0	3	0	2	23	30
Total	1132	297	300	195	96	37	2057

Notes: Desired hours of involuntary unemployed discriminate only between part-time, full-time and *both*. Finer categories are allocated randomly and proportionally by considering the crude information.

Source: Own calculations based on FiD, waves 2010 and 2011.

For women, by contrast, non-participation is the dominating alternative. More than half of the female sample does not work whereof only 10% is involuntarily unemployed. The great majority of employed women actually works and desires to work in one of the three part-time categories. While marginal and overtime employment does not seem to be very constraint, the restriction probability of the other categories vary between 27 % for small part-time and 38 % for full-time employment. For women, under-employment seems to be more relevant than over-employment.

The labor demand variables measured at the regional level are taken from a data set collected and edited jointly by the German Statistical Office with the Federal Institute for Research on Building, Urban Affairs and Spatial Development within the

Federal Office for Building and Regional Planning. The “Indicators and Maps on the Spatial Development” (“Indikatoren und Karten zur Raumentwicklung”, INKAR, see Helmcke, 2008) includes indicators at different regional levels for Germany. We use the data at the NUTS 2 level according to the Nomenclature of territorial units for statistics (NUTS, see European Commission, 2003). These are administrative districts at which regional policies are planned and implemented in Germany. The INKAR database can be matched based on regional identifiers in the FiD.

Since we are interested in the effects of a potential FWTB reform, our sample is restricted to couple households only. Moreover, we exclude observations with negative net income, couples with more than three children as well as couples where at least one spouse has reached the legal retirement age of 65. Further, we only consider couples where both spouses are ‘flexible’ with respect to their labor supply, i.e. are neither in full-time education, on maternity leave, fully disabled, nor retired. The descriptive statistics are given in Table 5 in the Appendix.

4 Econometric model

The econometric model is based on Euwals and van Soest (1999) and consists of several elements. First, *labor supply preferences* of both spouses are modeled within a standard discrete-choice decision model (van Soest, 1995; Aaberge et al., 1995), albeit on the basis of the stated desired, rather than actual working hours (van Soest et al., 2002; van Soest and Das, 2001). We assume that couples jointly maximize a unitary utility function with disposable income and leisure time for both spouses attached to a specific decision category. Desired hours are thereby not affected by actual hours and potential restrictions. By this assumption the unconstrained optimization of family utility results in a pure labor supply model.

Second, *constraints on the labor market* are considered in terms of labor demand rationing (Laroque and Salanié, 2002; Bargain et al., 2010) as well as restrictions on the preferred working hours conditional on participation (Euwals and van Soest, 1999). Individuals might want to work, but could be involuntarily unemployed. In addition, employed persons could still be restricted from working their desired number of hours. The latter constraints might be attributed to inflexible employers or to restrictions on the employees’ side (e.g. insufficient supply of (public) childcare).

Based on information about desired and actual working hours in the data and additional assumptions on constraints, we are able to estimate these different rationing probabilities. As the spouse’s restrictions have no direct effect on a person’s constraints, they are identified for each individual. Constraints can, though, be related through shared household characteristics and context conditions. We discuss preferences in sub-section 4.1, constraints in sub-section 4.2, and how both elements are related as well as identification issues in sub-section 4.3.

4.1 Preferences for work

A family chooses a labor supply arrangement by maximizing the direct utility function $U(\cdot)$ in the arguments net income y and leisure (or home production) l^m, l^f for men and women, respectively.⁴ Leisure time is defined as the difference of total time endowment $TE = 80$ and hours of work h^m or h^f . As explained above, we rely on the information about desired working hours for the identification of labor supply preferences. Desired hours are taken as revealed preferences as has been done before, e.g. by Euwals and van Soest (1999), van Soest et al. (2002), van Soest and Das (2001), or Callan et al. (2007). Consistent with the unitary labor supply model we assume that preferred hours are stated under the condition that both spouses choose freely without facing any restrictions. Labor supply preferences can therefore be inferred directly from desired working hours as stated in our data.⁵

Disposable income $y = y(h^m, h^f, w^m, w^f, y^{nl}, X^m, X^f, X)$ depends on both spouses’ labor supply, their before tax wage rates, non-labor income y^{nl} of the household as well as on individual or family characteristics (X^m, X^f, X) which determine taxes, contributions and transfers. We use a microsimulation model (Steiner et al., 2012) to compute y for all possible labor supply choices of each household. Wage rates w are derived from reported gross monthly wage earnings and observed working hours for the employed. Wages of non-employed persons are predicted on the basis of parameters from wage equations⁶ and then inserted into the labor supply model. Hourly wages are assumed to be constant for different hours categories throughout

⁴We omit individual and family subscripts in this exposition for reasons of simplification.

⁵This allows to disentangle hours restrictions from preferences in the following sub-section. An alternative interpretation would be that the question about the desired working hours is answered by individuals given the constraints their spouse faces. Then a deviation between desired and actual hours might be a mixture of restrictions and optimisation.

⁶These are estimated separately for men and women as well as East and West Germany.

this analysis. The wage equations control for selectivity as proposed by Heckman (1979) and are estimated independently from the labor supply model.

Following van Soest (1995) and Aaberge et al. (1995) we assume that couples choose out of a finite number of mutually exclusive alternatives comprising all possible combinations of hours categories for each spouse. A family's choice set CS contains $J = P \times R$ elements consisting of all pairwise combinations of the man's P and the woman's R hours categories. Alternative j corresponds to the combination of the hours category of the man, h_j^m , and women, h_j^f , and the resulting family net income y_j and can be written as (y_j, l_j^m, l_j^f) . Hours categories for both spouses include non-employment, marginal employment (10 hours), part-time (20 hours), reduced full-time (30 hours), full-time (40 hours) and overtime (45 hours). The unrestricted choice set thus consists of $J = 5 \times 5 = 25$ alternatives.

We use a linear-quadratic specification of the utility function:

$$U(v) = v'Av + b'v \quad (1)$$

with $v = (y, l^m, l^f)'$. A is a matrix and b a vector of parameters to estimate. The second (third) element of b allows for variation of preferences through observed characteristics of both spouses and the household ($b_l = x_l'\beta_l$ for $l=2,3$). Adding alternative-specific error-terms ϵ_j leads to the following utility specification:

$$u(v_j) = U(v_j) + \epsilon_j \quad (2)$$

Assuming ϵ_j to be iid type I extreme-value results in a closed form solution of the choice probabilities for alternative j :

$$P(j) = \frac{\exp\{U(v_j)\}}{\sum_r \exp\{U(v_r)\}} \quad (3)$$

Equation (3) implies the independence of irrelevant alternatives (McFadden, 1974). While this assumption is controversially discussed in the literature (see for example Train, 2009), Haan (2005) found that it represents a justifiable abstraction for empirical labor supply analyses with German data. Gross wage elasticities of labor supply and labor supply reactions to policy reforms that are implied by the structural parameters can be simulated.

