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FALLING UP THE STAIRS: THE EFFECTS OF "BRACKET CREEP" ON HOUSEHOLD INCOMES

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This paper analyzes how inflation-induced erosions of nominally defined amounts built into relevant tax rules ("bracket creep") alter distributional and revenue-generating properties of income taxes and social insurance contributions. Using a multi-country tax-benefit model, it provides quantitative estimates for Germany, the Netherlands and the U.K. In the absence of automatic inflation adjustment mechanisms, effects on individual tax burdens can be substantial, even with low inflation. Bracket creep is found to reduce tax progressivity. At the same time, overall tax revenues increase. In terms of tax systems' equalizing capacities, which depend on both these factors, the second effect dominates: if tax systems were left unadjusted then inflation would lead to lower and slightly more equally distributed household incomes. However, existing inflation adjustment regimes in the Netherlands and the U.K. successfully prevent large tax burdens changes.

1. INTRODUCTION

During the past three decades, the distinction between nominal and real variables has become a firmly established part of both political and public discourse. The attention and media coverage prompted regularly by the release of new inflation figures make widespread money illusion unlikely, even at low rates of inflation. Despite this general awareness, many tax rules still employ the "nominal view" of the world. This paper demonstrates how inflation alters distributional properties of nominally defined tax systems in three countries (Germany, the Netherlands and the U.K.) and analyzes the sensitivity of aggregate revenues to uniform tax base increases.

A large literature on the effects of inflation on taxation emerged in the 1970s and early 1980s when inflation was high. However, the topic has received much

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less attention since the widespread decline of inflation rates in the mid 1980s. As a result, it is largely still true that "the effect of inflation on the progressivity of the income tax system is important and noteworthy, but usually overlooked."[1] This is especially so in many European countries, where, during the 1990s, concerns about deflation have sometimes pushed inflation, and the costs associated with it, off the headlines.[2]

There are two main reasons for a renewed interest in the topic. First, inflation rates are now lower than they were in the 1970s and 1980s. An important question is therefore whether the currently experienced levels of inflation can result in marked distortions of tax liabilities. As will become apparent in this study, infrequent inflation adjustments can indeed cause significant additional tax burdens—even at low rates of inflation. Second, tax reforms implemented during the past two decades have significantly altered the structure of income tax schedules leading to a reduction in the number of tax bands and a flattening of rate schedules. Given the importance of the shape of (effective) tax schedules in determining how inflation alters real tax burdens, it is useful to reassess earlier arguments on the consequences of inflation. Do current tax systems still result in significant extents of "fiscal drag"?

Earlier empirical studies suggest a regressive nature of this fiscal drag in the sense that, in relative terms, tax burdens increase by more for low-income groups than for high-income taxpayers. There have been studies for Australia (Taxation Review Committee, 1974), Canada (Vukelich, 1972; Jarvis, 1977), the U.S. (Goetz and Weber, 1971; Von Furstenberg, 1975; Sunley and Pechman, 1976) and Italy (Majocchi, 1976; Lugaresi and Nicola, 1991). An early international comparison is provided in OECD (1976). These studies also show that, in a progressive tax system, average tax rates increase for all income groups and that any discretionary adjustments of the tax schedule have generally less than compensated for the effects of inflation. Earlier research into the topic did not, however, provide micro-based analyses of the effects of these tax-burden changes on the distribution of household incomes. I am also not aware of studies looking in detail at the performance of existing automatic inflation-adjustment schemes or using microsimulation techniques to assess the sensitivity of income tax systems to inflation across countries. This paper aims to address this gap.

To analyze how sensitive contemporary income tax systems are to inflation (or other uniform tax base increases), I simulate a range of inflation scenarios for Germany, the Netherlands and the U.K. Based on nationally representative household datasets, income tax (IT) and own social insurance contributions (SIC) are calculated for each individual using a multi-country tax-benefit model containing policy rules for a recent baseline year (1998). In a second step, calculations are repeated after increasing all monetary variables in the dataset to simulate an increase in the general price level. This simple procedure has the advantage of

[1]Bailey (1976), p. 296.

