Heterogeneous Labour Markets in a Microsimulation-AGE Model: Application to Welfare Reform in Germany

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Abstract

Labour market reforms that are designed to stimulate labour supply at the lower end of the wage distribution can never be precisely restricted to affect only the target group. Spillovers to and feedbacks from other segments of the labour market are unavoidable and may counteract the direct effects of the reform. An adequate representation of heterogeneous labour markets becomes therefore an important issue for the assessment of reforms. We analyse the possible interactions between labour market segments in a combined, consistent microsimulation-AGE model with both wage bargaining and competitive labour markets. We look at a stylised reform and find feedback effects to the labour supply of the low-skilled to be small. However, the macroeconomic and budgetary consequences of the reform turn out to be sensitive to the representation of the labour markets for the higher skill levels.

Keywords: applied general equilibrium model, microsimulation, discrete working time choice, heterogeneous labour markets, labour market reform

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1 Introduction

Many European countries are engaged in a continuous process of reforming their labour market institutions and the tax and welfare system. The EU countries even committed themselves to explicit labour force participation targets in the context of the so-called "Lisbon strategy" (Gelauff and Lejour, 2006). Labour market reforms particularly focus on the low-skilled segment of labour supply and demand (for a recent overview see Orsini, 2005). This segment is crucial for the overall labour market performance, because unemployment rates are the highest and participation is below average. At the same time we face particularly difficult conditions for employment gains here, because negative demand effects from skill-biased technological change and shifting world trade patterns meet with supply disincentives resulting from the tax and transfer schemes. The situation is often described as a "poverty trap", caused by the small (or even negative) difference between the welfare benefits when non-employed and net earnings at low wage levels, and a high transfer withdrawal rate.

Concrete policy proposals that aim at an amelioration of this situation face two main difficulties. First, those who are not able to work cannot compensate reductions 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. Because of this latter problem we cannot restrict ourselves to the low-skilled segment if we engage in an ex-ante evaluation of labour market reforms. The other segments must be taken into account as well, and the way we model the labour markets for the high skilled can make a considerable difference for the overall assessment of concrete reform proposals.

In general, the assessment of encompassing labour market reform proposals requires a model that combines the most important micro and macro features of the labour market. We think that this can only be achieved in a convincing way if we choose an integrated micro-macro approach that combines microsimulation features and general equilibrium feedback mechanisms. In particular, we take PACE-L, an applied general equilibrium (AGE) model with labour market focus as our point of departure and add a microsimulation module based on the German Socio-Economic Panel (GSOEP) with about 3000 households. (See Arntz et al., 2006b, for a more comprehensive discussion of this approach.)

Such an integrated approach can be contrasted with pure microsimulation studies on the one hand and pure AGE approaches on the other. The usual labour market application of microsimulation (for an overview see Gupta and Kapur, 2000) combines micro-information from a data set of individuals with a discrete-choice labour supply decision modelled in the tradition of van Soest (1995). Usually, however, this approach remains confined to the micro level and cannot address the macro issues of endogenously adjusting wages, unemployment and the public budget.[1] If we approach the analysis from the macro end, we deal with models in the AGE tradition (Shoven and Whalley, 1984) that combine a standard AGE setup with a somewhat more detailed labour market module (Hutton and Ruocco, 1999; Graafland et al., 2001; Böhringer et al., 2005). A common problem in this setup is the distinction between the intensive and extensive margin of labour supply. Even if this problem is solved in principle, as in Graafland et al. (2001), the model can react sensitively to the calibration of the labour supply to empirically estimated values (Arntz et al., 2006a).

Examples of a full micro-macro linkage in applied labour market research are rarely found. Two exceptions are Müller (2004) and Aaberge et al. (2004); the focus of those studies is considerably different, however. Müller (2004) simulates versions of a basic income in Switzerland, and Aaberge et al. (2004) analyse the fiscal consequences of ageing in the presence of labour market reactions in Norway. In the field of international trade and development economics, in contrast, the integrated micro-macro approach is more established (Cockburn (2001), Cororaton (2003), Rutherford et al. (2005)). An important difference between the trade literature models and the

[1] A recent example for Germany that does take involuntary unemployment into account is Bargain et al. (2005).

labour market models should be noted. 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 target the individual level, but also affect the macro level (wage and unemployment reactions).

In our simulation exercises, we explore the interaction between heterogeneous labour markets in the context of a reform that is targeted to the low-skilled segment. In particular, we simulate a reform that increases the labour supply incentives by reducing social assistance payments for those not working, and reducing the transfer withdrawal rate for low wage incomes. We explore to what extent and through which mechanisms the representation of the markets for skills and the formulation of the production structure matter in such a setting. This proceeds in two steps. We depart from our previous approach (Böhringer et al., 2005, Arntz et al. 2006b) and split labour into three instead of two skill groups, which together with physical capital are combined into a value-added aggregate through a flexible production form. In addition we model the labour market for high-skilled workers as perfectly competitive while sticking to the wage-bargaining formulation for the medium- and unskilled groups.

