A Collective Model of Female Labour Supply: Evidence for East and West German Women

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Abstract

Using data from the German Socio-Economic Panel for the years 1999–2004, I estimate a collective discrete choice model of female labour supply that takes into account non-participation and that uses a detailed microsimulation model of the German tax and transfer system. My goal is to infer the share of household net income that women in couples receive for their individual consumption. In particular, I study whether the allocation within the household is more egalitarian for women who grew up in the former East Germany. The key identifying assumption is that some (but not all) parameters of the utility function are identical for single women and women in couples. I find that women receive about 67 percent of household net income for their individual consumption. There is no statistically significant difference with respect to the woman's origin.

Keywords: Collective household models, labour supply, microsimulation, maximum simulated likelihood, Germany
JEL codes: D11, D12, J22

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1 Introduction

This paper uses the framework of the collective model of labour supply to study whether women who lived in East Germany before reunification have greater bargaining power within the household than women from West Germany. Common wisdom in Germany suggests that they have, and the collective model allows to make this idea of power more precise. Studying the allocation within the household can also usefully supplement studies on East-West differences in attitudes towards redistribution by the state. East Germans have a reputation of being (and have been found to be) more egalitarian in the public sphere. For instance, Alesina and Fuchs-Schündeln (2007) show that East Germans are more supportive of redistribution, even controlling for material self-interest. The collective model allows to study whether this greater support for public redistribution is mirrored by a more egalitarian distribution of resources within the household.

Using data from the German Socio-Economic Panel for the years 1999–2004, I estimate a discrete choice model of female labour supply with non-participation and taxation. Net incomes at each alternative are calculated using the tax-transfer simulation model STSM developed at DIW Berlin. The model is estimated using conditional logit and mixed logit specifications. In the latter case, estimation is done by Maximum Simulated Likelihood.

The collective framework that I use is from Vermeulen (2006). He uses it to study the within-household allocation in Belgium in the 1990s. The main contribution of the present article lies in the application of the model to the question of East-West differences in Germany. I was also fortunate to be able to use a large panel data set and, courtesy of DIW Berlin, a well-established microsimulation model of the German tax-transfer system.

I consider two types of households: women living alone and women living in childless couples. Women's preferences are assumed to be selfish; that is, they care only about their own consumption and their own leisure. Recovering the preferences of women living alone is straightforward since both hours worked and consumption can be calculated at each alternative. By contrast, for women in couples, only *household* net income can be calculated, which means that the coefficient on the woman's individual consumption is no longer identified. A popular reaction is to estimate a unitary model, which aims to recover the *household's* preferences. However, the unitary model does not allow to shed light on what is happening within the household, and is therefore not suitable to answer my question about differences in bargaining power between East and West German women. As a result, I turn to the collective model (Chiappori 1988b, 1992; see also the surveys by Vermeulen 2002 and by Chiappori and Donni 2006). Its key assumption is that the allocation of leisure and consumption within the household is Pareto-efficient. I use a

discrete-choice version of the collective model for the present article. The advantage is that in a discrete choice model of labour supply, it is easier to take non-participation and a complex tax and transfer system into account in the estimation. The particular model that I use is from Vermeulen (2006). Following the mainstream of the literature on the collective model, Vermeulen assumes that all consumption is private, and that there are no externalities in consumption and leisure. Moreover, Vermeulen makes the simplifying assumption that male labour supply is exogenous.

As noted, the model assumes that household net income is split up into the private consumption of the woman and the private consumption of the man. Unfortunately, the share that each partner receives is unobserved in the GSOEP. The goal of the present article is to recover the share, and to find out whether it is higher in couples in which the woman is from the former East Germany than in couples in which the woman is from the West. The strategy to recover the unobserved share is as follows: Under the assumption that there are no public goods and no externalities in consumption, and under the key identifying assumption that the coefficient on *individual consumption* is the same for single women and women in couples, the difference in the estimated coefficient on *household net income* can be used to infer the allocation of consumption (and hence each spouse's bargaining power) within the household. Women in couples are estimated to care less about a unit of household net income than women who live alone (and who therefore get all of the household's income for themselves); I interpret this as reflecting the fact that women in couples get only part of household net income for their individual consumption. *How much* less they care about household net income is used to identify the share that they receive.

The assumption that certain coefficients of the utility function are identical is key for the unique identification of the sharing rule. Note, however, that identification does not require *all* coefficients of the utility function to be identical. Since hours worked are observed also for women in couples, the coefficient on this variable (and functions of it) can be allowed to differ between the two groups of women. As a result, the marginal rate of substitution is *not* constrained to be the same, which makes the identifying assumption more convincing. Moreover, this paper is interested not in the bargaining power of all women, but in how this bargaining power differs between women from East Germany and women from West Germany. This means that even if there is some change in the consumption coefficient between women living alone and women living in couples, the difference can still be identified as long as the change does not differ systematically between East and West German women.

I estimate that women receive about 67% of household net income for their individual

consumption. Contrary to what many people in Germany believe, there is no evidence that women who lived in East Germany in 1989 have greater bargaining power; if anything, there is evidence that the sharing rule is higher for women from the West. However, the difference is never statistically significant and is driven almost exclusively by the years 2000 and 2001.

The rest of this paper is organized as follows. Section 2 shows how the present article relates to the previous literature. In section 3 I describe Vermeulen (2006)'s discrete choice model of female labour supply and discuss identification of the sharing rule. In section 4 I present the data. Section 5 reports the main results, and section 6 concludes.

2 Literature review

In this section I review the literature on the collective model of household demand.[1] The main purpose is to show how the contribution in the present article fits into the literature. While this is the general purpose of a literature review, it is particularly important here because the literature on the collective model falls into two strands that differ quite a bit in spirit.

The first strand is the basic model developed by Chiappori (1988b, 1992), Browning and Chiappori (1998), and Chiappori et al. (2002). Under certain separability assumptions about individual preferences, the model develops restrictions on continuous demand functions, with labour supply functions as an important special case. If these restrictions are fulfilled, the parameters of the bargaining process (up to an additive constant) and the individual utility functions (up to a translation) can be recovered from the labour supply functions. As shown by Chiappori et al. (2002), distribution factors (variables that affect only the bargaining process, but not the individual utility functions or the household budget constraint) faciliate the identification; also, with more than one distribution factor, one can derive a testable proportionality restriction that holds even in the case of general preferences.

The second category, to which the present paper belongs, directly estimates utility functions in a discrete choice framework. This approach was pioneered by Vermeulen et al. (2006); the discrete choice framework is introduced to allow taking into account non-participation and complicated budget constraints, which frequently arise in labour supply applications, such as the present one.

[1] This rather detailed literature review is part of the thesis only; the version directed at publication in a journal contains a much shorter review.

To complicate matters even further, the first (and older) strand contains a number of different results concerning the restrictions that can be tested; as already mentioned, the restrictions that can be tested depend on the assumptions about preferences, the availability of distribution factors, and the number of goods. The surveys by Vermeulen (2002) and Chiappori and Donni (2006, 2009) collect these different results.

Finally, the literature on the collective model fits into the wider literature on household demand, which includes not only the collective model, but also other cooperative models such as Nash bargaining models, and also non-cooperative models. In my review I focus on the collective model. I mention only briefly the Nash bargaining models and leave out completely the non-cooperative models. The surveys by Vermeulen (2002), Chiappori and Donni (2006) again provide useful overviews of the wider literature.

2.1 The unitary model

The standard theory of household demand (with labour supply as an important special case) models demand as arising from the maximization of an utility function subject to a budget constraint. Under certain assumptions, the resulting demand functions add up to total expenditure and are homogenous in prices and total expenditure (for the case of Marshallian demand functions). Moreover, the substitution (or Slutsky) matrix of compensated price responses is symmetric and negative semidefinite (see, for instance, Deaton and Muellbauer 1980, 44).

While this approach is conceptually straightforward in the case of a one-person household, in multi-person households the question arises whether household demand can still be modelled as resulting from the maximization of a single household utility function. The advantage of such a "unitary model" is its simplicity: one has a well-understood theory at one's disposal and can, provided that the restrictions mentioned above are satisfied, find a utility function that is consistent with observed demand behaviour. However, since in most data sets information on consumption is available only at the household level, one cannot identify how *individual* consumption levels enter the household's utility function.

Moreover, there are a number of other serious problems with the unitary model. First, there is the fundamental point that *postulating* a household utility function violates the principle of methodological individualism (Chiappori 1988b, 63). The argument is not directed against having a household utility function, but it demands that such a function should be derived from the interaction of the individual household members, who each maximize their own utility functions. Now, as pointed out by (Chiappori 1988b, 63), it is quite unlikely that such a model that starts from first principles would lead to exactly

the same (Slutsky) restrictions on demand functions that are obtained in the standard model for a single consumer. Indeed, Browning and Chiappori (1998) find that Slutsky symmetry is rejected for couple (but not for single) households. These empirical rejections are the second argument against the unitary model. In fact, apart from the Slutsky restrictions, another restriction implied by the unitary model, namely "income pooling" (i.e., once total expenditure is controlled for, it should not matter for household demand how the income is distributed between the man and the woman) has been repeatedly rejected (e.g., Horney and McElroy (1988); Thomas (1990); Schultz (1990), and many others since). This leads to the third argument against the unitary model, namely that it cannot be used to address a number of important policy questions. For instance, if household demand is affected by *who* receives the income, it may be a good idea from a social policy perspective to target certain welfare programs to the woman and not to the man.[2] Moreover, the unitary model allows to do welfare analysis only at the household level. It would be desirable to open up the household "black box", that is, to infer how consumption is distributed within the household and to recover individual utility functions that could then be used to do welfare analysis at the individual level (e.g. Lise and Seitz 2010).