In the standard labor supply model without constraints preferences are assumed

to be in line with the actual labor supply responses. Observed working hours are taken as revealed preferences that are not subject to restrictions. Changes in labor supply are interpreted in terms of employment effects as demand is assumed to be perfectly elastic. For the model with demand side and hours constraints this does not hold. The specification for the rationing probabilities is discussed in the following sub-section.

4.2 Demand side rationing and hours constraints

Similar to Euwals and van Soest (1999) we distinguish two basic mechanisms that constitute restrictions on the labor market. First, individuals might be *rationed by insufficient labor demand* as they are not productive enough to fill available vacancies (structural unemployment), they do not find a suitable match in a given time period (frictional unemployment), or there are temporary demand shortages (cyclical unemployment). A certain share of people looking for work is thus observed to be non-employed. Second, conditional on having access to the labor market the preferred employment relationship might not be available. Such *hours constraints* could arise from labor demand frictions in certain market segments. Firms might, e.g., only offer standardized jobs and not allow reduced working hours. On the other hand, constraints for specific employment categories also exist on the supply side. When families with little children do not have access to affordable formal childcare (rationing on the childcare market), particularly mothers might not be able to work their desired hours.

We analyze couple households in this paper; rationing has thus to be taken into account for each spouse. Demand side restrictions cannot be treated structurally, since we do not directly observe labor demand in our data. Nevertheless, exploiting information on desired and actual working hours, the individuals' willingness to work and job search activities, the availability of different forms of childcare, as well as proxy variables for the tightness of the regional labor market and variation of hours restrictions across sectors or occupations, we are able to disentangle labor demand rationing and different hours constraints. The probability that a given combination of hours categories j is part of the choice set given the restrictions, RCS , means that working hours h_j^f and h_j^m can potentially be chosen by the woman and the man

respectively:

$$\begin{aligned}
P(j \in RCS) &= P(h_j^f \in RCS, h_j^m \in RCS) \\
&= P(h_j^f \in RCS)P(h_j^m \in RCS) \\
&= \Psi_{emp}^f \Psi(h_j^f) \Psi_{emp}^m \Psi(h_j^m)
\end{aligned} \tag{4}$$

Similar to the double hurdle model of Blundell et al. (1987) it depends, first, on the likelihood that both spouses find a job ($\Psi_{emp}^f \Psi_{emp}^m$). Second, those jobs have to provide the opportunity to work an individuals' desired working hours and both spouses must have the capacity to work in this amount in spite of potential family duties ($\Psi(h_j^f) \Psi(h_j^m)$). Note that the multiplicative specification implies the independence of the restriction probabilities between the spouses and the rationing components (conditional on shared observed characteristics). We come back to the relations between the components, but for the moment discuss these factors one by one.

The employment probability Ψ_{emp} is operationalized in the following way. All people that are observed to work positive hours are considered employed ($emp = 1$). Individuals that state to actively search for a job and being available to the labor market, but are observed to work zero hours are regarded as involuntarily unemployed ($emp = 0$). Voluntarily inactive persons do not contribute to the identification. We assume that this latent probability depends on observed characteristics X_{emp} representing an individual's productivity (e.g. education, occupational qualification, previous labor market experience) as well as indicators for the performance of the regional labor market (e.g. unemployment rate, GDP per capita):

$$P^*(emp = 1) = \Psi_{emp} = X'_{emp} \beta_{emp} + e_{emp} \tag{5}$$

where e_{emp} is an error term. We estimate this equation on a pooled data set for men and women.

Whether an individual – conditional on being employed – is able to choose a given hours category, or whether this choice is restricted cannot be directly observed. Under certain assumptions the composition of the restricted choice set RCS (which is a sub-set of CS) can be inferred from the stated hours preference (h^d) and the observed actual working hours (h^a) of both spouses as the mapping from h^d to h^a is determined by the hours restrictions. For $h^d = h^a$, we know that h^a is part of RCS

and the individual only contributes to the identification of $P(h^a \in RCS)$. Similar to the employment probability voluntarily inactive people $h^d = h^a = 0$ do not contribute to the identification of hours constraints; we do not have any information on their potential hours restrictions.

When actual and desired hours deviate it is unclear which other choices are potentially available. Therefore additional assumptions have to be made in order to make the problem tractable. Take the example that an individual with $CS = \{0, 10, 20, 30, 40\}$ desires to work 20 hours, but actually works 40 hours per week. It is immediately obvious that the part-time category (20 hours) is not in RCS , but the full-time category is. Would the individual also prefer marginal employment (10 hours) or reduced full-time (30 hours) to the 40 hours? The labor supply equation (3) ranks the alternatives according to the related utilities. Therefore one can write down the probability that h_k^a is chosen conditional on these utilities:

$$P(h_k^a | u_0, u_1, \dots, u_J) = P(h_k^a \in RCS \text{ and } h_j \notin RCS \forall j \text{ with } u_j > u_k) \quad (6)$$

Since the u_j 's are unobserved, the related error terms ϵ_j would have to be integrated out conditional on h^d . In order to bypass this computational complexity we apply the approach by Euwals and van Soest (1999) assuming that utility decreases with the absolute distance between actual and desired hours⁷. In our example the choice set of an individual who desires to work 20, but actually works 40 hours is given by $RCS = \{0, 40\}$. As the 10 and 30 hours categories are closer to the desired 20 hours than to the actual 40 hours, these choices are apparently not available. The likelihood contribution of this individual is then:

$$P(h^a = 40 | h^d = 20) = P(\{10, 20, 30\} \notin RCS, 40 \in RCS) \quad (7)$$

There are also constellations with two equally distant alternatives. An example would be a situation when the individual prefers to work 30 hours, but is observed to work full-time. It is not clear whether the individual prefers to work 20 or 40 hours; the distances to the desired 30 hours are identical. We thus assume that 20 and 40 hours are preferred with probability 0.5. Hence, with a probability of 0.5 40

⁷This contrasts with the IIA assumption of the labor supply estimation. In future versions of this paper, however, we will relax the IIA by introducing a more complex error structure (see also section 4.3).

hours is chosen although 20 would be preferred as it is not available and with the same probability 40 hours is chosen because it is preferred to 20 hours. Whether 10 hours is an available alternative is unknown because 40 hours is preferred to 10 hours:

$$\begin{aligned}
 P(h^a = 40|h^d = 30) &= 0.5P(\{20, 30\} \notin RCS, 40 \in RCS) + \\
 &0.5P(30 \notin RCS, \{20, 40\} \in RCS)
 \end{aligned} \tag{8}$$

Hours constraints are allowed to vary with observed characteristics. With respect to labor demand, restrictions are assumed not to be uniformly distributed over different sectors. For certain sectors or types of jobs a full-time contract is the norm, whereas other areas feature more non-standard employment relationships. Therefore the demand for full-time and different types of part-time jobs varies across different sectors of the labor market. We use occupational information to approximate this variation. Hours constraints might, on the other hand, also arise on the supply side of the market when, e.g., individuals are not capable of working the desired number of hours: Parents with small children that do not have access to public childcare (are rationed on the childcare market) face this type of constraints. Therefore we model the latent risk of being hours constrained as follows:

$$P^*(f_j^a) = \Psi(h_j) = X_{h_j}'\beta_{h_j} + e_{h_j} \tag{9}$$

X_{h_j} represents the explanatory variables for the hours constraints and e_{h_j} an error term. We identify a rationing probability separately for each positive hours category h_j .