Working with three types of labour has several advantages, in particular with respect to empirical issues. First of all we can calibrate our model on estimates based on the same decomposition of labour, which in the meantime has become rather standard, at least for Germany (e.g. Fitzenberger 1999 or Falk and Koebel, 2001). Switching from a two-level nested CES production function to a flexible functional form is also much more in line with the econometrics of factor demand, where functions such as Translog or Diewert has typically been used. Finally the exclusion of the highly skilled from collective bargaining might be justified on empirical grounds.[2] Our simulation results show that both the implementation of empirically founded substitution patterns between the different skill groups and the labour market institutions for the high skilled can affect the macroeconomic outcomes of the reform significantly. Particularly, the revenue effect of the reform turns out to be highly

[2] A precise modelling strategy would require detailed information on union coverage for sectors and skills, which we do not have.

sensitive to these assumptions. The feedback effects on the labour supply of the low skilled remain small, however.

The remainder of this paper is organised as follows. In Section 2, we describe 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 describes our implementation of the three skill groups and heterogeneous labour market institutions in the model. Section 4 reports the results of the comparative scenario analysis. We compare the model version with three skill groups and heterogeneous labour markets with a simpler setup with only two skill groups and homogeneous labour market institutions. In Section 5, we draw conclusions and sum up. An appendix provides additional information about the estimation results of the discrete-choice model, the German tax and transfer system and the labour demand calibration.

2 The modules of the model

We analyse labour market reforms in an integrated micro-macro model. The micro module consists of a discrete choice (DC) labour supply set-up for heterogeneous households. The macro module is made up of a multi-sectoral AGE model of an open economy with wage bargaining. In this section, we present the two modules individually, and then discuss the links between them, which produce consistent feedback loops. A more extensive discussion of the micro-macro set-up can be found in Arntz et al. (2006b).

2.1 Labour supply: a logit discrete-choice approach

The labour supply analysis in our model is based on the microsimulation model for Germany by Buslei and Steiner (1999). This model combines a calculator for the household income under the current German tax and transfer system (see Appendix A.3) with a DC labour supply estimation of the van Soest (1995) type. 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 6 in the appendix.

According to the DC setup, the utility of each 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):

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

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:

$$\bar{U}_j(x_{j,k}) = x'_{j,k} A_j x_{j,k} + \beta'_j x_{j,k}. \tag{1}$$

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.2.

Given the individual parameters of the utility functions and the expected disposable incomes for the pre- and post-reform situations, we can proceed with simulation. Inserting disposable incomes in the utility function, we arrive at positive probabilities for each labour supply option. We 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.

2.2 The AGE framework

The labour supply module is embedded in an applied general equilibrium model of Germany ("PACE-L"). In this section, we only sketch the general parts of the model. The wage determination module of PACE-L is singled out in Section 3.2. An extensive, algebraic model description and a summary of the data sources used for calibration can be found in Böhringer et al (2005).

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 three skill types (for details, see Section **??**). 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. Capital is mobile across sectors, and the market for capital is perfectly competitive. In the simulations in Section 4 we additionally assume that capital is internationally immobile, which reflects a short- to medium-run model horizon.

Private households

We distinguish about 3000 individual worker households with flexible labour supply, one dummy household with fixed labour supply, and a capitalist household. The dummy household make up for the difference in structure between our micro data set and the national accounts. 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 Appendix A.3). 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.

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. 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.

2.3 Linking the microsimulation and AGE modules

The microsimulation module contains by its very nature a large number of households and labour market states, and detailed equations for the budget constraints at all relevant points. Literally 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 set-up where the two modules are kept separate and iterated until we arrive at a global solution. In policy simulations like the ones in Section 4, 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 modules converge.[3]

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. By assumption, all individual wage

[3] 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.

rates (of each skill group) move in parallel, so adjustment of the weights during the iteration is not an issue. Efficiency weighting corresponds to the assumption that all labour of the same skill type is perfectly substitutable, except for the efficiency factor derived from the empirical wages. Second, when we move from the AGE module to the labour supply module, the 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 (as we do not exploit information about the sectoral employment of the individuals). Unemployment probabilities differ by household type (26 household types differentiated by household composition and skill level), but are equal within each household 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 calibrated. 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.

3 Implementing three skill groups in the MS-AGE model

3.1 Production structure: NNCES implementation

Earlier versions of PACE-L (Böhringer et al., 2005, Arntz et al., 2006b) work with a conventional separable nested CES function to represent production (see Figure 1). Value added is split in a first stage into low skilled labour and an aggregate of high skilled labour and capital. In a second stage, capital and high skilled labour are