2.2 Nash bargaining models

To address these shortcomings of the unitary model, a first generation of papers (Manser and Brown 1980; McElroy and Horney 1981) models household demand as resulting from a bargaining process within the household. In contrast to the unitary model, each decision maker in the household now has his or her own utility function.[3] This first generation of models specifies a particular bargaining process, typically Nash bargaining. However, these early theoretical models have not led to many empirical applications. In fact, the tests proposed by McElroy and Horney (1981) and carried out by Horney and McElroy (1988) are tests of the unitary model, not of the Nash bargaining model.[4] To remedy the fundamental problem that the threat points in the Nash bargaining model are not observed, McElroy (1990) proposes to use data on singles to estimate the (threat-point)

[2]For example, Lundberg et al. (1997) show that a change in the payment of child benefits in the UK (paying the benefit to the mother and not the father) changed the pattern of household expenditure.

[3]The canonical case is that of two decision makers in a heterosexual couple. Children are usually not considered as decision makers of their own; however, their influence can be taken into account by modelling them as "preference factors" in their parents' utility functions. Recently, Dauphin and Fortin (2001) and Dauphin et al. (2008) have used the collective model to *test* for the number of decision makers in the household. Another recent development is to apply the formal structure of the (collective) household model to "dynasties", that is, to separately residing households within a family (or "dynasty") (Coate et al. 2009).

[4]See the debate between Chiappori (1988a, 1991) and McElroy and Horney (1990) on this point.

utility that the partners would obtain in case of separation. However, McElroy's idea was ultimately used not in the context of her own Nash bargaining model, but in that of the collective model (by Barmby 1994; Barmby and Smith 2001; Vermeulen et al. 2006; Couprie 2007). Following Vermeulen (2006), the present article also uses data on singles to identify key features of the model to be presented in section 3 below.

2.3 The collective model

2.3.1 The basic model

The collective model, already mentioned in passing, was first developed by Chiappori (1988), and has proved more fertile for empirical applications than the Nash bargaining model. I begin by briefly presenting the main theoretical results, before turning to a survey of the empirical applications.

The collective model again postulates two individual utility functions, but makes a weaker assumption about the bargaining process than the models by Manser and Brown (1980) and McElroy and Horney (1981) mentioned above. In fact, the collective model only assumes that the household allocation is Pareto-efficient, and stays silent about how this allocation is achieved. In other words, the collective model only assumes that the household will choose a point on the Pareto frontier, whereas the models by Manser and Brown (1980) and McElroy and Horney (1981), which impose more structure by assuming Nash bargaining, determine a particular point on the Pareto frontier. Chiappori generally advocates the use of minimal assumptions for methodological reasons; in the particular case of household models, he argues that Pareto efficiency is a plausible candidate for a minimal assumption since departures from efficiency seem unlikely in a long-lasting relationship which is presumably characterized by symmetric information.

Under the assumption of Pareto efficiency, there exists a weighting factor $\mu(w_1, w_2, y, \mathbf{z}, \mathbf{s})$ such that (h^i, C^i) solves the program[5]

$$\max_{\{h^1,h^2,C^1,C^2\}} \mu(w^1, w^2, y, \mathbf{s})U^1 + (1 - \mu(w^1, w^2, y, \mathbf{s}))U^2 \tag{1}$$

[5]The collective model can be applied to household demand in general. However, since my own application in this paper is to labour supply, I choose to already present the model in this context. The particular notation is from (Chiappori et al. 2002, 43).

subject to

$$w^1 h^1 + w^2 h^2 + y \geq C^1 + C^2 \tag{2}$$

$$0 \leq h^i \leq 1, \quad i = 1, 2 \tag{3}$$

where h^i is individual labour supply, and C^i denotes consumption of a *private* Hicksian composite good whose price is set equal to unity. w^i is the wage of person i, and y is nonlabour income at the household level. $\mathbf{z}$ is a vector of preference factors; such factors also show up in the unitary model. $\mathbf{s}$ is a vector of distributon factors, more on which below. Finally, in the most general case, individual preferences are allowed to depend not only on own consumption and leisure, but also on the partner's consumption and leisure. That is, the general form of the utility function is $U^i(1 - h^1, C^1, 1 - h^2, C^2, \mathbf{z})$. However, some of the results summarized below can only be obtained by imposing restrictions on preferences, namely that they are egoistic or caring. In the first case, utility depends only on own consumption and leisure; in the second case, a person's own utility is allowed to depend on the partner's utility, but not on how this utility is achieved (i.e., not on the partner's bundle of consumption and leisure).

Note that the difference with the unitary model is in the utility function, not the constraint, which is identical in the two models. In fact, superficially, even the utility functions look similar: the equation shows again a *household* utility function, just as in the unitary model. However, the key difference is that the Pareto weight μ (and hence the entire utility function) is allowed to vary with the vector of wages and with non-labour income. It is because of this additional influence of wages and nonlabour income (beyond their usual influence through the budget constraint) that the Slutsky conditions from standard consumer theory do not hold in the collective household model.[6] In the equation above, the Pareto weights are allowed to depend on a vector $\mathbf{s}$ of distribution factors, defined as factors that influence only the Pareto weights and neither the individual utility functions nor the budget constraint. Examples are the *share* of female non-labour income in total non-labour income (total non-labour income is in the budget constraint, of course), the age difference between the partners (Browning et al. 1994), or the sex ratio and divorce legislation (Chiappori et al. 2002). Distribution factors were introduced by Browning and Chiappori (1998) and Chiappori et al. (2002). In the original contributions of Chiappori (1988b, 1992), the Pareto weights depend only on individual wages and on nonlabour income.

[6]Browning et al. (2006) emphasize this point: what distinguishes the unitary from the collective model is *not* that the labour supply functions include variables other than the wages and the household non-labour income, but that the Slutsky restrictions are fulfilled in the unitary model but not in the collective model.

For a model of household labour supply with three observed goods[7] and with no distribution factors, Chiappori (1988) shows that even the minimal assumption of Pareto efficiency generates testable restrictions. However, in the case of general preferences (that is, allowing for externalities in consumption), these restrictions are non-parametric. Parametric restrictions on the labour demand functions are obtained only for the special case of egoistic preferences mentioned above.[8] To arrive at these restrictions, Chiappori shows that in this special case in which there are no externalities in consumption or leisure, any Pareto efficient allocation of the household can be decentralized through a process of two-stage bargaining. (This decentralization result is a direct application of the second fundamental theorem of welfare economics.) In the first stage of this hypothetical decentralized decision making, the household decides (through some unspecified decision process) on the "full income" (i.e., total private expenditure) of each household member. This "full income", which is equal to $w^i T^i + \phi^i$, is then spent on private consumption C^i and leisure L^i (T^i is the time endowment of person i). ϕ_i, called the "sharing rule", is person i's nonlabour income plus any net transfer that he or she receives from the other person in the household. The individual demands L^i and C^i result from the (decentralized) maximization of each person's individual utility function, subject to the constraint $w^i L^i + C^i \leq w^i T^i + \phi^i$.

Chiappori (1988b) is able to derive testable restrictions on the leisure demand functions L^1 and L^2.[9] If these restrictions are satisfied by the observed (or rather estimated) leisure demand functions, the individual consumption levels and the sharing rule are identified up to an additive constant. Finally, the individual utility functions are identified up to a translation (Chiappori 1992); once a constant is chosen for the sharing rule, the individual utility functions are exactly identified.

While the basic theory is in place with the contributions by Chiappori (1988b, 1992), there are a number of useful other results. Browning and Chiappori (1998) derive parametric restrictions in the general case (no restrictions on preferences and on goods), where Chiappori (1988b) had only shown non-parametric restrictions. They show that the matrix of compensated price responses is equal to the sum of a symmetric negative semidefinite matrix S and a matrix R that is at most of rank $k-1$, where k is the number of decision makers in the household.

[7]The three goods are individual leisure amounts of the man and the woman (L^1 and L^2), and consumption C of a Hicksian aggregate commodity, observed only at the household level.

[8]In fact, as shown by Chiappori (1992), the results are preserved for "caring" preferences; that is, preferences in which person 1 cares about person 2's utility, but not directly about person 2's leisure or individual consumption.

[9]Restrictions on individual consumption levels would not be testable because consumption is typically observed only at the household level.

Of course, this $SR(k-1)$ restriction can only be tested in data sets that contain price variation. That is, one cannot test it with cross-sectional consumption data. Moreover, while data on labour supply does exhibit cross-sectional price variation (of wages, the price of leisure), Browning and Chiappori (1998) show that in order to test the $SR(n-1)$ restriction, one needs at least 5 goods.

However, Browning and Chiappori (1998) show that even in these cases with no price variation or with not enough goods, parametric restrictions can be obtained given that one has at least two distribution factors.[10] In this case, the demand functions for two different goods and two different distribution factors are proportional: that is, if a certain distribution factors changes the demand for good i by twice as much as does another distribution factor, then the same ratio will also be observed for good j. This is due to the fact that the distribution factors have by definition only an income effect, and the change in income will always lead to the same change in the pattern of demand, regardless of the source of the income change (i.e., from *which* distribution factor it stems from). This proportionality restriction was first introduced and tested by Bourguignon et al. (1993) in a study on French cross-sectional consumption data, that is, on a data set without price variation.

Another important result concerning the role of distribution factors is derived by Chiappori et al. (2002). They show that the distribution factors are useful not only because they allow to derive testable restrictions even in the general case without price variation, but also because they facilitate identification in the special case in which there are no externalities in consumption or leisure.

The pioneering empirical applications of the basic model in the context of labour supply are Fortin and Lacroix (1997) and, again, Chiappori et al. (2002).[11] On data for two-earner households from the 1988 Canadian Census, Fortin and Lacroix (1997) reject the unitary restrictions of income pooling and symmetric cross-wage effects. By contrast, the restrictions of the collective model are not rejected, except for the subgroup of households with children of preschool age. However, the parameters of the sharing rule and of individual utility functions are rather imprecisely estimated. Using the new identification strategy that rests on distribution factors (in their case, the sex ratio and divorce laws), Chiappori et al. (2002) likewise cannot reject the collective restrictions on their sample of PSID data for 1988. They also find that the effect of the distribution factors go into the

[10] Recall from above that these are defined as factors that influence only the Pareto weights and neither the individual utility functions nor the budget constraint.

