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DISCUSSION
PAPER

Welfare effects of alternative financing of social security

Some calculations for Belgium *

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Abstract

We analyse the distributional impact of lowering social security contributions and compensating the revenue loss by an increase in indirect taxes. We empirically assess the distributional consequences of this shift by using two Belgian microsimulation models: MODÉTÉ for the tax benefit system, and ASTER for the indirect tax part. Since the underlying micro database of the tax benefit system does not contain expenditures, we first impute detailed expenditures in the income data survey, by means of semiparametric Engelcurves.

The currently living generation of pensioners belongs to the losers by such a reform: They do not profit from the reduced tax on labour income, but pay higher consumption prices. Less obvious, also part of the working population loses. Even not all those who leave unemployment after the reform are gainers.

We also investigate the sensitivity of the results w.r.t. the choice of welfare measure to assess the combined change in disposable income, consumer prices and - in the case of flexible labour supply - leisure. We show how the specific choice and parameters of the welfare measure will influence the conclusions, possibly even more than the predictive model for assessing the behavioural reactions in labour supply.

JEL Number: D12; H31; H55; J22

Keywords: microsimulation, social security contributions, demand system, indirect taxes, labour supply

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1 Introduction

In Belgium, as in many other European countries, proposals are launched to reduce social security contributions and switch to indirect taxes as an alternative base to finance the social security system. The protagonists of these reforms guesstimate that labour market distortions will in this way be diminished, and, as a result, that unemployment rates would decline.

One strand in the literature uses macro and/or computable general equilibrium (CGE) models to assess the impact of either general or selective reductions of social security contributions (see among others Bassilière et al. (2005), Cockx et al. (2005) and Stockman (2002) for Belgium, and Buscher et al. (2001), Böhringer et al. (2005) and Steiner (2003) for Germany). The conclusions evidently depend on the specific measures that are scrutinized. But in general the broad result seems to emerge of a warning against overly optimistic expectations to lower persistently high unemployment rates by decreasing social security contributions. Certainly a general (i.e. non targeted) reduction of social security contributions has only a modest impact on aggregate employment. Moreover, in the long term, a compensation by means of indirect taxes might lead to neutrality at the level of labour costs (and hence labour demand) due to compensating wage demands (see Steiner (2003) and OECD (1994)).

The second, complementary, approach is framed within the incidence analysis of public finance and focuses on the distributional impact of this kind of reforms. This focus is mostly absent in the above mentioned macro-models. Microsimulation models are the prime candidates here to serve as tools of analysis. Indeed, tax benefit models in principle allow to calculate for a representative sample of households or individuals the impact benefit of the lowered social security contributions and the incidence of the tax instrument used to finance the operation. In practice however, this possibility is more limited than suggested. First of all, few microsimulation models cover the whole range of tax and benefit instruments that make up the chain from gross income (let alone labour cost) up to a disposable income concept. Some models are tailored to study the impact of personal income taxes, others focus more on social transfers and benefits, and still others only model the indirect tax system. One of the reasons is that there are few representative micro datasets that both contain reliable income information and at the same time detailed expenditure information to calculate indirect tax liabilities. A problem that we will also face in this paper. Secondly, the integration of behavioural reactions - a core element in a CGE model - is much more complex in the rich world of thousands of heterogeneous agents of a microsimulation model than in the stylized CGE-world. The rapid progress in micro-econometric estimation and simulation techniques of the last decades has therefore only recently found its way in the development of "behavioural microsimulation". Actually, this recent development seems to have reinforced the compartmentalization of the microsimulation field, by focussing more on subgroups of the population for which behaviour can be suitably modelled.

Both these factors make it far from straightforward to extend the general CGE analysis of this kind of reform with distributional considerations. This paper tries to fill this gap. In doing so, we are in line with the contribution by Bach et al. (2006). These authors analyse the increase of the standard VAT-rate from 16 to 19 percent, introduced by the new German coalition government in 2005, and became effective as of January 1^{st} 2007. They produce both an "impact" analysis of the distributional consequences, and a second round effect, taking up behavioural response both on the expenditure side as on the supply side of the labour market. They do not dispose of one integrated microsimulation model, nor of a dataset covering both incomes and detailed expenditures, but cleverly link existing models and datasets.

We, too, do not aim at extending existing models or techniques. We rather combine two separately existing microsimulation models (and datasets) to investigate the distributional effects of a shift in the financing source of social security away from taxing labour towards indirect taxes. We describe the distributional effects for the whole population, and we obtain results that are very similar to those in Bach et al. (2006). The reform is regressive in terms of disposable income and the currently living generation of pensioners is most liable to pay for the reform. They do not enjoy the reduced labour income tax, but they face nevertheless higher consumption prices. Yet, our approach differs from the mentioned paper in two respects.

First, our behavioural model of labour supply is more limited in scope since we are only able to model labour supply for couples. This limits the possibility to describe distributional effects for the whole population if we want to take into account behavioural reactions on the labour market. Secondly, more than Bach et al. (2006), we empahsize the role played by the welfare measure to assess the distributional impact of this kind of reforms. Traditionally, and certainly in policy oriented analyses, one limits oneself to describe distributional patterns in terms of disposable income changes, at most corrected by means of a consumer price index. Yet theoretically sound welfare measures are available in the literature and have recently been extended and adapted for use in discrete choice models and microsimulation contexts (see, amongst others, Creedy and Kalb 2005a, Dagsvik and Karlström 2005 and Preston and Walker 1999). In this paper we want to investigate the sensitivity of the distributional picture of gainers and losers of a reform to the chosen welfare metric. A fortiori, when not only the allocation of the expenditure budget over the different consumption goods alters, but also the full income of the household is reallocated between consumption and leisure, it is important to capture the (supposedly negative) welfare impact of increased labour supply and labour market participation entailed by this kind of reform. The latter aspect has been pointed at in other recent contributions in the field like Aaberge, Colombino and Strøm (2000) and Aaberge, Dagsvik and Strøm (1995). To investigate this sensitivity we deliberately disconnect the normative tool used for assessing the change in the distribution of welfare, from the positive tool used to predict behavioural reactions both in commodity demands and labour supply. Our results confirm that even the choice of a specific cardinalisation affect the results. Therefore the particular choice needs to be motivated.

Using existing microsimulation models, we also share their limitations. Firstly, we do not appropriately deal with labour market imperfections and involuntary unemployment. Nor do we take into account partial or general equilibrium effects on the labour demand side. Also the impact of the reform on savings (future consumption) and durable consumption goods is not taken up in the present welfare analysis.

The structure of the paper is as follows. The next section describes the reform we analyse and simulate. It also briefly overviews the datasets and microsimulation models that we will use. We explain how we have matched expenditure data in the underlying income dataset of the tax benefit model, and how demand reactions and labour supply have been modelled. In section 3 we prepare the ground for the sensitivity analysis by describing the different possibilities to measure welfare effects of price changes. Section 4 presents the results of the reform without taking into account the labour supply reaction. We focus here on the sensitivity of the picture of gainers and losers to the chosen welfare concept. In section 5 we then introduce flexible labour supply for a *sub*sample of the population and redo the sensitivity analysis of the distributional picture to the chosen welfare concept. Section 6 concludes.

2 The simulated reform and the adopted microsimulation approach

2.1 The reform and the assumption of an unchanged gross wage

Most of the reforms analysed by means of macro or CGE-models concern reductions in social security contributions paid by the employer. Here, however, we have modelled a reduction of social security contributions paid by the *employee*. Indeed, we do not dispose of a model that covers the demand side of the labour market and the dependence of the labour cost on these contributions. We lower social security contributions paid by the employees by a substantial amount of 25%.

Moreover, we have assumed that the reduction of the social security contributions is fully shifted forward into an increase of the net wage. In the appendix (section 7.1) we have spelled out the assumptions sufficient to underpin an *unchanged gross wage*: a perfectly flexible labour demand. In that case, the reduction of the contribution is fully reflected into a corresponding increase in the net wage of the employee, and hence in disposable income. This assumption reflects the partial character of the analysis when we introduce labour supply reactions in the analysis.

With fixed labour supply, and eventually even with an increase in employment, the foregone revenues from the social security contributions have to be compensated. We have chosen to increase both the standard and the reduced VAT-rate. We have crudely estimated how much we had to increase both rates to obtain revenue neutrality in the case where labour supply was fixed. It turned out that we had to increase the standard VAT- rate from 21% to 25%, and the reduced rate from 6% to 7%. Table 1 shows the resulting price change for the commodities on which our indirect tax model is built. The first column shows the share in disposable income for 13 expenditure categories and for saving. The second column shows the indirect tax rate for the aggregates in percent of the producer price for the baseline Belgian indirect tax system of 2005 and the rightmost columns give the resulting consumer prices expressed in terms of fixed producer prices normalised at unity. The implemented VAT change also induces substantial relative price changes. Since tobacco products not only bear VAT and excise duties, but also an *ad valorem* excise which is expressed as a percentage of the consumer price (hence also taxing VAT and excise duties), the consumer price for tobacco products goes up with 9%. For commodities subjected to the standard VAT rate of 21%, the price increase amounts to around 3.3% (from 1.21 to 1.25), whereas the price of commodities taxed at the reduced rate goes up from 1.06 to 1.07, or 0.94%.

Table 1: Commodity breakdown, shares in disposable income, and indirect tax rates for the NIS budget survey 2001

Commodity aggregate	share in disposable income	baseline indirect tax rate in % of producer price	consumer price baseline	consumer price reform	price change in %
Food	11.3	6.2	1.0620	1.0721	0.95
Drinks - Non Alcoholic	0.9	7.7	1.0772	1.0874	0.94
Drinks - Alcoholic	1.3	40.9	1.4090	1.4556	3.31
Tobacco	0.8	207.5	3.0746	3.3516	9.01
Clothing, footwear	4.7	20.8	1.2085	1.2482	3.28
Rent, Utilities, Heating	23.7	5.0	1.0502	1.0590	0.84
Private transport	6.3	47.4	1.4738	1.5155	2.83
Public transport	0.4	5.3	1.0525	1.0613	0.83
Hygienics, Health	5.8	7.7	1.0775	1.0919	1.34
Leisure commodities	12.8	10.7	1.1067	1.1267	1.81
Other commodities	11.2	7.2	1.0722	1.0860	1.28
Durables	10.3	20.9	1.2094	1.2493	3.30
Savings	10.5	0.0	1.0000	1.0000	0.00
Income	100.0	10.9	1.1086	1.1281	1.76

2.2 Data and models

Since the switch from social security contributions to indirect taxes affects both disposable income and expenditure patterns (through the change in consumer prices), we ideally would want to dispose of a database that contains gross incomes, labour supply and a detailed breakdown of expenditures for a representative sample of households, and one integrated microsimulation model which traces out the path from gross income to welfare generated by consumption and leisure. We do however not dispose of either of these. The representative household surveys with reliable income information (such as the PSBH, the Panel Study of Belgian Households) do not contain a detailed breakdown of expenditures, and the survey of the Belgian National Statistical Institute, containing details on expenditures, is judged to be less reliable and is certainly less detailed for income data. As far as the microsimulation models are concerned, several Belgian tax benefit models (MISIM, MODÉTÉ) are available, and there is at least one indirect tax model (ASTER). But we lack one integrated microsimulation model, covering both direct taxes and benefits *and* indirect taxes.

