Analysing Welfare Reform in a Microsimulation-AGE Model: The Value of Disaggregation

Melanie Arntz[1], Stefan Boeters[2,*],
Nicole Gürtzgen[1], Stefanie Schubert[1,3]

[1] Centre for European Economic Research, Mannheim

[2] CPB, Netherlands Bureau for Economic Policy Analysis, Den Haag

[3] University of Essen-Duisburg

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Abstract

We present a consistent microsimulation-AGE model combining the labour market AGE model PACE-L, data from the German Socio-Economic Panel and a discrete choice labour supply estimation. The model is used to analyse a reform that cuts the social assistance minimum income and lowers the transfer withdrawal rate in order to encourage labour force participation at the lower end of the wage distribution. We compare a disaggregated and an aggregated version of the model as well as a partial and a general equilibrium variant. It turns out that both disaggregation and general equilibrium feedback tend to mitigate the labour supply response to the reform proposal. While some labour supply indicators react quite sensitively to the level of aggregation, most macroeconomic variables are considerably more robust.

Keywords: applied general equilibrium, discrete working time choice, wage bargaining, labour market reform, logit model, microsimulation

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*Corresponding author: Stefan Boeters, CPB, P.O. Box 80510, NL-2508 GM Den Haag, e-mail: s.boeters@cpb.nl. We thank Michael Feil, Manuel Frondel and a referee of this journal for constructive comments.

1 Introduction

Many European countries keep experimenting with labour market reforms that target the low-skilled segment (for a recent overview see Orsini, 2005). This segment suffers from negative demand effects from skill-biased technological change and shifting world trade patterns as well as supply disincentives resulting from tax and transfer schemes. A specific focus is on this latter "poverty trap", which arises once the difference between the welfare benefits when non-employed and net earnings at low wage levels are too small, and the transfer withdrawal rate is too high. Concrete policy proposals that aim at ameliorating this situation face two main difficulties. First, those who are not able to work cannot compensate the reduction in the welfare payments by more intense search on the labour market. For this group income losses are considered to be unacceptable. Second, lower transfer withdrawal rates usually lead to windfall profits for those workers who are in the respective income bracket and already active in the labour market. These windfall profits and the ensuing tax revenue losses can be so large to make the reforms infeasible from a public budget point of view.

The complex situation poses high requirements for economic models that are used for an ex-ante assessment of such reforms. On the one hand, policy makers will carefully target the relevant groups of workers and seek to cautiously equilibrate the exact values of the tax and transfer rates for a concrete labour market reform proposal to gain political support.[1] On the other hand, specifically tailored tax and transfer reforms – if actually successful in stimulating the labour market – have potentially considerable macroeconomic repercussions through the adjustment of wages and unemployment, as well as the need to balance the public budget. What is called for is therefore some kind of combined micro-macro analysis.

Most existing studies of policy reforms of the suggested type have been performed in the microsimulation tradition (for an overview see Gupta and Kapur, 2000). This means that first labour supply functions are estimated for a large set of individual data and then the effect of the changes in the budget constraints implied by the policy reform in question is simulated. Following van Soest (1995), discrete choice

[1] A current overview of the discussion in Germany can be found in German Council of Economic Experts (2006).

models of discrete labour supply have become popular because they provide a relatively convenient tool to deal with the complexities of non-linear budget constraints and the distinction between the intensive and extensive margin of labour supply (hours of work versus participation). These models have been driven to a sophisticated level with respect to estimation methods (Haan, 2004) and intra-household interaction (Bargain, 2005). Usually, however, they remain confined to the micro level and cannot address the macro issues of endogenously adjusting wages, unemployment and the public budget.[2]

At the other end of the spectrum, we have models in the applied general equilibrium (AGE) tradition (Shoven and Whalley, 1984) that combine a standard AGE setup with a somewhat more detailed labour market module (Hutton and Ruocco, 1999, Böhringer et al., 2005). This strand of AGE models fails to capture the heterogeneity of labour supply due to the restriction to a single representative household. This is problematic especially insofar as it tends to blur the distinction between the extensive and intensive margin of labour supply. There remains an ambiguity between a labour supply increase that is due to higher working hours and one that is due to higher participation. Clearly, this is an obstacle to the analysis of labour market reforms that aim at increasing participation levels among specific labour market segments such as low-skilled individuals. The distinction between the extensive and the intensive margin has been introduced in other AGE models that explore the middle ground between aggregated AGE analysis and micro data: the Dutch MIMIC model (Graafland et al., 2001) and PACE-L (Boeters et al. 2005, 2006, Arntz et al., 2006). These models use a considerably enlarged number of households which are still thought to be representative for a certain type of household in the micro data set. The researcher is then left with a number of difficult questions: how to construct the individual households, which properties to give them, how to calibrate their reactions to empirically estimated values and how to warrant the robustness of the model with respect to the aggregation level. Differences in the characteristics of the individual households can be shown to produce disquietingly divergent outcomes with the same tax reform (Arntz et al. 2006).

[2]There are some studies that complement microsimulation models with simple macroeconomic equations to capture feedback effects, e.g. Snower (1997).

In this paper, we propose an alternative solution to the micro-macro dilemma. We present a consistent micro-macro linkage, combining PACE-L and a microsimulation module based on the German Socio-Economic Panel (GSOEP) with about 3000 households. This set-up allows us to analyse reforms that target the individual level, but also affect macro variables like the wage and unemployment rates. Such an approach is novel in labour market research,[3] but there are other fields of economics where prototypes can be found. One area where the micro-macro linkage is prominently featured is the intersection of international trade and distribution and poverty analysis. Here the typical application is the analysis of trade liberalisation policy that affects both economic aggregates and specific types of households in different ways. Papers in this tradition are Gørtz et al. (2000), Rutherford et al. (2005), Cockburn (2006) and Cororaton and Cockburn (2007). An important difference between these micro-macro studies and labour market analyses is the starting point of the policy shock. While the trade literature models the impact from macro reforms (trade regime shifts) to the micro level (income of individual households), labour market analysis focuses on reforms that start at the individual level. This might explain why Rutherford et al. (2005) conclude that an intermediate level of disaggregation is sufficient, whereas in our analysis full disaggregation seems necessary. In our policy simulations, the comparison between two aggregation levels and between the partial and the general equilibrium model reveals considerable differences. E.g., the range for the changes in labour supply, as a response to the welfare reform considered is from 1.38% to 2.68% in the different model versions. Our preferred model, the disaggregated general equilibrium variant, is in most respects at the lower bound of this range. In general, both the disaggregation of the households and the inclusion of general equilibrium feedback tends to mitigate the economic effects of the reform proposal.

The remainder of the paper is organised as follows. In Section 2, we describe in detail the two building blocks of the model – the discrete choice labour supply module and the AGE framework – and our way of linking them. Section 3 reports the results of the comparative scenario analysis. We simulate cuts in the social assistance level and changes in the transfer withdrawal rate and describe to what extent the

[3]Recent discussion papers that follow a similar approach but focus on other policy issues are Aaberge et al. (2004) and Müller (2004).

results are sensitive to the level of disaggregation. In Section 4, we draw conclusions and sum up. An appendix provides additional information about the estimation results of the discrete-choice model and the German tax and transfer system.

2 The modules of the model and their linkage

Our model combines a discrete choice (DC) labour supply module for heterogeneous households with a multi-sectoral AGE analysis of an open economy. After presenting the two parts one by one (Sections 2.1 to 2.4), we focus on the links between the two modules, which produce feedback (2.5).