[2]However, in the Euro area, one would expect a unified monetary policy to lead to differing price developments across countries as long as important structural differences remain. Indeed, the process of "convergence" can itself contribute to accelerating inflation in some countries. See European Commission (1999).

holding “everything else” constant: it permits a focus on the change of interest (inflation) while avoiding identification problems that would arise when comparing household income data for different periods (i.e. having to unpick the various forces at work including any tax policy measures enacted during the time period under investigation and income changes due to other factors).

The evaluated scenarios refer to a situation where all incomes change in line with inflation. This means that issues related specifically to certain types of income are not addressed in the analysis. For instance, inflation tends to affect incomes from capital differently than incomes from other sources. Yet, the information contained in household data used in the simulation exercise is generally not sufficiently detailed or reliable to fully capture the tax treatment of capital incomes which, in many countries, differs significantly from the tax rules that apply to other types of income. Capital incomes as recorded in these data are, in any case, very limited in size for the vast majority of households so that any differential treatment of these incomes is unlikely to make a noticeable difference to the results reported here.

Results indicate that, even during times of low inflation, effects on IT and SIC burdens can be substantial if no regularly applied mechanism exists whereby tax and contribution rules are inflation-adjusted. For all three countries, an erosion of nominally defined tax parameters is found to reduce overall tax progressivity but, as a consequence of increasing overall tax liabilities, enhance the equalizing properties of tax systems. Finally, the paper also examines the performance of automatic indexing regimes used in two of the countries (Netherlands, U.K.) and finds that they are successful in preventing large inflation-induced changes of the size or distribution of tax burdens as long as nominal income changes are a result of inflation.

The paper is organized as follows. Section 2 briefly considers different types of taxes and discusses to what extent they can be affected by inflation. In particular, it focuses, as does the remainder of this paper, on the effects of inflation on the taxation of income. Section 3 considers and applies results from the literature on tax progressivity to discuss how changes in the real value of tax band limits, deductions and tax credits may, on a theoretical level, affect the distributional properties of tax systems. The data and methods used in the empirical part are explained in Section 4 while Section 5 briefly reviews a number of inequality, progressivity and redistribution measures used in the subsequent analysis. Section 6 analyzes the distributional properties of existing tax systems in the three countries and compares characteristics of tax schedules and the distributions of tax bases in order to illustrate the potential sensitivity of tax burdens to inflation. The results of the simulated inflation scenarios are presented in Section 7. A final section concludes.

2. Inflation and the Real Value of Income Taxes

The channels through which changes in the general price level affect real income tax burdens can be categorized as follows (for convenience, this section uses the term “income tax” to refer to all types of taxes and contributions levied on income).

2.1. *Influence on the Real Value of Tax Liabilities Already Owed*

A rather obvious effect of inflation on real tax burdens can be caused by collection lags, which are often substantial in the case of income taxes. If left unadjusted, the erosion of tax burdens due to collection lags can, for instance, lead to unequal tax treatments between pay-as-you-earn and self-assessing taxpayers.[3]

2.2. *Measurement of Pre-tax Income for Tax Purposes: Distortions of the Tax Base*

Secondly, and less straightforwardly, inflation can distort the measurement of incomes subject to tax. It is useful to discuss this in relation to the definition of income. One definition widely used in the public finance literature is the Haig-Simons (H-S) income concept, which equates income earned in a certain period to the change in the *power* to consume.[4] An income tax base assessed in terms of nominal values (such as the change in nominal values during the assessment period of a certain asset) ignores changes in potential consumption that are due to changes in the purchasing power of money. Ignoring gains and losses as a result of changes in the value of money thus leads to unequal tax burdens for equal amounts of (H-S) income, depending on how and when they are earned. Since inflation is, per definition, a time dependent phenomenon, it potentially affects all tax rules that determine tax liabilities on the basis of values denominated in previous periods' currency units. This includes the taxation of capital gains and, related, the tax treatment of interest income and expenses. The potential importance of this effect is immediately obvious in cases where a tax is levied on zero or negative real incomes (such as a nominal rate of return, which is smaller than or similar to inflation).[5] The implications of these distortions have received some attention in previous studies (Feldstein, 1997, 1999) and are not considered in the present paper.