[11] The very first application seems to have been the study by Kooreman and Kapteyn (1990), who use additional data on *preferred* hours to identify individual preferences. However, they see their application as merely illustrative.

expected directions: that is, a sex ratio and divorce laws that are favourable to women increase their weight in the household's decision process. The approach by Chiappori et al. (2002) has been used for a number of other countries as well: Moreau (2000) for France, Clark et al. (2004) for the UK, Vermeulen (2005) for the Netherlands, Fernández-Val (2003) and Crespo (2009) for Spain, and Garcia et al. (2007) for the countries of the European Community Household Panel (ECHP).

2.3.2 Extensions

As these theoretical results and empirical applications show, the collective model manages to open up the "black box" of the household quite a bit, especially considering that not many assumptions are made: Pareto efficiency plus the absence of externalities in consumption and leisure. Note, however, that the restrictions and the identification results are obtained for interior solutions, which is problematic when the model is applied to labour supply, where non-participation is frequent for women. Also, the budget constraint is assumed to be linear, which is reasonable for the estimation of demand given income, but not for the special case of labour supply, where budget constraints are typically highly complicated because of the interaction of taxes and transfers.

In recent years, the basic collective model has been extended in a number of directions, and the literature is still very much in development. As noted above, here is not the place for a comprehensive review. I focus on labour supply and in particular on how taxes and transfers and non-participation can be taken into account in an empirical application like the present one. By contrast, I leave aside household production (Apps and Rees 1997; Chiappori 1997; Aronsson et al. 2001; Bourguignon and Chiuri 2005; Rapoport et al. 2006; Couprie 2007; Donni 2008), inter-temporal issues (e.g., Mazzocco 2007), and recent developments in non-parametric tests of the collective model (Cherchye et al. 2007; Cherchye and Vermeulen 2008; Cherchye et al. 2008).

Non-participation is frequent on the labour market, especially for women. However, the restrictions and identification results of Chiappori's basic model are derived for an interior solution to the household's maximization program. As a result, the empirical studies mentioned above restrict the sample to two-earner households, which is costly in terms of the sample size and is certainly not a random subsample of all households. To remedy the problem, Donni (2003) and Blundell et al. (2007) introduce non-participation into the collective model. In Donni's model, labour supply of both spouses is a continuous variable, whereas in the model of Blundell et al., male labour supply is modelled as a binary choice. They make this choice to reflect the empirical observations that most men work either full-time or not at all. In their empirical application using data from the

UK, Blundell et al. are able to show, among other things, that a male wage increase has an impact on female hours of work even when the man does not work himself. Such an effect is consistent with the collective model, where an increase in male wages is thought of as increasing the man's bargaining power. By contrast, in the unitary model a wage increase for somebody who does not participate in the labour market (neither before not after the wage increase) will leave the budget constraint unchanged and has therefore no impact on female labour supply. As for Donni (2003)'s theoretical model, it is estimated by Bloemen (2004) on Dutch data, and by Hourriez (2005) on French data; in the latter case under the simplifying assumption that only women may choose non-participation, whereas men are constrained to participate.

While these empirical studies take into account non-participation, they do not allow for taxes and transfers, and are therefore not well-suited for policy analysis. Finding a good model for this purpose is, to my knowledge, still very much an open and active area of research. Donni (2003) extends the model by Chiappori et al. (2002) for the case of a convex budget set; he follows the approach of Hausman (see for instance Hausman 1985) who introduced the concepts of virtual wages and virtual non-labour income. Donni and Moreau (2002) estimate this extended model on French data. However, the drawbacks of this method are that it is valid only for interior solutions and for convex budget sets. Accordingly, Donni and Moreau have to convexify the budget set before they can estimate the labour supply model. The current workhorse model is therefore a model in which both male and female labour supply are discrete (Vermeulen et al. 2006), which makes it relatively easy to incorporate non-participation and taxes and transfers that lead to a non-convex budget set. The idea to use a discrete framework to analyze labour supply responses to tax and transfer reforms goes back to Van Soest (1995) and Aaberge et al. (1995), who use the framework of the unitary model. The difficulty that Vermeulen et al. (2006) face when they adapt the discrete choice framework to the collective model is that the model cannot be estimated, but has to be solved by a mix of calibration and estimation. Moreover, the approach uses data on singles to identify the individual utility functions.[12]

To avoid the complication that arises from the calibration step, I choose to follow the model of Vermeulen (2006), who estimates a special case of the discrete-choice approach of Vermeulen et al. (2006). He simplifies by ruling out leisure interactions and by considering

[12]Recall that Chiappori (1988b, 1992) studies identification in the case where only data on couples are available. As noted above, the idea to use data on singles as an additional source of identification goes back to McElroy (1990) and to Barmby (1994) and Barmby and Smith (2001). Lise and Seitz (2010) is a recent paper that also assume a certain stability of the utility function across household living arrangements.

male labour supply as given.[13] His model will be presented in detail in the next section. In section 5 I compare my results with those of the studied by Beninger et al. (2006) and Beninger et al. (2007), who apply the more general framework of Vermeulen et al. (2006) to German data.

3 The model of labour supply

In this section, I briefly sketch the model of labour supply that I will estimate. As noted, the model is from Vermeulen (2006). There are two types of households: women living alone, and households consisting of one man and one woman; everybody is of working age. I will refer to the second type of households as couples, although the two partners are not necessarily married.[14] As in Vermeulen (2006), I model only female labour supply; male labour supply is taken as given.

Following Van Soest (1995), female labour supply is modelled as a discrete choice between J alternatives for weekly working hours. The assumption of a discrete choice model will make it easier to incorporate a realistic (and hence highly complex) tax and benefit system. Also, non-participation is easily modeled in this framework as one of the J alternatives.

3.1 Preferences

The utility of alternative j for woman n has observed and unobserved components:

$$U_{nj} = V(c_{nj}, l_{nj}, \mathbf{d}_n) + \varepsilon_{nj}$$

where c_{nj} is woman's n consumption of goods and services at alternative j, and l_{nj} are weekly hours' worked. $\mathbf{d}_n$ is a vector of variables that capture observed heterogeneity in preferences ("taste shifters"): in the empirical part below, this vector includes education (highest degree in four categories), age, and—for the terms that include only leisure—a dummy for whether the woman lived in East Germany in 1989.

Woman n chooses alternative j if and only if she derives higher utility from it than from all other alternatives.

[13] Whereas Vermeulen (2006) uses a discrete-choice framework, Donni (2007) and Donni and Moreau (2007) consider the case where male labour supply is rationed in the context of a continuous model.

[14] As usual in the literature on the collective model, the household is taken as given. However, note that even though the collective model does not yet contain an explicit model of marriage formation or dissolution, the use of variables such as the sex ratio that are thought to influence the bargaining power within the household rely of course on an *implicit* model of the marriage market.

Note that preferences are selfish: the woman cares only about her own leisure and her own consumption. This (strong) assumption follows in the tradition of the collective model; it is made in order to apply the second fundamental theorem of welfare economics that justifies the decentralization of the within-household allocation through a "sharing rule" (see below on the form of the sharing rule that is assumed in this application).[15]

Following Vermeulen, I assume the following functional form for the observed part:[16]

$$V_{nj} = \beta_{\ell\ell}(\mathbf{d}_n)(\ell_{nj})^2 + \beta_{cl}\ell_{nj}c_{nj} + \beta_c c_{nj} + \beta_\ell(\mathbf{d}_n)\ell_{nj}$$

3.2 Assumptions about the error terms

The error terms ε_{nj} represent the influence of unobserved factors on the utility that woman n derives from alternative j.

The most convenient assumption about the error terms is that of the logit model, namely that the error terms are independent across individuals and alternatives, and that they are distributed as type I extreme value. This assumption is convenient because it gives rise to closed-form solutions for the choice probabilities (McFadden 1974); the model can therefore be estimated using Maximum Likelihood.

However, assuming that the error terms are independent alternatives implies restrictive substitution patterns between the alternatives (the "blue bus, red bus problem"). In addition to a logit model, I therefore also estimate a random parameters logit (a.k.a. mixed logit). In this model, there is random variation in the coefficients on ℓ and ℓ^2, conditional on the observed factors $\mathbf{d}$:

$$\begin{aligned}\beta_{\ell\ell}(\mathbf{d}_i) &= \beta_{\ell\ell 0} + \beta'_{\ell\ell 1}\mathbf{d}_i + \upsilon_{\ell\ell i} \\ \beta_{\ell}(\mathbf{d}_i) &= \beta_{\ell 0} + \beta'_{\ell 1}\mathbf{d}_i + \upsilon_{\ell i}\end{aligned}$$

The additional individual-specific error terms are assumed to be normally distributed

[15] The assumption of selfish preferences can be relaxed by assuming "caring" preferences. These still rule out direct externalities of consumption or leisure, but allow that the *utility* of the spouse enters one's own utility function.

[16] I tested this functional form assumption, in particular the constraint that the coefficient on consumption squared is zero. A likelihood ratio test gave a test statistic of 0.42. This is to be compared with the critical value of a χ^2 distribution with 1 degree of freedom. The p-value is 0.5168, which means that I cannot reject Vermeulen's restriction of a zero coefficient on consumption squared. However, note that for reasons that will become clear below, this test was conducted for women living alone, and not for women living in a couple.

with mean zero and variance-covariance matrix Σ, where

$$\Sigma = \begin{pmatrix} \sigma^2_{v\ell\ell} & \rho \\ \rho & \sigma^2_{v\ell} \end{pmatrix}$$

The elements of this matrix are additional parameters to be estimated. Following Vermeulen, I assume $\rho = 0$, which speeds up computation. In section 5 below, I test the logit model against the random parameters logit by testing whether the estimated variances are jointly equal to zero.

The mixed logit model is less restrictive than the logit. However, the drawback is that the choice probabilities no longer have a closed-form solution. The model is therefore estimated using Maximum *Simulated* Likelihood (see, for instance, Train 2003). The simulation of choice probabilities uses 50 Halton draws.