2.1 Labour supply: a logit discrete-choice approach

We base the labour supply module on a microsimulation model developed by Buslei and Steiner (1999), which combines a calculator for the household income under the current German tax and transfer system (see Section 2.2) with a DC labour supply estimation that follows van Soest (1995). Income-leisure options are constructed for all households using information from the 1999 wave of the German Socio-Economic Panel (GSOEP). For married males, there are three labour supply options, whereas for all other individuals (married women, single females and males) there are five. This corresponds to the empirical distribution of labour supply behaviour. The options are summarised in Table 8 in the appendix.

From an econometric angle, the multinomial logit is a natural starting point for the discrete choice among a fixed number of working hours. Among the econometric tools for analysing discrete choices, it is often used as a benchmark for more advanced models (for an overview see Train, 2003). Adoptions of the logit model to an AGE setting are rare. Among the few exceptions are the TREMOVE model (De Ceuster et al, 2004), in which the logit approach is used for modelling the demand for different car types, and an early version of WorldScan (Lejour et al., 1999), where it is used for modelling international capital mobility. In a labour market context, Arntz et al. (2006) is one of the very few examples to embed a logit approach in AGE modelling.

According to the DC setup, the utility of each of the k working hours option is a combination of a deterministic part, $\bar{U}$, that depends on a vector of alternative-specific characteristics, x_k, and an additive stochastic term. For household j we then have

$$U_j(x_k) = \bar{U}_j(x_{j,k}) + \varepsilon_{j,k}.$$

The distinctive feature of the logit approach is that the error term, ε_k, is assumed to be independently standard extreme-value distributed. Under this assumption there is an explicit formula for the probability of preferring option k over all other options $l \neq k$ from a set m (McFadden, 1974):

$$P(U_{j,k} > U_{j,l}) = \frac{\exp(\bar{U}_j(x_{j,k}))}{\sum_m \exp(\bar{U}_j(x_{j,m}))}, \quad \forall l \neq k$$

One characteristic consequence of this basic logit approach is the independence of irrelevant alternatives (IIA). Increasing the attractiveness of one option in isolation leads to a loss in probability for each of the other options which is exactly in proportion to the benchmark frequencies. Arntz et al. (2006) demonstrate the consequence of this feature in practical policy analysis compared to an alternative approach that allows shifting only between adjacent working time categories. This alternative approach to modelling discrete labour supply has been used for the Dutch MIMIC model (Graafland and de Mooji, 1999, Bovenberg et al., 2000, Graafland et al. 2001). Arntz et al. (2006) conclude that the fundamental difference in treating switches between alternatives leads to diverging results, and that the logit approach is preferable for its consistency with the underlying estimation techniques.

We remain with the logit approach, but introduce a new way of linking labour supply and the AGE framework, which preserves the full heterogeneity of the labour supply estimation. The model of Arntz et al. (2006) takes account of 26 representative household types (10 single households and 16 couple households), which differ by household composition and skill level (see Appendix A.1). Parameter estimates for the 26 representative households are calculated as arithmetic means of all respective individual households. This aggregation level will be the benchmark for the fully disaggregated specification that is presented in this paper. Instead of using arithmetic means for 26 household types, this full micro-macro linkage uses parameter values for all 3000 households from the GSOEP as well as their individual hourly wages.

In our specification, the argument vector, $x_{j,k}$, of the deterministic part of the utility function, $\bar{U}$, includes the logs of disposable income and weekly hours of leisure for men and women:

$$x_{j,k} = (log(C_j(h^f_{j,k}, h^m_{j,k})), log(T - h^f_{j,k}), log(T - h^m_{j,k})),$$

where h^f and h^m are the working time of the spouses, T is time endowment, and j and k are indexes for the household and the labour supply option, respectively. We follow van Soest (1995) in assuming a quadratic utility function with A and β as parameters that capture the quadratic and linear terms:

$$\bar{U}_j(x_{j,k}) = x'_{j,k} A_j x_{j,k} + \beta'_j x_{j,k}.$$

The parameters include interactions between leisure, income and certain household characteristics (age, dummy for citizenship, East Germany, handicaps and children in certain age brackets). These interactions account for differences in the preferences of households for certain hours-of-work options. In addition, constant terms capture fixed costs of working. For singles we include a constant for all positive hours categories; for couples, there are two constants, one for positive working hours of the woman, the other for both spouses working. We estimate the coefficients separately for couples, female singles and male singles. A complete list of regressors and details on the estimation results can be found in Appendix A.3.

2.2 The budget constraint

In the context of our DC set-up, the budget constraint must be determined for the finite set of hours categories, based on the German tax-benefit-system. First, net monthly earnings are calculated by deducting income taxes and social security contributions from gross monthly earnings. The disposable monthly income is then obtained by adding transfer payments. We consider unemployment benefits (UB) and assistance (UA), social assistance and child benefits (see Appendix A.4 for details).[4]

[4]In 2005 the German social benefit system has undergone a considerable change through the so-called "Hartz IV" reform. Work-related and work-independent benefits were integrated and the dynamic eligibility requirements were adjusted. We think that the disincentives at the lower end of the labour market were not changed much through this reform. Therefore, we remain with the institutional setting and the terminology of the pre-Hartz situation.

If labour supply is zero hours (voluntary unemployment), no unemployment compensation UC (UB or UA) is assigned. Each positive labour supply, in contrast, may result in three different probabilistic labour market states: employment (e), involuntary unemployment with unemployment compensation (b), or involuntary unemployment with social assistance (n). In Germany, UC is available for persons who have paid contributions to the mandatory unemployment insurance for at least one year. However, owing to the static nature of the model, we are not able to determine whether or not a person is entitled to unemployment compensation. Instead, we assume that UC is paid with an exogenous probability P_{UC}.[5] UC is determined on the basis of the chosen category of hours supplied, and the effective replacement ratio is calculated as a weighted average of UB and UA replacement rates. In a last step, the (supplemental) social assistance is assigned based on earnings and other transfer income.

The distinction of three labour market states requires that the value of disposable income for a particular category of working time is calculated as an expected value. We make the simplifying assumption that worker households do not save and use expected disposable income as a proxy for consumption. For singles, we generate the average of the disposable income, y^d, over the three labour market states with the respective probabilities, $P_{i,j}$, $i = e, b, n$, as weights:

$$C_j\left(h_{j,k}\right) = E(y_j^d(h_{j,k})) = \sum_{i=e,b,n} P_{i,j}\ y^d(h_{j,k}, i)$$

In particular, we have $P_{e,j} = (1 - u_j)$, $P_{b,j} = u_j P_{UC}$ and $P_{n,j} = u_j(1 - P_{UC})$, with u_j representing (household type specific) unemployment rates. For couples, the expected disposable income is determined by the weighted average of disposable incomes over the 9 combinations of labour market states:

$$C_j\left(h_{j,k}^f, h_{j,k}^m\right) = E(y_j^d(h_{j,k}^f, h_{j,k}^m)) = \sum_{i,g=e,b,n} P_{i,j}\ P_{g,j}\ y_j^d(h_{j,k}^f, h_{j,k}^m, i, g)$$

For the policy simulations, we use a first-order approximation of the tax-transfer schedule. We disturb the calculations of disposable income marginally at all relevant

[5] We assume P_{UC} to be uniform across households; it equals the empirical share of unemployed persons receiving unemployment compensation (0.8 according to IAB, 2002).

points to calculate numerically the local effective marginal burden of the total tax-transfer system.

