Incorporating labor demand effects into the microsimulation of tax and benefits reforms

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Abstract: Microsimulation models usually analyze the effects of tax reforms on labor supply only. In order to make them a more reliable tool for ex ante policy evaluation, they must take into account the demand side as well. This paper proposes a straightforward method to meet this necessity. It uses information on firms' labor demand behavior and feeds them into the labor supply model, completing the partial analytic analysis of the labor market on the micro data level. By simulating the effects of a comprehensive tax reform for Germany, reducing the progessivity of the current schedule, we show that demand effects play an important role for the employment predictions of microsimulation models. In our example, they offset the positive labor supply reactions of the tax reform by about 40 percent.

JEL Codes: D58, J23, H24

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1 Introduction

A central goal of government policy is to provide an institutional framework that promotes a high employment level. This task becomes even more important in times of economic crises, in which governments worldwide try to soften the impact of the financial crash on the real economy. Apart from various economic stimuli plans financed by an increase of the government debt, tax and benefit reforms to disburden households are the second method proposed by Keynesian theory to stimulate consumption, boost employment and eventually mitigate the effects of the economic downturn. Nevertheless, there is a considerable degree of uncertainty of how tax and benefit reform might actually affect households, their income distribution and employment behavior. Although many empirical studies analyze the effects of new tax schedules on the labor market[1], the number of effective cases studied is limited. In general, the research is limited to the tax credit reforms in the UK and the US as well as the new tax schedules introduced in the transition countries of the former Soviet Union.

One of the ways to overcome this lack of natural experiments are microsimulation models. They are based on the estimation of the households' individual tastes for leisure and consumption. Having derived these preferences, the behavioral effects of a tax reform on the labor supply can be simulated. Thus, microsimulation can be interpreted as a quasi-experiment, predicting the effect of changes in the tax and transfer system and making it an important tool for the ex-ante evaluation of policy reforms (see Peichl (2009)).[2]

[1] Feldstein (1995), Eissa and Liebman (1996) and Kumar (2008) analyze the effect of the US Tax Reform Act of 1986, expanding the Earned Income Tax Credit (EITC). Ellwood (2000), Meyer and Rosenbaum (2001), Meyer (2002) and Hotz et al. (2006) study the expansion of the EITC from the mid-eighties until the nineties. Grogger (2003) assesses the impact of the EITC in combination with time limits on welfare. An early study by Blundell et al. (1992) analyzes the labor supply of single mothers in Britain in the presence of taxes. In a different paper the same authors assess the tax reforms of the 1980s in the UK to calculate labor supply responses (Blundell et al. (1998)). Recently, many papers investigate the effects of Britain's 1999 Working Families' Tax Credit Reform on the labor market (see e.g. Blundell et al. (2005), Azmat (2006) or Leigh (2007)). Moreover, there are several papers on the Russian Flat Tax Reform implemented in 2001 (see Ivanova et al. (2005), Gaddy and Gale (2005), Martinez-Vazquez et al. (2006), Gogodnichenko et al. (2009) or Duncan and Sabirianova Peter (2009)).

[2] There are many studies that try to evaluate the effects of changes in the tax and transfer system by simulating the fiscal effects of the reform and the labor supply decisions of households; some examples are Aaberge et al. (1995), Aaberge et al. (1998), Aaberge et al. (1999), Aaberge et al. (2000), Blundell et al. (2000), Creedy and Kalb (2005), Kleven and Kreiner (2006), Immervoll et al. (2007), Fuest et al. (2008) or Paulus and Peichl (2009).

Technically, most microsimulation models simulate the effect of tax reforms by taking two steps. First, they analyze the change in net income after imposing the new tax schedule. In the second-round labor supply adjusts due to the changed disposable income. Normally, the analysis stops at that stage and the effects of the tax reform on employment are reported. In order to do so, the difference in labor supply is implicitly assumed to be equivalent to the difference in employment. This identity, however, neglects the labor demand side and is consequently only true, if labor demand is perfectly elastic. As soon as the demand curve is sloped, the labor supply effect is different from the employment effect. Almost all empirical studies find that labor demand is not perfectly elastic, but that own wage elasticities are negative and finite. Moreover, labor demand elasticities differ across skill groups, and assuming a correlation between skill and wage, also across income.

Consequently, most microsimulation models cannot effectively estimate the actual employment effects induced by tax reforms. Our paper remedies exactly that shortcoming. Following an approach proposed by Haan and Steiner (2006), we develop a method to incorporate the labor demand side into microsimulation models. Instead of relying on elasticity estimates from the literature, we estimate own labor demand functions using a newly developed labor demand model estimated on linked employer-employee data. The detailed administrative data allow us to identify precise labor demand reactions to wage changes for different skill groups. In a second step, we feed the labor demand information into the labor supply model. From a technical point of view, we, thus, add a third stage to the conventional two-step microsimulation procedure. After the calculation of the changed disposable income due to the tax reform and the corresponding labor supply reactions, we employ the labor demand information for different skill groups to find the new labor market equilibrium. In order to do that, we iterate the labor supply reactions taken from the microsimulation model and the demand reactions following our elasticities until the model converges. We thus complete the partial analytic analysis of the labor market.

By integrating the demand side, we propose an alternative approach to enhance the quality of microsimulation models. In the past, much research has been conducted on linking microsimulation models with Computable General Equilibrium (CGE) models.[3] The advantage of our approach is that we overcome possible ag-

[3]For an overview on this strand of literature, see e.g. Peichl (2009).

gregation and linking problems in micro macro models. Our analysis remains on the micro level, since both supply and demand side are estimated using micro data. Moreover, we do not have to model further markets and impose assumptions on how, for example, a decline in consumption translates into a reduction of output. We adopt a partial analytic framework and focus solely on the labor market.

Our extension enhances the prediction accuracy of microsimulation models and consequently the reliability of ex ante policy recommendations. This is especially important, since the actual employment outcome plays a crucial role for the fiscal effects of reforms. A non-elastic labor demand might reduce a positive labor supply effect considerably, lowering the expected tax revenue, increasing the unemployment benefits and possibly casting doubt on the financial feasibility of the whole reform. This is especially important since many tax reform can only be financed if employment effects are positive.