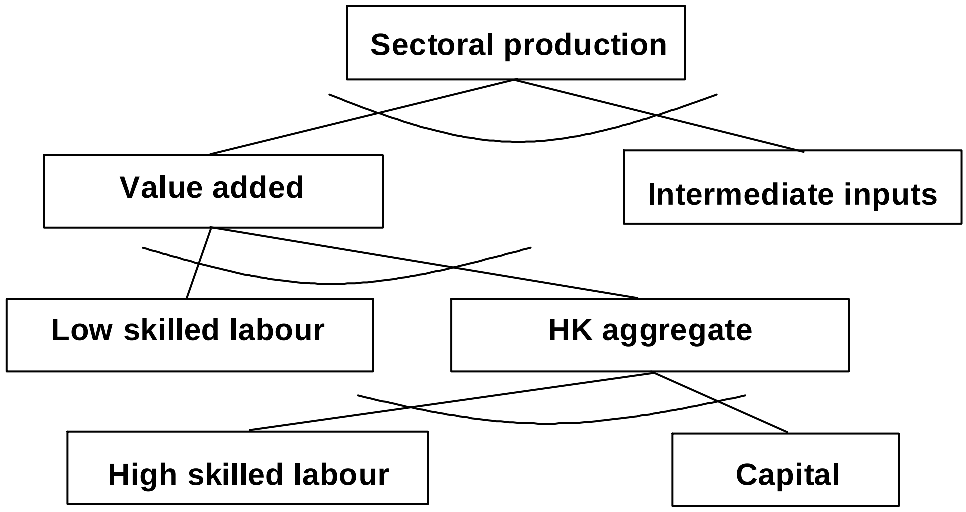

Figure 1: Conventional nested CES in PACE-L

separated. Such a set-up can account for stylised patterns of substitution elasticities, in particular the well known capital-skill complementarity (Fallon and Layard, 1975), but it is not flexible enough to represent full matrices of estimated cross price elasticities.

The restrictions through a structure of nested separable CES functions become the more severe the more primary factors we discriminate. If we extended the structure of Figure 1 and split up high skilled labour in a medium skilled and a high skilled component, we would end up with three free parameters (the three elasticities of substitution in the value-added nest) to be calibrated. A fully flexible structure, however, features at least 6 independent elasticities of substitution: a 4×4 matrix where 6 elements are mirror images of the opposite side and 4 elements are linearly dependent on the other entries in the same row or column. (With three value added components, this relation is more favourable: two endogenous parameters for three exogenous elasticities.) The symmetry assumption restricts the number of free parameters to six. Since for multi-factor production functions, i.e. production functions with three or more inputs, the elasticity of substitution is an ambiguous concept, there can be even more free parameters, depending on the chosen functional form.

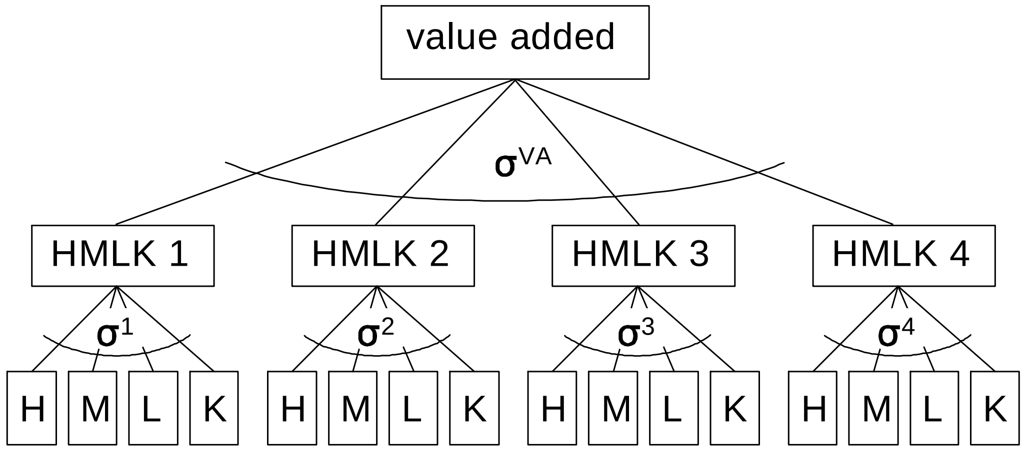

Figure 2: NNCES calibration of value added in production

The NNCES (non-separable, nested CES) approach to production function calibration (Pollak and Wales, 1987, Perroni and Rutherford, 1995, 1998) increases the flexibility of the nested CES framework through an extension to more generic forms. NNCES functions combine flexibility with regularity, which is not the case for most of the traditional flexible forms used in econometrics. The latter can locally represent arbitrary production or cost functions respectively, but they typically do not exhibit global regularity. Perroni and Rutherford (1995) argue that for AGE models global regularity, i.e. the dual cost function must be nondecreasing and concave in prices, must be satisfied, because otherwise computational problems might emerge.

The basic idea behind the NNCES function is that each factor of production can enter the production function at more than one single place (therefore "non-separable"). A typical set-up can be seen in Figure 2: value added is decomposed into four sub-nests, each of which then in turn contains input from all primary factors. Flexibility is increased not only by a larger number of elasticity parameters (five), but also because the shares of the production factors that enter the different sub-nests can be chosen freely.