2.3 Simulation based on conditional probabilities

Given the individual parameters of the utility functions and the expected disposable incomes for the pre- and post-reform situations, we can proceed with the simulation. However, we must choose between different simulation mechanisms that have been proposed in the literature and can be used with a labour-supply model like the one of Section 2.1. By inserting disposable incomes in the utility function, we arrive at positive probabilities for each labour supply option. These probabilities can be handled in different ways. First, we can take them at face value, treating each household in the sample as representative for a large group of identical households. Second, we can assign the labour supply option with the highest probability to each household. Third – and this is the simulation procedure we opt for – we can combine the probabilities with information about the initial choice as proposed by Duncan and Weeks (1998, see also Creedy and Kalb, 2005).

The Duncan-Weeks simulation method exploits the fact that we have information about the choices of the households in the initial situation, which can be used to transform the utility evaluations of the disposable income into conditional probabilities. This is done by drawing random numbers from the extreme-value distribution, and retaining only those that are consistent with the actual choice of the respective household. In the subsequent simulation, with changed disposable incomes at the different labour supply options, other options will be preferred for a subset of these random numbers. Thus in the initial situation, each household chooses exactly one option, whereas in the post-reform situation, we end up with a genuine probability distribution over all options.

Such a simulation method based on conditional probabilities has two advantages, one general and one specific to our comparison exercise. First, it makes use of the entire information in the initial dataset (including the actual choices of the individuals). Second, it considerably facilitates the comparison of the aggregated and the disaggregated model version (see Section 3). With other simulation methods, we would already start off with different probabilities in our two model variants, because

the the average of logit probabilities does not equal the probabilities calculated with the average of the parameters. This would make any comparison considerably more difficult.[6]

2.4 An AGE framework with decentralised wage bargaining

The labour supply module is embedded in an applied general equilibrium model of Germany ("PACE-L"). The main focus in this section is on the wage determination module of PACE-L, which, through the wage bargaining mechanism, directly interacts with the labour supply decision of the households. The other parts of the model are only sketched. An extensive, algebraic model description and a summary of the data sources used for calibration can be found in Böhringer et al (2005).

Labour Market

Wages are determined by sector-specific bargaining between trade unions and employers' associations. The bargaining outcome is generated through the maximisation of a Nash function, which includes the objective functions of both parties and their respective fallback options. We adopt the "right to manage" approach: Parties bargain over wages, and firms determine labour demand on the basis of the bargained wage. The union represents two types of workers, high skilled and low skilled. For each skill type, the union's objective function is calculated as employment times the value of a job minus the value of unemployment. The values of the labour market states are recursively determined as weighted averages of the incomes in the case of employment and unemployment, where the weights are computed from the transition probabilities between the labour market states (see Pissarides, 1990, for an overview of the search-and-matching approach).

We assume that the trade union is utilitarian with respect to the individual households. The marginal tax rates and the values of the states of employment and

[6]Following the suggestion of a referee, we checked the model results with the other simulation variants as well. Using unconditional logit probabilities produces uniformly participation responses that are about 50% higher. The maximum-probability method results in considerably diverging outcomes across groups, which in the general average level out into a somewhat lower participation effect. We do not expand into these comparisons because they have no direct connection with the micro-macro linkage, but are generic for any microsimulation exercise.

unemployment are therefore calculated as weighted averages over all households and working-time categories. In turn, the wage that results from bargaining in general equilibrium is used to derive the income positions of all households in all possible labour market states. Here we use the numerically approximated values of the marginal effective tax rate (see Section 2.2).

The markets for low and high skilled labour are balanced by aggregating on the demand side over sectors and on the supply side over households. We assume that, with respect to households types, the structure of labour demand is uniform across sectors. The microsimulation module covers all households with flexible time allocation and observable hours of work, which is about 60% of total labour supply. Pensioners, students, women on maternity leave, civil servants and the self-employed are excluded. In the general equilibrium model, they are represented by an additional aggregate household with fixed labour supply. Household-specific unemployment rates are aggregated into economy-wide unemployment per skill group. Changes in aggregate unemployment are distributed among households in proportion to their initial unemployment rates.

In a wage-bargaining setting, the wages respond to reforms in the tax and transfer system through three different channels. First, the reforms change the marginal burden of the total tax and transfer system (either through an explicit change of tax rates or through lower transfer withdrawal rates). This bears on the bargaining outcome through the average skill-specific effective marginal tax rates. However, the effect of a specific reform on the average marginal tax rate is in most cases not clear a priori, because the marginal burden increases for some individuals while it decreases for others. As a benchmark, we know that with a constant average tax rate, an increase in the effective marginal tax rate raises the degree of tax progression, which leads to wage moderation on the part of the unions (Koskela and Vilmunen, 1996). Second, reforms of the transfer system reduce expected income when being unemployed (and thus the fall-back position of unions) in two ways: directly through lower transfer payments and – if they succeed in stimulating labour supply – indirectly through a higher probability of unemployment (at given labour demand). This puts additional pressure on the wages. Third, there is a labour supply effect to the extent that the reform actually stimulates labour supply. In the wage bargaining context this is represented by the fact that the same wage goes along with higher unemployment if labour supply increases.

Firms

In each production sector, a representative firm produces a homogeneous output. The production function is of the nested constant-elasticity-of-substitution (CES) type, combining intermediate inputs, capital and labour of the two skill types. Each individual firm is assumed to be small in relation to its respective sector. All firms in one sector interact through monopolistic competition. This means that firms can exploit market power in their respective market segment. Cost minimisation yields demand functions for the primary factors at the sectoral level and corresponding uncompensated (own and cross) price elasticities for labour that are used in the Nash bargaining FOCs. Capital is mobile across sectors, and the market for capital is perfectly competitive. In the simulations in Section 3 we additionally assume that capital is internationally immobile, which reflects a short- to medium-run model horizon.

Private households

We distinguish the about 3000 individual worker households with flexible labour supply from the microsimulation module, one dummy household with fixed labour supply, and a capitalist household. The capitalist household receives all capital and profit income. Capitalists decide over consumption and investment according to the approach of Ballard et al. (1985). Their utility function is calibrated to empirical saving elasticities. Worker households, by contrast, do not save. The structure of consumption is assumed to be identical across all households. Aggregate consumption is distributed among the different consumption goods according to a CES function.

Government

The main focus of the model in this paper is on the complex tax and transfer system for private households, which are calculated in a special programme module (see Section 2.2 and Appendix A.4). Apart from the taxes and transfers for the private households, the government collects the following taxes: a uniform capital input tax, a profit tax, an output tax in production, and a differentiated consumption tax on all consumption commodities. The government budget contains the revenue from all these taxes, the public purchases of goods, and the balance of payments surplus or deficit. The income tax rate contains a proportional adjustment parameter that is used for balancing the public budget in the counterfactual policy simulations.[7]

[7]Actual policy proposals are rarely fully specified on the income side. Our assumption of a

Foreign Trade

Domestically produced goods are converted through a constant-elasticity-of-transformation function into specific goods destined for the domestic market and the export market, respectively. By the small-open-economy assumption, export and import prices in foreign currency are not affected by the behaviour of the domestic economy.[8] Analogously to the export side, we adopt the Armington assumption of product heterogeneity for the import side. A CES function characterises the choice between imported and domestically produced varieties of the same good. The Armington good enters intermediate and final demand. Foreign closure of the model is warranted through the balance-of-payments constraint.