3.3 Private consumption

3.3.1 Single women

For women living alone, consumption c_{nj} is equal to net income, which can be calculated for each of the J alternatives from knowledge of the wage offer (observed or predicted), of non-labour income, and of the tax-transfer system (see section 4.3 below for details). Likewise, hours worked at each alternative are known (in fact, it is hours worked that were used to define these alternatives in the first place). Since everything is observed, estimation of the discrete choice model is straightforward and allows to recover the parameters of the utility function for women living alone.

3.3.2 Women in couples

The case of women living in couples is different. Recall from above that it is assumed that only the woman's own consumption enters her utility function. However, unlike for women living alone, observing *household* net income is no longer enough for determining the woman's individual consumption. As a result, the parameters of the woman's utility function are no longer identified.

A popular way to deal with the fact that private consumption levels of each spouse are unobserved is to assume that the household acts as a single decision maker, and that it is total household net income that enters the household's utility function. One problem with this "unitary model" is that it implies that it should make no difference for labour

supply whether non-labour income is received by the man or by the woman. However, this restriction of income pooling has been repeatedly rejected in the data.

Another drawback of the unitary model is that it does not allow to say anything about the allocation of consumption *within* the household. However, the purpose of this paper is precisely to use this allocation of consumption to study the respective bargaining power of East and West German women. A framework that allows to address these questions is that of the collective model (Chiappori 1988b, 1992; see also the surveys by Vermeulen 2002 and by Chiappori and Donni 2006). The collective model infers the unobserved allocation of consumption and hence of utility within the household from observed demand (here: labour supply) behaviour.

The key assumption of the collective model is that the household, through some bargaining process that is left unspecified, arrives at an allocation of leisure and consumption that is Pareto-efficient. In the framework of Vermeulen (2006) that I am using, there are no public goods in consumption, there is no leisure interaction, and male labour supply is exogenous. In this case, the assumption of Pareto-efficiency amounts to assuming that household net income x is split up into private consumption of the man and private consumption of the woman: $c^f + c^m = x$. This is certainly a strong assumption. I believe that is more plausible for couples without children, and I therefore restrict my sample accordingly in the empirical part.

3.4 The sharing rule

Following Vermeulen, I assume that the woman gets an unobserved share κ of household net income.

$$c_{nj} = \kappa x_{nj}, \quad 0 < \kappa < 1 \tag{4}$$

The goal of this article is to recover this share. In particular, I allow the share to differ between couples in which the woman is from the former East Germany and couples in which the woman is from the West:

$$c_{nj} = (1 + \kappa_1 + \kappa_2 dEast1989_n)x_{nj} \tag{5}$$

The expressions $1 + \kappa_1$ (for West German women) and $1 + \kappa_1 + \kappa_2$ (for East German women) should lie between 0 and 1; reassuringly, the estimated parameters do actually fall within this range (see below). My hypothesis is that κ_2 is positive; that is, that East German women get a higher share of household net income for their private consumption than women from the West.

Note that other *distribution factors* such as the age difference between the spouses or the regional sex ratio could be included in the sharing rule as well; if these differ systematically between couples with women from the East and women from the West, this could partly explain any East-West difference. That is, if I find any difference between East and West German women (a significant κ_2), this need not reflect a direct causal effect of having been raised in the East, but could also be due to observable differences that have arisen since 1989. In other words, the aim of this paper is to *describe* the difference between East and West German women; explaining it is left for further research.

As noted above, for women living alone, private consumption is observed and equals net income: $c_{nj} = x_{nj}$. Defining the indicator variable $dCouple_n$ (1 if in couple, 0 if living alone), one can write the the private consumption level at alternative j for all women (those living alone and those living in couples) in a single expression:

$$c_{nj} = (1 + \kappa_1 dCouple_n + \kappa_2 dCouple_n dEast1989_n)x_{nj} \tag{6}$$

3.5 Identification

Plug this expression for private consumption into the utility function, which can then be written as a function only of observed variables.

$$\begin{aligned} U_{nj} = \beta_{\ell\ell}(\mathbf{d}_n)(\ell_{nj})^2 + \beta_{c\ell}\ell_{nj}(1 + \kappa_1 dCouple_n + \kappa_2 dCouple_n dEast1989_n)x_{nj} \\ + \beta_c(1 + \kappa_1 dCouple_n + \kappa_2 dCouple_n dEast1989_n)x_{nj} + \beta_\ell(\mathbf{d}_n)\ell_{nj} + \varepsilon_{nj} \end{aligned} \tag{7}$$

In this discrete choice model one can identify (up to scale) the parameters

$$\beta_{\ell\ell}(\mathbf{d}_i), \beta_{c\ell}, \beta^*_{c\ell 1} = \beta_{c\ell}\kappa_1, \beta^*_{c\ell 2} = \beta_{c\ell}\kappa_2, , \beta_c, \beta^*_{c1} = \beta_c\kappa_1, \beta^*_{c2} = \beta_c\kappa_2 \tag{8}$$

The parameters of the sharing rule can then be calculated as functions of these parameters:

$$\kappa_p = \frac{\beta^*_{c\ell p}}{\beta_{c\ell}} = \frac{\beta^*_{cp}}{\beta_c}, \quad p = 1, 2 \tag{9}$$

The standard errors of the sharing rule parameters can be calculated using the delta method.[17]

These expressions make clear that to identify the sharing rule, further assumptions about the utility function are needed. I assume that the coefficients on the variables involving

[17]The indicator variable s_n was introduced for this reason, namely that it allows to estimate the coefficients for women living alone and women in couples in a single equation.

private consumption (β_c and $\beta_{c\ell}$) are identical for women living alone and women living in couples.[18] This identifying assumption is formally derived in the appendix. Note that identification does *not* assume that preferences of women living alone and of women living in couples are perfectly identical. Hours worked are observed for both types of women, and the coefficients on hours worked and hours worked squared can therefore be identified without further assumptions. Since the coefficients on hours worked are allowed to differ, the marginal rate of substitution is allowed to differ as well between women living alone and women in couples.

Finally, equation (9) shows that because of the functional form of the utility function (in which consumption enters linearly and also interacted with hours worked), the parameters of the sharing rule can be calculated in *two* ways: either as the ratio of $\beta^*_{c\ell p}$ and of $\beta_{c\ell}$ or as the ratio of β^*_{cp} and β_c. Both ways should in theory give the same answer; the equality of the two ratios is therefore imposed as a constraint in the Maximum Likelihood estimation.

4 Data

4.1 The sample

I estimate the model with data from the German Socio-Economic Panel. The GSOEP is a large representative household panel that began in 1984 (Wagner et al. 2007). I use the years 1999 to 2004, a restriction that is dictated by the availability of the microsimulation model of the tax-transfer system. There are 150,424 observations, of which 78,099 observations for women.

As noted above, I study the labour supply of women who live alone and of women who live in two-person households (without necessarily being married). Since the assumption that household net income is split into private consumption of the man and private consumption of the woman is already rather strong, I choose to retain only two-person households without children because abstracting from public goods in consumption, although admittedly restrictive, is less strong an assumption for these households.[19] Finally, since I am

[18] This idea goes back to Barmby and Smith (2001) and was later used in a number of country studies that use the collective model for ex-ante simulation of tax reforms (see Vermeulen et al. 2006, for a description of the method used).

[19] Selecting a sample without children to mitigate concerns about public consumption is standard practice in the literature. For instance, Fortin and Lacroix (1997, 944) write that "in order to minimise the extent of non-separable public consumption (the best example of which being children expenditures), which may affect the validity of the restrictions imposed by the collective model, the sample is limited to couples with at most one child (under 18). Ideally, the sample should be restricted to couples with no children, but this restriction would reduce considerably the sample size. As a compromise, we also present estimation results for couples with no pre-school children (under 6)." While Fortin and Lacroix

interested in the difference in bargaining power between men and women in East and West, I restrict the sample to heterosexual couples; moreover, I include only respondents who were born in Germany and have German nationality.

Following usual practice in the literature, I select a subsample of women for which the model of labour supply choice seems most appropriate. I keep women between the age of 25 and 60 (both inclusive) who are either employed or non-participating (defined as unemployed and not looking for work). I exclude students and women on maternity leave, as well as the self-employed, the unemployed who are actively looking for work, civil servants, and the retired.

Using these criteria, the estimation sample consists of 10247 observations, of which 2398 observations for women living alone and 7849 observations for women in two-person households.

Figure 3 in the appendix shows the sample size by year and by origin of the women. Table 3, also in the appendix, shows descriptive statistics on this estimation sample. Due to the listwise deletion of missing values, the actual number of observations may be somewhat lower, depending on the specification.

4.2 Hours worked

The dependent variable is the number of contractual weekly working hours. As mentioned, I follow Van Soest (1995) in modelling the labour supply choice as a choice among discrete categories.

I use five categories for women's weekly labour supply: zero hours (non-participation), (0; 15] hours, (15; 34] hours, (34; 39] hours, and more than 39 hours. Each category needs to be assigned a single value; I choose the median of each category in the sample: 0, 10, 25, 38, and 40 hours. This choice of categories follows previous studies that were conducted with the microsimulation model STSM at DIW Berlin.

Note that I assign this single value not only for the four hypothetical categories that the woman does not choose, but also for the category that she actually chooses. That is, a woman who is observed to work 23 hours (and thus falls into the third category) is assigned the value corresponding to this category (25 hours) and not the 23 hours she actually works.

Figure 1 shows the distribution of the hours variable in the sample, pooled over all waves

thus make a compromise because of concerns about sample size, Blundell et al. (2007, 422) completely exclude couples with children, as in the present article.

from 1999 to 2004, before and after the categorization. The low share for the category 0 to 15 hours is explained by the fact that I include only women without children in my subsample.