Assuming the error terms for all latent constraint equations to follow a logistic distribution, we get the following specification for the Ψ 's:

$$\Psi = \frac{\exp(X'\beta)}{1 + \exp(X'\beta)} \tag{10}$$

Putting together the different components we can write the combination of preferred and actual working hours in terms of the employment and hours constraint probabilities. Using the illustration from above, the probability that the male spouse desires to work 40 hours and is also observed to have a job in this category and that the female spouse prefers 20 hours, but is actually working in the 40 hours category

can be expressed as:

$$\begin{aligned}
& P\left(h_j^{a_m} = 40, h_j^{a_f} = 40 | h_j^{d_m} = 40, h_j^{d_f} = 20\right) \\
&= P\left(h_j^{a_m} = 40 | h_j^{d_m} = 40\right) P\left(h_j^{a_f} = 40 | h_j^{d_f} = 20\right) \\
&= P(emp^m = 1) P(40 \in RCS^m) P(emp^f = 1) P(\{10, 20, 30\} \notin RCS^f, 40 \in RCS^f) \\
&= \Psi_{emp}^m \Psi^m(h_j = 40) \Psi_{emp}^f (1 - \Psi^f(h_j = 10))(1 - \Psi^f(h_j = 20))(1 - \Psi^f(h_j = 30)) \Psi^f(h_j = 40)
\end{aligned} \tag{11}$$

This defines the likelihood contribution of a household with a particular combination of desired and observed working hours. The simple multiplicative specification of the conditional probability implies that the different processes are independent conditional on the observed covariates. The constraint probabilities of both spouses are related through shared household characteristics (e.g. living in the same labor market context and facing identical institutional restrictions, e.g., for public childcare) and similar attributes (e.g. level of schooling and qualification or labor market experience). The effect of observables on the probability to have access to the labor market Ψ_{emp} is assumed to be constant for all hours categories and shifts the probability to be able to work a certain amount of hours downward equally for all potential choices. In contrast covariates are allowed to affect the various hours categories differently.

According to the conditional independence, the error terms of the different equations which represent preferences and different constraints are not correlated. Unobserved factors, e.g. personal traits or context conditions that could affect preferences as well as constraints, are ruled out by assumption. The different equations can thus be estimated separately and the expected probability to be observed in a certain hours category can be computed based on the expectations of these single equations. The choice probabilities are scaled down by positive probabilities of involuntary unemployment and hours constraints. In order to shift the differences between the pure and adjusted choice probabilities to other categories, the substitution pattern is modeled such that it respects the IIA assumption of the labor supply estimation (see the Appendix for details). We will relax this restrictive assumption and present a more general specification in the following sub-section.

4.3 Unobserved heterogeneity and joint estimation

In theory unobserved factors could influence preferences and different types of constraints in various ways. Unobservables might be pictured as individual traits or

shared influences of the social or regional environment. Individuals with certain characteristics that are, e.g., more motivated or equipped with certain non-formal skills could have a lower risk of involuntary unemployment because those unobserved traits increase their (perceived) productivity. Similarly, unobserved context conditions like the peoples' social environment or regionally varying cultural norms will affect their labor supply preferences through peer effects or an altered information set. The same factors will, on the other hand, have an effect on the likelihood to be demand or hours constrained because an individual's search intensity and efficiency are likewise affected by them.

As a consequence the structural parameters of the labor supply and rationing equations will be biased when those unobservables are correlated with the covariates in those equations and this correlation pattern is neglected if it is not accounted for unobserved heterogeneity. In addition to the potential omitted variable bias, we are faced with a selection problem for the identification of hours constraints. According to our specification hours constraints are defined conditional on having access to the labor market. The hours restrictions are thus identified based on a group of individuals that is not representative for the whole population – similar to the standard selection problem in the labor supply literature. The selectivity issue is even more severe as the observability of the restriction status with respect to the different hours categories directly depends on the individual's preferences. Put differently, people preferring to work full-time and who run the risk to be constrained there might have different unobserved characteristics than individuals who desire a part-time job, but cannot find one.

Therefore we augment the specification of the random utility function for the labor supply choice (2) by including unobserved characteristics and do the same for the probability of being employed (5) as well as the probabilities of not being hours-constrained in different categories (10):

$$u(v_j) = U(v_j) + \kappa_j^m + \kappa_j^f + \epsilon_j \quad (12)$$

$$\Psi_{emp} = X'_{emp}\beta_{emp} + \lambda + e_{emp} \quad (13)$$

$$\Psi(h_j) = X'_{h_j}\beta_{h_j} + \mu_{h_j} + e_{h_j} \quad (14)$$

The unobserved components of those different processes $\kappa_j^m, \kappa_j^f, \lambda^m, \lambda^f, \mu_{h_j}^m, \mu_{h_j}^f$

are allowed to be correlated. In order to identify the correlation structure, the likelihood contributions from the labor supply equation and the different rationing probabilities of the spouses are maximized jointly. One can write down the probability for each household i to be observed with a given combination of working hours j in terms of labor supply preferences and rationing probabilities conditional on unobserved characteristics. When both spouses are voluntarily inactive ($j = 0$) it amounts to:

$$P_i \left(h_{ij}^{a_m} = h_{ij}^{d_m} = 0, h_{ij}^{a_f} = h_{ij}^{d_f} = 0 \mid \kappa_{ij}^m, \kappa_{ij}^f, \lambda_i^m, \lambda_i^f, \mu_{h_{ij}}^m, \mu_{h_{ij}}^f \right) = \frac{\exp\{U(v_{i0}) + \kappa_{i0}^m + \kappa_{i0}^f\}}{\sum_r \exp\{U(v_{ir}) + \kappa_{ir}^m + \kappa_{ir}^f\}} \quad (15)$$