2.5 Linking the microsimulation and AGE modules

The microsimulation module contains by its very nature a large number of households, labour market states, and detailed equations for the budget constraints at all relevant points. Fully integrating this with the AGE model would generate a lot of slack which is only of minor importance for the general equilibrium reactions. We therefore opt for a model setup where the two modules are kept separate and iterated until we arrive at a global solution. In policy simulations like the ones in Section 3, we start with the modified rules of the tax and transfer system and first simulate labour supply changes under the assumption of constant wages and unemployment rates. The resulting labour supply is aggregated (by skill type) and transferred to the AGE model which is solved under the assumption of a fixed labour supply. This results in changes in wages and unemployment rates, which are fed back to the labour supply module for the next iteration. This proceeds until the two model

budget-balancing change in the income tax must therefore be understood as a shortcut for a complex process of balancing various expenditure and income generating measures in the administrative budgeting process.

[8] The assumption of a small open economy is chosen for simplicity and clearness, but it could certainly be improved upon through an investigation into empirical export demand and import supply elasticities. We followed the suggestion of a referee and did a sensitivity analysis under the assumption of unit trade elasticities. There were virtually no effects on labour supply. In the unemployment rate and the budget-balancing adjustment of the income tax rate some deviations could be observed.

modules converge.[9]

Three points in the linkage set-up need a closer look. First, in aggregating labour supply, we use efficiency weighting. That is, labour supply in hours is weighted by the respective wage rate of the initial situation. Except for this efficiency factor, all labour of the same skill type is perfectly substitutable in production. Second, when we move from the AGE module to the labour supply module, individual wages and unemployment rates need to be adjusted. We assume that all individual wages move in proportion to the average macroeconomic wage of the respective skill group. Unemployment probabilities differ between household type, but are uniform within each type. As the relative labour supply of the household types changes during the iterations of the model, a change in the overall unemployment rate (as an output of the AGE module) does not simply translate into proportional changes in the individual unemployment rates, but must be numerically adjusted. This is done in every iteration step at the transition from the AGE to the labour supply module. Third, in the AGE model with constant labour supply, an assumption is required about the taxation of income changes that are caused by the endogenously adjusting wage. As the individual tax rates are not available in the AGE model, we leave these income changes untaxed in the intermediate iterations of the model. The exact split into net income and tax revenue is only determined in the next run of the labour supply module. Compared to a more accurate approximation rule, this probably reduces the speed of convergence, but it does not affect the final equilibrium.

3 The gain from disaggregation

We now employ our model to simulate a social welfare reform that is designed to stimulate labour market participation of low-income workers. We first explain the before and after-reform situations and then simulate the labour market effects of the reform in two different model versions. Our main interest is in the fully disag-

[9] As a stopping criterion, we use a change in the unemployment rate between two subsequent iterations of less than 10e-5. Usually, the model converges to this precision within less than ten iterations. Remarkably, the convergence in aggregate labour supply is very fast, while the unemployment rates are more volatile, showing oscillating convergence and overshooting their final value in the first iteration by about 100 per cent.

gregated version where all households are characterised by their individual wages and parameter values of the utility function. To set the results into perspective, we complement this version with one at a higher aggregation level, which closely follows the logit model variant in Arntz et al. (2006). Here, wages and utility parameters are averaged for the 26 representative household types of Table 7. In addition, we distinguish between a partial and a general equilibrium variant in order to demarcate differences that are due to the basic labour supply set-up from those that result from general equilibrium feedback.

3.1 Status-quo system and reform scenario

Germany's social assistance system is particularly suited for our demonstration purposes since it produces strong labour market disincentives. The benefit level is widely considered to be too generous, and transfer withdrawal results in effective marginal tax rates that are close to 100 per cent at the bottom of the income distribution.

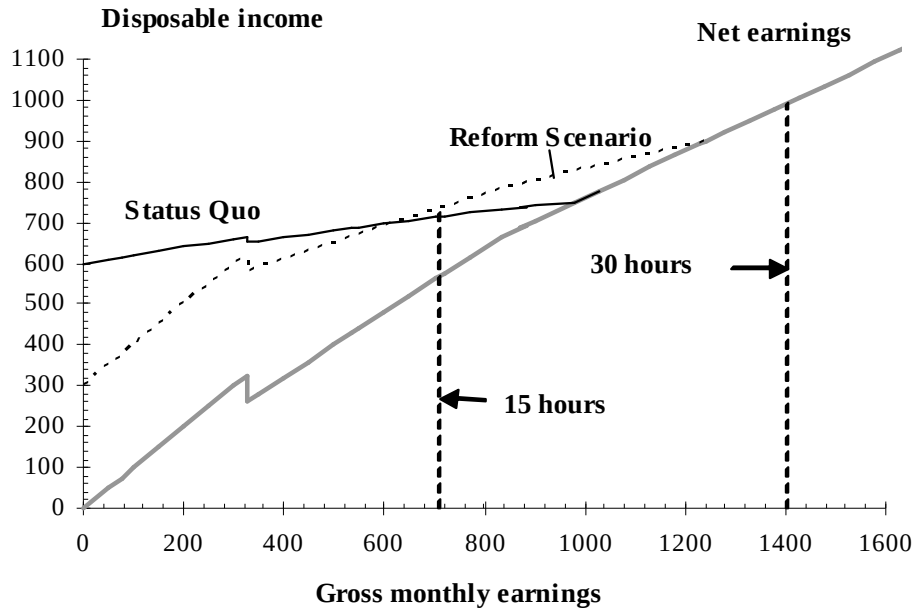

Figure 1: Income function of a single without children

Figure 1 illustrates the relationship between gross and net monthly labour earnings as well as disposable income for a single person without children. Disposable

income in the pre-reform situation (curve "Status Quo") starts at 600 €, which is the social assistance level for this household type. Benefits are phased out at a rate of approximately 80 per cent up to the income level where eligibility ends.[10]

Reform scenario

In our reform scenario, we fully abolish the basic social assistance rate for those welfare recipients who are considered to be able to work. Excepted from this requirement to work are individuals with more than one child (single parents and one of the spouses in couple households). To illustrate the reform scenario, the dashed line in Figure 1 ("Reform Scenario") depicts the new budget constraint for a single person without children. Here, benefits are cut by 50 per cent (from roughly 600 € to 300 €) and the transfer withdrawal rate is reduced to zero up to the net earnings level that is necessary to reach status-quo social assistance. In the example of Figure 1, the individual may now earn 300 € net labour income that is not withdrawn. Net earnings in excess of this amount are subject to a transfer withdrawal rate of 50 per cent up to the break even income where net income corresponds exactly to disposable income. In Figure 1, eligibility for social assistance extends up to net earnings of 900 €. By means of the reform, all positive working time categories become more attractive compared to non-participation, because of the substantial reduction in the benefit level. In addition, the lower transfer-withdrawal may lead to a particular rise in disposable income for the lower working time categories. If this is the case, taking up a part-time job gains in attractiveness compared to a full-time job.

The transfer withdrawal rate for single individuals who are considered non-employable remains the same as in the status-quo system, whereas for employable partners of non-employable persons in couple households it is lowered like for singles. For couple households with more than one child, benefit eligibility extends to considerably higher net earnings levels, e.g. with two children from 1327 € in the status-quo to 1754 €. The disincentives on female labour market participation are thus even increased, because the income range where additional female earnings lead to a loss in social assistance becomes larger.[11]

[10] "15" and "30 hours" in Figure 1 refer to a weekly labour supply of a worker with a gross hourly wage of 10.8 €, which is the mean over all low-skilled individuals.

[11] In this context, it is important that social assistance entitlement is conditioned upon total household income.

3.2 Partial equilibrium results

In this section, we first look at the partial equilibrium results, where gross wages are held fixed and the public budget is not balanced through tax adjustments. These results allow us to focus on the changes in the relative attractiveness of the labour supply options that directly result from the policy measure.