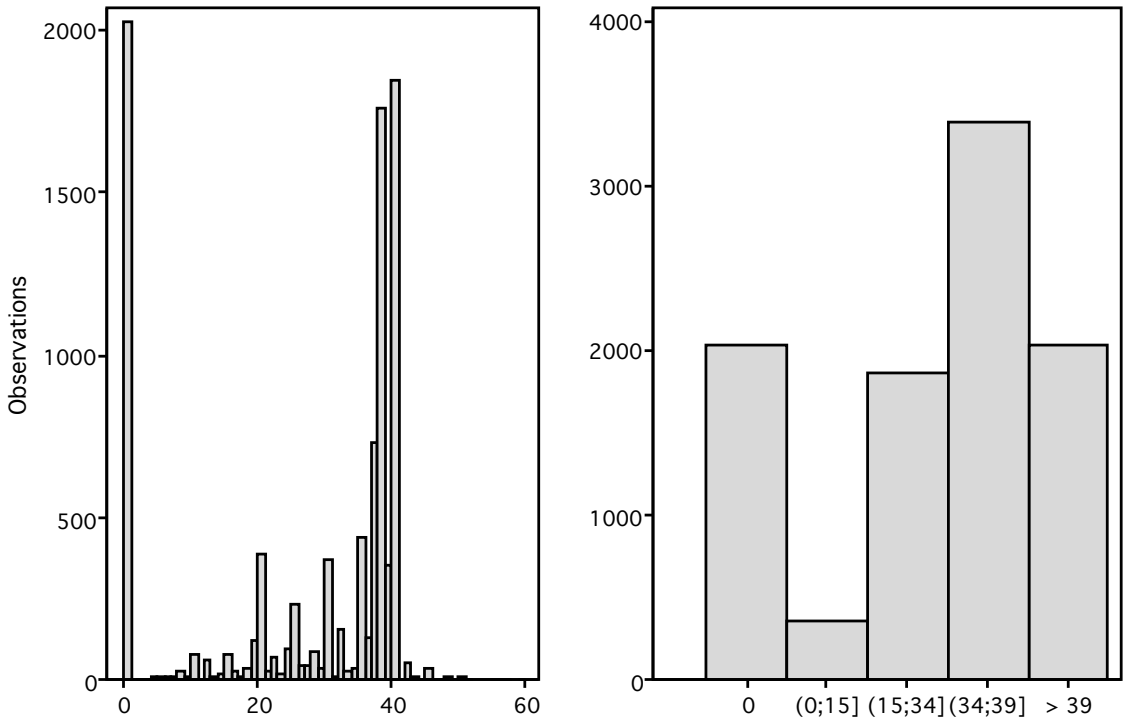

Figure 1: Contractual hours per week

4.3 Household net income

Apart from hours worked, the other variable that enters the utility function is private consumption. For women living alone, private consumption is equated with net household income; for women living in couples, private consumption is assumed to be a share κ of household net income. That is, household net income needs to be calculated in both cases. This task is complicated by the fact that net income is (at best) observed for the hours category that the woman actually chooses (but even then, as just seen, I use a single value for hours for all women within the category and not the actual hours for each women). As a result, household net income has to be simulated for each of the J hours categories.

This simulation is carried out using the tax-transfer simulation model STSM (*Steuer-*

Transfer-Simulationsmodell) of DIW Berlin.[20] I describe the model in the appendix, drawing mostly on the documentation by Steiner et al. (2008), as well as on my own experience with another variant of the STSM, in whose development I participate.

5 Results

Table 1 shows parameter estimates for the utility function given in equation (7). The parameters were estimated using Maximum Likelihood under the assumption that the error terms are i.i.d. extreme value. This gives rise to the conditional logit model.[21] For the moment, all parameters are constrained to be the same across years.

All women The first column shows parameter estimates from which an overall sharing rule (that is, for all women, regardless of whether they originate from East or West Germany) can be calculated. The interaction of *xnet* and *dCouple* is negative, which suggests that women in couples attach less value to one unit of household net income than do women living alone. Under the assumptions stated above, this is interpreted as a female share of total household consumption of less than 1, which is only plausible. However, note that the interaction of *xnet* and *dCouple* is not statistically significant; this will show up in the sharing rule, for which the 95% confidence interval includes the values of 1 (the woman receives everything), but also of 0.5 (equal sharing of consumption).

The parameters of interest have to be calculated from these Maximum Likelihood estimates. Their standard errors are calculated using the delta method. More precisely, and as noted in equation (9), the sharing rule can be calculated as

$$\frac{b[xnet] + b[xnet * dCouple]}{b[xnet]} \tag{10}$$

[20] As already mentioned in the acknowledgement, I was fortunate that I was able to use this state-of-the-art model. I would like to thank Viktor Steiner and Peter Haan for this opportunity, and for their hospitality during my stay at DIW Berlin.

[21] As noted above, I also estimate a random parameters logit model, which allows for correlation of the error terms across alternatives. The coefficients l and lSq are assumed to be (independently) normally distributed. The model is estimated using Maximum Simulated Likelihood with 50 Halton draws. A likelihood ratio tests allows to test whether the variances of these two coefficients are both equal to zero. The test statistic is 0.01. This is to be compared with the critical value of a χ^2 distribution with two degrees of freedom. The null hypothesis of zero variances cannot be rejected (p-value 0.9960). I therefore present only the results for the conditional logit in the table. Results for the random parameters logit are very similar. In particular, the estimated sharing rule (.667, with a 95% confidence interval of $[.293; 1.04]$) is almost identical to the one estimated in the conditional logit model and given in table 2.

xnet	.0012*	(.0004)	.0011*	(.0004)
xnet * dCouple	-.0004	(.00035)	-.00034	(.00036)
xnet * dCouple * dEast1989			-.0002	(.00022)
xnet * l	-.00003*	(9.9e-06)	-.000029*	(1.0e-05)
xnet * l * dCouple	9.9e-06	(8.8e-06)	8.5e-06	(8.9e-06)
xnet * l * dCouple * dEast1989			5.0e-06	(5.4e-06)
l	.3*	(.028)	.3*	(.028)
l * dReal	.033*	(.0094)	.033*	(.0094)
l * dAbi	-.02	(.014)	-.019	(.014)
l * dCollege	.052*	(.015)	.052*	(.015)
l * age	-.0066*	(.00052)	-.0066*	(.00052)
l * dEast1989	-.015	(.0097)	-.015	(.0097)
lSq	-.0027*	(.00058)	-.0026*	(.00058)
lSq * dReal	-.00036	(.00022)	-.00037	(.00022)
lSq * dAbi	.00065*	(.00032)	.00064*	(.00032)
lSq * dCollege	-.00072*	(.00032)	-.00072*	(.00032)
lSq * age	.000071*	(.000011)	.000071*	(.000011)
lSq * dEast1989	.00059*	(.00022)	.00054*	(.00023)
Log likelihood	-9045.98		-9045.56	
Observations	6391		6391	

Conditional logit, 1999–2004 pooled. *: statistically significant at the 5% level. Asymptotic standard errors in parentheses.

Table 1: Maximum Likelihood estimates for conditional logit model. Dependent variable: female weekly working hours, in five categories.

Or, equivalently, as

$$\frac{b[xnet * l] + b[xnet * l * dCouple]}{b[xnet * l]} \tag{11}$$

where $b[\cdot]$ stands for the estimated coefficient on the variable given in brackets. The two ratios are *constrained* to be the same.

The results of these calculations are shown in the first row of table 2. The table shows the estimated share of household net income that the woman gets for her individual consumption. For all women, regardless of whether they originate from East or West Germany, I estimate a share of about 67%. Unfortunately, the estimate is rather imprecise. As noted,

			CI	
	Coef.	SE	lower	upper
Net income				
All	.667	.191	.293	1.041
West	.705	.214	.286	1.125
East	.531	.219	.102	.960

Table 2: Estimated sharing rules

I cannot reject the hypothesis that the woman gets *all* of the household's net income. Nor can I reject a share of 0.5, which would be the expression of equal bargaining power.

The large standard error is of course problematic, in the sense that the particular sample used in this article gives a point estimate, but does not allow to make precise statements about the population. Fortin and Lacroix (1997) also get very imprecise estimates for the parameters for the sharing rule. They also suggest an explanation, which is equally relevant for the present article: "Unfortunately, in the case of sub-groups for which the collective model is not rejected, the sharing rule and individual preferences parameters are not precisely estimated. A possible explanation for this result is that these parameters are highly nonlinear functions of statistically significant and insignificant parameter estimates" (953).

East-West difference In column 3 of table 1, the coefficients on the interactions of $xnet$ and $xnet{*}l$ with $dCouple$ are allowed to differ by the origin of the woman. I find that women who lived in East Germany in 1989 care even less about household net income when living in a couple than do women who lived in West Germany in 1989. However, the difference is not statistically significant. The second and third row of table 2 show the sharing rules than can be calculated from these Maximum Likelihood estimates. I estimate a share of about 71% for women from the West and of 53% for women from the East. The lower sharing rule for women from the East reflects the negative interaction term of table 1. I conclude that contrary to what is widely believed in Germany, there is no evidence that East German women have a stronger position within couples.

Evolution over time In the model of table 1, I constrained the coefficients to be the same across all years from 1999 to 2004. I re-estimated the model, allowing for different sharing rules in each year. The results are shown graphically in figure 2. I find that the difference in the point estimate of table 2 is driven almost exclusively by the years 2000 and 2001. In all other years, the estimated sharing rules are practically indistinguishable for East and West German women. The lower panel of figure 2 shows that the difference is never statistically significant.