For our simulations, we use the existing microsimulation model IZAΨMOD of the Institute for the Study of Labor (IZA). IZAΨMOD is based on the German Socioeconomic Panel Study (GSOEP), a micro data household panel study, which is representative for the whole German population. By using information on gross wages, non-labor income and employment status as well as household characteristics such as number of household members, the disposable income of each household is calculated by applying the current German tax and transfer system. Given the income and the observed working time, the preferences of consumption and leisure are estimated. As a reform scenario, we choose the tax reform proposal by the German liberal party FDP in the run-up to the German elections in 2009. The main idea of the proposal is to lower progressivity of the current German tax schedule by introducing a system with three brackets.

Our simulation results show that without demand adjustments the tax reductions would yield 630,000 new workers (full-time equivalents). The reaction at the extensive margin is more than 220,000. Taking labor demand into account, however, significantly affects the employment outcome of our simulation. The positive effects of the tax reform are reduced by about 40 percent, which considerably increases the fiscal costs of the reform proposal, and, in fact, makes the reform disproportionately expensive, especially when taking into account the existing German budget deficit. Thus, labor demand works as a stabilizer to labor supply shifts just as a trivial illustration of a supply/demand model would suggest. The stabilizing effects also works in the other direction, that is, if a reform reduces labor supply, the incorporation of labor demand effects countervails the negative supply effects, making the overall employment effect less negative. Further sensitivity tests have shown, that, in line with theory, we find that the higher the demand elasticity, the smaller the demand adjustments.

The setup of the rest of this paper is as follows. Section 2 briefly describes the demand model used to estimate the labor demand elasticities. Section 3 presents IZA's microsimulation IZAΨMOD and the new demand module. Simulations results are presented and discussed in section 4. Section 5 concludes.

2 The labor demand model

The following chapter will first set up the empirical model. After that the estimation is presented, followed by a description of the data. Finally, estimation results are presented.

2.1 The empirical model

Most of the studies that estimate labor demand depart from the dual approach. Given a constant output, cost minimization yields the same factor demands as profit maximization (Hamermesh (1993), p. 25). In general we proceed in three steps: We, first, assume a cost function of some form. We, then, apply Shepard's lemma (see Shepard (1970)) to the cost function and derive estimable factor demand functions conditional on output. From the demand functions it is straightforward to calculate elasticities.

Concretely, there are several cost functions, which can be assumed, such as the Generalized Leontief or Quadratic ones.[4] For this study, we choose a non-constant returns to scale Translog (TL) specification with three differently skilled labor inputs, capital as quasi-fixed input factor and a time trend.[5] The TL cost function goes back to a paper by Christensen et al. (1973) and is, just like the Generalized Leontief specification, a linear second-order approximations to an arbitrary cost function. It belongs to the class of flexible cost functions, which do not restrict the substitution elasticities of input factors, and is therefore preferable to Cobb-Douglas or CES-functions.

[4] For more details and differences, see Peichl and Siegloch (2010a).

[5] In our estimations we also add industry dummies.

Let the short term costs C of a firm, given a certain output Y, be specified as[6]

$$\begin{aligned}\ln C(w_i, Y) = \alpha_0 + \sum_{i=1}^{3} \alpha_i \ln w_i + 0.5 \sum_{i=1}^{3}\sum_{j=1}^{3} \alpha_{ij} \ln w_i \ln w_j + \\ \beta_Y \ln Y + \sum_{i=1}^{3} \beta_{iY} \ln w_i \ln Y + 0.5\beta_{YY} (\ln Y)^2 \\ \gamma_K \ln K + \sum_{i=1}^{3} \gamma_{iK} \ln w_i \ln K + 0.5\gamma_{KK} (\ln K)^2 + \gamma_{YK} \ln Y \ln K \\ \delta_t t + \sum_{i=1}^{3} \delta_{it} t \ln w_i + 0.5\delta_{tt} t^2 + \delta_{tY} t \ln Y + \delta_{tK} t \ln K\end{aligned} \tag{1}$$

where w_i denotes unit costs (i.e. the wage) of the i^{th} labor input, K stands for capital and t is a time index. Besides the condition $a_{ij} = a_{ji}$ several other restrictions on the parameters hold, granting linear homogeneity in factor prices (Diewert and Wales (1987)):

$$\sum_{i=1}^{n} \alpha_i = 1 \quad \sum_{i=1}^{n} \alpha_{ij} = \sum_{j=1}^{n} \alpha_{ij} = 0 \quad \sum_{i=1}^{n} \beta_{iY} = 0 \quad \sum_{i=1}^{n} \delta_{it} = 0 \tag{2}$$

By imposing these restrictions we allow for non-constant returns to scale (NCRS)[7]. To make C independent of time t, the restrictions $\delta_t = \delta_{it} = \delta_{tY} = \delta_{tK} = \delta_{tt} = 0$ would have to hold (cf. Diewert and Wales (1987)).

Applying Shepard's lemma yields the factor demand function $X_i = \frac{\partial C}{\partial w_i}$. Exploiting the fact that the cost function is logarithmized and thus that $\frac{\partial \ln C}{\partial \ln w_i} = \frac{\partial C}{\partial w_i} \frac{w_i}{C}$, we arrive at the cost share of input factor, $S_i = \frac{w_i X_i}{C}$, by differentiating the log of C with respect to the log of w_i

$$S_i = \frac{\partial \ln C(w_i, Y)}{\partial \ln w_i} = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} w_j + \beta_{iY} \ln Y + \gamma_{iK} \ln K + \delta_{it} t \tag{3}$$

[6] There is substantial heterogeneity as far as the concrete specification of the cost function is concerned. Other variables such as the export share can be added to the cost functions. For an overview and analysis of the impacts of different specifications using data on the labor demand of German firms, see Peichl and Siegloch (2010a).

[7] If we wanted to assume constant returns to scale treating capital as fixed and assuming three labor inputs, we would have to impose the following additional restrictions: $\beta_Y + \gamma_K = 1$, $\beta_{YY} + \gamma_{YK} = 0$, $\gamma_{KK} + \gamma_{YK} = 0$, $\delta_{Yt} + \delta_{Kt} = 0$, $\beta_{1Y} + \gamma_{1K} = 0$, $\beta_{2Y} + \gamma_{2K} = 0$ and $\beta_{3Y} + \gamma_{3K} = 0$, where one of the last three restrictions is redundant if homogeneity of degree one in input has been imposed before (see Berndt and Hesse (1986)).

To each of the n share functions a disturbance term ε_i, $i = 1, .., n$, is added. It is assumed that the resulting disturbance vector $\varepsilon = \{\varepsilon_1, ..., \varepsilon_n\}$ is multivariate and normally distributed with mean vector zero and constant covariance matrix Ω^* (Berndt (1991), p. 471). Since the share functions add up to unity, each of the functions can be expressed as a linear combination of the others. As we estimate the system jointly, this would lead to a singular and nondiagonal covariance matrix of the error terms. To remedy that problem one equation has to be dropped by using the restrictions (2) and the relation $S_i = 1 - \sum_{j \neq i} S_j$ (see Greene (2008), p. 278).