Table 1 shows the labour supply responses for those two household types that react the strongest to the reform, low and high-skilled female singles without children. The participation rate of these households increases by 11.5 p.p. and 8.5 p.p. (aggregated version) or 7.2 p.p. and 6.5 p.p. (disaggregated version). Comparing these numbers leads to two questions: What is the reason for the difference in the participation reaction between the low and the high-skilled? And why is the decrease in non-participation lower in the disaggregated version?

Table 1: Hours distribution of single females without children

	Low-skilled single women			High-skilled single women		
		Post-ref. distrib.			Post-ref. distrib.	
Hours	Benchm. share (%)	Aggr. version	Disag. version	Benchm. share (%)	Aggr. version	Disag. version
	(1)	(2)	(3)	(4)	(5)	(6)
0	20.7	9.2	13.5	13.9	5.4	7.4
15	8.6	9.9	10.1	4.8	5.9	5.9
30	3.4	7.2	6.1	7.4	9.7	9.4
38	53.4	57.8	55.3	53.0	55.9	55.0
47	13.8	16.0	15.0	20.9	23.1	22.4

Concerning the first question, we try to get a better idea of the household-type-specific consequences of the reform by presenting the changes in the expected income for different labour supply options in Table 2. We concentrate on the aggregated version, where we need not deal with within-type heterogeneity. For all individuals in Table 2, the attractiveness of non-participation decreases considerably relative to the positive hours-of-work categories, which provokes the positive

participation reactions. For the high-skilled this is complemented by an increase of the attractiveness in at least one of the positive hours-of-work options (namely, 15 hours). For the low-skilled, no such additional positive incentive for taking up work is active. This difference can be traced back to the fact that the main distinguishing feature between the households is not the hourly wage, but the probability of unemployment. This is important because the households react to *expected* income, taking into account the risk of involuntary unemployment. For the low-skilled, the increase in labour income at the lower working time options is outweighed by the decrease in SA payments, whereas this is not the case for the high skilled.[12] This additional work incentive for the high skilled translates into the higher *relative* increase in participation in Table 1.[13] In terms of percentage-point changes, however, the low skilled react more strongly, because of their lower participation rate in the pre-reform situation.

Table 2: Expected disposable income of female singles without children

	Low-skilled female singles			High-skilled female singles		
Hours	Benchm. income	Post-ref. income	Relative change (%)	Benchm. income	Post-ref. income	Relative change (%)
0	600	300	-50.0	600	300	-50.0
15	702	688	-2.0	724	757	+4.4
30	968	958	-1.1	1090	1087	-0.3
38	1158	1149	-0.7	1316	1313	-0.3
47	1370	1362	-0.6	1560	1556	-0.2

We now turn to the question why participation responses are less pronounced in the disaggregated version (comparing columns (2) with (3) and (5) with (6) in Table 1). In a first step, we must recall that the simulation mechanism is based on conditional probabilities (see Section 2.3). This means that individuals are charac-

[12] Within the range of interest, the changes in expected income in Table 2 translate almost linearly into changes in utility values. Changes in differences between expected incomes can therefore be read as proxies for utility differences, which in turn drive the labour supply decision.

[13] If the only difference between the two household types was in the pre-reform frequencies of non-participation, then the model would produce an exactly proportional reduction of these frequencies.

terised by their initial labour supply choice, and changes are simulated relative to this initial choice. In particular, if we analyse the increase in participation generated by the reform, only those individuals are relevant who were out of the labour market in the initial situation. Individuals that were already participating will hardly ever switch to non-participation in the course of a reform that grossly discourages non-participation. In the disaggregated version, we thus produce additional effects to the extent that the characteristics of the non-participating individuals deviate from the average ones.

A part of the participation difference between the two versions can neatly be traced back to the heterogeneity of wages. A further breakdown of households shows that those not participating (before the reform) are characterised by much lower wages than the average. In fact, these within-type wage differentials clearly outweigh the between-types differentials, which we have found to be rather small.[14] Given these differences in wages, and consequently in expected income, the non-participating households are affected characteristically differently by the welfare reform. Both for high and low-skilled female singles, the part-time option of 15 hours, evaluated at the *average* wage ("AG level"), leads to almost the maximum gain from the reform (see Figure 2 for the case of high-skilled female singles). With lower wages, however, the gain in attractiveness of the 15 hours option is reduced (see "DA level" in Figure 2). This is not compensated by a corresponding increase in the attractiveness of the 30 hours option, which for most household is still above the level of complementary social assistance.[15] Thus, evaluated at their specific characteristics, the non-participating households react more weakly than evaluated at the averages of all individuals of the respective household type.

A similar decomposition effect is at work with respect to the parameters of the utility function. Additional experiments with only partially disaggregated versions of the model showed that both decomposition effects work in the same direction, they both weaken the participation response. However, the decomposition effect of

[14] Figures 3 and 4 in Appendix A.5 present the distributions of hourly wages for the two household types of female singles without children and compare the unconditional with the conditional average.

[15] In the disaggregated case, the expected income of the 15- and 30-hours option depicted in Figure 2 is the average of all individuals not participating in the initial situation. The true values are scattered around this average.

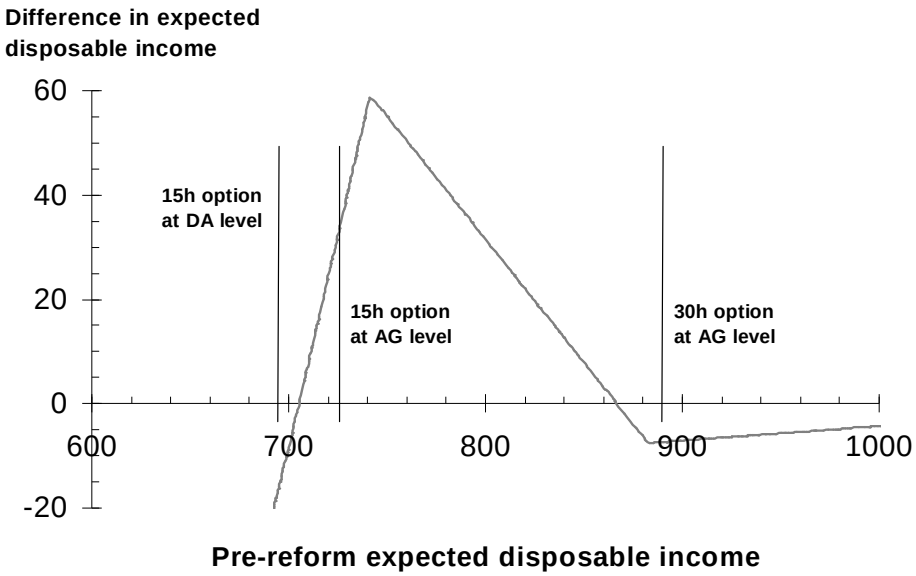

Figure 2: Reform gain of a female high-skilled single without children

the utility parameters is very difficult to pin down in concrete numbers, as several interacting parameters of the utility function are involved. What is going on here, in principle, is that the non-participating households have a higher-than-average valuation of (differences in) leisure, so they react less strongly to incentives originating from the income part of the utility function.

While Table 1 was confined to two particular household types, Table 3 present the effects of the reform on participation rates, average working time and total labour supply (in hours) for a number of sub-aggregates of individuals. Comparing low-skilled with high-skilled individuals, the aggregate participation reactions show a similar pattern to that in Table 1. Increases in participation rates are more pronounced among low-skilled individuals than among the high-skilled (corresponding to the lower participation rates of the low-skilled in the initial situation). As we have seen in the detailed analysis for female singles without children above, the differences between the low and the high-skilled is not so much in the wage (and therefore in the differential consequences of the tax and transfer system), but rather in the unemployment rates.