2.3. *Distortions of the Tax Function*

In the remainder of this paper I focus on a third type of effect: inflation-induced distortions of the tax function. Let taxes t be a function of pre-tax income y: $t = t(y)$. Note that, while omitted here for convenience, other tax-relevant characteristics z (such as family structure or employment status) will generally enter the tax function. In a typical income tax system the tax function incorporates adjustments a applied to pre-tax income y to yield taxable income (e.g. in the form of deductions), the tax rate schedule $s(.)$ as well as tax credits c. Since both a and c may depend on y we have $t(y) = s(y - a(y)) - c(y)$. If not corrected, inflation erodes the real values of any nominally defined parameters of $s(.)$, $a(.)$ and $c(.)$. The erosion of tax-bracket limits is perhaps the most obvious effect (hence the term "bracket creep"). The two factors determining to which extent inflation alters

[3]More frequent tax payments (monthly or quarterly instalments) can, however, reduce this effect to a large extent.

[4]Haig (1921) and Simons (1938).

[5]A more detailed discussion can be found in Immervoll (2002).

the real tax burden levied on a given pre-tax income y are the rate of inflation and the shape of the tax function $t(.)$.

3. Tax Burdens, Progressivity and Household Incomes

How will the erosion of the real value of tax function parameters affect household incomes? Clearly, if $t(.)$ is progressive such that, for all observed y, marginal tax rates $t'(y)$ are never smaller than average tax rates $t(y)/y$ and there exists at least one tax unit for whom $t'(y) > t(y)/y$ then total household income will fall (and tax revenues rise). The opposite is true for regressive taxes. But, except for the most trivial tax functions, it is not immediately obvious how these losses or gains are distributed and, hence, how inflation changes the degree of redistribution built into tax systems. For instance, high-income taxpayers will suffer the largest *absolute* tax burden increases due to the compression of the tax rate schedule. At the same time, the erosion of (fixed amount) tax credits will translate into the *same* absolute change of tax burdens for all tax units entitled to them. Also, the *relative* change in tax burdens will be highest for low-income tax units who did not pay any tax before inflation but are pushed into tax liability by the compression of zero-rate tax bands.

Several factors will play a role in determining the combined effect of these changes on the distribution of household incomes. For a given tax unit, the slope of the relevant section of the tax function determines the absolute change in the tax burden as a result of nominal income changes. If we are interested in the extent to which inflation will cause relative changes of tax burdens then the elasticity of the tax burden is the appropriate concept. This elasticity ε, in turn, depends on both the marginal and the average tax rate.

(1) $$\varepsilon = yt'(y)/t(y)$$

The consequences for the distribution of tax burdens among all tax units will depend on ε at all values of observed pre-tax incomes. As discussed below, ε measured across all individuals is an indicator of liability progressivity and this provides the link to the common conjecture that tax increases as a result of inflation-induced distortions of the tax function depend on tax progressivity. While relative tax burden changes thus depend on the progressivity of $t(.)$, the effect of any tax or tax change on the post-tax income distribution (and, hence, its redistributive properties) is a function of both the progressivity and the size of the tax. Hence, the extent to which inflation-induced relative changes in tax burdens translate into changes in tax units' post-tax income will be determined by the size of the initial tax burden. The impact on household incomes will then also depend on the composition of households and, more specifically, on the extent to which tax units with different levels of pre-tax income (and other tax-relevant characteristics) share the same household.

Empirically, the distributional consequences of inflation-induced distortions of $t(.)$ can be established using well-known redistribution indicators that summarize differences between pre- and post-tax income distributions. By computing these measures before and after inflation we obtain estimates of how inflation can alter a tax system's redistributive properties. Before we turn to this exercise, however, it is useful to consider the role of individual elements of typical income tax functions. Based on an understanding of the distributional properties of each of these elements and how they are affected by inflation, we might speculate about the resulting distributional effects and thus establish a basis for the empirical analysis that follows.