We therefore first created one integrated database containing both incomes and expenditures. Next, different existing microsimulation models were linked. The database was created by imputing expenditures on a representative survey with income data (the PSBH-survey of 2001). For 13 aggregated expenditure categories and for savings (see the first column of table 1) we estimated nonparametric Engel curves of the income share in the 2001 budget survey of the Belgian National Statistical Institute. We then used the nonparametric regressions to impute shares for the same classification on the income survey. More details about the nonparametric regressions are in the appendix (section 7.2).

To calculate the impact of lowering social security contributions on households' disposable income, the microsimulation model MODÉTÉ was used. MODÉTÉ is a Belgian standard static tax benefit model developed by DULBÉA-ETE in the framework of the EU-project EUROMOD. It runs on the PSBH-survey of 2001 and it allows to simulate income assistance, child benefits, taxes and social security contributions. Pensions and unemployment benefits are not simulated as the PSBH does not collect all necessary information on past employment records. For more details, see Joyeux (1999). For our simulations with flexible labour supply the standard MODÉTÉ has been extended with a labour supply model for the subsample of couples, along the lines described in Orsini (2006) and briefly summarised in the appendix (section 7.4).

To calculate the impact of changes in indirect taxes on the consumer prices for the commodity aggregates, we used the microsimulation model ASTER. In the appendix, section 7.3, we explain how ASTER calculates the indirect tax rates for the commodity aggregates, starting from the detailed VAT and excise legislation in 2005. The indirect tax system is the one of 2005 but we expressed all nominal amounts in € of 2001, the year of the budget survey.[1] The third column of table 1 shows the resulting tax rate for the aggregates in % of the producer price.

2.3 Sequence of the calculations

1. In the MODÉTÉ tax benefit model, social security contributions paid by the employees are lowered by 25%.

2. As explained above we assume that the reduction of the contribution is fully reflected into a corresponding increase in the net wage of the employee. In a first round MODÉTÉ calculates the change in disposable income of the household under the assumption of *fixed labour supply*. This incorporates the change in social security contributions paid by the employee, but also a considerable effect on personal income tax liabilities.

3. The resulting change in disposable incomes gives us a first estimate of the budgetary cost of the lowering of the social security contributions. From this a first guess of the increase in VAT rates necessary to compensate the lost government revenue, is derived. The three rightmost columns of table 1 show the change in consumer prices between the baseline and the reform with fixed labour supply (to be discussed below). Near revenue neutrality was obtained by increasing the normal rate of 21% to 25%, and the reduced rate of 6% to 7%.[2] In terms of disposable income this raised the indirect tax liabilities from 10.86% to 12.81% (bottom line of table 1).

4. Under the assumption of fixed labour supply, we only have to estimate the effect of the change in disposable income and in relative prices on consumption patterns to have all necessary ingredients for a welfare analysis. This effect is disentangled in two separate steps.

   (a) We first use the Engel curves, estimated for the imputation of budget shares in the income survey, to calculate the impact of the change in real disposable income on the income shares. This Engel curve already takes up part of the price changes since the explanatory variable is *real* disposable income. We deflated nominal disposable income by the Stone price index Q_h for household h, defined as:

$$\begin{aligned} \ln Q_h &= \textstyle\sum_i \omega_{ih} \ln q_i \\ \text{or } Q_h &= \textstyle\prod q_i^{\omega_{ih}} \end{aligned} \tag{1}$$

[1]The excises are nominal amounts of 2005. They have been deflated to 2001 €'s by deflating them with a factor 0.9249, the ratio of the CPI in 2001 to the one of 2005.

[2]We first increased all VAT rates proportionately to reach revenue neutrality. The factor needed to get at a revenue neutral reform was 1.18. Translated into an increase of the existing VAT rates, this gave us the new rates mentioned in the text.

where ω_i^h refers to household h's budget share for commodity i and q_i to the consumer price for commodity i. Note that to estimate this real income effect, we use the income shares of the baseline in (1) to deflate disposable income before and after the reform. In table 11 in the appendix (section 7.2) we summarize this real income effect by means of the median of the household specific income elasticities.

(b) For the effect of the change in relative prices, we use the QUAID system, underlying ASTER 3.0:

$$\omega_i^h = \alpha_i^h + \beta_i^h \log\left(\frac{y^h}{a^h(\mathbf{q})}\right) + \lambda_i^h \log\left(\frac{y^h}{a^h(\mathbf{q})}\right)^2 + \sum_j \gamma_{ij} \log q_i \qquad (2)$$

where y^h refers to total expenditures for household h.[3] The price index $a^h(\mathbf{q})$ was approximated by the Stone price index. The price coefficients (γ_{ij}'s) have been estimated on the National Accounts data, and hence do not take into account the preference heterogeneity, which does appear in the income coefficients β_i^h and λ_i^h. To implement the effect of the changes in relative prices, we only used the matrix of price coefficients $[\gamma_{ij}]$, since the effect of the change in real income has already been taken up by the nonparametric Engel curve. The demand system in (2) was not estimated for durables nor savings. We therefore put the corresponding γ_{ij}'s equal to 0 for the last two commodities. The relative price effects are summarized in the same way as the income effects: by means of the median of the household specific price elasticities in Table 11 in the Appendix (section 7.2).

5. These new income shares were then used to calculate new consumption quantities by multiplying them with the new disposable income and dividing by the new consumer prices.

6. On this new consumption pattern we then calculate indirect tax liabilities. This allows for a refinement of the estimate of the net budgetary cost of the reform, and eventually an adaptation of the necessary increase in indirect tax rates.

7. Once we obtained (near) revenue neutrality, we used the post-reform income shares to calculate the new household specific Stone price indices that will be used in one of the the welfare measures that we discuss in the next section.

8. For the simulations with flexible labour supply, an additional iterative procedure is necessary. Since the labour supply model is estimated as a choice between aggregate consumption (or *real* disposable income) and leisure, the changed consumer

[3]We omitted the second price index of a QUAID-system appearing in the denominator of the λ_i-coefficient.

price index was fed back into the labour supply model. This led to a fresh estimate of the change in disposable income. We then reiterated the calculations from step 3 onwards.

3 Four concepts of welfare measurement

3.1 Disposable income

A common and popular approach to calculate the effects of tax reforms is to calculate the monetary benefits or losses in disposable income of different categories within the population. Disposable income is composed of gross labour income, which equals gross hourly wages, say w, times labour supply, denoted by L, *plus* non-earned income, say M, *minus* net taxes $T = \theta(wL, M, \zeta)$. Net taxes contain all income taxes minus any net of tax transfers of the government (such as net pensions or net unemployment benefits). These depend on gross labour income wL, non-earned income M and a number of other characteristics such as household composition, house ownership, composition and sources of non-earned income etc. The latter information is recollected in a variable ζ denoting the tax-benefit-type of the household. It contains all the necessary information to calculate the income taxes recollected from and the benefits accruing to that household. Amongst other things, ζ contains the status on the labour market of different members of the household, because this may influence the amount of tax reductions or exemptions, as well as the tax liabilities.[4]

Hence, ***disposable income***, say y, equals:

$$y = wL + M - \theta(wL, M, \zeta). \tag{3}$$

Consider now a reform of the tax-benefit system. We denote the tax-benefit system pre-reform by θ^0 and the post-reform situation by θ^1. If we *assume that labour supply L does not change due to the reform,* the ***gain in disposable income***, say $\mathrm{d}y$, equals:

$$\mathrm{d}y \equiv y^1 - y^0 = \theta^0(wL, M, \zeta) - \theta^1(wL, M, \zeta). \tag{4}$$

where the superscripts 0 and 1 refer to baseline and reform respectively. Equation (4) shows that the impact effect on disposable income equals minus the change in tax liabilities. This allows to express the impact monetary cost of the reform to the government as the summation of the changes in disposable incomes across all households.

The reform of the tax-benefit system might affect different households and household members differently. Let us therefore introduce h as an indicator for households, and

[4] In some European countries household income is taxed jointly, while in other countries the marginal tax rate is applied on spouses' incomes separately. In the latter case there are rules to divide common income, e.g. imputed rents from house ownership or interests on common savings accounts, to household members. In some cases there may be tax rules to split income from a single earner in the household across members without earned income.

let the members of a household be indicated by j_h. Then gross labour income within a household, I_h, is written as $I_h = \sum_{j_h} w_{j_h} L_{j_h}$, where w_{j_h} and L_{j_h} are respectively the gross wage and the labour supply of household member j_h. Indicating the total net amount of taxes - this is taxes *minus* benefits - for household h in situation s by $T_h^s = \theta^s(I_h, M_h, \zeta_h)$, we calculate the monetary cost of the reform to the government as:

$$\sum_h \left(T_h^0 - T_h^1\right) = \sum_h \mathrm{d}y_h. \tag{5}$$

3.2 Real income

Purchasing power, and hence welfare, of nominal disposable income depends on the price level of consumer goods. Consumed quantities of goods by household h are denoted by $\mathbf{x}_h = (x_{h1}, \ldots, x_{hi}, \ldots x_{hn})$ and the corresponding consumer prices, identical for all households, by $\mathbf{q} = (q_1, \ldots, q_i, \ldots, q_n)$. We assume that producer prices and gross wages are fixed.[5] Therefore, it is possible to normalize the producer prices of all consumer goods to one, and measure the associated quantities in monetary terms (in the application this will be in year 2001 euro's). The consumer prices are then equal to $q_i = 1 + t_i$ where t_i is the indirect tax rate on good i. The budget equation for household h reads as:

$$y_h = I_h + M_h - \theta(I_h, M_h, \zeta_h) = \mathbf{q}'\mathbf{x}_h. \tag{6}$$

The basic aggregation identity:

$$Q_h X_h \equiv \mathbf{q}'\mathbf{x}_h, \tag{7}$$

defines an implicit quantity level index X_h, associated with a chosen price level index Q_h. So, the nominal disposable income y_h, can be converted into a ***real income*** concept, X_h, measuring the quantity of consumer goods a household can buy with its budget, given the price level Q_h:

$$X_h \equiv \frac{y_h}{Q_h}. \tag{8}$$

Both the price index Q_h and the quantity index X_h are household specific through the quantities $\mathbf{x}_h$ in (7). A joint reform of the tax-benefit system (changing disposable income y_h) and indirect taxes (changing consumer prices) will affect these quantities by means of the classical demand function:

$$\mathbf{x}_h = f(\mathbf{q}, y_h). \tag{9}$$

We used the Stone price index index as a specification for the household specific price index Q_h. This index was already defined in equation (1), but is repeated here (in its

[5] This could be rationalised by a simplified Leontief model of the supply side of the economy which is linear in the - among each other - perfectly substitutable different types of labour supply, whose gross wages w_{j_h}, increased by the amount of employer taxes on labour demand, reflect the constant marginal productivities of different labour types.

logarithmic form):

$$\ln Q_h = \sum_i \omega_{ih} \ln q_i,$$

where

$$\omega_{ih} = \frac{q_i f(\mathbf{q}, y_h)}{y_h} \tag{10}$$

denotes the budget share of commodity i for household h.