Since we do not have any information on their restriction probabilities these households only contribute to the identification of labor supply preferences. Taking the other example from above where the male spouse desires to work 40 hours and is also observed to have a job in this category with the female spouse preferring 20 hours, but being observed to work 40 hours, a household's probability to be in this particular state conditional on unobservables becomes:

$$P_i \left(h_{ij}^{a_m} = h_{ij}^{d_m} = 40, h_{ij}^{a_f} = 40, h_{ij}^{d_f} = 20 \mid \kappa_{ij}^m, \kappa_{ij}^f, \lambda_i^m, \lambda_i^f, \mu_{h_{ij}}^m, \mu_{h_{ij}}^f \right) = \frac{\exp\{U(v_{ij}) + \kappa_{ij}^m + \kappa_{ij}^f\}}{\sum_r \exp\{U(v_{ir}) + \kappa_{ir}^m + \kappa_{ir}^f\}} \frac{\exp(X_{emp_i}^m \beta_{emp} + \lambda_i^m)}{1 + \exp(X_{emp_i}^m \beta_{emp} + \lambda_i^m)} \frac{\exp(X_{h_{ij}=40}^m \beta_{h_j=40} + \mu_{h_{ij}=40}^m)}{1 + \exp(X_{h_{ij}=40}^m \beta_{h_j=40} + \mu_{h_{ij}=40}^m)} \times \frac{\exp(X_{emp_i}^f \beta_{emp} + \lambda_i^f)}{1 + \exp(X_{emp_i}^f \beta_{emp} + \lambda_i^f)} \left(1 - \frac{\exp(X_{h_{ij}=10}^f \beta_{h_j=10} + \mu_{h_{ij}=10}^f)}{1 + \exp(X_{h_{ij}=10}^f \beta_{h_j=10} + \mu_{h_{ij}=10}^f)} \right) \times \left(1 - \frac{\exp(X_{h_{ij}=20}^f \beta_{h_j=20} + \mu_{h_{ij}=20}^f)}{1 + \exp(X_{h_{ij}=20}^f \beta_{h_j=20} + \mu_{h_{ij}=20}^f)} \right) \left(1 - \frac{\exp(X_{h_{ij}=30}^f \beta_{h_j=30} + \mu_{h_{ij}=30}^f)}{1 + \exp(X_{h_{ij}=30}^f \beta_{h_j=30} + \mu_{h_{ij}=30}^f)} \right) \times \frac{\exp(X_{h_{ij}=40}^f \beta_{h_j=40} + \mu_{h_{ij}=40}^f)}{1 + \exp(X_{h_{ij}=40}^f \beta_{h_j=40} + \mu_{h_{ij}=40}^f)} \quad (16)$$

The individual likelihood contribution of a household can be written as:

$$L_i \mid \kappa_j^m, \kappa_j^f, \lambda^m, \lambda^f, \mu_{h_j}^m, \mu_{h_j}^f = \prod_{j=0}^J P_i \left(h_{ij}^{a_m}, h_{ij}^{a_f}, h_{ij}^{d_m}, h_{ij}^{d_f} \mid \kappa_{ij}^m, \kappa_{ij}^f, \lambda_i^m, \lambda_i^f, \mu_{h_{ij}}^m, \mu_{h_{ij}}^f \right)^{d_{ij}} \quad (17)$$

where d_{ij} is an indicator that is equal to one for the observed combination of actual and desired hours of both spouses in the household and zero otherwise. The sample likelihood is then given by:

$$L = \prod_{i=0}^N \int \int \int f(\kappa) f(\lambda) f(\mu) L_i \quad (18)$$

The distribution of the unobserved components can be integrated out from the likelihood, e.g. by simulation techniques. The model is then estimated by maximum simulated likelihood. We will assume a discrete distribution of the unobserved components (Haan and Uhlenhorff, 2013). Identification will be enhanced by exploiting

the longitudinal dimension of the FiD data for three consecutive years. Results for the model estimates as well as simulated elasticities and reform effects from the augmented specification with unobserved characteristics will be available in the next version of the paper.

5 Empirical findings

First, we discuss the parameter estimates and the in-sample fit of our structural model with respect to the observed distribution of actual hours of work (sub-section 5.1). Second, we present numerically calculated labor supply elasticities (sub-section 5.2). Third, we discuss the results of a policy simulation that analyzes the consequences of introducing the FWTB for labor supply and employment (sub-section 5.3). Throughout this section the labor supply model with demand side and hours constraints is systematically compared with a conventional labor supply model without constraints based on actual hours of work that serves as a benchmark.

5.1 Parameter estimates and model fit

The parameter estimates of the labor supply equation cannot be directly interpreted because of the non-linearities in the model. Nevertheless, it is instructive to compare the effect of the covariates on household utility between the estimates based on the actual and desired hours (Table 6 in the Appendix). Although the patterns of significant coefficients are qualitatively similar, there are marked quantitative differences implying discrepancies in the related elasticities (see sub-section 5.2 below). The derivatives of the utility function with respect to consumption indicate whether the model estimates are consistent with implications of economic theory. The first derivatives with respect to consumption are mostly positive implying it is a normal goods for the great majority of the sample (see bottom of Table 6 in the Appendix).

The probability of being demand side constrained depends non-linearly on the individual's age, qualification and nationality (Table 7 in the Appendix). As expected the loss of human capital due to previous unemployment experience increases the rationing probability. Living in a tight labor market as approximated by the regional unemployment rate is also significantly related to a higher risk of involuntary unemployment. The equations that describe the probability to be hours-

constrained in the various categories reveal only few significant influences (Table 8 in the Appendix). There are gender-specific differences reflecting observed employment patterns: women have a significantly lower probability to be constrained in the part-time categories. On the other hand, they face a significantly higher restriction probability in full-time jobs. There is little occupation-specific heterogeneity in hours constraints.

How do the models perform in terms of fitting the observed distribution of working hours for men and women? Table 2 reports the distribution of observed hours (first column) as well as the expected probabilities predicted by a standard labor supply model without constraints (second column) and the model with demand side and hours restrictions (third column). Overall both models fit the data reasonably well. The labor supply model with constraints improves the fit for most hours categories. This is particularly true for non-employment: for men and women the constrained model is able to almost exactly reproduce the share of people with zero hours. The fact that the unrestricted model fails to replicate this share may be seen as evidence that involuntary unemployment cannot be neglected in models for the German labor market.

Table 2: Model predictions

Hours of work	Observed	Unconstrained	Constrained	Observed	Unconstrained	Constrained
	Men			Women		
0	0.096	0.051	0.099	0.531	0.461	0.522
1-14	0.012	0.051	0.022	0.130	0.253	0.231
15-24	0.016	0.057	0.022	0.146	0.126	0.110
25-35	0.070	0.097	0.089	0.115	0.071	0.057
36-40	0.404	0.248	0.279	0.057	0.047	0.031
>40	0.402	0.497	0.479	0.021	0.042	0.037

Notes: Observed=Observed actual hours, Unconstr.=Discrete choice model based on actual hours, Constr.=Unconstrained model based on desired hours of work augmented by involuntary unemployment and hours constraints.