Comparison with related studies To put my results into perspective, I compare them with two related studies. As noted, the study that is most closely related is by Vermeulen (2006). In fact, I estimate almost exactly the same equation that he does; in particular, I use the functional form for the utility function that he proposes. Using data on Belgium for the 1990s, Vermeulen finds that women in childless couples behave

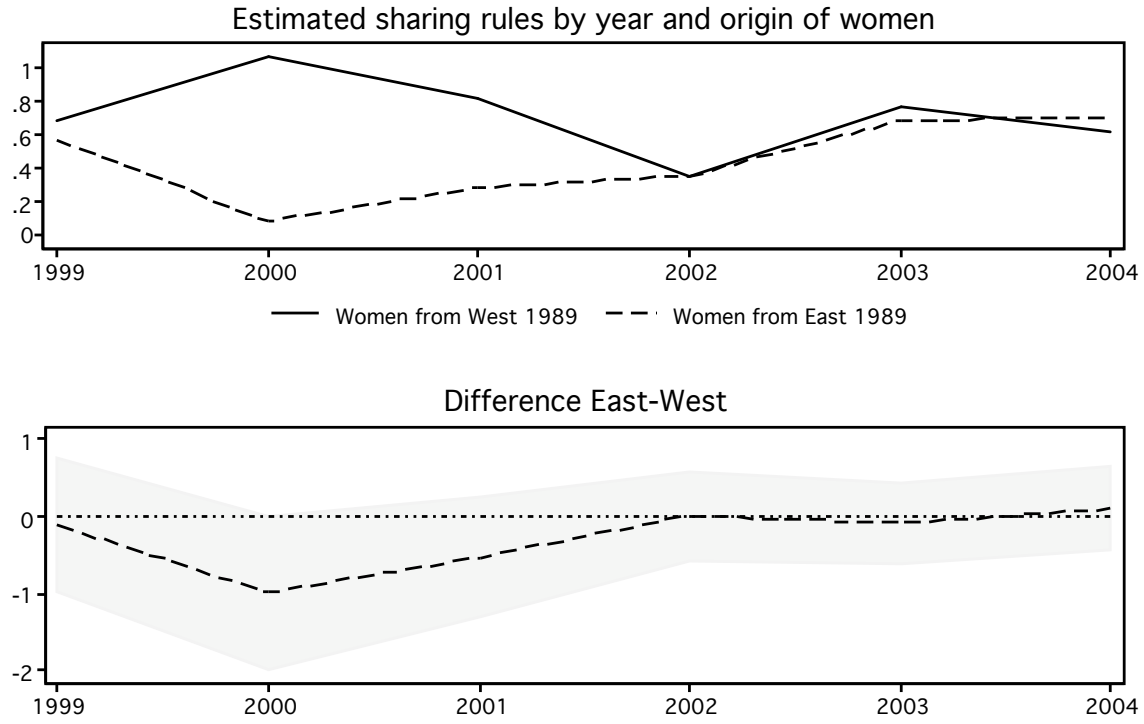

Figure 2: Sharing rules by year (point estimates and 95% confidence band)

as if they received about 18% of total household consumption for zero earnings capacity; this share is estimated to rise with earnings capacity (0.00047 for each euro). Earnings capacity is defined as "the difference between total household consumption when the female works full-time, and total household consumption when she does not participate in the labour market" (p. 103). This result implies that at an earnings capacity of 100 euros, women are estimated to receive 22.4% of household net income. At an earnings capacity of 500 euros, the share is 41.2%, and at 1000 euros it rises to 64.7%. These estimates are close to what I find for Germany.

Beninger et al. (2006) and Beninger et al. (2007) use the 1998 wave of the German Socio-Economic Panel to estimate a less restrictive collective model in which male labour supply is endogenous and in which a leisure interaction term is included in the spouses' utility functions. As in the present paper, labour supply is modelled as a discrete choice, and non-linear taxation is taken into account. By contrast, the sharing rule is not estimated, but identified through a mix of estimation and calibration. Beninger et al. (2006) and Beninger et al. (2007) make the same assumption as in Vermeulen (2006) and in the present article that singles' preferences can be used to identify certain parameters of the utility function of people in couples. After this estimation stage, they calibrate the

measure of bargaining power (as well as the coefficient on the leisure interaction term) so as to minimize, for each couple, the difference with observed labour supply behaviour. The calibrated "power index" reported by Beninger et al. (2007) suggests very equal bargaining power for the majority of couples: the normalized male power index has a mean of 0.51 , with a standard deviation of 0.08, a minimum of 0.33 and a maximum of 0.93 (the normalized male and female power indices sum up to 1). That is, Beninger et al. (2007) find a more equal distribution of bargaining power than the point estimates in the present article. However, recall from above that my 95% confidence interval also includes the value of 0.5.

Using a very similar approach for the 2004 wave of the German Socio-Economic Panel, Beninger (2006) finds a slightly less equal distribution of bargaining power between the two spouses. The mean of the normalized male power index is 0.57 for West Germany and 0.54 for East Germany, with standard deviations of 0.08 and 0.075. These findings run counter to my result (for 1999–2004) that *women* have a stronger position in the West, although this difference is not statistically significant. However, Beninger uses current region of residence, not where the persons lived in 1989.

6 Conclusion

In this paper I estimate a collective model of female labour supply with non-participation and non-linear taxation. The framework is from Vermeulen (2006); the main contribution of the paper is the application of the model to differences in bargaining power between East and West German women. The data are from the German Socio-Economic Panel for the years 1999–2004. The sharing rule is identified using preferences of singles.

I estimate that women receive about 67% of household net income for their individual consumption. Contrary to what many people in Germany believe, there is no evidence that women who lived in East Germany in 1989 have greater bargaining power; if anything, there is evidence that the sharing rule is higher for women from the West. However, the difference is never statistically significant and is driven almost exclusively by the years 2000 and 2001.

These estimates are in a plausible range, comparable to the results of Vermeulen (2006) for Belgium and the results of Beninger et al. (2006), Beninger (2006), and Beninger et al. (2007) for Germany. However, they find a more equal distribution of bargaining power; Beninger actually finds a stronger position for the man, which runs counter to the point estimate of 67% for the *woman* that I find. However, recall from above that my 95% confidence interval also includes the value of 0.5. Finally, Beninger (2006) finds that

women have *greater* bargaining power in East Germany, which also runs counter to the results of the present article. In future work, I plan to combine their richer framework (which allows for endogenous labour supply of the man and for leisure interaction between the spouses) with the larger sample (for 1999–2004) and with the microsimulation model that I use in the present article in order to explore these differences in the results.

Although my sample is already larger than theirs, the consumption share that goes to the woman is unfortunately rather imprecisely estimated, as noted above. Fortin and Lacroix (1997), who also get very imprecise estimates for the parameters for the sharing rule, suggest that "a possible explanation for this result is that these parameters are highly nonlinear functions of statistically significant and insignificant parameter estimates" (953). They also point to the obvious possibility of increasing the sample size to increase the precision of the estimates. They have in mind the inclusion of households in which one partner does not work; they could not include these households the analysis because the restrictions and identification strategy of Chiappori (1992) are valid only for interior solutions to the household's maximization problem. The discrete-choice framework of Vermeulen (2006) that I use does allow me to deal with non-participation, and I accordingly already include households in which one or even both partners do not work. By contrast, unlike Fortin and Lacroix (1997), I completely exclude households with children in order to mitigate concerns about public consumption. One way to increase the sample size that I will explore in future work is to follow the compromise solution of Fortin and Lacroix and to exclude only those couples with pre-school children.

A more important way to increase the sample size is to go back further in time, until the early 1990s. This is more important not only in terms of absolute numbers, but also because it is a more interesting period for the East-West comparison (and its evolution over time) than the period of 1999–2004 that I currently use. As mentioned, the current restriction is due to the fact that the existing microsimulation models for Germany, both at DIW Berlin and ZEW Mannheim, go back until 1999 only (and to 1995 in some old versions). Writing a (possibly simplified) version of the microsimulation model that goes back until the early 1990s will be the main task for future research.

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A Appendix

A.1 Identification

As noted in the text, to identify the share κ it has to be ruled out that women living alone and women living in couples have different preferences for consumption; that is, that they have different coefficients on the terms in the utility function that involve consumption. In other words, it has to be ruled out that *dCouple* is a preference shifter for the terms involving consumption. Accordingly, only age and education are interacted with these terms in the estimation of the conditional logit and mixed logit models. By contrast, the preference for leisure *is* allowed to vary by the woman's origin. That is, *dCouple* can be allowed to be among the preference shifters for all terms that do not involve consumption.

In this subsection I will show formally that if *dCouple* is included among the preference shifters for the consumption terms, the share κ is no longer identified. For notational simplicity, I will leave out other (unproblematic) preference shifters such as age. Also, I illustrate the identification problem for an utility function that is linear in consumption and leisue. That is, unlike in the main body of the text, I set the coefficients on leisure squared and on the interaction of leisure and consumption equal to zero. Finally, I consider only the case of the conditional logit model, in which all coefficients are fixed.

The simplified utility function is then given as follows:

$$U_{nj} = \beta_c(\mathbf{d}_n)c_{nj} + \beta_\ell(\mathbf{d}_n)\ell_{nj} + \varepsilon_{nj} \tag{12}$$

Recall from the main body of the text that individual consumption of woman n at alternative j can be written as

$$c_{nj} = (1 + \kappa_1 dCouple_n)x_{nj} \tag{13}$$

Finally, observed heterogeneity is taken into account by choosing expressions for $\beta_c(\mathbf{d}_n)$ and $\beta_\ell(\mathbf{d}_n)$:

$$\beta_c = \beta_{c0} + \beta_{c1} dCouple_n \tag{14}$$

$$\beta_\ell = \beta_{\ell 0} + \beta_{\ell 1} dCouple_n \tag{15}$$

Plug these expressions into the utility function:

$$U_{nj} = (\beta_{c0} + \beta_{c1} dCouple_n)c_{nj} + (\beta_{\ell 0} + \beta_{\ell 1} dCouple_n)\ell_{nj} + \varepsilon_{nj} \tag{16}$$

Next, acknowledge that c_{nj} is observed only for $dCouple_n = 0$, in which case it is equal

to household net income. That is, plug in the expression for c_{nj} given above:

$$U_{nj} = (\beta_{c0} + \beta_{c1} dCouple_n)(1 + \kappa_1 dCouple_n)x_{nj} + (\beta_{\ell 0} + \beta_{\ell 1} dCouple_n)\ell_{nj} + \varepsilon_{nj} \quad (17)$$