Indexing again the pre-reform situation by a superscript 0, and the post-reform situation by a superscript 1, the ***change in real income*** for household h, $\mathrm{d}X_h$, obtained by deflating nominal disposable income by means of the price index, equals:

$$\mathrm{d}X_h \equiv \frac{y_h^1}{Q_h^1} - \frac{y_h^0}{Q_h^0}. \tag{11}$$

Obviously the ranking of winners and losers of a reform, induced by the gain concept in (11), might differ from the ranking induced by the change in welfare measured by (4), and this for several reasons. Note first that even for a reform that only changes disposable income and keeps consumer prices constant, *i.e.* $\mathbf{q}_0 = \mathbf{q}_1$, the measure in (11) will differ from the one in (4) for two reasons. First of all, since households have a different allocation of the budget, they are affected differently by given price levels: the Stone price index differs across households because household budget shares differ across households. This cannot alter the sign of the evaluation by means of (11) as compared to the change in disposable income in (4), but it can alter the ranking of households in a distribution of winners and losers. Secondly, since the change in households' disposable income leads to changes in budget shares, the price index changes in the post-reform situation, even with constant consumer prices. This effect can even change the sign of the evaluation. Finally, if the reform also affects consumer prices, the difference in assessment of the welfare effects of the reform by means of (4) *vis-à-vis* (11) is obvious.

3.3 Consumption based welfare

The purpose of deflating nominal income y_h by means of a price index, is to approximate purchasing power, and hence quantities consumed. Yet, deflating by an *ad hoc* index, such as the Stone price index, is not firmly grounded in theory. More theoretically sound is to start from an expenditure function, derived from the previously specified demand functions, $f(\mathbf{q}, y_h)$, and defined as:

$$y_h = e(\mathbf{q}, U), \tag{12}$$

where U is the welfare level obtained from consumption $\mathbf{x}_h$ by means of the function $u(f(\mathbf{q}, y_h))$. This expenditure function can be used as a money metric welfare function for a household with disposable income y_h^0 and facing prices $\mathbf{q}^0$ as follows (see King, 1983):

$$mmu_h(\mathbf{q}^r, \mathbf{q}^0, y_h^0) = e\left(\mathbf{q}^r, u\left(f\left(\mathbf{q}^0, y_h^0\right)\right)\right), \tag{13}$$

where $\mathbf{q}^r$ is a set of reference prices to convert welfare in the situation $\left(\mathbf{q}^0, y_h^0\right)$ into monetary units. We will use as reference prices the baseline prices $\mathbf{q}^0$. We can now construct a ***consumption based welfare gain***, denoted by CWG, of the impact of a reform converting the baseline prices and disposable income $\left(\mathbf{q}^0, y_h^0\right)$ into the post-reform situation $\left(\mathbf{q}^1, y_h^1\right)$ for household h as follows:

$$CWG_h(\mathbf{q}^0, \mathbf{q}^1, y_h^0, y_h^1) \equiv e\left(\mathbf{q}^0, u\left(f\left(\mathbf{q}^1, y_h^1\right)\right)\right) - e\left(\mathbf{q}^0, u\left(f\left(\mathbf{q}^0, y_h^0\right)\right)\right). \tag{14}$$

The first term in the right hand side of equation (14) embodies the counterfactual situation of reaching the post-reform utility level at the pre-reform prices. It can be expressed by means of the compensated demand functions for consumption goods, denoted here as $\tilde{x}\left(\mathbf{q}, U\right)$:

$$e\left(\mathbf{q}^0, U_h^1\right) = \mathbf{q}^{0\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right), \tag{15}$$

where we denote the utility level in the post-reform situation by $U_h^1 \equiv u\left(f\left(\mathbf{q}^1, y_h^1\right)\right)$. In the application in this paper, we simulated these compensated demands by calculating a real income effect on observed pre-reform demands, based on the nonparametric Engel curves.

Using (15), the consumption based welfare gain CWG_h in (14) can be rewritten as

$$\begin{aligned}
CWG_h(\mathbf{q}^0, \mathbf{q}^1, y_h^0, y_h^1) &= \mathbf{q}^{0\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right) - y_h^0 \\
&= y_h^1 - y_h^0 - \left[y_h^1 - \mathbf{q}^{0\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right)\right] \\
&= \mathrm{d}y_h - \left[\mathbf{q}^{1\prime}\tilde{x}\left(\mathbf{q}^1, U_h^1\right) - \mathbf{q}^{0\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right)\right] \\
&= \mathrm{d}y_h - \left[\mathbf{q}^{1\prime}\tilde{x}\left(\mathbf{q}^1, U_h^1\right) - \mathbf{q}^{0\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right) + \mathbf{q}^{1\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right) - \mathbf{q}^{1\prime}\tilde{x}\left(\mathbf{q}^0, U_h^1\right)\right] \\
&= \mathrm{d}y_h - \left[(\mathbf{q}^1 - \mathbf{q}^0)'\tilde{x}\left(\mathbf{q}^0, U_h^1\right) + \mathbf{q}^{1\prime}\left(\tilde{x}\left(\mathbf{q}^1, U_h^1\right) - \tilde{x}\left(\mathbf{q}^0, U_h^1\right)\right)\right] \\
&= \mathrm{d}y_h - \left[\mathrm{d}1q_h + \mathrm{d}2q_h\right],
\end{aligned} \tag{16}$$

where $\mathrm{d}1q_h$ denotes the first term in the square brackets of (16), and $\mathrm{d}2q_h$ the second one.

Equation (16) shows how we have to correct the change in nominal disposable incomes ($\mathrm{d}y_h$) to take into account the effect of the price change of consumption commodities. The first term, denoted by $\mathrm{d}1q_h$, is an aggregate measure of price change. The weights in this measure are equal to the compensated demands evaluated at pre-reform prices but at an income that can assure the post-reform utility level U_h^1. Note that, contrary to the change in real income in (11), the consumption based welfare gain in (16) coincides with the change in disposable income when the reform does not alter the prices of consumption goods, *i.e.* when $\mathbf{q}^0 = \mathbf{q}^1$. The second term, $\mathrm{d}2q_h$, vanishes when only relative prices change. It can therefore be interpreted as the contribution to the welfare change due to a relative price change.

Summarizing, we have three different welfare measures with fixed labour supply:

1. the change in disposable income in (4);

2. the change in real income in (11), and
3. the theoretically more sound consumption based welfare gain in (16).

In the next subsection we explain how to extend (16) for the case of flexible labour supply.

3.4 Welfare gain with variable labour supply

The main objective of many reforms is to stimulate labour supply, and we treated this as fixed in the previous measures. As a first approach, the measures presented above could of course be adapted by recalculating the new disposable income y_h^1 on the basis of an estimate of the post-reform labour supply using a behavioural labour supply model. However, such a measure does not capture the welfare effect of the possibly lower amount of leisure following a reform that wants to stimulate labour effort and labour market participation.

In order to evaluate this effect by means of an expenditure function as in (12), we have to introduce an expenditure function with variable labour supply. Following common practice (see e.g. Creedy and Kalb, 2005a), we first linearize the budget equation as follows:

$$w_n L + \mu = \mathbf{q}'\mathbf{x}, \tag{17}$$

where, for notational simplicity, we omitted the subscript h for the household, w_n denotes the net wage rate and μ a *virtual* lump sum income. This virtual lump sum income is determined such that, given household preferences, the actually chosen optimal bundle of consumption goods, $\mathbf{x}$, coincides with the one that would be chosen under a linear budget constraint of the type $w_n L + \mu$. In equation (17), labour supply L, is the sum of labour supply of all individual household members and consumption quantities $\mathbf{x}_i$ refer to household consumption as well.

The net wage rate *for the household*, w_n, is obtained from the individual gross wages by two manipulations. First, for households with individuals active in the labour market and for the unemployed where a gross wage was available, we determined the effective marginal tax rate, say θ', by simulating in MODÉTÉ an increase in labour supply of one hour and looking at the change in disposable income. This allows us to calculate for each individual a net wage rate w_n as:

$$w_n = \left(1 - \theta'\right) w. \tag{18}$$

Secondly, we have chosen the largest net wage among household members, as the net wage w_n appearing in the linearized budget constraint (17). For the individuals that are unavailable for the labour market (in practice the retired) we imputed, quite ad hoc, the quantile value of the 25th percentile in the distribution of net wages obtained in the previous step.

The expenditure function with variable labour supply can now be defined as follows:

$$\mu = e\left(\mathbf{q}, w_n, U\right), \tag{19}$$

where the welfare level U is now obtained from both, consumption *and* leisure: $U = u\left(f\left(\mathbf{q}, w_n, \mu\right), T - g\left(\mathbf{q}, w_n, \mu\right)\right)$, and the demand for consumption goods and supply of labour derived from optimizing preferences, given the linearized budget constraint: $\mathbf{x} = f\left(\mathbf{q}, w_n, \mu\right)$, and $L = g\left(\mathbf{q}, w_n, \mu\right)$, with T denoting the time endowment.[6]

Similarly as above, we can now calculate a money metric utility for situation $(\mathbf{q}, w_n, \mu)$ as :

$$mmu = e\left(\mathbf{q}^r, w_n^r, u\left(f\left(\mathbf{q}, w_n, \mu\right), T - g\left(\mathbf{q}, w_n, \mu\right)\right)\right), \tag{20}$$

where $\mathbf{q}^r$ and w_n^r denote the reference consumer prices and reference net wage respectively.