Source: Own calculations based on INKAR, waves 2010 & 2011 and FiD, waves 2010 & 2011.

The part-time categories are overpredicted with both specifications. The augmented model with restrictions performs better for men and also shows a slight improvement for the women’s marginal employment category where the discrepancy between observed and predicted shares is largest. The unconstrained model has a slight edge in two remaining part-time categories for women. A potential reason could be unobserved fixed costs of working (Euwals and van Soest, 1999) that are not explicitly dealt with in the current specifications. Adding unobserved heterogeneity (see sub-section 4.3 above) might help to capture this pattern.

While both models fit the overall share of full-time and overtime hours well, they fail in discriminating between those two categories. The model with hours constraints is not able to significantly improve the fit in this part of the distribution. Altogether, however, the model with hours constraints improves the fit of observed distribution of actual working hours.

5.2 Elasticities

Wage elasticities with respect to hours worked and participation have to be calculated numerically. First, the probabilities for choosing the different hours categories are calculated based on the estimated structural parameters as well as the status quo disposable incomes. Then, gross wage rates are increased by one percent for one spouse at a time and disposable incomes are re-simulated. The wage elasticities can be inferred by the difference between the probabilities for the different hours categories based on the counterfactual and the status quo disposable incomes. We consider changes in expected participation rates in percentage points and in expected working hours in percent separately for women and men (Table 3).

Table 3: Labor supply elasticities

	Men		Women	
<i>Percentage point change participation rate</i>				
Unconstrained - actual hours	0.04	[0.03,0.05]	0.10	[0.08,0.11]
Unconstrained - desired hours	0.01	[0.00,0.01]	0.07	[0.04,0.09]
<i>Percent change hours</i>				
Unconstrained - actual hours	0.10	[0.06,0.13]	0.38	[0.30,0.46]
Unconstrained - desired hours	0.02	[-0.01,0.04]	0.26	[0.17,0.34]

Notes: Unconstrained - actual hours=Discrete choice model based on actual hours, Unconstrained desired hours=Discrete choice model based on desired hours, bootstrapped 95%-confidence bands in parentheses.

Source: Own calculations based on FiD, waves 2010 and 2011.

The first rows in each panel contain the elasticities from the conventional labor supply model (based on actual working hours). The second rows of each panel in Table 3 refer to the pure labor supply elasticities based on the preferences part of the constrained labor supply model as described in sub-section 4.1 above. It exploits desired instead of actual hours of work as revealed preferences. Note that restrictions are not relevant for these pure labor supply elasticities.

The elasticity pattern from the standard labor supply model confirms previous findings for Germany (see for example Steiner and Wrohlich (2008) and Dearing et al. (2007)). The hours elasticities for women (about 0.4) are markedly higher

compared to men (0.1). Participation elasticities are very small in this group. The hours elasticities from the estimates based on desired hours are clearly smaller; for women they shrink to about 0.25 and for men to 0.02. The participation elasticities are also reduced. This indicates an upward bias in the unconstrained labor supply model that is estimated with actual working hours as has been found by Bargain et al. (2010) or Haan and Uhlenдорff (2013).

5.3 Policy simulations

Based on the estimated parameters of the structural model, this section performs an ex-ante evaluation of the introduction of the family working time benefit (FWTB) which aims to improve the financial incentives for a more equal distribution of employment and family duties among spouses with children aged between one and three years. Conditional on both partners working between 25 and 35 hours a week (*extended part-time*) the income difference to their hypothetical full-time income is partially compensated (see section 2 above).

Analogous to the labor supply elasticities, the reform effects are inferred numerically by computing the difference between status quo probabilities for different hours categories and probabilities based on counterfactual incomes after the FWTB is introduced. We report the employment effects in terms of the change in the probability of working *extended part-time*, the change of the overall participation rate as well as the change in absolute working hours (Table 4). All those results refer to the targeted group of families with children aged between one and three years.

The model with constraints predicts a statistically significant increase of the probability that both spouses choose *extended part-time* (and are, therefore, eligible for FWTB) by 0.31 pp. These effects are driven by a slight reduction of working hours for employed men (0.12%) and an, on the other hand expansion of female employment. For women the probability of being employed increases by 0.10 pp. while the absolute amount of working hours increases by 0.46%. Although the overall effect is rather small, this suggests that FWTB has the potential to reach its intended goal of a more equal distribution of employment and family duties.

The conventional unconstrained labor supply model predicts an increase of the probability that both spouses choose *extended part-time* of 0.43 pp.; relying on this model based on actual hours of work as revealed preferences would clearly overstate

Table 4: Employment effects: Family Working Time Benefit

	Men		Women	
<i>Percentage point change reduced full-time</i>				
Unconstrained	0.43	[0.27,0.58]	0.43	[0.27,0.58]
Constrained	0.31	[0.17,0.45]	0.31	[0.17,0.45]
Incentive effect	0.68	[0.40,0.97]	0.68	[0.40,0.97]
Entitlement 30 hours	1.69	[1.26,2.12]	1.69	[1.26,2.12]
<i>Percentage point change participation rate</i>				
Unconstrained	0.02	[0.01, 0.02]	0.15	[0.10,0.20]
Constrained	-0.01	[-0.02,-0.01]	0.10	[0.06,0.14]
Incentive effect	0.01	[0.00, 0.01]	0.22	[0.13,0.30]
Entitlement 30 hours	0.07	[0.06, 0.09]	0.68	[0.53,0.82]
<i>Percent change hours</i>				
Unconstrained	-0.08	[-0.12,-0.05]	0.60	[0.40,0.79]
Constrained	-0.12	[-0.16,-0.07]	0.46	[0.26,0.65]
Incentive effect	-0.15	[-0.21,-0.09]	0.82	[0.48,1.16]
Entitlement 30 hours	-0.30	[-0.39,-0.20]	3.45	[2.74,4.15]

Notes: Unconstrained=Discrete choice model based on actual hours, Constrained=Discrete choice model based on desired hours augmented by involuntary unemployment and hours constraints, Incentive effect=Discrete choice model based on desired hours, Entitlement 30 hours=Combined effect of introducing FWTB and removing constraints for working around 30 hours, bootstrapped 95%-confidence bands in parentheses.

Source: Own calculations based on INKAR, waves 2010 and FiD, waves 2010 and 2011.

the potential of this reform. The relatively large restriction probability for employees working around 30 hours would prevent some couples from making use of the FWTB. Although the difference between the estimates is statistically significant only at the 10 % level, this illustrates the importance of explicitly modeling hours constraints when evaluating labor market policies, especially when these policies change the relative attractiveness of different hours categories.