Multiplying out gives

$$\begin{aligned} U_{nj} = {} & \beta_{c0} x_{nj} + \beta_{c1} dCouple_n x_{nj} \\ & + \beta_{c0}\kappa_1 dCouple_n x_{nj} + \beta_{c1} dCouple_n \kappa_1 dCouple_n x_{nj} + \ldots + \varepsilon_{nj} \end{aligned} \quad (18)$$

The terms involving only ℓ_{nj} are unproblematic and have been replaced by three dots for ease of reading. The expression can be simplified by using the fact that $dCouple_n$ is an indicator variable, and hence $(dCouple_n)^2 = dCouple_n$:

$$U_{nj} = \beta_{c0} x_{nj} + [\beta_{c1} + (\beta_{c0} + \beta_{c1})\kappa_1] dCouple_n x_{nj} + \ldots + \varepsilon_{nj} \quad (19)$$

β_{c0}, the coefficient on consumption for women living alone, can be identified (up to scale). However, the equation makes clear that β_{c1} and κ_1 are not identified. Intuitively, this reflects the fact that if women living in couples are estimated to care less about one unit of *household* net income than do women living alone, then this may be because they receive only part of this household income for their own consumption (unlike women living alone, who can dispose of the entire household income) *or* because their preferences for consumption are different when they live in a couple. Both explanations are plausible. However, to identify the share that the woman receives, the second explanation has to be ruled out. That is, the identifying assumption is that $\beta_{c1} = 0$. Then κ_1 can be solved for because both β_{c0} and the product $\beta_{c0}\kappa_1$ are identified (up to scale). Finally, in the East-West comparison, it additionally has to be assumed that $dEast1989$ affects only the coefficients on leisure, but not the coefficients involving consumption.

A.2 Summary statistics

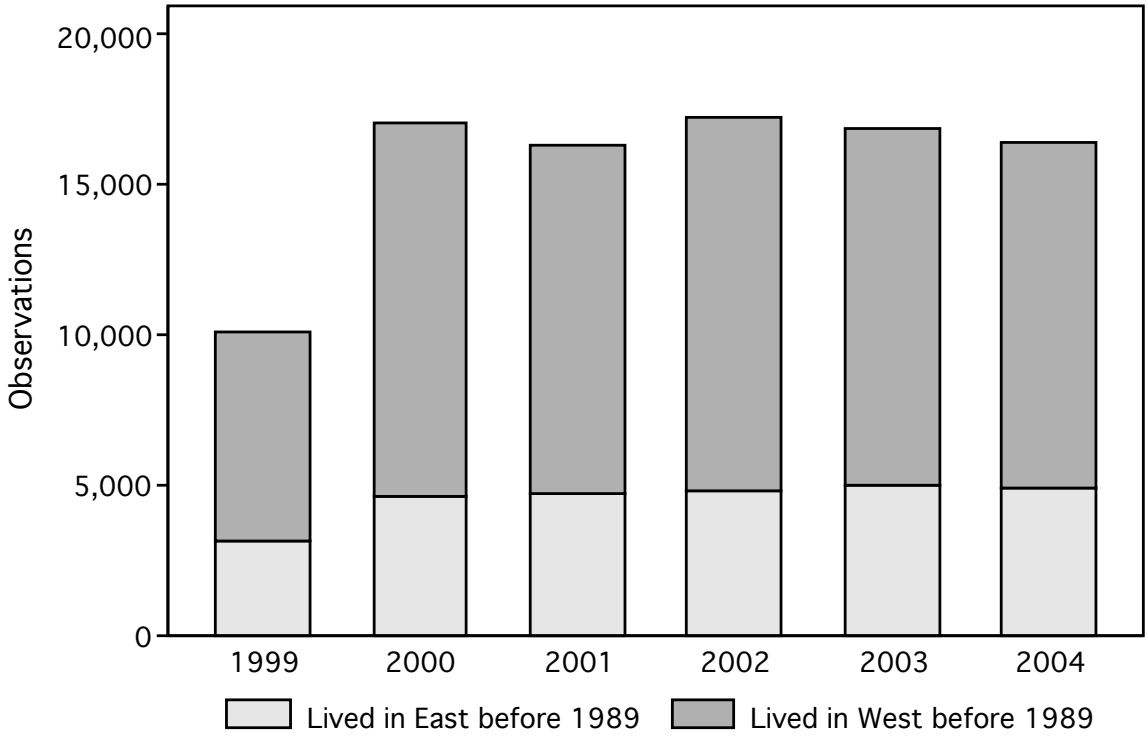

Figure 3: Sample size, by year and region in 1989

Table 3: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Working	0.8	0.4	0	1	10247
Agreed Upon Weekly Work Time	34.09	8.29	2	60	7640
Gross hourly wage (observed)	14.78	8.01	0.14	178.83	7585
Gross hourly wage (predicted)	13.27	3.71	0.45	36.42	9598
Asset income (week)	44.66	236.95	0	11641.68	10247
Public transfers (week)	21.5	57	0	1248.58	10247
Private transfers (week)	2.37	20.3	0	789.15	10247
Public pensions (week)	54.84	134.32	0	1710.38	10247
Total non-labour income (week)	123.38	276.12	0	11641.68	10247
Total non-labour income, incl. earnings of spouse (week)	402.91	504.43	0	11641.68	10247
Lives in two-person household	0.77	0.42	0	1	10247
Married	0.58	0.49	0	1	10247
Age	44.97	11.39	25	60	10247
Lives in East	0.24	0.43	0	1	10247
Lived in East in 1989	0.28	0.45	0	1	9861
No degree	0.01	0.08	0	1	10002
Hauptschule	0.36	0.48	0	1	10002
Realschule	0.39	0.49	0	1	10002
Abitur	0.24	0.43	0	1	10002
Higher education	0.18	0.38	0	1	10127
Potential experience	26.88	12.29	1	47	10088

Note: Monetary values are in 2005 euros.

A.3 Calculation of net income for each hours category

For each household, net income has to be simulated for each of the J hours categories. This simulation is carried out using the tax-transfer simulation model STSM (*Steuer-Transfer-Simulationsmodell*) of DIW Berlin. The microsimulation model STSM is programmed in Stata. It allows to do microsimulation—the simulation of net income before and after a reform—both with and without adjustments of labour supply. The two goals of microsimulation are (1) to identify winners and losers of a hypothetical reform of the tax-transfer system, and (2) to simulate the budgetary (fiscal) effects of the reform. Although no hypothetical reform is evaluated in this paper, I nevertheless need a microsimulation model to simulate the net income a household would earn for each of the J hours categories that the woman can choose from.

The following brief description of the STSM builds on the detailed documentation of Steiner et al. (2008), which also contains references to a number of ex-ante simulations for which the model has been used. I also draw on personal experience with another variant of the STSM, which is currently maintained at ZEW Mannheim. Finally, background information for my description of the German tax-transfer system comes from two additional sources (in German): first, the book by Lampert and Althammer (2004), which is the standard textbook on social policy in Germany and provides more detailed information on transfers and on social security contributions; second, the textbook by Schreiber (2008), which describes the German income tax law.

A.3.1 Taxes

According to the German income tax law (*Einkommensteuergesetz*, EStG), seven income types are liable to income tax: income from dependent employment, capital, renting and leasing, self-employment, agriculture and forestry, business enterprise, and "other income."[22] The GSOEP has information on the first three income sources. As noted above, the sample excludes the self-employed and pensioners, for which the remaining income sources would be relevant. Adding these income sources gives **"income from all sources"** (*Gesamtbetrag der Einkünfte*).

"Income from dependent employment" is by far the most important income source for most households. In the GSOEP, this income source is well captured: one can observe for each individual the income received as an employee, the income from secondary jobs,

[22] "Other income" is not a catch-all category, but a well-defined enumeration of a few other income sources. Since 2005, the most important of these other sources are pensions. However, in the period of study (1999–2004), pensions were not subject to the income tax (except pensions for civil servants, which are counted as income from dependent employment).

bonuses, and the pensions that former civil servants receive.[23] When income is simulated for each of the J hours categories, only income from dependent employment will vary across the alternatives. It is given as gross hourly wages times the number of hours in each category.[24]

The remaining income sources are assumed to be constant for the purpose of the simulation. Moreover, the wage offers (that is, gross hourly wages), are assumed to be constant across the hours categories.[25]

"Adjusted gross income" (*Gesamtbetrag der Einkünfte*) is obtained as "income from all sources" minus the tax allowance for people over age 64 and the tax allowance for agriculture and forestry. The former is modelled in the STSM but does not play a role in the present paper, in which the sample is limited to people between 25 and 60. The second tax allowance is not modelled, since the STSM focuses on people in dependent employment.

"Income" is "adjusted gross income" minus "other expenditures" (*Sonderausgaben*) and "extraordinary charges" (*außergewöhnliche Belastungen*).[26] According to the income tax law, taxpayers can deduce actual expenditures and charges or a lump-sum amount. Un-

[23] As noted, pensions received by former employees who were not civil servants are not counted as "income from dependent employment", but as "other income".

[24] For people who currently work, gross hourly wage is calculated as monthly labour earnings divided by monthly working hours (weekly hours times 52/12). For people who do not currently work, earnings and hours are unobserved, and hence gross hourly wage has to be estimated. (This is also true for people who do work but for whom observations are missing on at least one of these variables.) The wage regression (for the natural logarithm of the gross hourly wage) is estimated separately by sex and by residence in East or West Germany. The predictors are education, tenure, industry, firm size, federal state, and dummy for civil servants. (For people who are currently not working, tenure, industry, and firm size are unobserved. It is assumed that if these people decided to work, they would have average values for industry and firm size and, of course, zero years of tenure (Steiner et al. 2008, 6).) Labour market experience is also controlled for. Here, a strong point of the GSOEP is that, due to the panel structure, one can calculate actual labour market experience (instead of just potential experience, that is, age - (6 + years of schooling)). To correct for selection bias, the wage regression is estimated together with a participation equation, under the assumption that the errors are jointly normally distributed (Heckman 1979). The variables that are included in the participation equation but excluded in the wage regression are non-labour income, a dummy for marriage, dummies for children in different age categories, and dummies for disability and for German nationality.