The expression for the ***welfare gain***, with the reference prices equal to pre-reform prices, $\mathbf{q}^r = \mathbf{q}^0$ and $w_n^r = w_n^0$, now becomes:

$$WG(\mathbf{q}^0, \mathbf{q}^1, w_n^0, w_n^1, \mu^0, \mu^1) = e\left(\mathbf{q}^0, w_n^0, U^1\right) - e\left(\mathbf{q}^0, w_n^0, U^0\right), \tag{21}$$

where

$$U^s = u\left(f\left(\mathbf{q}^s, w_n^s, \mu^s\right), T - g\left(\mathbf{q}^s, w_n^s, \mu^s\right)\right), \qquad s = 0, 1.$$

The second term in (21) is of course equal to $\mu^0 = \mathbf{q}^{0\prime} x(\mathbf{q}^0, w_n^0, \mu^0) - w_n^0 L(\mathbf{q}^0, w_n^0, \mu^0)$, whereas the first term is an extension of (15) above for leisure and hence needs the compensated consumption and leisure demand:

$$e(q^0, w_n^0, U^1) = \mathbf{q}^{0\prime} \tilde{x}\left(\mathbf{q}^0, U^1\right) - w_n^0 \widetilde{L}(q^0, w_n^0, U^1).$$

After some rewriting along the lines leading to (16), we get for the welfare gain for household h with endogenous labour supply:

$$WG_h = \mu_h^1 - \mu_h^0 - \left[\mathrm{d}1q_h + \mathrm{d}2q_h\right] + \left[\mathrm{d}1w_{nh} + \mathrm{d}2w_{nh}\right], \tag{22}$$

where, compared to (16), the change in virtual income now replaces the change in disposable income $\mathrm{d}y_h$, the effect of the price in consumption goods has been defined above, and the effect of the change in the net wage rate is also disentangled into two effects (omitting the household subscript h):

$$\mathrm{d}1w_n = \left(w_n^1 - w_n^0\right) \widetilde{L}(q^0, w_n^0, U^1), \tag{23}$$

and

$$\mathrm{d}2w_n = w_n^1 \left[\widetilde{L}(q^1, w_n^1, U^1) - \widetilde{L}(q^0, w_n^0, U^1)\right]. \tag{24}$$

[6] Note that the expenditure function could also be defined in terms of full income $\mu + w_n T$, instead of in terms of virtual income μ. See Blundell et al. (1994) p.22-27.

3.5 How much weight do we attach to leisure?

In principle we could use our labour supply model to estimate the values of the compensated labour supplies in (23) and (24). However, there is no a priori reason why the macro-economic objectives of the proposed reform (to activate unemployed) would coincide with the preferences of the individuals. Therefore we wanted to dispose of an evaluation tool that allows to be more or less generous towards the policy makers' objective. The macro-economic employment objective could possibly be justified by an objective function that attaches less weight to leisure than the affected individuals.

To investigate the sensitivity of the welfare evaluation w.r.t. the weight attached to leisure in the welfare function we have therefore chosen to separate the *positive* aspects in the analysis from the *normative* ones. For the positive part, we use a combination of empirical models to predict as secure as possible the behavioural reactions in terms of consumption (income and price effects) and labour supply. But once we have estimated consumption and leisure in both baseline and reform situation, these quantities can be plugged into another evaluation tool. As an example, we have used the CES-LES-utility function, defined as:

$$u(\mathbf{x},l) = \left[\delta_l^{1-\rho} l^\rho + \sum_{i=1}^{n} \delta_i^{1-\rho} \left(x_i - \gamma_i \right)^\rho \right]^{\frac{1}{\rho}}, \tag{25}$$

with $l \equiv T - L$ equal to leisure, *i.e.* total time endowment, T, *minus* labour supply L; δ_i, δ_l are the share parameters of consumption goods and leisure, satisfying $\sum_{i=1}^{n} \delta_i + \delta_l = 1$; γ_i are the committed expenditures; $\rho = 1 - \frac{1}{\sigma}$ and σ is the (Allen-Hicks) substitution elasticity. The share parameter δ_l is a measure for the weight attached to leisure in the evaluation and will be crucial in the sensitivity analysis.

For this CES-LES utility function, the expenditure function is obtained as:

$$e(\mathbf{q}, w_n, U) = \mathbf{q}'\gamma + \left(\phi(\mathbf{q}, w_n) \right)^{-\left(\frac{1-\rho}{\rho}\right)} U, \tag{26}$$

where $\phi(\mathbf{q}, w_n) \equiv \sum_i \delta_i q_i^{(1-\sigma)} + \delta_l w_n^{(1-\sigma)}$ is used as an abbreviated notation for a weighted average of prices $\mathbf{q}$ and w_n. Using the baseline prices as reference prices, the expression for the welfare gain in (21) then becomes:

$$WG_{\text{CES-LES}} = [\phi(\mathbf{q}^0, w_n^0)]^{\frac{1}{1-\sigma}} \cdot (U^1 - U^0), \tag{27}$$

where the welfare levels U^0 and U^1 are obtained from:

$$U^s = \left[\delta_l^{1-\rho} \left(T - g\left(\mathbf{q}^s, w_n^s, \mu^s \right) \right)^\rho + \sum_{i=1}^{n} \delta_i^{1-\rho} \left(f_i\left(\mathbf{q}^s, w_n^s, \mu^s \right) - \gamma_i \right)^\rho \right]^{\frac{1}{\rho}} \tag{28}$$

for $s = 0, 1$.

To be sure, the labour supply function $g(.)$ and the demand functions $f_i(.)$ are *not the ones* derived from the CES-LES-framework. Functions g and f are modelled separately in a way which best predicts real world behavioural responses to policy changes (with the random utility model for labour supply, and QUAIDS for commodity demands). Next, we plug these new consumption and labour supplies into the normative evaluation tool (28) and (27) which does not have to fit the behavioural model. The additional parameter δ_l allows us to investigate whether the welfare evaluation of changing labour supply is sensitive to the weight attached to leisure in the evaluation function.

For the application we calibrated the CES-LES utility function in (25). To remain as close as possible to consumer's commmodity preferences, the share parameters for the consumption commodities (the δ_i parameters 's) have been calibrated on the elasticities generated by the QUAID system referred to earlier. The calibrated values are displayed in table 11 in the appendix (section 7.2). Next, we perform a sensitivity analysis on the share parameter of leisure by first fixing δ_l and then rescaling the share parameters of the consumption commodities proportionately such that all share parameters together sum to unity. The committed expenditures have been put equal to 0. Parameter ρ is related to the substitution elasticity σ by $\sigma = \frac{1}{1-\rho}$. The calibrated value of the substitution elasticity equals 0.696.

4 Results with fixed labour supply

4.1 Revenues

Table 2 shows the revenue effects of lowering social security contributions paid by the employee by 25% and increasing the standard VAT rate from 21 to 25% and the reduced rate from 6 to 7% under the assumption of fixed labour supply. All figures are in million euros of 2001.

Table 2: Effects on revenues in Million Euros of 2001 of the reform with fixed labour supply

	baseline	reform	change	
			mio €	%
gross income	122277	122277	0	0.0
disposable income	113617	115430	1813	1.6
social security contributions employee	14956	11664	-3292	-22.0
social security contributions employer	27915	27915	0	0.0
personal income taxes	38542	40015	1473	3.8
indirect taxes	11207	12865	1658	14.8

Even without labour supply effects, the assumption of a full shifting of the lower social security contributions into an increase of the net wage, leads to a substantial earning back effect through increased income taxes. The gross cost of 3292 million € is partially compensated by an increase in income taxes of 1473 €. The remaining revenue loss is nearly covered by the mentioned increase in the indirect tax rates.[7] We are left with a cost of 155 million €.

In terms of the policy relevant parameter of shares in government revenue for the three big categories of revenues: social security contributions, personal income tax and indirect tax, the reform reduces the share of social security contributions from 46.2% to 42.8%. Personal income taxes and indirect taxes go up from 41.6% and 12.1% to respectively 43.3% and 13.9%.

4.2 Standard analysis: changes in disposable income, in real income and in consumption

Table 3 summarizes the results for the reform under the assumption of fixed labour supply. All figures in € have been equivalised by means of the square root of household size. The deciles have been constructed on the basis of equivalised disposable income in the baseline, and contain 10% of the population of *individuals*.[8]

The results in table 3 are intuitive and broadly correspond to the findings of Bach et al. (2006) for Germany, but are nevertheless revealing. On average, the reform increases equivalised disposable income by 240 € (or 1.29%), but on average the associated price increase erodes this gain nearly completely when measured by means of the Stone price index deflator, and even turns the reform into a small loss as measured by means of the consumption based welfare gain measure.

However, the results are very unevenly distributed across income classes or other socioeconomic groupings. For the non-actives, disposable income is constant.[9] The reform entails an increasing pattern of the gain in disposable income across income classes, both in absolute and in relative terms, and in a relatively limited gain in disposable income for the older age classes.[10] The non actives are of course hit by the price increase. This leads to an average loss of consumption possibilities of 118 € (or 1.03%) measured by means of the CWG. According to the same measure, only the upper four deciles succeed in compensating the price increase by a big enough increase in disposable income. For all other deciles there is a net loss. The decomposition by age class reveals how the reform triggers an intergenerational redistributive effect. The two oldest age classes lose

[7]The small difference between the aggregate change in disposable incomes (1813 million €) and the sum of changes in social security contributions and personal income taxes (1819 millio €) is due to minor changes in means tested benefits.

[8]Also the averages of the variables in the table have been weighted by the product of the number of individuals in the household and the household specific weighting factor for the PSBH-survey.

[9]To be consitent with the goods included in the CWG measure, the figures for disposable income in table 3 already subtract savings and expenditures on durable goods from disposable income. Therefore, disposable income of non-actives is not anymore constant. Disposable income including savings and durable goods is constant for almost all non-actives.

[10]There might be persons working, and thus paying social contributions, in households with a retired household head.

Table 3: Changes in disposable income, real income and consumption based welfare gain (fixed labour supply)

	yearly equivalised disposable income (*excluding* savings and durable expenditures)			real income	price change			
	baseline	change	change	change	in €		CWG	
	in €	dy_h	in %	dX_h	-d1q_h	-d2q_h	in €	in %
All	18605	240	1.29	11	-227	-29	-16	-0.19
by decile of equivalised disposable income in baseline								
1	6814	54	0.79	-47	-107	-9	-61	-0.83
2	10295	95	0.92	-47	-147	-15	-66	-0.64
3	12520	140	1.12	-30	-173	-21	-54	-0.45
4	14393	171	1.19	-21	-194	-25	-47	-0.36
5	16198	216	1.33	3	-213	-27	-23	-0.15
6	18189	235	1.29	4	-231	-30	-25	-0.15
7	20285	296	1.46	40	-252	-32	13	0.09
8	23018	342	1.49	61	-274	-36	32	0.19
9	27277	393	1.44	74	-310	-40	43	0.23
10	37118	459	1.24	77	-373	-53	34	0.14
by age class of the household head								
<18	5564	-108	-1.94	-255	-183	-4	-296	-2.47
≥18	17437	277	1.59	31	-242	-24	11	-0.02
≥30	18122	259	1.43	32	-223	-29	7	0.00
≥40	20730	292	1.41	44	-242	-31	18	0.07
≥50	21425	275	1.28	16	-257	-34	-16	-0.22
≥65	12780	50	0.39	-108	-169	-24	-143	-1.13
≥75	11565	43	0.37	-92	-144	-14	-114	-1.01
by activity status								
non active	11353	54	0.48	-90	-154	-18	-118	-1.03
active	21190	306	1.44	48	-253	-33	21	0.10

more than 1%. For the age classes between 30 and 50, there is a welfare gain.