We assume three different types of labor, where 1 stands for high-skilled, 2 for medium-skilled and 3 for unskilled labor. We eliminate the equation for the highly skilled S_1. After that, the terms containing $\ln w_1$ in the two remaining equations can be replaced by exploiting that $\sum_j \alpha_{ij} = 0$, and writing the differences of the logs of wages as wage ratios. This gives us the system of share equations to be estimated[8]

$$\begin{aligned} S_2 &= \alpha_2 + \alpha_{22} \ln\left(\frac{w_2}{w_1}\right) + \alpha_{23} \ln\left(\frac{w_3}{w_1}\right) + \beta_{2Y} \ln Y + \gamma_{2K} \ln K + \delta_{2t} t + \varepsilon_2 \\ S_3 &= \alpha_3 + \alpha_{32} \ln\left(\frac{w_2}{w_1}\right) + \alpha_{33} \ln\left(\frac{w_3}{w_1}\right) + \beta_{3Y} \ln Y + \gamma_{3K} \ln K + \delta_{3t} t + \varepsilon_3 \end{aligned} \quad (4)$$

From the cost share it is straightforward to arrive at the labor demand elasticities. The own-wage elasticity is defined as

$$\overline{\mu}_{ii}^{TL} = \frac{\alpha_{ii} - \widehat{S}_i + \widehat{S}_i \widehat{S}_i}{\widehat{S}_i} \quad (5)$$

and the cross-wage elasticity yields

$$\overline{\mu}_{ij}^{TL} = \frac{\alpha_{ij} + \widehat{S}_i \widehat{S}_j}{\widehat{S}_i} \quad (6)$$

Fitted cost shares are used to calculate the elasticities (Berndt (1991), p. 475).

[8] It is possible to estimate the TL system (4) with or without the underlying cost function. If a cost function, as generally defined by equation (1), is included, we get an estimate of α_0. Additionally, it is necessary to include the cost function, in order to impose constant returns to scale, since many parameters on which restrictions have to be imposed, e.g. $\beta_Y + \gamma_K = 1$, do not appear in the share functions.

2.2 Estimation technique

Equation 4 shows that we are faced with a system of equations to be estimated. This is done by using the method of Seemingly Unrelated Regression (SUR) developed by Zellner (1962). Although consistency is not lost when estimating the equations separately with ordinary least squares (OLS), SUR is more efficient. The main advantage of SUR is that error terms can be contemporaneously correlated across regressions.

In a first step, SUR uses equation-by-equation OLS to obtain the covariance matrix of the error terms, Ω. Then a generalized least squares (GLS) estimation is preformed on the system of equations, conditional on Ω (see Greene (2008)). As a possible extension, there is the Iterated SUR (ISUR) method, which iterates the procedure just described until the changes in the estimated parameters and in Ω become arbitrarily small. The results of ISUR are numerically identical to the results obtained when using the maximum likelihood (ML) estimator (Berndt (1991)). As mentioned before, one of the cost share functions has to be dropped. For Zellner's SUR-method the invariance is only guaranteed if, in the first round, the system is estimated equation by equation using least squares without the symmetry restrictions imposed. This invariance also holds when ML estimation procedures are employed (Berndt (1991)). We thus use the ML estimator which was fitted to SUR by Gould et al. (2005).

2.3 Data

We use linked employer-employee data (LEED) to estimated the demand for differently skilled labor. The advantage of LEED in the context of labor demand estimations is straightforward. When only relying on employee data, it is possible to observe qualification and wages, but generally no information on firms is available. When using datasets on firms, variables like output, persons employed and investments are observed, but in general the individual wages of the employees are not available. Sometimes the sum of wages and the number of workers can be used to calculate an average wage. This procedure, however, has a major disadvantage, since the most important variable determining the labor demand from a theoretical perspective, i.e. the wage, is derived from an aggregate. It is not observed on the micro level which automatically casts doubt on the reliability and accuracy of the results.

Our data is taken from a dataset called LIAB. It is the linked employer-employee dataset from the Institute of Employment Research (IAB) in Nuremberg, Germany. The LIAB combines data from the employment statistics from the German Federal Employment Agency (Bundesagentur für Arbeit) with the IAB Establishment Panel, which are panel data on plant level. The employment statistics come from official records, namely the German employment register, which covers all employees paying social security taxes or receiving unemployment benefits. Since 1973 employers have been required to report all employees covered by social security to the social security agencies (Bender and Haas (2002), p. 7). All these notifications are aggregated to a big dataset called *employee history*, which covers about 80 percent of the German employees. Civil servants, self-employed and family workers are not included in the statistics. Among others, the employee history provides information on daily wages, age, seniority, schooling, training, occupation, industry and region (Bender et al. (2000), p. 652).

"The IAB establishment panel contains annual information about establishment structures and personnel-policy decisions in the period from 1993 onwards." (Alda et al. (2005), p. 328). It is a stratified random sample from the population of all establishments that only covers establishments with at least one socially insured employee. The name establishment has to be taken literally, since the unit of observation is the individual plant, not the company. Consequently, there can be several plants per company (Kölling (2000), p. 292). The establishment panel covers 16 industries and 10 employment size classes. In 1993 the sample comprised 4265 plants, that is 0.27 percent of all plants in Western Germany. The Eastern German subsample was established in 1996. By the year 2005 the unified sample has increased to 16,280 establishments.

The employee history is linked with the establishment panel via a plant identifier. In order to reduce the size of the datasets, several versions of the LIAB are available. We pick this cross-sectional design, which covers the years from 1993 to 2006, 4000 to 16000 establishments and 1.8 to 2.5 millions employees a year (Jacobebbinghaus (2008), p. 11). We restrict our analysis to the years from 1996 to 2006, in order to have a sufficiently high number of Eastern German plants. As far as the employees are concerned, we are interested in full-time workers, excluding trainees, home and part-time workers. Moreover, we do not take into account marginally employed workers whose wages are below the lower earnings limit for contributions to the statutory pension fund. As for qualification we distinguish between three skill levels: high-skilled workers hold a university, polytechnical or college degree. Medium-skilled employees have either completed a vocational training or obtained the German highest high school diploma, called "Abitur". Unskilled workers have neither finished vocational training nor obtained the Abitur.[9] Since we are interested in the labor demand depending on the skill levels, individuals with missing information on qualification are dropped. In the end the average deflationized real wage per skill group per establishment can be computed, as well as the number of employees per plant and skill level.