Actually, the problem turns around. Instead of too few parameters, we now have too many. We face the six exogenous elasticities with 17 free parameters at hand (the five elasticities and 3 free share parameters for each factor). For resolving the resulting indeterminacy, it has been proposed to restrict certain elasticities to zero or one (Pollak and Wales, 1987) or to add a penalty function. We follow a suggestion by Rutherford and penalise dispersion of input factors across several nests as well as large values of the elasticities of substitution. The approach can be expressed algebraically as follows:

$$\begin{aligned}
\max \quad & \sum_{n,i} (\theta_i^n)^2 - \left(\sigma^{VA}\right)^2 - \sum_n (\sigma^n)^2 \\
\text{s.t.} \quad \eta_{ij} &= \sigma^{VA} + \sum_n \left(\sigma^n - \sigma^{VA}\right) \theta_n^i \theta_n^j / \theta_n^{VA} \\
\theta_n^{VA} &= \sum_i \theta_i^{VA} \theta_n^i \\
1 &= \sum_n \theta_n^i
\end{aligned}$$

where i and j are indexes for the factors of production and n is an index for the nests at the intermediate level ("HMLK 1" etc. in Figure 2). The θ_n^i are the shares of the individual nests in the total amount of factor i, θ_n^{VA} is the share of the respective nest in total value added. The Allen-Uzawa elasticities of substitution η_{ij} as well as the aggregate value shares θ_i^{VA} are exogenous to the calibration, the σ's and the θ_i^n's must be endogenously determined. The numerical results of this calibration procedure are listed in Appendix A.4.

Calibration of an NNCES function on estimates derived from traditional flexible forms faces a particular problem. While for the NNCES typical measures of the 'elasticity of substitution' (or second-order curvature index) like the Allen-Uzawa, Morishima or shadow elasticity of substitution are all identical and hence the matrix of substitution terms identical (Perroni and Rutherford, 1997), this is not automatically the case with other flexible functional forms.[4] Thus the question arises on how to construct a symmetric elasticity of substitution matrix, which is a required input for calibration . We proceed in a pragmatic way by first computing Morishima elasticities of substitution (M_{ij}) from the information on demand elasticities (own- and cross-price) in Falk and Koebel (1997). We then take averages of M_{ij} and M_{ji}

[4]See Frondel (1999) and Frondel and Schmidt (2000) for a detailed discussion of different measures of the elastictiy of substitution.

for all $i \neq j$ (where $M_{ij} \neq M_{ji}$) and define the result as Allen-Uzawa elasticities of substitution. Table 1 contains the results of this procedure:

Table 1: Cross price elasticities for value added components

	η_{LM}	η_{LH}	η_{MH}	η_{LK}	η_{MK}	η_{HK}
Agriculture	1.02	0.27	-0.05	0.93	0.42	0.27
Energy and mining	0.27	0.36	0.13	0.14	0.15	0.14
Manufacturing	1.45	1.21	0.54	0.79	0.26	0.19
Construction	0.83	1.25	0.17	1.10	-0.01	0.64
Trade and transport	0.04	0.16	0.12	0.05	0.01	0.14
Financial services	1.14	2.01	0.68	0.62	0.10	0.68
Other services	0.17	0.40	0.35	0.37	0.67	0.57

η_{ij}: Allen-Uzawa elasticities of substitution, L: low skilled, M: medium skilled, H: high skilled, K: capital

3.2 Competitive labour markets vs. collective wage bargaining

We choose a flexible, parametric set-up for the model, so that we can choose for each skill group between a competitive labour market and sectoral wage bargaining. Our default setting for the simulations in Section 4 is wage bargaining for the low and medium skilled and a competitive labour market for the high skilled. In the latter case the labour market equations are straightforward. The competitive wage does the job of equalising supply and demand. Wage bargaining, by contrast, requires a more in-depth explanation.

In the wage bargaining regime, wages are determined by sector-specific negotiations between an employers' association and a trade union. 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 unemployment are therefore calculated as weighted averages over all households and working-time categories of the respective skill group. 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 Appendix A.3).

The three labour markets are balanced by aggregating on the demand side over sectors and on the supply side over households of the respective type. We assume that, with respect to households types, the structure of labour demand is uniform across sectors. The households captured by the microsimulation model include 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 microsimulation model. 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 the wage-bargaining regime, the wages respond to reforms in the tax and transfer system through two 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.

4 Policy Simulations: Welfare reform with heterogeneous labour markets

We now apply the model described in Section 2 and 3 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 version with three skill types and heterogeneous labour markets. However, to set the results into perspective, we complement this version with one that closely follows Arntz et al. (2006b), where we have only two skill types and wage bargaining on all labour markets. In this way, we get a clearer picture of the exact role of labour market differentiation.

4.1 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 as discussed in the introduction. The benefit level is widely considered too generous from an incentive point of view, and transfer withdrawal results in effective marginal tax rates that are close to 100 per cent at the bottom of the income distribution.