The assessment of the reform seems to be quite robust w.r.t. the choice of welfare measure. Of course, looking at the change in disposable income only is misleading. But correcting nominal income changes by means of a deflator like the Stone price index, or instead working with the consumption based welfare gain derived from the money metric utility framework does not make much difference as far as the distributional pattern is concerned. Note that the second component of the price change ($\mathrm{d}2q_h$) is unimportant compared to the first factor ($\mathrm{d}1q_h$) in equation (16). It is the general rise in the price level, not the change in relative prices, which causes the welfare losses.

In table 4, we present a picture of the gainers and loosers according to the different welfare measures considered thus far. This methodology was advocated by King (1983). It gives *an* answer to the frequently raised policy question: "Who gains? Who loses?". The table consists of three parts, each corresponding to a different household characteristic: equivalised disposable income, weekly labour supply (as a step to the analysis with flexible labour supply), and age of the household head. The different columns in the table correspond to five quintiles in the distribution of gains and losses. The column with heading Q1 shows the characteristics of the subgroup containing the 20% largest losers. The column with heading Q5 shows the characteristics of the 20% biggest winners of the reform. The different rows in each part of the table correspond to the choice of a different gain or loss concept. The first row, for instance, is obtained by ordering the population on the basis of the absolute change in equivalised disposable income (*including* savings and durable expenditures). Other rows order on changes in other variables, such as nondurable expenditures (taking savings and durables out of disposable income), on non durable expenditures deflated by the Stone price index, or on the consumption based welfare gain. We also add the orderings based on the percentage changes, next to the absolute ones.

Looking at the first part of the table reveals whether the winners and losers of the reform can be differentiated according to their equivalised income, and whether the answer on this question is sensitive to the chosen welfare concept. The answer on the first question is affirmative. Focussing on a distribution of gainers and losers based on the absolute change in *global* equivalised disposable income (first row), disposable income (excluding savings and durable expenditures) increases with the position in the distribution from loss to gain. That means: the losers (e.g. group Q1) are the poorer households, the gainers are the richer ones. The pattern flattens out a bit when using the percentage change in disposable income instead of the absolute change. But also in this case, the reform turns out to be a regressive one. Leaving out savings and durable expenditures from the ordering concept by switching to changes in nondurable expenditures exacerbates this regressive pattern. For the ordering based on the absolute change, the ratio of the income of the 20% biggest winners to that of the 20% biggest losers is now three to one. The introduction of the price correction reduces the regressivity of

Table 4: Disposable income, labour supply and age for different orderings of gainers and losers (fixed labour supply)

	Quintile group of winners and losers				
	Q1	Q2	Q3	Q4	Q5
	equivalised disposable income (*excluding* savings and durable expenditures)				
ordering based on:					
abs change equiv disp income	12287	14958	16394	20757	30126
% change equiv disp income	12292	20785	19276	21069	24225
abs change equiv non durable exp	10621	14476	16930	21221	29794
% change equiv non durable exp	11762	16161	20515	21159	23448
abs change deflated non durable exp	15270	13300	18099	20197	26182
% change deflated non durable exp	12317	16221	20370	21475	22663
abs change consumption based welfare	15862	13670	18449	20117	24940
% change consumption based welfare	12614	16051	20632	21601	22146
	average weekly labour supply				
abs change equiv disp income	8.6	21.3	27.0	31.2	31.0
% change equiv disp income	8.6	22.9	26.9	30.5	31.3
abs change equiv non durable exp	5.5	16.1	27.3	31.7	30.4
% change equiv non durable exp	7.5	16.7	26.2	31.1	30.9
abs change deflated non durable exp	11.7	15.0	25.9	31.5	30.6
% change deflated non durable exp	8.9	17.3	26.5	31.5	30.1
abs change consumption based welfare	12.4	15.3	26.0	31.0	30.5
% change consumption based welfare	8.9	17.6	26.6	31.3	30.1
	age				
abs change equiv disp income	63.4	40.9	40.4	41.6	43.6
% change equiv disp income	63.4	43.6	40.5	43.1	40.9
abs change equiv non durable exp	65.0	54.8	40.6	40.8	44.2
% change equiv non durable exp	65.2	55.1	41.2	42.6	41.0
abs change deflated non durable exp	63.4	57.0	40.6	41.2	43.3
% change deflated non durable exp	62.1	58.8	41.5	42.3	41.8
abs change consumption based welfare	62.7	57.3	42.9	41.5	42.8
% change consumption based welfare	61.4	59.3	41.9	42.2	42.0

the picture, although the remaining regressivity is substantial. The robustness w.r.t. the choice of correcting by means of the Stone price deflator or making use of the money metric utility of consumption based welfare is confirmed here.

The bottom two parts of the table repeat this picture of gainers and losers for two other characteristics. The middle part of the table shows average weekly labour supply for the groups of losers and winners. More or less independently of the chosen ordering concept, the losers group(s) mainly consist(s) of non-actives, while the households with actives are in the winners groups. This is in line with the third part of table 4, where age of the household head in the group of the biggest losers is substantially above the one in the other groups.

4.3 Taking leisure into account

From the analysis sketched up to now, one might conclude that the choice of a specific evaluation measure, once corrected in one way or another for the effect of price changes does not matter much. In table 5 this issue is elaborated more profoundly. It compares the picture of losers and winners according to consumption based welfare gain with the consumption based measure derived from the CES-LES-utility function. The first row in each panel of table 5 displays the characteristics of losers and winners when the ordering is based on the CWG-measure of equation (16). The next three rows show the CES-LES-welfare gain of equation (27) for different values of the share parameter of leisure (δ_l). As mentioned before, we calibrated the share parameters, the δ_i's, for the different commodity aggregates such that they best fit the observed expenditure patterns. When attaching no weight to leisure ($\delta_l = 0$) both evaluation tools are exclusively consumption based. The picture of different categories of losers and winners is more affected by switching between those two evaluation tools than by using the change in real income as an alternative to the CWG-measure (see table 4). Nevertheless, the qualitative results seem to be maintained. The non and less active are more concentrated among the (biggest) losers. The older generation is most liable to pay the bill.

From the macro-economic objective of the reform (activating unemployed) this results seems to be comforting. However, this objective doesn't have to coincide with the individual agent's objectives. To assess the welfare effect of the reform in case more weight is attached to leisure, we provide a similar losers/gainers picture for a higher share parameter of leisure (δ_l). It is striking that the importance attached to leisure does play a role, even if labour supply is fixed.

The results in table 5 are surprising. If we increase the weight of leisure from 0 to 0.5 and then to 0.9, nondurable expenditures of the biggest losers decrease, while that of the middle groups in terms of loss increase. In this sense, the regressive pattern of the reform is exacerbated: poorer households seem to join the losers group. The group of biggest losers also becomes more predominantly populated by non-active people. The

Table 5: Disposable income, activity and age for different orderings of gain and loss (fixed labour supply)

	Quintile group of winners and losers				
	Q1	Q2	Q3	Q4	Q5
	equivalised disposable income (*excluding* savings and durable expenditures)				
ordering based on:					
change in consumption based welfare	15861	13670	18449	20117	24940
change in welfare, share leisure = 0.0	14949	14062	18647	20236	25170
change in welfare, share leisure = 0.5	12409	16453	20274	20232	23694
change in welfare, share leisure = 0.9	11624	17099	21070	20000	23257
	% of households that are non active				
change in consumption based welfare	80.3	66.1	12.6	1.1	1.9
change in welfare, share leisure = 0.0	86.6	57.1	6.8	1.9	1.5
change in welfare, share leisure = 0.5	95.2	49.8	3.5	0.2	5.1
change in welfare, share leisure = 0.9	95.5	52.4	1.0	1.8	6.1
	average weekly labour supply				
change in consumption based welfare	12.4	15.3	26.0	31.0	30.5
change in welfare, share leisure = 0.0	10.7	15.6	26.1	30.1	31.4
change in welfare, share leisure = 0.5	3.1	20.9	32.5	33.0	23.6
change in welfare, share leisure = 0.9	2.3	21.9	34.6	33.6	20.9
	age				
change in consumption based welfare	62.7	57.3	42.9	41.5	42.8
change in welfare, share leisure = 0.0	66.2	52.8	42.2	41.6	41.2
change in welfare, share leisure = 0.5	67.0	53.1	41.4	39.7	43.7
change in welfare, share leisure = 0.9	65.7	55.5	40.5	39.4	45.2

age of the biggest losers increases when $\delta_l = .5$ and then decreases for $\delta_l = .9$ but remains high. Also, the average weekly labour supply per capita of the biggest losers *de*creases. Increasing the share of leisure in the welfare evaluation tool, seems to shift not only more inactives into the group of the biggest gainers but also into the group of biggest losers.

This result is not due to the factor which transforms the utility difference into a money metric (the factor $\left[\phi(\mathbf{q}^0, w_n^0)\right]^{\frac{1}{1-\sigma}}$ in equation (27)). This factor is monotonously increasing in prices. Therefore gains and losses of people with higher net wage w_n are inflated relatively more than those of people with smaller wages. Due to the progressive tax system low income earners and unemployed tend to have a relatively high net wage, which might explain the unexpected result. [11] In the appendix (section 7.5) we provide however a similar analysis as in table 5 for a welfare measure that is not expressed in monetary units. The results are roughly the same, so the puzzle remains.

More seriously, it turns out that rank reversals in the classification of gainers and losers when increasing the weight of leisure in the utility function, occur for households with a different consumption level, but with the same amount of leisure. Hence, our results cannot be explained solely by the employment/leisure characteristics of the respondents. Differences in consumption behaviour remain to play a dominant role, even when attaching more weight to leisure.

So, despite some of the signals highlighted at the beginning of this subsection, the choice of welfare measure for evaluating a policy can play a crucial role, certainly for a more detailed analysis. We therefore argue for the need to justify the chosen welfare measure more carefully than is usually done, or to make the analysis independent from its particular choice. By lack of a more firm motivation for one of the measures provided, we pursue in the next section an example of the latter track.

4.4 Employment as a macro-economic objective

While the ranking of gainers and losers is affected by the weight of leisure in the evaluation function, even when labour supply is fixed, the fact that one is gaining or losing is not. In this subsection we therefore focus on this dichotomous picture of gainers and losers. We already notified that non-actives are amoung the losers. More surprising, and less prominent in the policy debate, is the fact that a non-negligible part of the actives is also affected negatively by the proposed reform (see table 6). This might raise the question in how far the proposed reform does indeed stimulate employment.

Before turning to this question, we first want to investigate whether there are some salient characteristics which differentiate losing actives from gaining actives. In table 7 we give mean equivalised disposable income (including and excluding savings and

[11] For the retired households we imputed the first quartile value of the distribution of the household net wage and therefore have a relatively low net wage by definition.