Besides an arguably more accurate estimate of the reform effect, explicitly modeling constraints also allows to disentangle the pure incentive effect of FWTB on labor supply preferences from constraints. The mere financial incentive from the FWTB increases of the probability that both spouses desire to work *extended part-time* by 0.68 pp. Yet, involuntary unemployment and hours constraints drive down this effect to approximately half the size. The fact that the estimate of the conventional labor supply model lies in between the pure incentive effect and the total effect including constraints might suggests that the parameter estimates of the conventional model implicitly incorporate some parts of the restrictions.

Table 4 also reports the joint effect of introducing FWTB and eliminating any restrictions to work *extended part-time* conditional on both partners choosing that hours category (apart from involuntary unemployment). This can be interpreted as augmenting the FWTB by a perfectly enforced legal entitlement to work *extended part-time* as well as abolishing all childcare rationing. It could also be interpreted

as a longer-term effect which also incorporates changes of working time norms by firms.⁸ The reform effect on the probability that both spouses work *extended part-time* increases sharply by 1.69 pp. Hence, abolishing hours constraints – if this were possible – could be more effective than the financial incentive of FWTB.

6 Discussion and conclusions

In Germany, as well as in other industrialized countries, actual and desired sharing of market work and family duties among parents with young children, fall apart. While fathers tend to be over-employed, i.e. they wish to work less hours than they actually do, mothers tend to wish longer hours than they actually do. This leads to the fact that the majority of German families with young children choose the single-earner or the 1.5-earner model although the majority in this group states that they would prefer an equal sharing of market work and family duties.

The question is what prevents parents from working their desired hours. In this paper, we have extended the standard labor supply model by allowing for involuntary unemployment and working hours constraints in the context of couple households. Based on this model, we have been able to assess the labor supply reaction of a recent reform proposal called family working time benefit (FWTB) that targets mothers and fathers of children aged one to three years who both work around 30 hours per week. This benefit is intended to replace part of the foregone net earnings compared to a full-time job for mothers and fathers individually. However, they are only eligible for the benefit if they both decide to work around 30 hours per week. Since our model explicitly considers constraints in the availability of jobs around 30 hours per week, we are able to disentangle the effect of financial incentives from the effect that would arise if in addition working hours constraints were removed as well.

Our results show that for this particular reform proposal, the reaction to the change in financial incentives is actually smaller than the labor supply reaction to a hypothetical removal of hours constraints. To be more precise, we find that based on an unconstrained labor supply model that is estimated on desired hours of work, the probability that parents both choose around 30 hours per week increases by 0.68

⁸Changes of working time norms by employees would result in an adjustment of desired hours which is beyond the scope of this study.

percentage points. This can be interpreted as the pure effect of financial incentives. In an augmented model that takes into account involuntary unemployment as well as hours constraints, the effect is reduced to 0.31 percentage points. Thus, only half of the families that would like to respond to the financial incentives induced by the reform, are actually able to adjust their working hours. The result of the standard labor supply model estimated on actual hours of work without explicitly modeling hours constraints (which serves as benchmark) lies in between these two results at 0.43 percentage points. A comparison of these results shows that the modeling of hours constraints is important since the behavioral response is upward biased in the standard model. Finally, our approach allows to explicitly simulate the removal of hours constraints (which can be interpreted as the introduction of a strictly enforced legal entitlement to part-time work) in addition to financial incentives. For this case we find that the probability that couples choose to work around 30 hours simultaneously increases by 1.68 percentage points, which almost triples the amount of the pure incentive effect. We thus conclude that hours constraints play a very important role in explaining why parents are not able to realize their desired sharing of market work and family duties.

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Appendix

Computation of expected state probabilities

Due to the non-linearity of the labor supply equation elasticities as well as the labor supply effects from the implementation of the FWTB have to be simulated on the basis of the parameter estimates. For the unconstrained model where $P_j^a = P_j^d$ this simulation is solely based on the expected choice probabilities \hat{P}_j from equation (3) above, albeit estimated on the basis of the observed actual working hours. Averaging the difference $\hat{P}_j^* - \hat{P}_j$ over all households in the sample yields elasticities or reform effects where \hat{P}_j^* represents expected choice probabilities after a marginal increase in the wage rate or a policy reform.

In the model with labor demand and hours constraints the computation of the expected state probabilities depends on the expected choice probabilities \hat{P}_j^d from the labor supply equation (3) on the desired working hours. On the other hand expected rationing probabilities from the constraint equations have to be taken into account. First, the likelihood of being in each category j with positive working hours is scaled down by the expected probability of getting a job ($\hat{\Psi}_{emp}\hat{P}_j^d$). The non-working category receives the difference between the pure and adjusted choice probabilities ($\sum_{j>0} (1 - \hat{\Psi}_{emp})\hat{P}_j^d$) corresponding to the share of involuntarily unemployed. This is done separately for each spouse; the risk of being unemployed is distributed according to the choice probabilities across the categories of the spouse.

Second, the likelihood to work a category with positive hours is adjusted for the expected probability of being hours-constrained ($1 - \hat{\Psi}(h_j)$). The difference between the pure and adjusted choice probability is shifted to all other categories according to their relative choice probabilities (which therefore respects the IIA assumption of the labor supply model). Given the expected choice probabilities \hat{P}_j^d and abstracting from the risk of involuntary unemployment as well as the combination with the spouse's choice probabilities and the spouse's hours constraints, the expected state

probabilities \hat{P}_j^a for three choices $j = 0, 1, 2$ are given as:⁹

$$\begin{aligned}
1 &= \hat{P}_0^a + \hat{P}_1^a + \hat{P}_2^a \\
&= \hat{P}_0^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_2^d} + \hat{P}_2^a(1 - \hat{\Psi}(h_2))\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_1^d} \\
&\quad + \left[\hat{P}_1^d + \hat{P}_2^a(1 - \hat{\Psi}(h_2))\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d} \right] \times \hat{\Psi}(h_1) \\
&\quad + \left[\hat{P}_2^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d} \right] \times \hat{\Psi}(h_2)
\end{aligned} \tag{19}$$

The three equations for the respective expected state probabilities \hat{P}_j^a :

$$\hat{P}_0^a = \hat{P}_0^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_2^d} + \hat{P}_2^a(1 - \hat{\Psi}(h_2))\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_1^d} \tag{20}$$

$$\hat{P}_1^a = \left[\hat{P}_1^d + \hat{P}_2^a(1 - \hat{\Psi}(h_2))\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d} \right] \times \hat{\Psi}(h_1) \tag{21}$$

$$\hat{P}_2^a = \left[\hat{P}_2^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d} \right] \times \hat{\Psi}(h_2) \tag{22}$$

are functions of the expected state probabilities of the other categories. One can substitute (22) in (21) to get an expression for \hat{P}_1^a in terms of observables:

$$\hat{P}_1^a = \frac{\left[\hat{P}_1^d + \hat{P}_2^a(1 - \hat{\Psi}(h_2))\hat{\Psi}(h_2)\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d} \right] (1 - \hat{\Psi}(h_1))}{1 - \hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d}(1 - \hat{\Psi}(h_2))\hat{\Psi}(h_2)\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d}(1 - \hat{\Psi}(h_1))} \tag{23}$$