The results further indicate that the effects on labour supply are stronger among

Table 3: Partial labour supply effects

Group	Aggregated version			Disaggregated version		
	PR	AWT	TLS	PR	AWT	TLS
Married men	1.88	-0.11	1.90	1.39	-0.14	1.35
Married women	0.97	0.13	1.54	0.10	-0.07	0.09
Singles	5.85	-0.36	6.74	4.39	-0.41	4.91
Low-skilled	3.66	0.14	5.47	2.28	0.02	3.33
High-skilled	1.87	-0.05	2.19	1.18	-0.08	1.34
All	2.20	-0.05	2.68	1.38	-0.08	1.64

PR: participation rate (change in percentage points), AWT: average working time (change in per cent), TLS: total labour supply in hours (change in per cent)

singles than among individuals in couples. Couple households are less likely to be affected by the reform because they include more often more than one child and are therefore subject to less severe cuts in the social assistance level. Within couples, married men are found to react stronger than their female counterparts, because the reform scenario discourages labour market participation of couple women with many children.[16] The effect on the average working time (columns "AWT") is not uniform. We have seen in Table 2 that, depending on the individual wage, the reform may favour particularly the low hours-of-work categories or not. In line with the pattern for female singles, we have an increase in hours of work for the low skilled and a fall for the high skilled in Table 3. However, these changes are small and in the general average almost cancel out. The overall change in labour supply (columns "TLS") is therefore dominated by the participation effect.

A further interesting difference between the two model versions emerges in couple households, where the disaggregation leads to a clear shift from female to male par-

[16] This effect is produced by the interaction of the tax-transfer reform and the household labour supply patterns. Through the reform a certain region of low household incomes becomes more attractive. For many households this can be reached by women switching from full to part-time or from part-time to non-participation. Men, in contrast, only choose between full-time and non-participation. This is not suited for the necessary fine-tuning of household income.

ticipation responses. The reason is that with high hourly wages, a couple's earnings may fall out of the gross income range where households are still entitled to supplemental social assistance payments in our reform scenario. Accounting for the full wage distribution captures the disincentives on female labour market participation brought about by the reform in a more detailed manner, since these disincentives are particularly relevant in households with below-average male earnings where additional female earnings may lead to a loss in benefit entitlement.

3.3 General equilibrium results

Finally, we turn to the general equilibrium effects of the reform scenario. In addition to the effects captured by the partial model of Section 3.2, we thus account for wage and labour demand reactions as well as the adjustment of the marginal income tax rate to balance the public budget. Table 4 reports labour supply changes, while Tables 5 and 6 show general equilibrium results for the labour market and other macroeconomic impacts, respectively. Again, we distinguish between an aggregated version (left hand part of the tables) and a disaggregated version (right hand part).

Table 4 shows that labour supply responses are smaller but qualitatively the same as in the partial model version. Like in the partial model, participation rises for almost all groups (the only exception are married women in the disaggregated version). The increase in the participation rate is mitigated from 2.20 p.p. to 1.91 p.p. (aggregated case) and from 1.38 p.p. to 1.22 p.p. (disaggregated version), compared to the values from Table 3. The dampening feedback effect is caused by lower wages (Table 5), which clearly dominate small gains in disposable income through lower marginal income tax rates.

Post-reform average working time is in general lower in the general equilibrium model than in the partial model (Table 4 compared to 3). This can be explained by a relatively higher attractiveness of the low-hours working-time options. Lower wages are here partially compensated by complementary SA payments, whereas this is not the case for the full-time options. As a recurrent pattern, the extensive margin dominates the overall labour supply response, so that the difference in overall labour supply between the general equilibrium and the partial model follows the participation response.

Table 4: Labour supply effects in general equilibrium

Group	Aggregated version			Disaggregated version		
	PR	AWT	TLS	PR	AWT	TLS
Married men	1.62	-0.20	1.52	1.24	-0.20	1.12
Married women	0.70	0.01	1.03	-0.06	-0.12	-0.21
Singles	5.45	-0.49	6.12	4.22	-0.49	4.62
Low-skilled	3.18	-0.04	4.58	2.03	-0.06	2.89
High-skilled	1.62	-0.14	1.81	1.04	-0.13	1.12
All	1.91	-0.15	2.22	1.22	-0.14	1.38

PR: participation rate (change in percentage points), AWT: average working time (change in per cent), TLS: total labour supply in hours (change in per cent)

Table 5: General equilibrium effects on wages and employment

	Aggregated version			Disaggregated version		
	Low skilled	High skilled	Total	Low skilled	High skilled	Total
Gross wage (%)	-4.73	-2.66	-3.63	-4.12	-2.18	-3.09
Labour supply (%)	2.97	1.15	1.38	1.44	0.60	0.71
in 1 000 persons	153.70	347.50	501.20	98.12	222.98	321.10
Employment (%)	3.55	0.99	1.28	3.07	0.81	1.06
in 1 000 persons	146.99	295.31	442.30	135.36	254.82	390.17
Unempl. rate (p.p.)	-0.69	0.16	0.07	-1.66	-0.26	-0.45
Av. marg. tax (p.p.)	4.45	0.65		4.09	1.70	

Table 5 reports the consequences of the reform for wages, employment and unemployment. As a direct response to the higher labour supply, gross wages fall for both skill groups.[17] Downward pressure is higher on low-skilled wages, which reflects the difference in labour-supply changes (second and third row of Table 5). In the general equilibrium model, we are further able to distinguish between labour supply and employment. Table 5 shows that employment increases even more than labour supply. Here another set of forces is at work: the deterioration in the fallback option of the trade unions in the wage bargaining and the increase in the (average) marginal income tax rate.[18] Both these effects lead to additional downward pressure on wages. This is also reflected in the unemployment rates. In the disaggregated version, the unemployment rate is unambiguously decreasing. In the aggregate version, by contrast, unemployment is even increasing for the high-skilled.[19] Here, two forces are at work: the more pronounced increase in labour supply and the lower rise in the average marginal tax rate.

As high-skilled labour represents a considerably larger fraction of our population, the additional labour supply and employment of high-skilled workers exceeds that of low-skilled workers if measured in absolute rather than relative terms (Table 5). All in all, the employment gains produced by the reform are in the range of 400.000 persons.

Table 6 presents the effects on some further macroeconomic variables. The downward movement of the wages is complemented by a rise in the interest rate and a shift in the functional income distribution from labour to capital. Given our stylised assumption that only capitalists invest, this translates also into a shift in spending from consumption to investment. GDP increases by about half a percent as a direct

[17] The changes in labour supply differ between Tables 4 and 5 because the latter also includes the efficiency weighting of the individual (see Section 2.5).

[18] The welfare reform under consideration is almost revenue neutral, as can be seen in row "Inc. tax adjustment" in Table 6. Thus it is not the budget-balancing adjustment of the tax rate that drives the results. Instead, many households are located in the region to which transfer withdrawal is extended through the reform (about 1000 to 1200 € in Figure 1), and therefore face a higher marginal burden.

[19] For the low skilled, the aggregated model version produces a constellation where the unemployment rate falls in spite of a larger number of unemployed persons. This becomes possible because of the increase in labour supply.

Table 6: General Equilibrium Effects on Macroeconomic Variables

	Aggregated version	Disaggregated version
VA share of labour (p.p.)	-1.20	-1.00
Interest rate (%)	4.81	3.89
Aggr. consumption (%)	-0.57	-0.42
Aggr. investment (%)	5.22	4.21
GDP (%)	0.61	0.51
Inc. tax adjustment (p.p.)	-0.11	0.00

consequence of higher employment. All these effects are consistently slightly lower in the disaggregated than in the aggregated version of the model.