Table 6: Frequency table activity status of winners and losers

category	% non-actives	% actives	total
losers			
row percent	75.02	24.98	100.00
column percent	96.36	22.06	–
cell percent	39.26	13.07	52.33
winners			
row percent	03.11	96.89	100.00
column percent	03.64	77.94	–
cell percent	01.48	46.19	52.33
total			
row percent	–	–	–
column percent	100.00	100.00	–
cell percent	40.74	59.26	100.00

durables) and labour supply per capita of losing and gaining actives. As it turns out none of these characteristics seem to clearly discriminate those categories. All of this gives evidence to the findings of other studies mentioned in the introduction that a general reduction in social security benefits is not fine tuned enough to generate the intended labour supply incentives. We turn in the next section towards a more quantitative analysis of these labour incentive effects.

5 Introducing flexible labour supply

In appendix 7.4 we describe the discrete choice model used to predict changes in labour supply following the reform of lowering social security contributions and increasing indirect taxes. The estimation of the model and its use in simulations of Belgian tax reforms is discussed in Orsini (2006). The model is the by now standard one in which a multinomial logit is estimated for a set of discrete choice possibilities as far as labour supply is concerned (see Van Soest, 1995 for the basic reference, and Creedy and Duncan, 2002 and Creedy and Kalb, 2005b for overviews).

Unfortunately, with our data, the model could only be estimated for a subset of households, viz. the couples. Evidently, we only considered the couples with adults at working age. The results discussed in this section therefore only cover this modelled subpopulation.

Moreover two important additional problems arise due to the probabilistic nature of the discrete choice model. In the post-reform situation the model does not produce a specific level of hours worked by the individual (or household) but probabilities attached to each choice. This makes it not straightforward to simply apply the money

Table 7: Characteristics of active losers and winners

	equivalised disposable income (*in*clusive savings and durables)
losers	20857
winners	21528
	equivalised disposable income (*ex*clusive savings and durables)
losers	15693
winners	16341
	weekly labour supply per capita
losers	28
winners	31

metric utility measures as described in section 3.4, nor to do the aggregation exercise by means of calculating inequality or poverty measures (or any distributional analysis) on the microdata in the post-reform situation.[12] Recently, Dagsvik and Karlström (2005) derived the random expenditure function in the context of discrete choice, and for the second issue, several possibilities arise and are discussed and compared experimentally in Creedy, Kalb and Scutella (2004). One possibility is to use the *expected* labour supply in the post-reform situation. When the baseline situation is calibrated to replicate the (discretized) labour supply choice before the reform, this comparison with expected labour supply after the reform is of course a bit weird. Yet, as a first (and preliminary) step and mainly for computational reasons, we do work with this expected labour supply (and income) in the post-reform situation.

Table 8 summarizes the labour supply effects by decile of equivalised disposable income (of the subpopulation only). We have summarized the transitions by categorizing the population into households where at least one individual is active in the baseline, and the non-active households.

Table 8 confirms the results found in numerous other studies that the participation effect is more important than the reaction at the intensive margin, and that the participation effect is mainly relevant for the bottom of the income distribution. Note however from the bottom two lines of the table, where weekly household labour supply in baseline and reform situation is displayed, that in terms of expected labour supply, the transition from non-participation to participation leads to a limited labour supply increase of a bit more than one hour a week.

Table 9 then repeats the analysis of the previous section by investigating the sensi-

[12]In fact we are on the side of the remark in Duncan and MacCrae (1999) that "The methods by which discrete models of labour market status are applied to discrete microsimulation are to a degree under-developped" (p. 34-35), certainly as far as the distributional analysis is concerned. Most papers who use behavioural microsimulation only report aggregate results for subgroups of the population.

Table 8: Change in labour supply by decile of disposable income

		non active in baseline		active in baseline with labour supply		
Decile	Total	stay non active	entry	unchanged	increased	decreased
1	112	10	62	20	19	1
2	99	2	3	53	38	3
3	104	1	0	72	30	1
4	109	0	0	89	16	4
5	107	0	0	84	20	3
6	105	1	0	85	18	1
7	117	0	0	101	12	4
8	124	0	0	108	14	2
9	119	0	0	99	16	4
10	113	0	0	94	10	9
Total	1109	14	65	805	193	32
L^0	27.573	0.000	0.000	32.194	20.711	29.623
L^1	27.670	0.000	1.018	32.194	20.950	29.304

tivity of the distribution of winners and losers to the weight we attach to leisure in our normative evaluation tool. The table displays where we find the entrants of the labour market (upper panel), and the households who increase their labour supply (bottom panel) in the distribution of losers and gainers. The quintiles again contain 20% of the individuals for this subpopulation and are constructed for different gain/loss concepts in the rows. The results are intuitive. Only looking at consumption, those households who are 'activated' or increase their labour supply are overrepresented in the winners-part of the distribution. At the intensive margin (bottom part of the table) the effect of attaching more weight to leisure clearly moves households who increase their labour supply to the losers groups (quintiles 1 and 2). For the extensive margin the result is less clear and non monotonic. Only when the weight attached to leisure is high enough do we get a clear effect. This of course probably has to do with the small change in labour supply from 0 in the baseline to (on average) an expected value of slightly more than one hour after the reform.

Finally, we confront the results of the welfare analysis with the macro-economic employment objective. From table 10 one can notice that, even from the policy maker's most favourable point of view to attach no weight to leisure, 11% of those who are activated by the policy, and 2.6% of those who are increasing labour supply lose by the measure. Naturally, these numbers increase when attaching more weight to leisure. This confirms the conjecture raised at the end of the previous section that the incentive effects of the proposed reform of a general cut in social security contributions are not uniformly positive. Activing unemployed can forthermore bear a welfare cost for some

Table 9: Welfare effects of the reform for different orderings of gains and losses (flexible labour supply)

	Quintile group of winners and losers					
	Q1	Q2	Q3	Q4	Q5	All
	% entrants in the labour market					
ordering based on:						
change consumption based welfare	5.7	2.5	1.0	1.8	17.9	6.0
change welfare, share= 0.0	8.2	1.1	2.0	0.3	17.4	6.0
change welfare, share= 0.5	7.7	1.6	0.8	0.7	20.4	6.0
change welfare, share= 0.9	27.1	0.0	0.0	0.0	1.7	6.0
	% actives who increase their labour supply					
change consumption based welfare	15.6	11.6	15.9	14.9	34.4	18.9
change welfare, share= 0.0	14.9	17.2	15.4	18.1	27.5	18.9
change welfare, share= 0.5	40.1	17.5	8.1	13.1	19.4	18.9
change welfare, share= 0.9	72.4	21.9	0.4	0.0	0.0	18.9

Table 10: Winners and losers and labour supply incentives

		percentage losers/winners		
δ_l	category	entrants	labour supply increase	labour supply decrease
0.00	losers	10.77	02.59	21.21
	winners	89.23	97.41	78.79
0.50	losers	23.08	17.62	00.00
	winners	76.92	82.38	100.0
0.90	losers	93.85	99.48	00.00
	winners	06.15	00.52	100.0

agents, as well in terms of consumption (because of the rise in prices) and, naturally, also in terms of leisure.

6 Conclusion

In this paper we analysed the distributional impact of lowering social security contributions and compensating the revenue loss by an increase in indirect taxes. For the empirical application, a link between two existing Belgian microsimulation models, MODÉTÉ for the tax benefit system, and ASTER for the indirect tax part, was established. This was mainly accomplished by imputing detailed expenditures in the income data survey by means of nonparametric Engel curves. The behavioural models to predict changes in expenditure behaviour (QUAIDS for the ASTER model) and in labour supply (a discrete choice model) remained unconnected.

This empirical construction also deprived us from one - actually illusory - integrated measure of welfare change. We disconnected however the positive analysis from the normative evaluation. By using a flexible form like the CES utility function to describe household welfare obtained from consumption and leisure, we investigated the sensitivity of the distributional analysis with respect to the chosen welfare measure, more specifically for the weight attached to leisure in the utility function.

The positive analysis with fixed labour supply is in line with recent results in other empirical papers like Bach et al. (2006) and confirms the prior expectation that there are considerable distributional effects of this shift in financing base. The currently living generation of pensioners are most liable to pay the bill. They do not profit from the reduced tax on labour income, but do pay higher consumption prices. In terms of equivalised disposable income, the reform is regressive. This picture is not really sensitive to the choice of measuring the welfare gain or loss by means of real income, defined as disposable income deflated with a Stone price index, or by using a money metric defined on consumption only. It is however sensitive to the decision to neglect or integrate leisure in the welfare concept used to assess the effect of the reform. Even with labour supply fixed, taking up leisure in the welfare function may seriously affect the picture of gainers and losers of a reform. We therefore concentrated on aspects of the evaluation which are independent of the choice of welfare function. About one quarter of the households with persons that are working lose by the measure. Despite the fact that these results might be the result of non-active losing members belonging to such households, this figure raises some doubts about the incentive effects of such a general reform.

The analysis with flexible labour supply, though limited to a subpopulation of couples only, seems to confirm this conjecture. The positive analysis is in line with the results found in many other papers that the labour supply effect is mainly found at the extensive margin of labour market participation. For the welfare analysis, the picture of gainers and losers evidently is affected by the weight attached to the lost leisure for individuals who entry the labour market or increase their labour supply. Yet, even when attaching no weight to leisure, about one tenth of the persons activated by the measure bears a welfare loss from the reform. To reconcile macro-economic objectives with welfare objectives, other or more fine tuned measures seem to be in place.

7 Appendix

7.1 Effect of changes in social security contributions on the labour market

To rationalise the assumption that the reduction of social security contributions to be paid by the employee are channelled completely into an increase in the net wage, we write down the effect of social security contributions on net wage, gross wage, wage cost and labour market equilibrium in a partial equilibrium framework. We denote gross wage by w, the net wage by $w_n = w(1-t_n)$, where t_n is the social security contribution paid by the employee, and the wage cost faced by the employer by $w_c = w(1+t_c)$, with t_c the employer's social security contribution. Labour demand is determined by wage costs: $L_d(w_c) = L_d(w(1+t_c))$, while labour supply depends on the net wage: $L_s(w_n) = L_s(w(1-t_n))$. Changes in t_c, t_n and w lead to the following changes in labour demand and labour supply:

$$\begin{aligned}
\Delta L_d &\cong \frac{\partial L_d}{\partial w_c}\Delta w_c \\
&\cong \frac{\partial L_d}{\partial w_c}\left[\frac{\partial w_c}{\partial t_c}\Delta t_c + \frac{\partial w_c}{\partial w}\Delta w\right] \\
&= \frac{\partial L_d}{\partial w_c}\left[w\Delta t_c + (1+t_c)\Delta w\right] \\
&= \frac{\partial L_d}{\partial w_c}\frac{w_c}{L_d}\frac{L_d}{w_c}\left[w\Delta t_c + (1+t_c)\Delta w\right] \\
&= \varepsilon_d L_d \frac{w}{w_c}\Delta t_c + \varepsilon_d \frac{L_d}{w_c}(1+t_c)\Delta w \\
&= \varepsilon_d L_d \frac{\Delta t_c}{1+t_c} + \varepsilon_d L_d \frac{\Delta w}{w}, \qquad (29)
\end{aligned}$$