Similarly, substituting (21) in (22) one can write \hat{P}_2^a as function of observables:

$$\hat{P}_2^a = \frac{\left[\hat{P}_2^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d} \right] (1 - \hat{\Psi}(h_2))}{1 - \hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d}(1 - \hat{\Psi}(h_2))\hat{\Psi}(h_2)\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d}(1 - \hat{\Psi}(h_1))} \tag{24}$$

Finally (23) and (24) can be used to write \hat{P}_0^a terms of observable quantities

$$\begin{aligned}
\hat{P}_0^a &= \hat{P}_0^d + \frac{\left[\hat{P}_2^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d} \right] (1 - \hat{\Psi}(h_2))}{1 - \hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d}(1 - \hat{\Psi}(h_2))\hat{\Psi}(h_2)\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d}(1 - \hat{\Psi}(h_1))} \hat{\Psi}(h_1)\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_2^d} \\
&= \frac{\left[\hat{P}_2^d + \hat{P}_1^a(1 - \hat{\Psi}(h_1))\hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d} \right] (1 - \hat{\Psi}(h_2))}{1 - \hat{\Psi}(h_1)\frac{\hat{P}_2^d}{\hat{P}_0^d + \hat{P}_2^d}(1 - \hat{\Psi}(h_2))\hat{\Psi}(h_2)\frac{\hat{P}_1^d}{\hat{P}_0^d + \hat{P}_1^d}(1 - \hat{\Psi}(h_1))} \hat{\Psi}(h_2)\frac{\hat{P}_0^d}{\hat{P}_0^d + \hat{P}_1^d}
\end{aligned} \tag{25}$$

This procedure can be easily extended to J categories and a combined choice set of a couple household. The resulting expressions get rather ugly; therefore we refrain from presenting the general case here.

⁹These expressions generalize for J states and $J - 1$ hours constraints of both spouses in couple households, but become much less convenient to read.

Additional tables

Table 5: Summary statistics

Variable	Mean	Std. Dev.	N
<i>Household characteristics</i>			
Net income, log.	8.033	0.4	2,057
German	0.889	0.315	2,057
East	0.170	0.376	2,057
Child aged 0	0.26	0.439	2,057
Child aged 1 – 3	0.43	0.495	2,057
Child aged > 3	0.183	0.387	2,057
<i>Individual characteristics woman</i>			
Age	35.197	6.303	2,057
Handicapped ≤50%	0.033	0.178	2,057
Handicapped >50%	0.014	0.116	2,057
Time non-employed	0.778	1.769	2,057
Occ.: Managers	0.078	0.268	2,057
Occ.: Professionals	0.239	0.426	2,057
Occ.: Technicians	0.315	0.465	2,057
Occ.: Clerical support workers	0.164	0.371	2,057
Occ.: Service & sales workers	0.212	0.409	2,057
Occ.: Craft & related trades	0.029	0.167	2,057
Occ.: Agricultural workers	0.262	0.44	2,057
Occ.: Plant & machine operators	0.123	0.329	2,057
Occ.: Elementary	0.14	0.347	2,057
Occ.: Armed Forces	0.004	0.062	2,057
Edu.: Isced 0-2	0.143	0.35	2,055
Edu.: Isced 3-4	0.620	0.486	2,055
Edu.: Isced 5-6	0.237	0.425	2,055
<i>Individual characteristics man</i>			
Age	38.434	6.979	2,057
Handicapped ≤50%	0.025	0.156	2,057
Handicapped >50%	0.01	0.098	2,057
Time non-employed	0.05	1.183	2,057
Occ.: Managers	0.078	0.268	2,057
Occ.: Professionals	0.239	0.426	2,057
Occ.: Technicians	0.315	0.465	2,057
Occ.: Clerical support workers	0.164	0.371	2,057
Occ.: Service & sales workers	0.212	0.409	2,057
Occ.: Craft & related trades	0.029	0.167	2,057
Occ.: Agricultural workers	0.262	0.44	2,057
Occ.: Plant & machine operators	0.123	0.329	2,057
Occ.: Elementary	0.14	0.347	2,057
Occ.: Armed Forces	0.004	0.062	2,057
Edu.: Isced 0-2	0.136	0.343	2,051
Edu.: Isced 3-4	0.555	0.497	2,051
Edu.: Isced 5-6	0.309	0.462	2,051
<i>Regional characteristics</i>			
Reg. rate of unempl.	7.735	2.971	2,057

Notes: Std. Dev.=Standard deviation, N=Amount of non-missing observations, East=Household lives in Eastern Germany, Occ.=occupation, edu.=Education aggregated by isco code, Reg. rate of unempl.=Rate of unemployment on the level of *Raumordnungsregionen*.

Source: Own calculations based on INKAR, waves 2010 and 2011 and FiD, waves 2010 and 2011.