As far as the establishment data is concerned, we are mainly interested in output and capital and therefore limit our analysis to the following six industries: (1) manufacturing, (2) construction, (3) trade, (4) traffic, (5) services and (6) education & health services. We ignore the mining, the agricultural, the banking and insurance as well as the public sector, since these sectors measure their turnover in a different way (Kölling and Schank (2002), p. 13). As for capital there is no direct measure. We approximate capital by the investment in the preceding year. Output and capital are both deflationized using the German consumer price index. Plants with missing information on output or capital are dropped, as well as establishments with less than three workers in one of the three skill categories. Finally, we use weights to make the establishment sample representative for the whole population of German establishments.

The data from the employee history are linked with the establishment sample year by year. Persons working in a plant, which is not part of the Establishment panel, are dropped, as well as establishments whose workers could not be identified in the employment statistics. Eventually, all waves are combined to a pooled cross-section. The set comprises 11 years (from 1996 to 2006) and 3829 establishments, which are on average observed 3.2 times during our period of consideration. On the whole, this gives us 12,344 establishment-year observations.

2.4 Labor demand elasticities

All we need for our demand module are the own-wage demand elasticities for the three skilled types of workers. We therefore restrict the presentation of estimation results to them. For a more thorough analysis and discussion of the effects of different

[9] With that specification we follow several studies, such as Steiner and Wagner (1997), Buslei and Steiner (1999), Bellmann et al. (2002), Kölling and Schank (2002) or Addison et al. (2008).

specifications, see again Peichl and Siegloch (2010a). Estimation statistics can be found in the Appendix.

For the unskilled we find the highest own wage elasticity with -1.82, followed by the high-skilled with -0.90 and the medium-skilled with -0.42[10]. This findings are in line with previous studies on labor demand in Germany (for a detailed literature review cf. Peichl and Siegloch (2010b). Although point estimates of other studies are not identical to our findings, a global pattern can be detected. First, all elasticities are negative and finite, as postulated by theory and corroborating the claim that employment effect cannot be solely determined by labor supply shifts. Second, the absolute value of the own wage elasticity of the unskilled is higher than the elasticity of the medium-skilled. The higher elasticities of unskilled workers are normally explained by skill-biased technological change that favors the highly skilled and thus reduces the relative number of the unskilled who are replaced by machines (see e.g. Bound and Johnson (1992)) and/or by globalization and international competition from low-wage countries that destroy jobs for unskilled workers in industrial countries (cf. for example Freeman (1995)). As for the relationship between the high-skilled and the medium-skilled, the empirical picture is somewhat ambiguous. In about half of the studies on Germany the absolute value of the high-skilled elasticities is bigger than the value of the medium-skilled. In the other half, it is the other way round. Fourth, as far as the magnitude is concerned, most elasticities lie in the interval from -0.05 to -0.9. Yet, elasticities with an absolute value higher than one are not unusual for low-skilled workers.

3 The microsimulation model

The following section will present the microsimulation model of IZA, called IZAΨMOD[11]. After a brief presentation of the data set, the model is based on, the two conventional modules, i.e a static tax benefit module and a behavioral labor supply module of IZAΨMOD are presented. The following subsection describes the new demand module, which extends the existing microsimulation model. The section is concluded by presentation of a reform scenario, which we use to numerically demonstrate the effects of the new demand module.

[10] Using population shares of the three skill groups as weights, the overall labor demand elasticity yields -0.7.

[11] For a detailed documentation of the model see Peichl et al. (2009).

3.1 The data set

Both the tax benefit and the supply module of IZAΨMOD are based on the German Socio-Economic Panel Study (GSOEP), which is a micro data household panel study. GSOEP was started in 1984 as a representative cross-section of the adult population living in private households in (Western) Germany and dealt with the expansion of its "survey territory" due to the fall of the Berlin wall in late 1989 by introducing the East German sample in June 1990 (see Wagner et al. (2007), p. 148). The number of cases was enlarged over the time by additional samples that represent the entire German population. Moreover, the representativeness of the sample was improved by oversampling certain groups such as high income households or foreigners. Thanks to a refresher sample in 2006 the cross-sectional number of cases is at the level of about 25,000 individual respondents.

The main purpose of GSOEP is to measure well-being. Besides information on psychological and, more recently, also on behavioral concepts, the main focus rests on data on household income, which is also the major dimension of information exploited by IZAΨMOD. Among others we draw the following data from GSOEP: gross wage, job type, government transfers, working time, composition of household, age of all members, education of members, housing costs. IZAΨMOD is constantly updated to the newest GSOEP wave, but it is also possible to employ older waves (back to the year 2005) to analyze potential effects of changes in the German population, e.g. in the household composition.

IZAΨMOD differentiates between five types of households: (A) single households, (B) single parents, (C) couple households where only one spouse is flexible as far as working hours are concerned and (D) couples with two flexible spouses.[12] The fifth category are inflexible households, whose labor supply decision is assumed to be inflexible, such as pensioners or students. It is assumed that the labor supply reaction of the inflexible households is based on a different consumption leisure decision (or at least with a different weighting of the relevant determinants[13]) than that of those working full time. We assume that a person is not flexible in his/her labor supply, meaning he or she has an inelastic labor supply, if a person is either

- younger then 16 or older then 65 years of age,
- in education or military service

[12] This notation will be kept during the rest of the documentation.

[13] Therefore, it is not possible to assume the same econometric relationship for these persons.

- receiving old-age or disability pensions
- self employed or civil servant.

Every other employed or unemployed person is assumed to have an elastic labor supply.

Another important differentiation is the assignment of individuals to three skill levels. As assumed for the demand estimation, the high-skilled hold a university, polytechnical or college degree. Medium-skilled workers have either completed a vocational training or obtained the German highest high school diploma, called "Abitur". Unskilled workers have neither finished vocational training nor obtained the Abitur.

The database is updated to the year of analysis (i.e. 2009) using an static ageing technique proposed by Quinke (2001), which allows controlling for changes in global structural variables as well as a differentiated adjustment for different income components of the households.[14]

3.2 The tax benefit and labor supply module

In the past, the microsimulation model the Institute for the Study of Labor, IZAΨMOD, consisted of two parts. The first is a static microsimulation module for the German tax and benefit system. The second one, an econometrically estimated labor supply model, which enables IZAΨMOD to take into account behavioral reactions to tax reforms. These two module will be presented in the following. In the next subsection, we present the newest extension to the model, which allows the user of IZAΨMOD to assess the global economic effects of policy measures.