where in the last but one line ε_d is introduced to denote the elasticity of labour demand with respect to the wage cost w_c, and in the last line we use the fact that $w/w_c = 1/(1+t_c)$ in the first term and $(1+t_c)/w_c = 1/w$ in the second term. Analogously, we derive for the change in labour supply:

$$\begin{aligned}
\Delta L_s &\cong \frac{\partial L_s}{\partial w_n}\Delta w_n \\
&\cong \frac{\partial L_s}{\partial w_n}\left[\frac{\partial w_n}{\partial t_n}\Delta t_n + \frac{\partial w_n}{\partial w}\Delta w\right] \\
&\cong \frac{\partial L_s}{\partial w_n}\left[-w\Delta t_n + (1-t_n)\Delta w\right] \\
&= \frac{\partial L_s}{\partial w_n}\frac{w_n}{L_s}\frac{L_s}{w_n}\left[-w\Delta t_n + (1-t_n)\Delta w\right] \\
&= -\varepsilon_s L_s \frac{w}{w_n}\Delta t_n + \varepsilon_s \frac{L_s}{w_n}(1-t_n)\Delta w \\
&= -\varepsilon_s L_s \frac{\Delta t_n}{1-t_n} + \varepsilon_s L_s \frac{\Delta w}{w}, \qquad (30)
\end{aligned}$$

where ε_s is the elasticity of labour supply with respect to the net wage w_n.
Starting from equilibrium in the labour market ($L_d = L_s$), the change in the equilibrium gross wage w is found from equating (30) and (29), which gives:

$$\varepsilon_d \frac{\Delta w}{w} - \varepsilon_s \frac{\Delta w}{w} = -\varepsilon_s \frac{\Delta t_n}{1-t_n} - \varepsilon_d \frac{\Delta t_c}{1+t_c}.$$

Solving for the change in the gross wage, we get (assuming the demand elasticty is negative):

$$\frac{\Delta w}{w} = \frac{1}{\varepsilon_s + |\varepsilon_d|} \left[\varepsilon_s \frac{\Delta t_n}{1-t_n} - |\varepsilon_d| \frac{\Delta t_c}{1+t_c} \right]. \tag{31}$$

Remember that the change in wage cost and net wage are:

$$\frac{\Delta w_c}{w_c} = \frac{\Delta w}{w} + \frac{\Delta t_c}{1+t_c}, \tag{32}$$

$$\frac{\Delta w_n}{w_n} = \frac{\Delta w}{w} - \frac{\Delta t_n}{1+t_n}. \tag{33}$$

The change in equilibrium quantity of labour is:

$$\begin{aligned} \frac{\Delta L}{L} &= -|\varepsilon_d| \left[\frac{\Delta w}{w} + \frac{\Delta t_c}{1+t_c} \right] \\ &= -\frac{1}{\frac{1}{\varepsilon_s} + \frac{1}{|\varepsilon_d|}} \left[\frac{\Delta t_n}{1-t_n} + \frac{\Delta t_c}{1+t_c} \right]. \end{aligned} \tag{34}$$

We only consider reductions of the contributions paid by the employee ($\Delta t_c = 0$). Equation (31) then shows that the assumption of a perfectly elastic labour demand ($|\varepsilon_d| = \infty$) is sufficient to get the case of an unchanged gross wage. From (33) it is seen that in that case, the net wage simply increases with the same percentage as the social security contributions are reduced. Finally, equation (34) shows that the change in labour supply coincides with the equilibrium change in labour under this assumpton.

7.2 Semiparametric Engel curves and income effects

The general form for Engel curves can be written as:

$$w_i = g_i(y, \mathbf{z}) + \varepsilon_i, \tag{35}$$

with w_i the budget share on good i, y disposable income, $\mathbf{z}$ a vector of household characteristics ,and ε_i a random error term.[13] The function $g_i(.,.)$ is an unknown function that has to be estimated. When the vector $\mathbf{z}$ has high dimension a fully nonparametric estimation of $g(.,.)$ becomes unfeasible or would require a vast amount of data. Therefore we resorted to a semiparametric specification where we retained only disposable income and age of the household head in the nonparametric part. The other household

[13] We will stick to the usual terminology of *budget share* although we use shares in disposable income here.

characteristics remain in the vector $\mathbf{z}$ and enter the Engel curve specification linearly. The latter can then be written as:

$$w_i = \beta_i'\mathbf{z}+F_i\left(y, age\right) + \varepsilon_i, \tag{36}$$

where $F_i\left(.,.\right)$ is a function of age and disposable income with no a priori assumed functional form. Rewriting (36) as:

$$F_i\left(y, age\right) = w_i - \beta_i'\mathbf{z}+\nu_i, \tag{37}$$

where ν_i is a random error term with conditional mean equal to zero, allows to formulate the regression analogue of (37) as:

$$F_i\left(y, age\right) = E\left(w_i - \beta_i'\mathbf{z} \mid y, age\right). \tag{38}$$

Once we have estimates for the β-coefficients, (38) can be estimated by nonparametric regression. The β-coefficients can be estimated from (36) by taking the conditional expectation of (36) with respect to age and disposable income to get:

$$E\left(w_i \mid y, age\right) = \beta_i' E\left(\mathbf{z} \mid y, age\right) + F_i\left(y, age\right), \tag{39}$$

and subsequently subtracting this from (36) to eliminate $F_i\left(y, age\right)$ and permitting to estimate, in the budget survey, the β-coefficients by simple OLS-regression of:

$$w_i - E\left(w_i \mid y, age\right) = \beta_i'\left[\mathbf{z} - E\left(\mathbf{z} \mid y, age\right)\right] + \varepsilon_i, \tag{40}$$

where the conditional expectation terms are replaced by their respective nonparametric estimates:

$$\begin{aligned}
\widehat{E}\left(w_i \mid y, age\right) &= \frac{\sum_h K\left(\frac{y-y_h}{b_y}\right) K\left(\frac{age-age_h}{b_{age}}\right) w_{ih}}{\sum_h K\left(\frac{y-y_h}{b_y}\right) K\left(\frac{age-age_h}{b_{age}}\right)}, \text{ and} \\
\widehat{E}\left(\mathbf{z} \mid y, age\right) &= \frac{\sum_h K\left(\frac{y-y_h}{b_y}\right) K\left(\frac{age-age_h}{b_{age}}\right) \mathbf{z}_h}{\sum_h K\left(\frac{y-y_h}{b_y}\right) K\left(\frac{age-age_h}{b_{age}}\right)},
\end{aligned}$$

where the functions $K\left(.\right)$ are standard Gaussian kernel functions given by:

$$K\left(u\right) = \frac{1}{\sqrt{2\pi}} e^{-\frac{u^2}{2}},$$

and b_y and b_{age} are the bandwidths for respectively income and age. The summation is over all households h of the budget survey. The bandwidths are chosen optimally, but they are not adaptive. Else, adding-up could not be satisfied. Hence, the bandwidths are independent of the commodities and are the same for all households. Filling in the estimated β-coefficients in (38) would permit nonparametric estimation of the function $F_i(.,.)$ in the budget survey as:

$$\widehat{F}_i(y, age) = \frac{\sum_h K\left(\frac{y-y_h}{b_h}\right) K\left(\frac{age-age_h}{b_{age}}\right)\left[w_{ih} - \widehat{\beta}_i' \mathbf{z}_h\right]}{\sum_h K\left(\frac{y-y_h}{b_h}\right) K\left(\frac{age-age_h}{b_{age}}\right)}. \tag{41}$$

For imputation of budget shares in the income survey we make use of the overlapping variables y, age, and the household characteristics in $\mathbf{z}$ and expression (39).[14] While the linear part in the latter poses no problem, we also need an estimate of $F_i(y, age)$ in the income survey. For this we make use of expression (41) in which the points of estimation, y and age, will now be observations from the income survey rather than the budget survey. Let index *bs* indicate observations from the budget survey and *is* observations from the income survey. Households in the budget survey are identified by subscript h and households in the income survey by subscript j. For *each* household j in the income survey, the imputed function $F_i(.,.)$ for good i is given by (an imputed value is indicated by a tilde):

$$\widetilde{F}_i^{is}\left(y_j^{is}, age_j^{is}\right) = \frac{\sum_h K\left(\frac{y_j^{is}-y_h^{bs}}{b_h}\right) K\left(\frac{age_j^{is}-age_h^{bs}}{b_{age}}\right)\left[w_{ih}^{bs} - \widehat{\beta}_i' \mathbf{z}_h^{bs}\right]}{\sum_h K\left(\frac{y_j^{is}-y_h^{bs}}{b_h}\right) K\left(\frac{age_j^{is}-age_h^{bs}}{b_{age}}\right)}. \tag{42}$$

The imputed budget share of good i for household j in the income survey will then be[15]:

$$\widetilde{w}_{ij}^{is} = \widehat{\beta}_i' \mathbf{z}_j^{is} + \widetilde{F}_i\left(y_j^{is}, age_j^{is}\right). \tag{43}$$

In the text we explain how we also used these nonparametric Engelcurves to calculate the effect of changes in disposable income on the income shares. A summary of these Engel curves is given in table 11 below by means of the median income elasticity, following the changes in disposable income triggered by the reform discussed in the text.

7.3 ASTER and Belgian indirect taxes in 2005

In Belgium, as in most other countries, three types of indirect taxes can be distinguished: (1) excises, (2) the value-added tax (VAT) and (3) ad valorem taxes. The link between the producer price and the consumer price of commodity i can be written as follows:

$$q_i = (1 + t_i) \cdot (p_i + a_i + v_i \cdot q_i), \tag{44}$$

where q_i denotes the consumer price of commodity i, p_i the producer price, a_i the excise, v_i the ad valorem tax rate and t_i the VAT rate.

[14] In this exercise we do not add back an error term to the imputed budget shares.

[15] Remark that, to be correct, this should read as the conditional budget share, i.e. $E\left(\widetilde{w}_{ij}^{is} \mid \mathbf{z}_j^{is}, y_j^{is}, age_j^{is}\right)$.

Table 11: Commodity breakdown, income and price elasticities, and share parameters of CES utility function

Commodity aggregate	income elasticity (median)	price elasticity (median)	CES-LES share parameter δ_i	%
Food	0.48	-1.25	0.0340	11.6
Drinks - Non Alcoholic	0.42	-1.70	0.0027	0.9
Drinks - Alcoholic	0.99	-0.10	0.0054	1.8
Tobacco	-0.15	-1.07	0.0013	0.4
Clothing, footwear	1.03	-1.07	0.0222	7.6
Rent and Utilities	0.43	-1.32	0.0918	31.3
Private transport	1.08	-0.79	0.0221	7.5
Public transport	0.37	-8.73	0.0027	0.9
Hygienics, Health	0.74	-0.30	0.0214	7.3
Leisure commodities	0.99	-0.72	0.0552	18.8
Other commodities	0.75	-1.09	0.0346	11.8
Durables	1.08	-0.97	0.0000	0.0
Savings	1.97		0.0000	0.0

The producer price in function of the consumer price then reads as:

$$p_i = \left[\frac{1-(1+t_i)v_i}{1+t_i}\right] q_i - a_i, \tag{45}$$

which, for the simpler case where the ad valorem rate equals zero, yields:

$$p_i = \frac{q_i}{1+t_i} - a_i. \tag{46}$$

This is the equation we use to infer from the known consumer price q_i and excise a_i the producer price which will be assumed fixed. Note that this producer price can become negative, pointing to either a too low consumer price, or an inconsistency between the excise information and the producer price (e.g. different units).