One useful early result from the literature on tax progressivity is that the progressivity of tax burdens (liability progressivity) will unambiguously increase if ε increases for all y in the sense that the resulting distribution of tax liabilities will weakly Lorenz dominate the pre-change distribution (Jacobsson, 1976). An issue that immediately arises, however, is that ε is undefined for all tax units paying no tax at all (zero denominator in (1)) and, as demonstrated by Keen *et al.* (2000), characterizing the degree of tax progressivity solely in terms of ε will therefore not be possible in these cases. This is of course a serious limitation since zero-tax liabilities are found in all existing tax systems. In fact, in the case of bracket-creep, we have seen above that the relative tax burden changes caused by inflation are largest for precisely those tax units who are pushed out of the tax-exempt income ranges and into tax liability. As a result, knowledge of ε and the size of the tax is not sufficient for analyzing the effects of inflation-induced distortions of $t(.)$ on post-tax incomes. Taking account of zero-tax payments considerably complicates the task of establishing conditions for a progressivity ranking of different tax systems. Similar complications arise when analyzing whether tax changes (due to discretionary reforms or, e.g. inflation) that alter the number of tax-exempt tax-units make tax systems more or less progressive.

Leaving aside these issues for a moment, we know that, *as long as the number of tax-exempt tax units is unchanged*, liability progressivity will unambiguously increase if ε increases for all y where $t(y) > 0$ (Keen *et al.*, 2000). This result is useful for thinking about how inflation might change that part of redistribution which is due to the changing shapes of tax schedules $s(.)$. For rate schedules with uniformly increasing tax rates, taxpayers can be affected in two different ways. First, inflated incomes may increase taxpayers' marginal tax rates $t'(y)$ if they are pushed into the next higher tax bracket. In this case, their average tax rate $t(y)/y$ will go up as well but the relative increase will be less than for the marginal rate so that $\varepsilon = y\, t'(y)/t(y)$ will increase. For a second group of taxpayers whose taxable incomes $y - a(y)$ are sufficiently below the next higher tax bracket limit, $t'(y)$ will remain unchanged. However, the average tax rate will increase because, as a result of the erosion of lower tax bracket limits, a larger part of these taxpayers' incomes will be taxed at higher rates. For these taxpayers, ε will therefore decrease. It thus follows that the conditions for an unambiguous increase in liability progressivity are *not* met. The numbers of increasing and decreasing ε will of course depend on the distribution of taxable incomes in relation to $s(.)$. Notably, the width of tax brackets will play an important role with narrow brackets making inflation-induced progressivity increases more likely.[6]

[6]In the extreme case of continuously increasing marginal rates ε will increase for all taxpayers whose taxable incomes are in the continuous sections of $s(.)$. As seen from the German income tax rate schedule shown below this is relevant for the majority of German taxpayers.

But what happens if we drop the above restriction and compare alternative tax structures that do no longer result in the same number of tax units paying no tax? The number of tax-units with zero tax burdens is influenced by both tax deductions a and tax credits c. For wastable (or "non-refundable")[7] flat amount tax credits ($dc/dy = 0$) the story is simple. Larger values of c increase the tax threshold and thus reduce tax burdens to zero for some tax units. Since, at the same time, the value of such an increase in credits is the same for all remaining taxpayers this results in an unambiguous increase in liability progressivity (as long as the tax credit does not reduce all tax burdens to zero). An inflation-induced erosion of the real value of c will therefore always make the distribution of tax burdens among tax units *less* progressive.