The simulation steps of the two conventional modules can broadly be described as follows: In the static microsimulation module we simulate the current tax system in 2009, using updated database. The result of this simulation is the benchmark for different reform scenarios. The modeling of the tax and transfer system uses the technique of microsimulation.[15] IZAΨMOD computes individual tax payments for each case in the sample, considering gross incomes and deductions in detail. The individual results are multiplied by the individual sample weights to extrapolate the

[14] Cf. Gupta and Kapur (2000) for an overview of those techniques and Peichl et al. (2009) for implementation in IZAΨMOD.

[15] Cf. Gupta and Kapur (2000) or Harding (1996) for an introduction to the field of microsimulation.

fiscal effects of the reform with respect to the whole population. After simulating the tax payments and the received benefits at the status quo, we apply the tax reform and simulate the change in disposable income. That enables us to analyze the first-round distributional effects of the tax reform.

In the behavioral module, we use the disposable income at the status quo and the information on employment status and working hours to estimate the consumption/leisure preferences of the households' utility function. We apply a discrete labor supply model as proposed by Van Soest (1995), assuming seven working time categories: 0, 10, 15, 20, 30, 40 and 50 hours. The direct utility function is estimated using McFadden's conditional logit model (see McFadden (1973)), maximizing the probability that the household chooses the observed working hour category, given its characteristics and its calculated net income. We, then calibrate the error terms of each household using an analytical approach, proposed by Bonin and Schneider (2006). In a last step, we use the estimated consumption/leisure preferences and the calibrated error terms to simulate the labor supply effect induced by the tax reform and the changed disposable income.

3.3 The labor demand module

We now add a third module to IZAΨMOD, which is intended to take into account labor demand adjustments after a change of the labor supply. The rationale behind the demand module can be best described graphically. Figure 1 visualizes the operating mode of the demand module. In the beginning, we are situated in the labor market equilibrium of point A. A tax reform shifts the labor supply to the northeast (LS^B). Without a demand module, implicitly assuming a perfectly elastic labor demand, the resulting employment would rise to E^B. Taking into account the labor demand curve, however, it is trivial to see that this cannot be the equilibrium of the labor market under perfect competition, since supply does not equal demand. As the own-wage labor demand elasticities are theoretically and empirically negative, the rise in employment $\Delta E^1 = E^B - E^A$ is associated with a decrease in the wage, $\Delta w^1 = w^C - w^A$. We thus calculate Δw^1 using ΔE^1 and the demand elasticities and simulate the net income of the household given w^C. The change in net income will again have an effect on labor supply, which is simulated using the behavioral labor supply module. Assuming a positive labor supply elasticity, the labor supply shifts to the left (from LS^B to LS^D), reducing the initial positive employment effect. Once again using the demand elasticities, this reduction of the employment, $\Delta E^2 = E^D - E^B$, will lead to an increase in the wage, $\Delta w^2 = w^E - w^C$, shifting the supply curve to the right (LS^D to LS^F). This procedure is iterated until the employment shifts and thus the wage shifts become arbitrarily small[16] and the model converges. At this point supply equals demand and we are situated in the new market equilibrium, at point Z. We assume that the model converges instantaneously, i.e. within one period; that is why the intermediate stages of the iteration process are presented in grey.

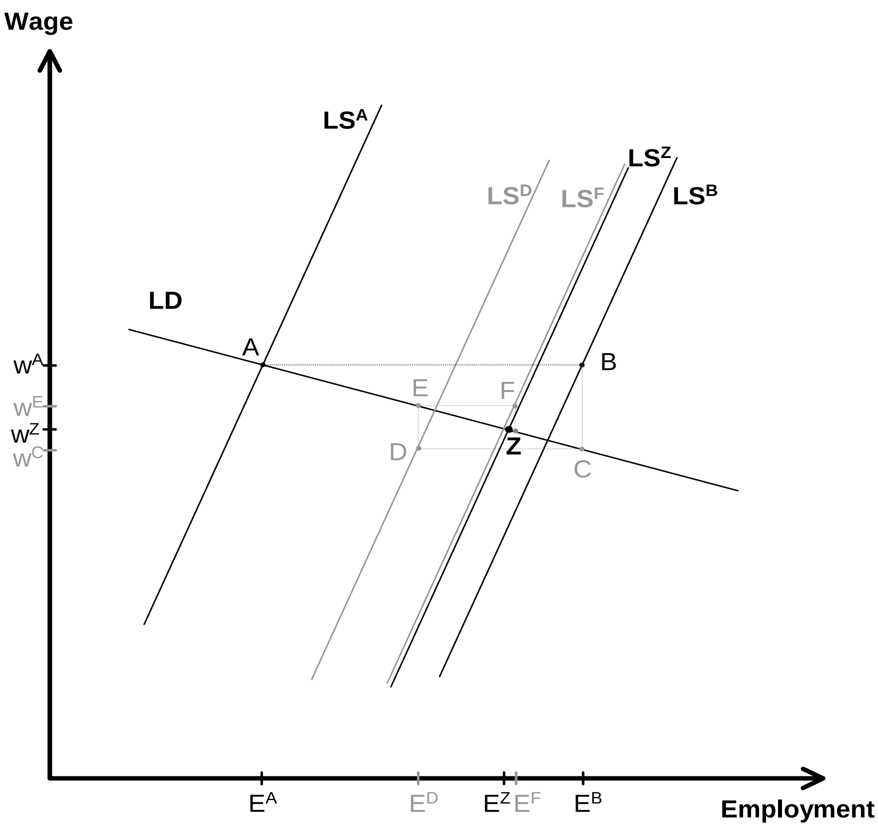

Figure 1: Supply and demand adjustments

As seen, different skill groups have different labor demand elasticities and thus induce different wage changes due to labor supply reactions. We consequently iterate labor supply reactions and demand adjustment separately for type and for every skill

[16]We consider an overall change of less than 10,000 hours a months, which equals 250 full-time equivalents or less than 0.1 percent of the average labor supply effect of our reform scenarios to be arbitrarily small. The maximum number of iterations is set at 500.

group within a household type.

Nevertheless, some restrictive assumptions have to be made to justify such a calculation. Most notably, the demand elasticity must be constant at any point of the demand curve and equal to the estimated one. Furthermore, the assumptions of a perfectly competitive market must be fulfilled so that we are not faced with wage rigidities whatsoever. Last, the demand side is assumed not to react to the policy change so that the labor demand curve does not shift and the labor demand elasticities do not change.