For a commodity i ($\forall i$), the *implicit proportional excise tax rate* α_i is defined as follows:

$$\alpha_i = \frac{a_i}{p_i}. \tag{47}$$

Replacing a_i in equation (45) by making use of (47), we obtain:

$$q_i = (1+t_i)\cdot(p_i + \alpha_i \cdot p_i + v_i \cdot q_i)\,. \tag{48}$$

This expression can be rewritten as:

$$q_i = \frac{(1+t_i)\cdot(1+\alpha_i)}{1-v_i\cdot(1+t_i)} \cdot p_i = z_i \cdot p_i, \tag{49}$$

where $z_i = \frac{(1+t_i)\cdot(1+\alpha_i)}{1-v_i\cdot(1+t_i)}$ is the ratio of consumer to producer price for commodity i. From this we can obtain the total tax rate for commodity i as:

$$\begin{aligned}
\tau_i &= z_i - 1 && (50)\\
&= \frac{q_i - p_i}{p_i} && (51)\\
&= \frac{t_i(1+\alpha_i+v_i)+v_i}{1-(1+t_i)v_i} + \frac{\alpha_i}{1-(1+t_i)v_i} && (52)\\
&= \tau_i^t + \tau_i^a, && (53)
\end{aligned}$$

where we now have decomposed the total tax rate τ_i into an implicit VAT rate τ_i^t and an implicit excise rate τ_i^a.

The total tax rates τ_i and the two components τ_i^t and τ_i^a have all been expressed in relation to the producer price of the commodity. Therefore the total indirect tax liability T_i has to be calculated on the expenditures at the producer prices $p_i x_i$. To calculate the tax liability from observable expenditures $e_i = q_i x_i$, we do the following:

$$\begin{aligned}
T_i &= \tau_i p_i x_i && (54)\\
&= \frac{\tau_i}{q_i} p_i q_i x_i && (55)\\
&= \frac{\tau_i}{z_i} e_i && (56)\\
&= \frac{\tau_i}{1+\tau_i} e_i && (57)\\
&= \frac{\tau_i^t}{1+\tau_i} e_i + \frac{\tau_i^a}{1+\tau_i} e_i && (58)\\
&= T_i^t + T_i^a, && (59)
\end{aligned}$$

where T_i^t and T_i^a refer to the VAT tax liability for commodity i and excise tax liability respectively.

Up to here we can apply the formulae for commodities at the most detailed level. In simulations we will however use tax rates on aggregates. We proceed from the tax calculation at the lowest level of aggregation to a higher level of aggregation as follows. The tax liability for commodity aggregate K, denoted by T_K is obtained as the sum of the tax liabilities paid on the individual commodities:

$$\begin{aligned}
T_K &= \sum_{i \in K} T_i && (60)\\
&= \sum_{i \in K} T_i^t + \sum_{i \in K} T_i^a, && (61)
\end{aligned}$$

from which we define the tax rates on the aggregates as:

$$\begin{aligned}
\tau_K &= \frac{T_K}{e_K - T_K} && (62)\\
&= \frac{T_K^t}{e_K - T_K} + \frac{T_K^a}{e_K - T_K} && (63)\\
&= \tau_K^t + \tau_K^a. && (64)
\end{aligned}$$

It are these tax rates for the aggregates which are then used to calculate the tax liabilities on aggregates of expenditures:

$$\begin{aligned}
T_K^t &= \tau_K^t(e_K - T_K)\\
&= \frac{\tau_K^t}{1+\tau_K} e_K, && (65)
\end{aligned}$$

and

$$\begin{aligned}
T_K^a &= \tau_K^a(e_K - T_K)\\
&= \frac{\tau_K^a}{1+\tau_K} e_K. && (66)
\end{aligned}$$

The values τ_K are reported in table 1.

7.4 Labour supply model

Traditional approaches, based on the estimation of continuous labor supply functions, have proven computationally cumbersome even in the simplest case, let alone in the more complex cases in which multiple welfare program participation, the social stigma of benefit take up and the fixed cost of labor supply are considered. The analysis has been greatly simplified by the discrete approach proposed by Dagsvik (1994). Such models explicitly recognize the institutional constraints on labor supply which result in a limited set of working time alternatives (inactivity, some part-time categories, full-time and over-time).

Most importantly, however, the computational burden of estimating labor supply functions boils down to ML estimation of a conditional logit function.

The ML estimation allows to identify the preference parameters, conditional on the imposed functional form of the utility function. The approach is fully structural as it separates preferences from constraints, and it thus allows to simulate the effects of all possible changes in the budget constraints.

Discrete choice models of labor supply are based on the assumption that a household can choose among a finite number $J+1$ of working hours (J positive hours and non-participation); each choice $j = 0, ..., J$ corresponds to a given level of disposable income C_{ij} (we suppose here that choice j=0 corresponds to non-participation) and each discrete bundle of leisure and income provides a different level of utility. The approach has become standard practice as it provides a straightforward way to account for taxes and benefits, hence nonlinear and nonconvex budget sets, and the joint labor supply of spouses. In effect, choices $j = 0, ..., J$ in a couple correspond simply to all the combinations of the spouses' discrete hours. We assume that females may choose between working 0, 20, 40 or 50 hours, while men may work 0, 40 or 50 hours.[16]

The database contained almost no cases of males in couples working part-time. Labour supply was not modelled for singles, given the limited size of the sample. At the same time, we excluded couples where one or both partners are either self employed or retired. In the first case, in fact, we do not dispose of information on working time, while in the second case the labour supply is fixed at zero.

Household's utility V_{ij} derived by household i from making choice j, corresponds to the sum of the deterministic part of the utility U_{ij}, which is assumed to depend on a function of spouses' leisures $l_{f_{ij}}$, $l_{m_{ij}}$, disposable income C_{ij} (equivalent to aggregate household consumption in a static framework) and household characteristics Z_i, and of a random term ϵ_{ij}:

$$V_{ij} = U(l_{f_{ij}}, l_{m_{ij}}, C_{ij}, Z_i) + \epsilon_{ij}.$$

When the error term ϵ_{ij} is assumed to be identically and independently distributed across alternatives and households according to an extreme value type I distribution, the probability that alternative k is chosen by household i is given by:

$$P_{ik} = \Pr(V_{ik} \geq V_{ij}, \forall j = 0, ..., J) = \frac{\exp U(l_{f_{ik}}, l_{f_{ik}}, C_{ik}, Z_i)}{\sum_{j=0}^{J} \exp U(l_{f_{ij}}, l_{m_{ij}}, C_{ij}, Z_i)}.$$

The likelihood for a sample of observed choices can be derived from that expression and maximized to estimate the parameters of function U. When actual working hours are used, the econometrician assumes that individuals choose freely their working hours and face no demand-side constraints.

In the following, we assume a quadratic specification of the utility function as in Blundell et al. (2000). Hence, the utility function of a couples household has the following form:

$$\begin{aligned} U_{ij} &= \alpha_c C_{ij} + \alpha_{cc} C_{ij}^2 + \alpha_{hf} l_{f_{ij}} + \alpha_{hhf} l_{f_{ij}}^2 + \alpha_{hm} l_{m_{ij}} + \alpha_{hhm} l_{m_{ij}}^2 \\ &\quad + \alpha_{chf} C_{ij} Lf_{ij} + \alpha_{chm} C_{ij} Lm_{ij} + \alpha_{hmhf} l_{f_{ij}} \cdot l_{m_{ij}}. \end{aligned} \tag{67}$$

[16]Hours worked were censored at 80 hours per week and discretized according to the following rule for females:

$$\begin{aligned} H &= 0, \forall h \in [0, 10] \\ H &= 40, \forall h \in [11, 44] \\ H &= 50, \forall h \in [45, 80], \quad \text{for males and} \end{aligned} \qquad \begin{aligned} H &= 0, \forall h \in [0, 10] \\ H &= 20, \forall h \in [11, 34] \\ H &= 40, \forall h \in [35, 44] \\ H &= 50, \forall h \in [45, 80], \quad \text{for females.} \end{aligned}$$

Table 12: Disposable income, activity and age for different orderings of gain and loss (fixed labour supply)

	Quintile group of winners and losers				
	Q1	Q2	Q3	Q4	Q5
	equivalised disposable income (*excluding* savings and durable expenditures)				
ordering based on:					
change in consumption based welfare	15861	13670	18449	20117	24940
change in non-monetary welfare, share leisure = 0.0	14949	14062	18647	20236	25170
change in non-monetary welfare, share leisure = 0.5	12350	16518	20565	20107	23525
change in non-monetary welfare, share leisure = 0.9	11665	17126	21349	19967	22945
	average weekly labour supply				
change in consumption based welfare	12.4	15.3	26.0	31.0	30.5
change in non-monetary welfare, share leisure = 0.0	10.7	15.6	26.1	30.1	31.4
change in non-monetary welfare, share leisure = 0.5	2.6	19.8	32.1	32.4	24.6
change in non-monetary welfare, share leisure = 0.9	1.8	20.2	34.3	32.5	22.6
	age				
change in consumption based welfare	62.7	57.3	42.9	41.5	42.8
change in non-monetary welfare, share leisure = 0.0	66.2	52.8	42.2	41.6	41.2
change in non-monetary welfare, share leisure = 0.5	68.4	50.2	42.1	39.9	42.9
change in non-monetary welfare, share leisure = 0.9	67.6	52.5	41.3	39.4	44.1

We assume that preferences vary across households through taste-shifters (age, number of small children) on income and leisure coefficients, and we follow Van Soest (1995) and introduce a dummy variable for part time work, β_{pt}. Dummy variables also capture different aspects not explicitly treated in the model: search costs, rationing effect and dynamic maximization.

For more details on the model and on estimation results, see Orsini (2006).

7.5 The choice of welfare measure

In this appendix we replicate (part of) table 5 for a welfare measure which is ordinally equivalent to $WG_{\text{CES-LES}}$, but is not expressed in monetary terms. The results are in table 12. The measure is defined as the factor $\left(U^1 - U^0\right)$ of equation (27). The function of prices $\left[\phi(\mathbf{q}^0, w_n^0)\right]^{\frac{1}{1-\sigma}}$ with which this measure is pre-multiplied in (27), converts it into a money metric utility concept. We therefore call $\left(U^1 - U^0\right)$ a non-monetary welfare measure.

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