4 Conclusions

We present a model for the analysis of tax and transfer reforms that consistently combines a microsimulation labour supply module and an applied general equilibrium module. This framework is used to analyse the consequences of a revenue-neutral tax and transfer reform that is designed to stimulate labour supply at the lower end of the wage distribution. The comparison of the results from the disaggregated and an aggregated version of the model shows that the microsimulation set-up adds essential elements to the analysis of such labour market reforms.

Compared to models with only one aggregate household, the main advantage of the microsimulation-AGE model is that the extensive and the intensive margin of labour supply can be distinguished, so that it is possible to break down changes in total labour supply into changes in the participation rate and changes in the average hours of work. Furthermore, a complex budget constraint can be formulated for each individual household, which integrates the details of national tax and transfer systems in the model. Compared to pure microsimulation studies, the microsimulation-AGE model expands on the endogenous determination of the wage and unemployment rates, the closure of the public budget and sectoral effects.

Turning to the results of our policy scenario and the comparison of the model variants (aggregated vs. disaggregated, partial vs. general equilibrium), we obtain the following results:

- In all model variants, the tax and transfer reform generates considerable positive participation effects. These are most pronounced for single women. Single men and spouses in couples are less affected.
- The effects on the average working time are small for all groups and in all model variants. Changes in overall labour supply are therefore dominated by the participation response.
- Disaggregation of the households mitigates the participation effects due to interaction of the actual participation decision with the wage and parameters of the utility function. In the case of married women, the participation effect changes even qualitatively.
- General equilibrium feedback further dampens the labour supply reactions through a fall in wages. The range of the dampening effect is broadly the same with both levels of aggregation.
- The differences between the two versions with different aggregation levels are in general larger than those between the partial and the general equilibrium model.

Our general conclusion is that both the full disaggregation of the model and general equilibrium feedback is necessary for a detailed study of tax and transfer reforms. The quantitative effects of the model variations are considerable. As a prominent example, the aggregate labour supply changes range from 1.38% to 2.68%, differing almost by the factor two. The disaggregated general equilibrium model is at the lower bound of this range, because it combines the mitigating effects of disaggregation and general equilibrium feedback. Qualitatively, the combination of micro and macro features is necessary to get the full range of interesting economic variables in our view. Disaggregation is required if we focus on specific groups on the labour market (e.g. female singles without children that do not participate); the AGE framework is needed to analyse variables as the wage, consumption, investment or GDP.

As it stands, our model exploits individual data insofar as they are directly related to labour supply. There are other ways in which information from individual data sets could be used to extend and enrich the mechanisms captured by the model. Examples are the sector of employment, the consumption structure, and savings of the individual households. However, extending the model with new features is not a value in itself. It must carefully be checked whether the new interaction effects that are then introduced into the model really can be expected to play a significant role for the analysis of the policy reform in question.

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Appendix

A.1 Household classification for labour supply module

Table 7: Household Disaggregation

Abbreviation	Definition
CijxK	couple, woman skill group i, man skill group j, x children
Mi0	male single, skill group i, no children
Wi0	female single, skill group i, no children
xKi	single (male or female), skill group i, x children

i = L (low skilled), H (high skilled), x = 0, 1, 2 or more

A.2 Working hours options for different household types

Table 8: Discrete Working Hours by Household Types

Individual	Hours Options				
men, married or single without children	0			38	49
men, single with children	0	15	30	38	47
women, single	0	15	30	38	47
women, married	0	9.5	24	38	47

A.3 Estimation results from the microsimulation model

Table 9: Maximum Likelihood Estimates for single females

	Coef.	SE	z	P>z
Net household income	-6.44	1.85	-3.48	0.001
Net household income^2	0.43	0.08	5.22	0.000
Net hh income X leisure	0.48	0.30	1.63	0.103
Leisure X East Germany	-0.96	0.29	-3.32	0.001
Leisure X nationality	0.23	0.41	0.57	0.566
Leisure	77.59	14.10	5.50	0.000
Leisure^2	-9.96	1.80	-5.55	0.000
Leisure X age	-1.11	0.31	-3.65	0.000
Leisure X age^2	0.10	0.04	2.42	0.016
Leisure^2 X age	0.59	0.12	4.83	0.000
Leisure X handicapped	-0.17	0.90	-0.18	0.853
Leisure X children <6 years	4.99	0.60	8.32	0.000
Leisure X children 7-16 years	1.50	0.35	4.29	0.000
Leisure X children >=17 years	-0.48	0.31	-1.53	0.127
Dummy for employment	-2.13	0.25	-8.67	0.000
Number of obs.		540		
Log Likelihood		-636.0		

Conditional logit with five hours-of-work options (0, 15, 30, 38, 49), SOEP 1999

Table 10: Maximum Likelihood Estimates for single males

	Coef.	SE	z	P>z
Net household income	6.76	2.73	2.48	0.013
Net household income^2	-0.019	0.10	-0.19	0.848
Net hh income X leisure	-1.42	0.44	-3.21	0.001
Leisure	169.71	20.03	8.47	0.000
Leisure ^2	-21.13	2.60	-8.12	0.000
Leisure X East Germany	-0.05	0.33	-0.15	0.881
Leisure X nationality	0.29	0.48	0.60	0.547
Leisure X age	-0.74	0.32	-2.34	0.019
Leisure X age^2	0.41	0.12	3.35	0.001
Leisure^2 X age	0.06	0.04	1.46	0.143
Leisure X handicapped	1.32	0.83	1.60	0.110
Dummy for employment	-9.96	1.13	-8.78	0.000
Number of obs.		952		
Log Likelihood		-1286.7		

Conditional logit with five hours-of-work options (0, 15, 30, 38, 49), SOEP 1999

Table 11: Maximum likelihood estimates for couples

	Coef.	SE	z	P>z
Net household income	8.95	5.11	1.75	0.080
Net household income^2	-0.003	0.26	-0.01	0.989
Net hh income X leisure of male spouse	-1.46	0.42	-3.46	0.001
Net hh income X leisure of female spouse	-0.43	0.38	-1.14	0.253
Net hh income X nationality	-6.92	3.82	-1.81	0.070
Net hh income^2 X nationality	0.56	0.27	2.09	0.036
Net hh income X East Germany	5.50	1.87	2.94	0.003
Net hh income^2 X East Germany	-0.49	0.14	-3.37	0.001
Leisure of male spouse	56.72	7.15	7.94	0.000
Leisure of male spouse^2	-4.06	0.47	-8.66	0.000
Leisure of male spouse X nationality	-0.40	0.41	-0.98	0.328
Leisure of male spouse X East Germany	-6.05	2.80	-2.16	0.031
Leisure of male spouse X age	-0.36	0.08	-4.31	0.000
Leisure of male spouse X age^2	0.48	0.10	4.99	0.000
Leisure of male spouse X handicapped	0.76	0.72	1.06	0.290
Leisure of female spouse	79.98	7.00	11.43	0.000
Leisure of female spouse^2	-8.40	0.53	-15.77	0.000
Leisure of female spouse X nationality	0.27	0.40	0.67	0.501
Leisure of female spouse X East Germany	-7.10	2.59	-2.74	0.006
Leisure of female spouse X age	-0.39	0.09	-4.18	0.000
Leisure of female spouse X age^2	0.58	0.11	5.26	0.000
Leisure of female spouse X handicapped	0.97	0.71	1.36	0.175
Leisure of female spouse X children <6 years	4.63	0.31	14.98	0.000
Leisure of female spouse X children 7-16 years	2.13	0.22	9.59	0.000
Leisure of female spouse X children >=17 years	-0.56	0.22	-2.56	0.011
Leisure of male spouse X Leisure of female spouse	-1.50	0.55	-2.72	0.006
Leisure of male spouse X Leisure of female spouse X nationality	0.26	0.14	1.78	0.075
Leisure of male spouse X Leisure of female spouse X East Germany	1.03	0.70	1.47	0.142
Dummy for employment of female spouse	-2.55	0.25	-10.09	0.000
Dummy for employment of both spouses	0.61	0.24	2.54	0.011
Number of obs.		1910		
Log Likelihood		-4186.1		