3.4 The simulated tax reform

In order to demonstrate the effects of the new demand module, we simulate a tax reform proposed by the German liberal party FDP in the run-up to the German elections in 2009. The main idea of the reform is to lower the tax burden of the existing progressive schedule and the rapidly increasing marginal tax rates by introducing a tax system with three brackets.

The tax allowances is raised from 7834 to 8000 euros. The starting tax rate, which applies to income from 8000 to 20,000 euros is 10 percent (in the status quo it is 15 percent). The second tax bracket goes from 20,000 euros to 50,000 euros per year and has a rate of 25 percent. In the highest bracket, income above 50,000 is taxed at a rate of 35 percent, which is much smaller than the current rate of 42 percent. Finally, the existing tax rate of 45 percent for the very rich earning more than 250,000 euros per year is dropped. Besides that, the benefit payments for children were raised to 200 euros per child. At the same time the tax allowance for children, which can be chosen instead of the benefits payments in case the household is better off with a higher allowances, is raised to 8000 euros.

The explicitly stated intention behind the tax reform is to the reduce tax burden for all income groups. It is supposed to have a positive effect on the employment of all groups, especially for the unemployed (i.e. at the extensive margin) and thus stimulate consumption. Thus, the reform was also designed as an answer to the current economic crises.

4 Simulation results

Table 1 presents full-time equivalents (FTE) in thousands at the status quo. On the whole, we consider about 19 million FTE who work 40 hours per week.

Type	**FTE**
Single females (A_F)	2091.4
Single male (A_M)	3583.5
Single parents (B)	729.1
Semi-flex couples (C)	2220.3
All-flex couple, female (D_F)	3777.2
All-flex couple, male (D_M)	6796.7
Overall	**19198.1**

Source: Own calculations based on IZAΨMOD

Table 1: Full-time equivalents at the status quo

The reform scenario described in chapter 3 is simulated with and without the demand module. Table 2 summarizes the overall effects of the reform, that is, for each household type the working hours of the three skill groups are aggregated. The second column of table 2 reports the isolated labor supply effect without demand adjustments. Without labor demand adjustments the reform yields positive effects, increasing the labor supply by about 630,000 full-time equivalents at the intensive margin[17]. The third column shows by how much the incorporation of the demand side affects the initial LS effect. When labor demand adjustments are taken into account, the positive supply effects are, however, reduced significantly. On average the reduction is 40 percent. Looking at a single parent household for example, the reform leads to a positive labor supply effect of 30,200 FTE. Demand adjustments reduces this positive effect by 12,400 FTE, that is by 41 percent. Eventually, the employment effect for single parents is 17,800. It can be seen that the LS effect is unambiguously positive for each household type, whereas the LD adjustments reduces the positive LS effect considerably for all types. This also explains the negative sign of the ratios of supply and demand effect for each type, reported in column 5.

Hence, labor demand works as a stabilizer to employment shifts. If the supply

[17] The reform also encourages 220,000 workers to participate in the labor force. At this stage, we cannot, however, calculate the effect an incorporation of demand adjustments would have at the extensive margins, since the elasticities estimated are hours elasticities and not participation elasticities.

HH-Type	LS effect	LD effect	Iterations	LS/LD effect
A_F	81.9	-67.8	>50	-0.83
A_M	115.7	-46.4	17	-0.40
B	30.2	-12.4	>50	-0.41
C	59.2	-18.9	8	-0.32
D_F	141.9	-55.4	>50	-0.39
D_M	197.5	-48.4	30	-0.24
Overall	**626.4**	**-249.3**		**-0.40**

Source: Own calculations based on IZAΨMOD

Table 2: Full-time equivalents at the status quo

effect is positive, the eventual employment effect after LD adjustments is smaller than the initial labor supply effect just as suggested by figure 1. The magnitude of demand effects differs but is, other than claimed in previous studies (cf. e.g. Buslei and Steiner (1999)), considerable. In general, the demand effect is strongest for women: it reduces the positive supply effects for female singles by 83 percent, which is significantly higher compared to the other numbers. It countervails almost 40 percent of the supply effect for female spouses of all-flexible couples; and finally it offsets more than 40 percent of the positive labor supply effect of single parents, who, in our sample, are women in over 90 percent of the cases.

Table 3 shows the effects broken down into skill groups. We detect that the labor demand effect is biggest for the medium-skilled, followed by the low-skilled. The table shows that the very strong LD effect for single women is driven by the medium-skilled, where the negative LD effect even overcompensates the positive LS effect, so that the ratio of LS and LD effect smaller than -1.

In order to open the black box, we demonstrate the iteration of hours changes and wage adjustments for two selected examples. Table 4 presents the results. The model converges much more quickly for unskilled single men; after seven iteration the changes in hours and wages are less than 0.01 percent. When comparing unskilled single men with the medium-skilled single women, the role of different elasticities becomes evident. Although the percentage changes in hours are somewhat comparable (5.02 vs. 4.17 percent), the induced wage changes differ considerably (-2.76 vs. -9.94 percent). As the elasticity for the unskilled is much higher than the one for the medium-skilled, a given hour change can be induced by a smaller wage change. Moreover, the example of medium-skilled single women shows that the model may not converge at all. Up until iteration stage four, hour and wage

HH-Type	Skill level	LS effect	LD effect	LS/LD effect
A_F	High	19.6	-4.1	-0.21
	Medium	56.8	-61.5	-1.08
	Low	5.4	-2.3	-0.42
A_M	High	18.2	-2.3	-0.13
	Medium	78.2	-38.6	-0.49
	Low	19.3	-5.5	-0.28
B	High	7.9	-1.9	-0.23
	Medium	19.0	-9.4	-0.49
	Low	3.3	-1.2	-0.35
C	High	13.6	-1.4	-0.10
	Medium	41.0	-16.2	-0.40
	Low	4.6	-1.3	-0.29
D_F	High	31.4	-5.9	-0.19
	Medium	99.4	-46.8	-0.47
	Low	11.1	-2.7	-0.24
D_M	High	37.6	-4.0	-0.11
	Medium	141.6	-42.7	-0.30
	Low	18.3	-1.7	-0.09
Overall		**626.4**	**-249.3**	**-0.40**

Source: Own calculations based on IZAΨMOD

Table 3: LD adjustments by skill

changes actually increase; after that they decrease. In the further iteration process the model does not converge, but circles imposing approximately the same wage and hour changes over and over again, until the maximum number of iterations is reached. The reason for possible non-convergence is the non-trivial interaction of demand and supply estimation which is unique to household and skill-types, since they have different consumption/leisure preferences, different demand elasticities and different non-linear budget sets due to the tax reform.[18]

The numerical results for unskilled single men accurately mirror the graphical representation of figure 1. In the beginning of the iteration process hour and wage changes are relatively high, but they decrease quickly as the model approaches the new market equilibrium. Nevertheless, the number for medium-skilled women demonstrate that the model does not necessarily have to converge. Analogous to the Cobweb Theorem by Ezekiel (1938), the model might also explode in certain

[18] A tax reform aiming at the working poor, for example, should have a different effect on supply/demand adjustments than a reform reducing the marginal tax rate for the very rich.

demand and supply constellations.