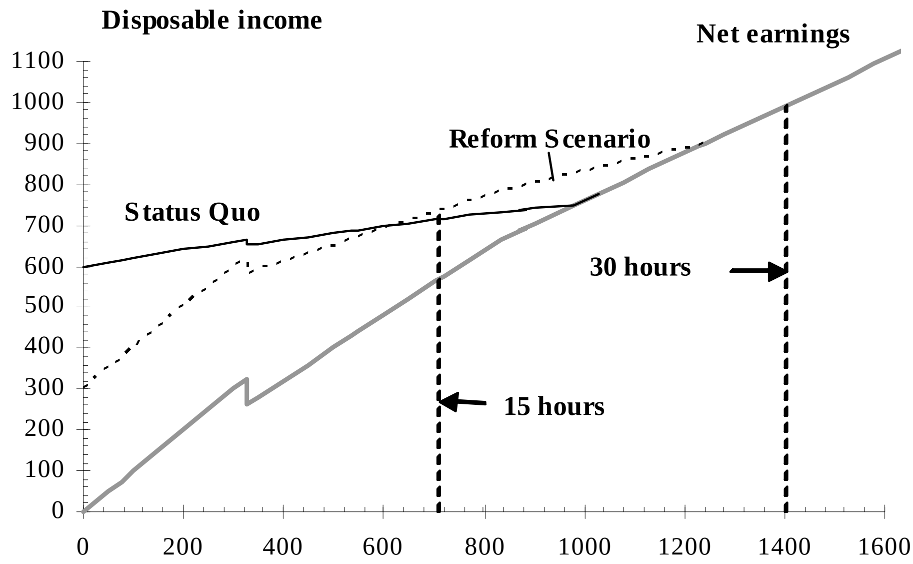

Figure 3: Income function of a single without children

Figure 3 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 break even income, where eligibility ends.[5]

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.[6] Excepted from this requirement to work are individuals with more than one child (single parents and one

[5] “15” and “30 hours” in Figure 3 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.

[6] In 2005 the German social benefit system has undergone a considerable change through the so-called "Hartz IV" reform. Work-related and work-independend benefits were integrated and the dynamic eligibility requirements were adjusted. We think that the disincentives at the lower end

of the spouses in couple households). To illustrate the reform scenario, the dashed line in Figure 3 ("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 3, 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 3, eligibility for social assistance extends up to net earnings of 900 €. Through 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 that 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.[7]

4.2 Simulation results

Table 2 shows the labour supply effects in our policy simulations. We compare two versions of the model: The left-hand side of Table 2 shows the results with the

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.

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

full-fledged three-skills model, where the high skilled are separated from the other two skill types in the production function, and where the labour market for the high skilled, in contrast to the other two skill types, is competitive and without unemployment. For brevity, we call this the "heterogeneous" version. The right-hand side of Table 2 gives the results from a model variant where we work with a homogeneous aggregate for high and medium skilled labour. These two groups are indistinguishable as an input to production, they share the same wage and the same unemployment rate, which is the result of sectoral wage bargaining ("homogeneous" version).

Table 2: Labour Supply Effects

Group	Heterogeneous labour markets			Homogeneous labour markets		
	(1) PR	(2) AWT	(3) TLS	(4) PR	(5) AWT	(6) TLS
Married men	1.39	-0.14	1.34	1.36	-0.16	1.29
Married women	0.22	-0.06	0.43	0.12	-0.11	0.22
Singles	4.32	-0.74	4.30	4.23	-0.76	4.17
Low-skilled	2.53	-0.09	3.72	2.52	-0.11	3.70
Medium-skilled	1.25	-0.25	1.42	1.19	-0.27	1.34
High-skilled	0.85	-0.25	0.71	0.66	-0.35	0.41
All	1.42	-0.22	1.62	1.35	-0.26	1.51

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)

The labour supply responses in Table 2 are qualitatively identical in both model versions and can broadly be characterised as follows:

- Participation goes up for all groups that we distinguish, which is the direct effect of a reform that makes non-participation less attractive.
- The average working time slightly decreases for all groups, a consequence of

the fact that the reform disproportionally favours low working hours (with corresponding low income).

- The change in total labour supply, which combines participation and hours-of-work effects, is positive for all groups. The participation effect obviously dominates.

- Classified by household type, the labour supply effects are the strongest for singles, followed by married men and married women. This is not easily reconciled with the stylised fact that the labour supply elasticity of married women is higher than that of married men. However, incentive effects are intricate within couple households and simulation results need not necessarily closely follow the labour supply elasticity patterns.

- In terms of skill-levels, the labour supply effect is the more pronounced the lower the skill level. This is what one would expect given that the reform is targeted towards the lower end of the labour market, and that the low-skilled are most likely to have low incomes.

Comparing the two versions of the model (left and right panel of Table 2) reveals the following features:

- The changes in the labour supply responses are in general small, but qualitatively uniform over all groups. In the homogeneous version we have (1) a lower participation effect, (2) a larger decrease in working hours, and (3) a lower increase in total labour supply. (The latter is straightforward as (1) and (2) work in the same direction.)

- The reaction of the high skilled depends the most on the model formulation. This is what one would expect given that is here where the modification directly applies. The consequences for the low and medium skilled are significantly less severe.