For deductions a, on the other hand, the effect on progressivity is less straightforward. Where deductions are income inelastic ($da/dy = 0$) they affect progressivity in two opposing ways. They exempt taxpayers with $y < a$ from paying taxes altogether (and hence increase liability progressivity). However, at the same time they reduce absolute tax liabilities of taxpayers facing higher marginal tax rates by more than those of taxpayers with lower marginal rates. In a tax system with uniformly increasing marginal tax rates this latter effect will flatten tax liabilities (and therefore reduce liability progressivity). Since inflation changes the real value of nominally defined deductions a we need to establish the balance of these two effects in order to be able to say what happens to progressivity. Keen *et al*. (2000) show that an increase in a never leads to an unambiguous reduction in liability progressivity: if some tax units are taken out of the tax system then the resulting distribution of tax burdens cannot be (weakly) Lorenz dominated by the pre-change distribution.[8] This leaves us to determine the conditions under which the effects of the "flattening out" of tax liabilities due to the larger absolute tax reductions for higher-income taxpayers is "sufficiently small" in the sense that an increase in a (and the resulting increase in the number of zero-tax liabilities) would be *guaranteed* to make the distribution of tax liabilities more progressive. It turns out that an increase in a leads to an unambiguous increase in liability progressivity if and only if the rate schedule $s(.)$ is not "too progressive" such that the proportionate reduction in tax liabilities due to the increase in a is still larger for the poor than for the rich.[9] In the case of a reduction of a we need to look at the reverse of these conditions. Inflation-induced erosions of a will increase the number of taxpayers and, hence, never lead to an unambiguous increase in liability progressivity. Secondly, eroded a will cause unambiguous reductions in liability progressivity if and only if the rate schedule $s(.)$ is not "too progressive" in the above sense.

To sum up, while inflation-induced erosions of tax credits will always reduce liability progressivity, the effect is ambiguous as far as the erosion of deductions and tax bracket limits are concerned. In addition, theoretical conclusions about

[7] Tax credits that reduce tax burdens but cannot result in negative overall taxes: $c < s(y - a)$. Any parts of tax credits exceeding $s(y - a)$ are akin to cash benefits and are not considered in this paper.

[8] Note that, for a discrete distribution of y it is possible that a change in $a(.)$ does not change the number of zero-tax liabilities.

[9] The formal criterion is log-concavity. See Keen *et al*. (2000, p. 58).

how inflation might affect progressivity in a nominally defined tax system are more difficult to arrive at once c or a are functions of y (as is, for instance, the case if income dependent SIC are tax deductible). In these cases, the results would depend both on the functional forms of $c(y)$ and $a(y)$ and on whether and how these are distorted by inflation. In any case, if we are ultimately interested in how inflation affects the degree to which income taxes equalize net household incomes then results regarding liability progressivity are not sufficient. In addition one needs to know the size of tax burdens before inflation as well as the pattern of household sharing between tax units with different pre-tax incomes. The empirical analysis that follows examines the balance of this multitude of effects.

4. Data, Model and Simulated Scenarios

I use a tax-benefit microsimulation model to compute IT, compulsory SIC and disposable incomes for a representative sample of households in Germany, the Netherlands and the U.K. The data contain information on a large number of individual and household characteristics including detailed breakdowns of incomes by source. In conjunction with a tax-benefit simulation model it is possible to compute IT, SIC and entitlements for a range of benefits at individual, tax unit and household level.

The tax-benefit model used is EUROMOD, an integrated multi-country microsimulation model for 15 EU countries, which provides a Europe-wide perspective on social and fiscal policies that are implemented at European, national or regional level. It is designed to examine, within a consistent comparative framework, the impact of national policies on national populations or the differential impact of any co-ordinated European policies on individual Member States.[10] A frequent use of tax-benefit models is for the *ex ante* or *ex post* analysis of policy reforms. By computing taxes and benefits after changing the model's policy parameters and comparing results with pre-reform values one can derive detailed pictures of a reform's distributional, revenue or incentive implications. The strength of the microsimulation approach lies precisely in its ability to analyze one type of change at a time while holding "everything else" constant.