Conditional logit with fifteen hours-of-work options (female spouse: 0, 9.5, 24, 38, 47; male spouse: 0, 38, 49), SOEP 1999

A.4 Calculation of disposable income

Gross monthly earnings are obtained by multiplying the gross hourly wage with monthly hours of work corresponding to the respective category of weekly labour supply. While the fully disaggregated model accounts for the full distribution of gross hourly wages, the aggregated version distinguishes two average wages for low and high-skilled labour. Low-skilled workers are defined as persons without any formal vocational training, whereas individuals holding a vocational or university degree are assumed to be high-skilled. Individual gross hourly wages are obtained from the German SOEP. Since gross hourly wages are unobserved for those not employed, wages have to be estimated using a Mincer-type wage regression with education, experience and some further controls (e.g. nationality, marital status). Estimates are corrected for the positive selection of employed individuals for whom wages are observed. Variables for identifying the labour force status are the income of other household members and whether someone is handicapped. Household-type-specific wages are a weighted average of individual wages within each household-type, with the weights being supplied hours of work in the benchmark.

To obtain net earnings per month, income taxes and social security contributions are deducted from gross monthly earnings. In general, we apply the tax and transfer rules of the year 2000. The share in social security contributions borne by employees is taken to amount to 20 per cent of gross monthly earnings. Gross monthly earnings of 325 € are exempted from social security contributions. Income taxes are calculated on the basis of taxable income, which is obtained by subtracting a standard deduction from gross earnings. For couple households, income tax legislation allows for marital income splitting: According to this method, the tax schedule is applied to half of the joint taxable income, while the resulting tax amount is doubled to obtain total income taxes paid by the couple.

Finally, disposable monthly earnings are obtained by adding transfer payments to net monthly labour earnings The most important transfer payments in Germany include unemployment insurance, unemployment assistance, social assistance, housing benefits and child benefits. In our model, we account for unemployment benefits and assistance, social assistance and child benefits, while housing benefits are neglected. In Germany, unemployment benefits (UB) are available for persons who have paid contributions to the statutory unemployment insurance for a minimum of one year. In particular, the duration of unemployment benefits depends on the unemployed person's former labour market experience and age. The monthly

amount received equals a constant fraction of previous net monthly earnings. The replacement rate for persons without children is 60 per cent and for persons with children 67 per cent. Unemployment benefits are not means-tested. The entitlement to unemployment benefits is thus completely independent from the labour or transfer income received by the respective spouse.

For those persons who do not have enough experience to obtain unemployment benefits or who have exhausted their unemployment benefits, unemployment assistance (UA) and social assistance (SA) become relevant. The replacement rate for UA payments for persons without children is 53 per cent and for persons with children 57 per cent. In contrast to unemployment benefits, both welfare payments are means-tested, i.e. payments are reduced if either the unemployed person or remaining household members receive other incomes. While UA is only available for those persons who have exhausted their unemployment benefits, eligibility for SA does not require any former entitlement to unemployment benefits. Our model takes into account the means-tested nature of SA payments, but neglects the means-tested nature of UA payments.

A.5 Distribution of hourly gross wage for female singles

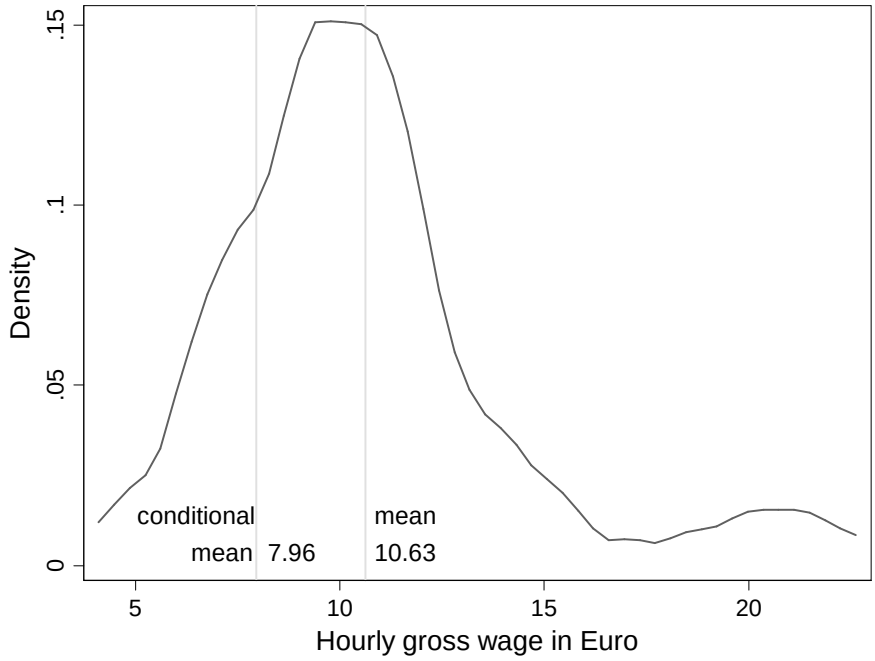

Figure 3: Low-skilled female singles

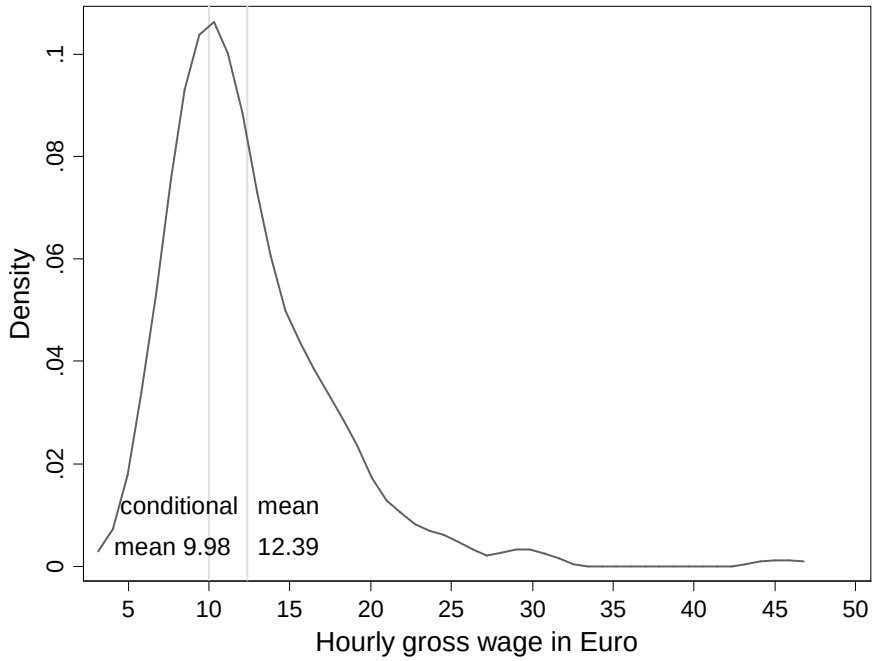

Figure 4: High-skilled female singles