Table 6: Estimation results: labor supply model

	Desired hours		Actual hours	
	coeff.	(s.e.)	coeff.	(s.e.)
<i>Consumption</i>				
Linear term	-64.59***	(18.51)	-32.26*	(18.13)
x Age woman	0.06	(0.04)	0.15***	(0.03)
x Age man	0.00	(0.04)	-0.06**	(0.03)
x German	1.90**	(0.84)	1.46**	(0.69)
x East	1.44*	(0.77)	1.36**	(0.68)
x Child 0	52.72**	(21.09)	28.57	(20.34)
x Child 1 – 3	18.72	(24.47)	-3.69	(23.65)
x Child > 3	44.86*	(26.21)	19.19	(21.32)
Quadratic term	2.32***	(0.70)	1.56**	(0.67)
x Child 0	-1.82**	(0.73)	-1.18*	(0.70)
x Child 1 – 3	-0.82	(0.95)	-0.24	(0.91)
x Child > 3	-1.85*	(1.02)	-0.73	(0.78)
<i>Leisure woman</i>				
Linear term	9.90	(17.13)	34.37*	(19.68)
x Age	-0.03	(0.17)	-0.13	(0.18)
x Age squared	0.08	(0.23)	0.24	(0.25)
x German	-0.10	(0.59)	-0.01	(0.57)
x East	-1.67***	(0.45)	-1.57***	(0.43)
x Handicapped > 50%	-0.45	(0.57)	-0.06	(0.63)
x Handicapped <= 50%	0.71	(1.00)	-0.34	(0.98)
x Child 0	-48.73*	(28.55)	-88.72***	(29.88)
x Child 1 – 3	-26.18	(20.32)	-60.93***	(22.39)
x Child > 3	27.04	(22.26)	-3.89	(23.91)
Quadratic term	-4.05***	(1.13)	-3.56***	(1.26)
x Child 0	16.61***	(1.92)	18.23***	(2.02)
x Child 1 – 3	5.04***	(1.30)	6.66***	(1.42)
x Child > 3	-2.18	(1.50)	-0.52	(1.61)
<i>Leisure man</i>				
Linear term	-27.55	(25.44)	-42.87*	(25.07)
x Age	-0.56***	(0.12)	-0.60***	(0.10)
x Age squared	0.75***	(0.15)	0.78***	(0.13)
x German	0.09	(0.59)	-0.41	(0.46)
x East	1.20**	(0.49)	1.36***	(0.40)
x Handicapped > 50%	2.81***	(0.58)	1.70***	(0.50)
x Handicapped ≤ 50%	1.77**	(0.90)	1.38*	(0.75)
x Child 0	36.26	(32.39)	9.59	(30.76)
x Child 1 – 3	-4.16	(29.55)	-38.34	(28.51)
x Child > 3	39.83	(32.69)	23.22	(31.44)
Quadratic term	0.81	(1.69)	5.26***	(1.56)
x Child 0	0.71	(2.02)	1.09	(1.84)
x Child 1 – 3	-1.67	(1.92)	0.74	(1.73)
x Child > 3	-4.09*	(2.27)	-1.70	(2.02)
<i>Interactions</i>				
Leisure woman x man	0.50	(1.51)	0.16	(1.60)
x Child 0	-9.46***	(2.26)	-6.76***	(2.24)
x Child 1 – 3	1.47	(1.83)	2.77	(1.87)
x Child > 3	1.57	(2.14)	1.65	(2.09)
Cons. x Leisure woman	2.87***	(1.03)	-0.14	(1.09)
x Child 0	-5.31***	(1.51)	-3.39**	(1.54)
x Child 1 – 3	-2.09	(1.28)	-0.10	(1.32)
x Child > 3	-1.86	(1.40)	0.22	(1.33)
Cons. x Leisure man	3.27**	(1.47)	1.37	(1.42)
x Child 0	-0.04	(1.83)	1.38	(1.72)
x Child 1 – 3	1.58	(1.75)	2.82*	(1.67)
x Child > 3	-1.92	(1.90)	-2.20	(1.77)
Observations	74,052		74,052	
Wald chi2	4,205.45		4,305.46	
Log-likelihood	-5,269		-5,219	
Positive 1st Derivates (in %)				
<i>U_c</i> (consumption)	0.77		0.99	
<i>U_{lm}</i> (leisure man)	0.15		0.17	
<i>U_{lf}</i> (leisure woman)	0.89		0.94	

Notes: Desired hours=Discrete choice model based on desired hours of work, Actual hours=Discrete choice model based on actual hours of work, East=Household lives in Eastern Germany, coeff.=regression coefficient, s.e.=standard errors.

Source: Own calculations based on FiD, waves 2010 and 2011.

Table 7: Estimation results: involuntary unemployment

	coeff.	(s.e.)
Constant	2.25	(1.57)
<i>Individual characteristics</i>		
Female	0.03	(0.17)
Age	-0.34***	(0.08)
Age squared	0.41***	(0.10)
East	-0.22	(0.30)
Handicapped ≤50%	0.04	(0.39)
Handicapped >50%	-0.02	(0.67)
German	-0.49**	(0.23)
Edu.: Isced 0-2	1.01***	(0.27)
Edu.: Isced 3-4	0.42*	(0.23)
Loss of human cap.	0.85***	(0.06)
<i>Regional characteristics</i>		
Reg. rate of unempl.	0.16***	(0.04)
Observations	2,979	
Log-likelihood	-608	
<i>Predicted rationing prob.</i>		
Men	0.076	
Women	0.155	

Notes: Loss of human cap.=Time not in employment, Reg. rate of unempl.=Rate of unemployment on the level of *Raumordnungsregionen*, edu.=Education aggregated by isco code (reference category: highly qualified), coeff.=regression coefficient, s.e.=standard errors.

Source: Own calculations based on INKAR, waves 2010 and 2011 and FiD, waves 2010 and 2011.

Table 8: Estimation results: hours constraints

	Hours categories				
	1-14	15-24	25-35	36-40	>40
Constant	-1.79 (1.52)	0.04 (0.58)	-0.40 (0.45)	-1.11*** (0.38)	-3.67*** (0.72)
Female	-0.89 (1.18)	-1.96*** (0.39)	-0.52** (0.22)	0.77*** (0.24)	0.06 (0.35)
<i>Childcare variables</i>					
Children ≤ 3	0.00 (0.59)	0.16 (0.25)	0.07 (0.23)	-0.04 (0.22)	-0.41 (0.36)
Children ≤ 3 x rationed	0.30 (0.89)	0.17 (0.52)	0.62 (0.48)	0.49 (0.41)	
<i>Labor demand variables</i>					
Occ.: Professionals	-0.25 (0.76)	0.67* (0.38)	0.03 (0.35)	0.05 (0.30)	-0.32 (0.60)
Occ.: Technicians	0.30 (0.76)	0.10 (0.34)	0.02 (0.30)	-0.17 (0.27)	0.44 (0.49)
Occ.: Clerical support workers	0.46 (0.72)	0.40 (0.36)	-0.06 (0.32)	0.13 (0.29)	0.90* (0.50)
Occ.: Service & sales workers	-0.54 (0.92)	-0.13 (0.38)	-0.22 (0.32)	-0.01 (0.30)	1.10** (0.47)
Occ.: Craft & related trades	-0.63 (0.86)	0.30 (0.36)	0.03 (0.31)	-0.64** (0.30)	-0.58 (0.62)
Occ.: Plant & machine operators	-0.62 (1.15)	0.71 (0.44)	0.29 (0.40)	-0.65 (0.40)	-0.89 (0.80)
Occ.: Elementary	-1.32 (1.16)	0.71* (0.40)	0.43 (0.35)	-0.41 (0.33)	1.40*** (0.51)
Observations	281	394	393	580	790
Log-likelihood	-55	-210	-251	-298	-133
<i>Predicted rationing prob.</i>					
Men	0.120	0.668	0.452	0.207	0.032
Women	0.055	0.230	0.331	0.356	0.033

Notes: East=Household lives in Eastern Germany, Occ.=occupation (reference categories: managers, armed forces, agricultural workers), rationed=self-reported reason why child is not in formal childcare includes no place available, opening times do not fit, geographical distance, coeff.=regression coefficient, s.e.=standard errors.

Source: Own calculations based on FiD, waves 2010 and 2011.