[25] To relax this assumption, a strand of the microsimulation literature links the microsimulation model of labour *supply* with a computable general equilibrium model (CGE) of labour *demand*. An example of such a linked model that uses the German Socio-Economic Panel is the study by Arntz et al. (2008).

[26] "Other" expenditures because expenditures that are directly related to the generation of income, say, from dependent employment, are already taken into account when calculating "income from all sources". Examples of these professional expenditures (*Werbungskosten*) are the costs for commuting to work or for for work-related clothing. However, as for "other expenditures" and "extraordinary charges", professional expenditures are not observed in the GSOEP. The microsimulation model uses the lump-sum amounts that every taxpayer is entitled to, instead of the actual amounts that have to be justified with receipts. The one exception are expenses for commuting, which are observed in the GSOEP and are added to the lump-sum deduction.

fortunately, though, the actual amounts are not observed in the GSOEP. The microsimulation model therefore assumes that every taxpayer deduces the lump-sum amounts.

Finally, **"taxable income"** is calculated as "income" minus the tax allowance for children (*Kinderfreibetrag*) and the tax allowance for single parents (*Haushaltsfreibetrag*). Concerning the tax allowance for children, the STSM conducts a higher-yield test to compute whether parents benefit financially from applying this tax allowance, as opposed to receiving child benefits (in Germany, parents can receive either the tax allowance or the child benefits, not both at the same time). The single parents' tax allowance is paid to unmarried parents who have at least one child living with them in the same household and for whom they receive either the tax allowance for children or child benefits. Until 2004, every unmarried parent was entitled to the tax allowance for single parents; since 2004, only unmarried parents who live alone are entitled to it. Since the GSOEP contains the necessary information on household living arrangements, the STSM can take this new, stricter legislation into account. (These living arrangements are assumed to be constant across the J hours categories.)

Income tax is calculated by applying the income tax tariff to this measure of "taxable income". The STSM assumes that all married couples living in the same household choose "joint filing". Under joint filing, the taxable incomes for both spouses are added, and the income tax tariff is applied to one half of this amount. The income tax thus calculated is then multiplied by two to get the amount of income tax that the household has to pay.

A slight complication arises from the progressivity tax (*Progressionsvorbehalt*). Certain transfer payments (e.g., unemployment benefits or maternity leave benefits) are themselves exempt from taxation, but are added to taxable income when the tax rate is calculated from the income tax tariff. For instance, if a household has taxable income I (say, from one spouse's earnings), and receives unemployment benefits B (for the other spouse), then the tax rate is found by plugging $I + B$ into the tax function, but this tax rate is then applied only to the taxable income I. The STSM takes this progressivity tax into account.

Finally, the income tax thus calculated is augmented by 5.5%, a "solidarity surcharge" (*Solidaritätszuschlag*) that was created in 1991.

A.3.2 Social security contributions

Net income differs from gross income not only because of the income tax, but also because of the social security contributions that are paid on labour earnings. In Germany, social security contributions are a large chunk (about 40%) of labour costs, which are the sum

of gross wages plus employers' compulsory social security contributions. It is therefore important for the microsimulation model to take these social security contributions into account.

Concerning **health insurance** (*Krankenversicherung*), civil servants and the self-employed are privately insured; by contrast, employees usually have statutory health insurance, unless their earnings exceed a certain threshold, in which case they can opt for private insurance. In the years 1999–2004, the average contribution was slightly under 14% of gross wages, up to the contribution assessment ceiling.[27] Half of the contribution is paid by the employee.

The GSOEP has information on the type of health insurance and, for private insurance, the contribution paid. When simulating net income at each of the J hours categories, the case may arise that by working more hours, an employee would exceed the threshold and could opt for private insurance. Since one does not know the contribution he or she would have to pay in that case, the STSM assumes that employees will stay with the statutory health insurance regardless of the hours category.

In addition to health insurance, employees pay contributions to the **long-term care insurance** (*Pflegeversicherung*). The contribution is 1.7% of gross wages, up to the same contribution assessment ceiling as for health insurance. For **old-age insurance** (*Rentenversicherung*), the contribution was slightly above 19% in the period of study, again up to a contribution assessment ceiling. This ceiling is higher for old-age insurance than for health and long-term care insurance. Finally, contributions to the **unemployment insurance** (*Arbeitslosenversicherung*) are 6.5% of the gross wage, up to the same contribution assessment ceiling as for old-age insurance. During the period of study, all these contributions were equally shared between employees and employers. Details on the rates and contribution assessment ceilings for each year are summarized in the book by Lampert and Althammer (2004, 244).

A.3.3 Transfers

Modelling social transfers is an important part of microsimulation; without taking them into account, the net income for zero hours would be severely underestimated. The microsimulation model STSM captures the four most important social transfers in Germany: unemployment benefits, child-rearing benefits, housing benefits, and social assistance. A fifth important category, child benefits, is already taken into account when computing

[27] Before 1 January 2009, the exact contribution was dependent on the particular insurance fund within the system of statutory health insurance. Only the *average* contribution can be used in the STSM because information on the insurance fund is not available in the GSOEP.

taxable income (see above).

In the period of study (1999–2004), financial help to the unemployed in Germany consisted of two programs: unemployment benefits and unemployment assistance.[28] **Unemployment benefits** (*Arbeitslosengeld*) are paid to the unemployed who register with the employment office and who have paid contributions to the unemployment insurance for at least twelve months during the two years preceding the date on which they become unemployed. Unemployment benefits, which are based on the insurance principle, are not means-tested and are a function of previous net earnings (60% of previous net earnings; 67% for unemployed individuals with at least one child); the duration of benefits depends on age and on the length of the period during which the individual has paid insurance contributions.

Although the panel structure of the GSOEP would allow to calculate the entitlement to and the amount of unemployment benefits for most individuals, it was decided to use not unemployment benefits, but unemployment assistance as a social transfer in the zero-hours category. The argument is that unemployment benefits are temporary whereas the static model of labour supply that is integrated into the microsimulation model models the long-run, not the adjustment to it.

Unemployment assistance (*Arbeitslosenhilfe*) is paid to the unemployed who were no longer entitled to unemployment benefits. The assistance was of unlimited duration and amounted to 53% of previous net earnings (57% for the unemployed with at least one child). Unlike for unemployment benefits, there is a means test: unemployed individuals whose income (from other sources, including the spouse's income) is above a certain threshold are not entitled to unemployment assistance. Another means test concerns the wealth of the household (more precisely, the relatively liquid components of wealth). While the income test can be easily carried out using the GSOEP data, wealth is not observed in all waves. The microsimulation model STSM therefore makes the rather crude assumptions that the household's wealth exceeds the threshold if income from interest payments exceeds 200 euros per year or if income from rental payments exceeds 100 euros per month.

Child-rearing benefits (*Erziehungsgeld*) are paid to parents of young children, under certain conditions. Until 2001, child-rearing benefits were paid during the first 24 months

[28] On 1 January 2005, unemployment assistance was regrouped with the former social assistance, under the new name of "Unemployment Benefits II" (*Arbeitslosengeld II*). The old unemployment benefits, although not directly concerned by this reform, were nevertheless relabelled "Unemployment Benefits I" in order to better distinguish the two programs. For the sake of completeness, the *duration* of "Unemployment Benefits I" was changed by other reforms (on 1 January 2006 and then again in 2008), but given that the data for the present article are for the period 1999–2004, these reforms are not relevant here.

after the birth of the child. Since 2001, parents can choose between a benefit that is paid during 24 months and a slightly higher benefit that is paid during 12 months only.[29] The microsimulation model STSM makes the simplifying assumptions that after 2001, all households choose the variant of the child-rearing benefits with a duration of 24 months.

The two conditions for receiving child-rearing benefits are that the parent who demands the benefit works less than 19 hours per week (30 hours since 2001), and that the household net income does not exceed a certain threshold. This threshold is highest when the child is less than six months old (e.g., in 2001, the threshold was 38350 euros for married couples); households who exceed the threshold are not entitled to child-rearing benefits. For children older than six months the thresholds are lower; at the same time, child-rearing benefits are withdrawn only gradually when the threshold is exceeded.

Housing benefits (*Wohngeld*), to which both renters and owner-occupiers are entitled, are means tested. The amount of housing benefits depends on the number of household members and the income of the household.[30] Moreover, there is a maximum amount of rent (or, for owner-occupiers, loan repayments and maintenance costs) that is subsidized; this maximum amount depends on the age and equipment of the dwelling, and on the rent level of the dwelling. The microsimulation model STSM assumes a take-up rate of 100% for housing benefits.

The same assumption of 100% take-up is made for **social assistance** (*Sozialhilfe*). Social assistance is the welfare program that aims to guarantee a minimum standard of living for everyone.[31] There are standard rates of social assistance for the head of the household[32]; these differ between the federal states. The rates for the other members of the household are calculated relative to this standard rate; these relative rates are the same in all federal states. Beneficiaries also receive certain one-off payments. The microsimulation model assumes that these make up 18% of the regular amount. Finally, expenses for rent and for heating are covered as well (up to a certain amount).

Social assistance is means-tested, with respect to both income and wealth. As for the unemployment assistance (see above), only the means test for income can be directly carried out with the GSOEP data. By contrast, wealth is not observed in all waves; the

[29] In 2007, that is, after the period of study in the present article, the child-rearing benefit was replaced by the "parental leave benefit" (*Elterngeld*).

[30] A complication arises because the definition of income that is used in the calculation of housing benefits is not the same as in the calculation of the income tax. As a result, the microsimulation model recalculates household income according to the appropriate definition in the module that computes the housing benefits.

[31] Since 2005, people who are considered ready to work (for at least three hours per day) no longer receive social assistance but the new "Unemployment Benefits II", the amount of which is closer to social assistance than to the former unemployment assistance.

[32] Social assistance uses a particular definition of the household (*Bedarfsgemeinschaft*).

STSM assumes that the household's wealth exceeds the threshold for social assistance if income from interest payments exceeds 150 euros per year or if income from rental payments exceeds 100 euros per month.