In order to check the robustness of the demand module, we run several other simulations. When using different tax reform scenarios, the labor demand effect quantitatively changes, but qualitatively stays the same. More importantly, labor demand also works as a stabilizer when the initial tax reform reduces labor supply, just as theory and figure 1 suggest. In other words, if a reform reduces labor supply, demand adjustments mitigate this effect so that the resulting employment effect is less negative than the initial labor supply reaction.

We also check the sensitivity of the model with respect to different elasticities. We compare the baseline scenario with low-, medium- and high-skilled own wage elasticities of -1.82, -0.42 and -0.90 respectively with a low- and high-elasticity scenario. In the former, we reduce all elasticities by 20 percent and the latter we increase them by one fifth. Table 5 summarizes the results. It becomes evident that the higher the elasticities the smaller the offsetting demand effect (LS/LD). In most cases, the number of iterations also is higher, the lower the elasticities.

This finding can be best explained graphically. Figure 2 is a simplification of the iteration process described in figure 1 and shows the effect of a tax reform in presence of a high-elasticity and a low-elasticity demand curve (LD^L and LD^H). In the LD^L-case the wage reduction and the countervailing labor demand effect is higher than in the LD^H-case. The rationale behind this graphical finding is the following: If labor demand is more elastic, a given change in working hours can be achieved with a smaller change in the wage. Let us assume a fixed rise in working hours due to a tax reform. The higher the absolute value of the own wage demand elasticity, the smaller is the decrease in wage, which is necessary to induce such a change in working hours. With the iteration process described above, this implies that the wage reactions and thus the effects of the demand module are smaller.

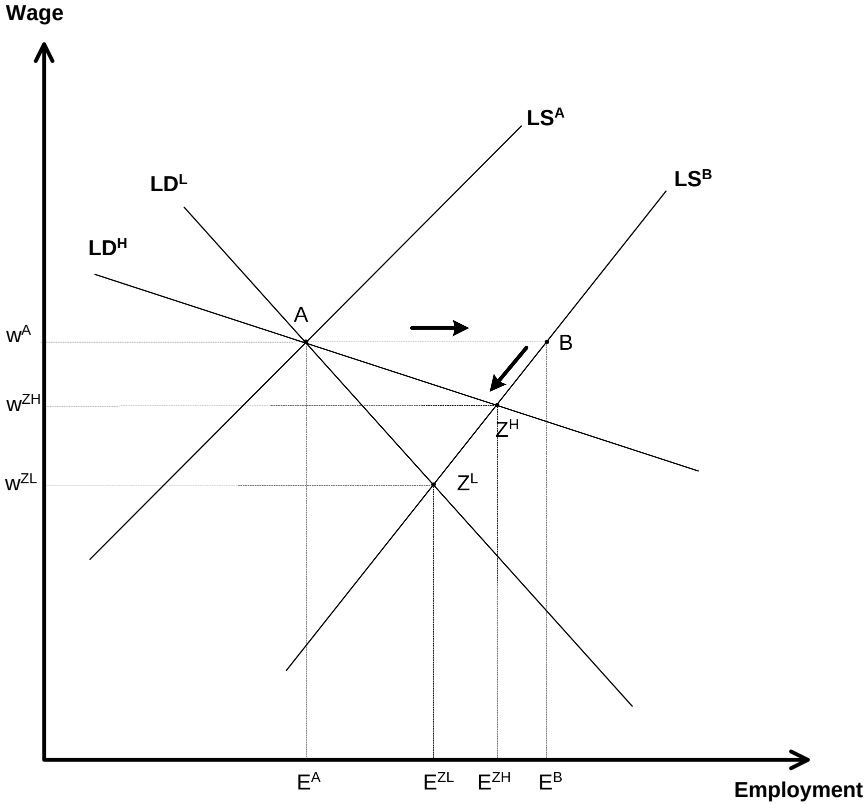

Figure 2: The role of different elasticities

Iteration No.	Adjustments (in %)	Unskilled Single Men	Medium-skilled Single Women
1	Hour	5.02	4.17
	Wage	-2.76	-9.94
2	Hour	-1.83	-4.50
	Wage	1.00	10.71
3	Hour	0.69	4.43
	Wage	-0.38	-10.55
4	Hour	-0.25	-4.52
	Wage	0.14	10.75
5	Hour	0.06	4.40
	Wage	-0.03	-10.47
6	Hour	-0.02	-4.54
	Wage	0.01	10.80
7	Hour	0.00	4.39
	Wage	0.00	-10.45
8	Hour	0.00	-4.47
	Wage	0.00	10.64
9	Hour	0.00	4.21
	Wage	0.00	-10.02
10	Hour	0.00	-4.18
	Wage	0.00	9.95

Source: Own calculations based on IZAΨMOD

Table 4: Iteration process

	Low-elasticity scenario		Baseline scenario		High-elasticity scenario	
HH-Type	LS/LD effect	Iterations	LS/LD effect	Iterations	LS/LD effect	Iterations
A_F	-6.45	21	-0.83	>50	-0.50	>50
A_M	-0.54	>50	-0.40	17	-0.35	10
B	-0.56	22	-0.41	>50	-0.39	7
C	-0.37	>50	-0.32	8	-0.28	8
D_F	-2.55	>50	-0.39	>50	-0.31	25
D_M	-0.36	46	-0.2	30	-0.21	5
Overall	**-1.69**		**-0.40**		**-0.31**	

Source: Own calculations based on IZAΨMOD

Table 5: Elasticity sensitivity

This theoretical insight can be detected both in the high demand effects for the medium-skilled, i.e. the skill group with the least elastic demand, as shown in table 3 and in the simulation results presented in table 5. Consequently, our simulations show that the model converges more quickly, when the demand elasticities are higher.