Note that although the medium and high skilled form a uniform aggregate in the homogeneous model, this does not mean that their labour supply responses are identical. They actually face the same wages and unemployment rates, but, depending on the particular situation of the individual household, this can have different consequences. This carries over to the aggregate results for the skill types to the extent that there are differences in the distribution of high and medium skilled individuals on household types. The fact that the high skilled have a lower participation response (in percentage points) than the medium skilled is explained by their higher initial participation rate (see Table 7 in Appendix A.1). Another potential cause for non-uniform reactions are differences in the individual wages. For high-wage individuals wage changes are more significant, compared to non-work income, than for low-wage individuals.

The interpretation of the results of the heterogeneous model variant therefore requires some care. Not all differences between the skill groups are caused by the heterogeneity of the labour market structure.

We now turn to some aggregate labour market variables to put the labour supply responses in the general equilibrium context which is one of the distinguishing features of our model.

Table 3 highlights some general effects of our reform scenario on the labour markets:

- On labour markets with collective wage bargaining (all cases except the high skilled in the heterogeneous model), a reform that encourages labour supply exerts a downward pressure on wages. Here three forces are at work. First, there is a direct effect of the increase in labour supply (as it would be on a competitive labour market). Second, the trade unions' fallback options deteriorate, since the cut in social assistance directly effects the expected income in the state of unemployment. Third, the reform increases average marginal tax rates, because those who newly enter the phase-out region of the social assistance (between 1000 and 1300 € in Figure ??) dominate the average. This

Table 3: Labour Market General Equilibrium Effects

	Heterogeneous labour markets			Homogeneous labour markets		
	Low skilled	Med. skilled	High skilled	Low skilled	Med. skilled	High skilled
Gross wage (%)	-4.33	-2.13	0.42	-4.38	-2.24	-2.24
average		-1.87			-2.89	
Labour supply (%)	1.86	0.83	0.38	1.85	0.78	0.23
average		0.85			0.78	
Employment (%)	3.24	1.17	0.38	3.27	1.07	0.23
average		1.17			1.11	
Unempl. rate (p.p.)	-1.13	-0.32	–	-1.15	-0.19	-0.19
average		-0.32			-0.30	
Av. marg. tax (p.p.)	3.84	1.70	0.60	4.14	2.00	0.96

in turn leads to wage moderation (see Koskela and Vilmunen, 1996, for the general argument).

- The unemployment rate goes down, which is also an effect of the increase in the marginal tax rate. Consequently, employment can increase more than labour supply.[8]

The two panels of Table 3 differ in the following respects:

- The most striking, even qualitative, difference between the two model variants is the wage of the high skilled. When the high skilled are lumped together with the medium skilled on a unionised labour market, their wage goes down by 2.2%, whereas it increases by 0.4% on a separate, competitive labour market. This last feature of the heterogeneous model is surprising, because, from

[8]The difference in the numbers for the change in labour supply between Tables 2 and 3 has two reasons: In 2, labour supply is given in hours, whereas in 3 in efficient (wage-weighted) hours. Labour supply in Table 3 contains also the dampening effect of the dummy household with fixed labour supply.

a partial-equilibrium perspective, we would expect a fall in the wage as a consequence of higher labour supply on a competitive labour market as well. Obviously there are other forces at work. Through the additional employment of the medium and low skilled, the marginal product of high skilled workers must have increased by so much that they can be paid a higher wage although more of them are employed.[9]

- The slightly lower wages for the low and medium skilled are the most likely candidate for explaining that the labour supply responses are somewhat lower in the homogeneous model. The situation is not totally clear-cut, however, because at the same time the unemployment rate changes. This also works on labour supply, because the labour supply decision is based on the expected income. At least in the case of the low skilled, we have a lower unemployment rate in the homogeneous model, which works in the opposite direction of the lower wage.

Table 4: General Equilibrium Effects on Macroeconomic Variables

	Heterogeneous labour markets	Homogeneous labour markets
VA share of labour (p.p.)	-0.60	-1.04
Interest rate (%)	3.04	4.02
Aggr. consumption (%)	0.09	-0.43
Aggr. investment (%)	3.33	4.36
GDP (%)	0.64	0.53
Inc. tax adjustment (p.p.)	-0.30	0.01

While the feedback effects from the high skilled to the labour markets of the other

[9] This could be further investigated by a sensitivity analysis where we change the elasticities of substitution between the different skill types. We would expect the wage increase for the high skilled to disappear or at least to shrink if the high skilled can be better substituted with the other skill types.

skill types is limited, there are significant consequences for a number of macroeconomic variables (Table 4). In contrast to the two other skill groups, total wage income for the high skilled goes up in the heterogeneous model, which considerably ameliorates the fall in the labour share in value added (-0.6% instead of -1.0%). The higher income of the high skilled also translates into a rise in consumption (+0.1% instead of -0.4%). This apparently overcompensate the fall in investment, so that we end up with a higher increase in GDP than with the homogeneous model. A further striking difference between the two model variants is the consequence for the budget-balancing income tax adjustment. In the homogeneous model we end up with a reform that is almost self-financing. A slight adjustment of 0.01 percentage points is sufficient to balance the public budget. In the heterogeneous model, the situation has changed significantly. The wage increases for the high skilled create so much additional tax revenue through the existing income tax that the income tax rate can be cut by 0.3 percentage points. A policy reform that seems (almost) revenue-neutral in the one model variant becomes a means of revenue generation in the other.