However, in the context of the present analysis the main use of the model is to simulate the effects of changes in variables describing the underlying *population* (people's incomes in this case) while initially keeping *policy parameters* unchanged. By increasing each individual's incomes and keeping all tax parameters at their original nominal value we can simulate the effects of inflation in a nominally defined tax system. This exercise can be repeated for different countries and using a range of assumptions regarding the inflation-adjustment regimes a country might operate. Changes in real tax burdens can then be computed as the arithmetic difference between the "before" and "after" inflation scenarios. The analysis is thus static in nature insofar as it does not attempt to capture any behavioral adjustments that tax units may consider in response to changing tax burdens and since the formulation of a tractable model of relevant labor, financial and

[10]Immervoll *et al.* (1999) and Sutherland (2000) present a general overview over EUROMOD and the model-building project. A detailed and more technical description is provided by Sutherland (2001).

property markets for three countries is beyond the scope of this paper.[11] For improving our understanding of how inflation alters the functioning of a tax system this focus on the "mechanics" in the absence of (or prior to) any behavioral adjustments provides a useful starting point. In fact, establishing the immediate effects on tax burdens is a pre-requisite for analyzing any potential behavioral adjustments these tax burden differences may give rise to. Of course it is important to keep in mind the static nature of the analysis when interpreting results—particularly when looking at the cumulative effects of inflation over longer periods of time.

Micro-data for the Netherlands are from the Socio-Economic Panel (SEP). Households with large amounts of missing information are excluded, bringing the sample to 4,568 households. U.K. data are from the Family Expenditure Survey. No observations are excluded since the sample contains no households with significant missing information. There are 6,797 U.K. households. The data source used for Germany is the German Socio-economic Panel (SOEP) with a sample size of 7,494. In each case, the samples are weighted to adjust for non-response bias and to bring the results up to population levels. All simulations presented in this paper relate to 1998 policy rules as the first version of EUROMOD incorporates tax and benefit policy rules current in June 1998.[12]

Using relevant policy rules and information from the micro-data, EUROMOD is able to simulate IT, SIC (as payable by employees, employers or benefit recipients), child benefits and other family benefits, and means-tested benefits. Income components that are not simulated (such as market incomes or pensions) are taken directly from the data. Together, simulated and non-simulated income components can be used to arrive at the desired income measures (taxable income, disposable income, etc.) for each observation. The simulations capture both the detailed policy rules relating to each of these instruments and the interactions between them (e.g. tax deductibility of employees' SIC payments or the tax treatment of transfer payments). Any standard tax deductions, allowances and credits are taken into account in the simulations along with any such provisions that depend on income, family situations or other characteristics recorded in the underlying micro-data. It is not generally possible to simulate itemized tax deductions as detailed information on relevant expenditure is not available. Details on the scope of the simulations are provided in Sutherland (2001) and in EUROMOD country reports available at www.econ.cam.ac.uk/dae/mu/emod.htm.

The effects of inflation on taxes paid on income are explored by inflating all monetary variables in the micro-data using a range of hypothetical and actual

[11]By computing marginal effective tax rates or detailed budget constraints static microsimulation models can be used as input into econometric studies trying to establish the likely behavioral effects of (dis-)incentives built into tax-benefit systems. The effects of "bracket creep" on employees' marginal effective tax rates are, for instance, studied in Immervoll (2000).

[12]For the Netherlands and the U.K., all monetary variables in the micro-data were, prior to the simulations, brought forward to this year using the most appropriate indices for each income component. Future versions of EUROMOD will contain actual data from 1998 and will thus permit the sensitivity of results with respect to the choice of data-year to be assessed. The baseline version of EUROMOD used for the present analysis incorporates data from the 1998 (Germany), 1996 (Netherlands) and 1995/6 (U.K.) waves of the respective data sources. The uprating approach is documented in Sutherland (2001).

inflation rates.[13] First, a range of hypothetical inflation scenarios is used in order to establish and compare the sensitivity of revenues and distributional parameters to inflation across the three countries in the absence of any inflation adjustment schemes. As a next step, I repeat the analysis with inflation rates actually observed during the 1998 to 2003 period to determine how well automatic inflation adjustments performed over this period in the two countries where they exist (the Netherlands and the U.K.).