5 Conclusions

Microsimulation models, which simulate the labor market effect of tax and benefit reforms, are an important tool for the ex ante evaluation of policies. Due to a lack of empirical evidence, which could be analyzed, they function as quasi-experiments, enabling policy makers to asses the distributional, fiscal and behavioral effects of reform scenarios. By convention, MSM focus only on the labor supply side, implicitly assuming a perfectly elastic labor demand curve. This assumption has crucial consequences for the predicted labor market outcome, as labor supply effects are said to equal employment effects. Both theory and empirical evidence, however, suggest that labor demand is not perfectly elastic at all.

We estimate the short-run labor demand for Germany, differentiating between three skill groups, using a newly developed demand model which is based on a rich linked employer-employee data set. In line with other studies on German labor demand, our results suggest that own wage labor demand elasticities are negative and finite. More precisely, we find own wage elasticities for unskilled, medium-skilled and high-skilled workers of about -1.82, -0.42 and -0.9 respectively. Thus, we can infer that the usefulness of results based on conventional microsimulation models that only focus on the supply side is limited, because they do provide any information if and how the labor supply reaction induced by the reform actually translates into an employment effect. The employment, however, is crucial when evaluating the fiscal and distributional effects of a tax and benefit reform. It immediately follows that to be a reliable instrument for the ex ante evaluation of such a reform, MSM must take into account labor demand effects.

In this paper we propose a straightforward method following Haan and Steiner (2006) to meet this necessity. We extend IZAΨMOD, the microsimulation model of the Institute for the Study of Labor, to incorporate demand effects. We do that by employing the empirically derived labor demand elasticities and interacting labor supply reactions and demand adjustments by skill group until the partial analytic labor market equilibrium is achieved. Simulation results using the new demand module confirm the theoretical argument that labor demand plays an important role for the eventual employment outcome. Simulating a reform which reduces the high progressivity of the German tax schedule by introducing three brackets, we find that, on average, labor demand adjustments offset the positive labor supply effect of the reform by 40 percent. Instead of leading to about 630.000 new full-time equivalents, that is the pure LS effect, the reform would only yield 380.000 new 40-hour-jobs. Such a difference has considerable effects for the overall evaluation of such a reform. Simulations of other reform scenarios and sensitivity analyses have shown that the new LD module functions just as theory suggests.

Thus, the new demand module is an important improvement of IZAΨMOD, since employment predictions become more accurate and ex ante policy recommendations more reliable. Moreover, the proposed method has several advantages compared to existing approaches to broaden the focus of MSM and to take into account not only the labor supply side. Most prominently, there is a strand of literature trying to link MSM to Computational General Equilibrium (CGE) models. First, our approach solely focuses on the labor market. We remain in the partial analytic framework and thus reduce complexity, since we do not have to assume the interaction of labor and other markets. Moreover, the analysis remains on the micro level, since both supply and demand side characteristics are estimated using household and firm data respectively. Hence, we do not sacrifice one of the key targets of MSM, which is to assess behavioral changes on the microeconomic level. Finally, our method is much more transparent than the linking of CGE to MSM which lacks a theoretical basis.

Nevertheless, there are shortcomings of the approach, which have to be addressed in future research. It would be desirable to not only dock a demand extension to an existing labor supply model, but to assume an integrated and comprehensive labor market model. This would enable us to relax the relatively strong assumption of a perfectly competitive labor market and to impose rigidities such as efficiency wages, labor unions or search frictions. When assuming an integrated labor market, it would also be possible to allow labor demand to react to tax reforms and supply changes as well. In such a framework, the demand curve would shift and these shifts would have to be part of the iteration process as well. At the moment, this kind of simultaneity is, however hard to achieve due to practical reasons, as the usage of the LIAB dataset is only possible via remote access, making an iteration process for the labor demand prohibitively time consuming and unviable from a programmer's point of view. Last, we should allow for more variability as far as time horizons and adjustments velocities are concerned. At the current stage, we take a short-term perspective, assuming that labor demand does not react to tax reform and supply reactions and that the we achieve the new short-equilibrium instantaneously. In the future, long term effects on both sides of the markets should be assessed as well.

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A Appendix:

Estimated Model: Cost share following Translog cost function
$S_2 = \alpha_2 + \alpha_{22} \ln\left(\frac{w_2}{w_1}\right) + \alpha_{23} \ln\left(\frac{w_3}{w_1}\right) + \beta_{2Y} \ln Y + \gamma_{2K} \ln K$ $+\delta_{2t} t + \sum_{i=1}^{5} d_{2Ii} I_i$
$S_3 = \alpha_3 + \alpha_{32} \ln\left(\frac{w_2}{w_1}\right) + \alpha_{33} \ln\left(\frac{w_3}{w_1}\right) + \beta_{3Y} \ln Y + \gamma_{3K} \ln K$ $+\delta_{3t} t \sum_{i=1}^{5} d_{3Ii} I_i$

Estimation method	ML

Model statistics	
Observations	12344
Log pseudolikelihood	16960.18
Wald chi2	507.42
Prob > chi2	0.0000

Theoretical fit	
Pred. cost shares < 0	0
% strict quasi-concavity	1.0

Estimates	Coefficient	Robust Standard Error
α_2	-0.1509119	1.218305
α_3	5.362622	1.130473
α_{22}	0.0992506	0.0209122
α_{23}	0.0992506	0.0209122
α_{32}	0.0914202	0.0101051
α_{33}	-0.1248655	0.0199885
β_{2Y}	-0.0066456	0.002315
β_{3Y}	-0.0039417	0.0019692
γ_{2K}	-0.0024207	0.0014663
γ_{3K}	0.000916	0.0013322
δ_{2t}	0.000508	0.0006078
δ_{3t}	-0.0025901	0.0005647

$d_{2IConstruction}$	0.0442617	0.0110116
$d_{3IConstruction}$	-0.0484409	0.010624
$d_{2ITrade}$	0.1001394	0.0106793
$d_{3ITrade}$	-0.0502993	0.0076521
$d_{2ITraffic}$	0.110358	0.0125407
$d_{3ITraffic}$	-0.0532396	0.0099345
$d_{2IServices}$	-0.0153455	0.0111761
$d_{3IServices}$	-0.0433518	0.009708
$d_{2IPubServices}$	-0.0198877	0.0098535
$d_{3IPubServices}$	-0.0953637	0.0070405

Table 6: Estimation statistics of cost share equations