4.3 Sensitivity analysis: What makes the high skilled so special?

To cast more light on the difference between the two model variants of the previous section, we now complement them with an intermediate case, which allows us to decompose the effects. Table 5 reproduces the most interesting variables from Tables 3 and 4. In between, we have a hybrid case where we separate high and medium skilled workers in the production function and calibrate this function to the empirical labour demand elasticities. On the other hand, high and medium skilled are *not* separated in terms of the labour market structure. We assume that the bargaining parties set a uniform wage for these two groups, on the basis of the average values for income (in the event of employment and unemployment) and the marginal tax rate.

The hybrid case in Table 5 is in some respects actually in-between the two other

Table 5: Sensitivity Analysis: Labour Market and Macroeconomic Variables

	Heterogeneous labour markets	Hybrid case	Homogeneous labour markets
High skilled			
Gross wage (%)	0.42	-0.44	-2.24
Labour supply (%)	0.38	0.34	0.23
Employment (%)	0.38	0.83	0.23
Unempl. rate (p.p.)	–	-0.46	-0.19
VA share of labour (p.p.)	-0.60	-0.67	-1.04
Interest rate (%)	3.04	3.45	4.02
Aggr. consumption (%)	0.09	0.13	-0.43
Aggr. investment (%)	3.33	3.78	4.36
GDP (%)	0.64	0.74	0.53
Inc. tax adjustment (p.p.)	-0.30	-0.35	0.01

cases, in other respects it is even more extreme, however. In the hybrid model, as in the heterogeneous one, the calibration of the NNCES production function seems to produce a significant demand shift towards high skilled labour. In the heterogeneous model, where unemployment was not an issue, this led to an increase in the wage of the high skilled. In the hybrid model, the wage does not increase, but the wage cut is significantly smaller than in the homogeneous model, and we have a considerable drop in unemployment instead. High skilled employment rises even more than in the heterogeneous model. The consequence is that consumption and GDP are highest in the hybrid model. This, in turn, means that the income tax rate can be cut even more than in the heterogeneous model.

In the shift from the homogeneous to the heterogeneous model, we thus combine two important steps with partly counteracting consequences. The NNCES production structure in combination with the specifications of the policy reform in question lead to a considerable demand shift towards high skilled labour. The step from a wage bargaining model to a competitive labour market leads to the result that this demand shift translates primarily into a higher wage instead of lower unemployment.

5 Conclusions

This paper contributes to the understanding of general equilibrium effects of microeconomic labour market reforms. Starting from a fully integrated Micro-Macro model, which distinguishes two types of workers in the macro part, for which the same wage-setting process was assumed, we explore the consequences of replacing the "two-skills" by a "three-skills version". The latter featuring not only a more precise description of the production side, but also differences in wage formation.

Our simulation results indicate that adding heterogeneity in the aforementioned way results in much more than "model cosmetics". The enriched three-skills version has more to offer than a slightly more realistic but ineffective depiction of reality. Including a perfectly competitive labour market adds a transmission channel to the macroeconomic part of the model that can change the effects on important target variables. In our simulation exercise the swing in the functional income distribution towards capital income is clearly less pronounced than in the "homogeneous case". Such changes might thus even effect the political appeal of some reform proposals.

In order to allow for an unrestricted matrix of elasticities of substitution within the value-added part of the production function we use the NNCES function. While we implement it here for four inputs, the NNCES in principle is capable of dealing with even more factors of production. While our little exercise has demonstrated the potential usefulness of a higher degree of heterogeneity to study policies targeted at the low skilled, the heterogenous version might also be very interesting for other applications, e.g. analyses of trade and migration policies in multi-sector models when industries exhibit very heterogenous production structures.

Turning to the results of our policy scenario we find that the labour supply effects remain qualitatively unchanged by the change in labour markets:

- 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.
- General equilibrium feedback further dampens the labour supply reactions of low- and medium-skilled workers through a fall in wages. The range of the dampening effect is broadly the same with both levels of aggregation.
- Wages of high-skilled workers, however, rise. Here general equilibrium effects act as a booster.

Concerning major macroeconomic variables we find that:

- The increase in labour supply of high-skilled workers leads to higher employment and consequently to higher output (GDP). There is a small negative effect on relative employment of the unskilled, leading to a slightly smaller drop in the low-skilled unemployment rate.
- The increase in labour supply of high-skilled workers has basically the same effect as an increase of the capital stock: production possibilities are increased. However, high-skilled workers partly absorb the (positive) effects which otherwise would accrue to physical capital.
- High-skilled human capital, traded on a competitive market, turns around the sign of the effect on public budgets.

Our results can be regarded as a warning that the concrete treatment of heterogenous labour in economic models sometimes matters. We view our findings as an argument for more heterogenous or richer models, as well as sensitivity analysis, in particular if the results are directly used for policy consultation.

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A Appendix

A.1 Descriptive statistics

Table 6: 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

Table 7: Descriptive statistics

	Low skilled	Medium skilled	High skilled	All
Number of individuals	854	3016	761	4631
Share in dataset (%)	18.44	65.13	16.43	100.00
Number of singles	152	522	137	811
Share in skill group (%)	17.80	17.31	18.00	17.51
Number of women in couples	412	1225	273	1910
Share in skill group (%)	48.24	40.62	35.87	41.24
Number of men in couples	290	1269	351	1910
Share in skill group (%)	33.96	42.08	46.12	41.24
Participation	587	2455	687	3729
Participation rate (%)	68.74	81.40	90.28	80.52
Share in total participation (%)	15.74	65.84	18.42	100.00
Average hours per worker	35.31	37.39	39.99	37.54
Share in total hours (%)	14.81	65.57	19.62	100.00
Average gross wage per hour	22.68	24.80	34.05	26.30
Share in total wage bill (%)	12.77	61.83	25.40	100.00

A.2 Estimation results from the microsimulation model

Table 8: 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

Dummy page for table 10

Table 9: 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 10: Maximum likelihood estimates for couples

	Coef.	SE	z	P>z
Net household income				
Net household income^2				
Net hh income X leisure				
Leisure				
Leisure^2				
Leisure X East Germany				
Leisure X nationality				
Leisure X age				
Leisure X age^2				
Leisure^2 X age				
Leisure X handicapped				
Dummy for employment				
Number of obs.		952		
Log Likelihood		-1286.7		

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

A.3 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, 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.

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}.[10] 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.

[10] 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).

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

A.4 Details of the NNCES calibration

Tables 11 to 17 present the numerical results of the NNCES calibration in the seven production sectors of PACE-L. Note the following details:

- Usually all four subaggregates are needed for the calibration. In two sectors, however, three subaggregates are sufficient, and the fourth is left empty.
- The calibration procedure is reasonably efficient in concentrating the factors in the subaggregates. Of the 28 cases (four factors in seven sectors), 5 times the factor is concentrated in one subaggregate, 15 times in two subaggregates, 7 times in three, and only once it is spread over all four subaggregates.
- The elasticities are almost always in the unit interval. Only three times (out of potentially 35), the elasticity exceeds one.

Table 11: NNCES calibration for sector “Agriculture”

	(1)	(2)	(3)	(4)
Share	0.08	0.28	0.04	0.60
Low skilled	0.21	–	0.79	–
Medium skilled	0.26	–	–	0.74
High skilled	–	–	0.04	0.96
Capital	–	0.50	–	0.50
σ^n	1.06	–	0.00	0.11
σ^{VA}		0.93		

Table 12: NNCES calibration for sector Energy and mining

	(1)	(2)	(3)	(4)
Share	0.37	0.16	0.38	0.09
Low skilled	–	–	–	1.00
Medium skilled	–	–	0.96	0.04
High skilled	–	0.94	–	0.06
Capital	0.91	0.03	0.06	0.00
σ^n	–	0.23	0.30	0.48
σ^{VA}		0.12		

Table 13: NNCES calibration for sector Manufacturing

	(1)	(2)	(3)	(4)
Share	0.32	0.10	0.42	0.16
Low skilled	–	0.07	0.93	–
Medium skilled	0.58	0.01	0.42	–
High skilled	–	–	0.35	0.65
Capital	–	0.85	0.15	–
σ^n	–	0.49	1.58	–
σ^{VA}		0.00		

Table 14: NNCES calibration for sector Trade and transport

	(1)	(2)	(3)	(4)
Share	0.30	0.10	0.20	0.40
Low skilled	–	1.00	–	–
Medium skilled	–	0.01	0.09	0.90
High skilled	0.13	0.05	0.82	–
Capital	0.99	0.01	–	–
σ^n	0.32	0.29	0.31	–
σ^{VA}	0.01			

Table 15: NNCES calibration for sector Construction

	(1)	(2)	(3)	(4)
Share	0.16	0.19	0.65	–
Low skilled	1.00	–	–	–
Medium skilled	–	0.18	0.82	–
High skilled	0.22	0.54	0.24	–
Capital	0.14	–	0.86	–
σ^n	1.14	0.00	0.06	–
σ^{VA}	0.83			

Table 16: NNCES calibration for sector Financial services

	(1)	(2)	(3)	(4)
Share	0.51	0.31	0.00	0.18
Low skilled	–	0.77	–	0.23
Medium skilled	–	0.12	–	0.88
High skilled	–	0.84	0.06	0.10
Capital	0.73	0.27	–	–
σ^n	–	0.91	–	0.74
σ^{VA}	0.00			

Table 17: NNCES calibration for sector Other services

	(1)	(2)	(3)	(4)
Share	0.70	0.18	0.12	–
Low skilled	–	–	1.00	–
Medium skilled	1.00	–	–	–
High skilled	0.27	0.65	0.09	–
Capital	0.74	0.19	0.08	–
σ^n	0.64	0.54	0.49	–
σ^{VA}		0.17		