5. Measures of Inequality, Redistribution and Progressivity

To see how inflation alters the distributional properties of IT and SIC, I examine the impact of these instruments on the inequality of current household incomes[14] in the 1998 "before inflation" situation and then compare this to how they change inequality in a range of simulated inflation scenarios. The inequality measures used are members of the so-called single parameter Gini (or S-Gini) family (Donaldson and Weymark, 1980; Yitzhaki, 1983). By choosing the value of an "ethical" parameter v, the S-Gini (SG) allows different weights w to be put on the contribution of lower versus higher income groups to total inequality:[15]

(2a) $$SG(v) = \int_0^1 w \cdot (p - L(p))dp$$

where

(2b) $$w = v \cdot (v-1) \cdot (1-p)^{v-2}, \quad v > 1,$$

p is the rank of individuals in a population with individual observations ordered in ascending order of the variable (here income) whose inequality is to be measured and $L(p)$ is the Lorenz curve, i.e., the share of total income earned by the poorest $p \cdot 100\%$. For $v = 2$, we have $w = 2$ and $SG(v)$ is the standard Gini coefficient of inequality where departures from equality ($p - L(p)$) are weighted equally for all p, while $v > 2$ (<2) gives more weight to smaller (larger) p.

Choosing appropriate v, one can rank different distributions (e.g. before- and after-tax incomes) in terms of inequality or, alternatively, find the ethical parameter v where rankings change. For empirical applications, it is therefore desirable to find intuitive interpretations of different v values. In principle, and as demon-

[13]The same factor is used for all income components. Relative prices are, thus, assumed to be unaffected. This assumption follows from the aim of the simulations to isolate the effects of changes in the general price level from other changes. In particular, since the purpose of the paper is to isolate the distributional effects of taxes and how they are affected by inflation, all benefits are assumed to be increased in line with prices. Benefits that are *not simulated* in EUROMOD are simply inflated by the relevant factor, while, for *simulated* benefits (e.g. family benefits, social assistance), all relevant policy parameters (amounts, limits, thresholds, etc.) are adjusted. Immervoll *et al.* (forthcoming) consider the effects of "fiscal drag" on poverty measures in a scenario where both taxes and benefits fail to be adjusted for inflation.

[14]The analysis does not, therefore, consider the inter-temporal redistribution mechanisms built into social insurance schemes.

[15]See, e.g. Duclos (2003). A stimulating discussion of alternative interpretations of Gini coefficients is provided by Yitzhaki (1998).

strated by Blackorby and Donaldson (1978), relative inequality indices can be linked to a particular social evaluation function. For the S-Gini, a simple method for determining useful ranges of v is presented by Duclos (1998). Consider Okun's (1975) "leaking bucket" experiment where a hypothetical transfer from a richer person to a poorer person involves some efficiency loss in the sense that the gain enjoyed by the recipient is less than then loss suffered by the donor. Linking v to this efficiency loss, it is possible to derive, for a given v, the implied fraction of the transfer that can be "lost" in the process while still making the transfer socially desirable. Choosing these amounts of tolerable wastage is perhaps more feasible or, at least, more intuitively appealing than directly deciding on an appropriate value of v. For rank-preserving transfers from a person with rank $p_1 = 0.67$ to a person with rank $p_2 = 0.33$ it turns out that with $v = 2$, the implied tolerated wastage amounts to 50 percent of the transferred amount. With $v = 1.5$ the amount would be only 29 percent, and with $v = 3$, a rather high 75 percent, so that a transfer would still be judged desirable if only a fourth of the amount paid by p_1 reaches the recipient p_2.[16] In the analysis that follows, I will present results for these three values of v.

The difference between the S-Gini index of inequality of pre-tax income SG_g and the S-Gini concentration index of net income CI_n is a measure of vertical redistribution. It indicates to which extent net incomes are more equally distributed than gross incomes and, for $v = 2$, corresponds to the well-known Reynolds-Smolensky redistribution index RS (Reynolds and Smolensky, 1977).

(3a) $$RS = SG_g(2) - CI_n(2) = 2\left(\int_0^1 p - L_g(p)dp - \int_0^1 p - C_n(p)dp\right),$$

where $L_g(p)$ and $C_n(p)$ are, respectively, the Lorenz and concentration curves of before- and after-tax income. The degree of vertical redistribution is reduced by any changes in the ranking of individuals in the pre- and after-tax distribution, captured by a re-ranking term d. The equalizing effect of the tax system, measured as the difference between the pre- and post tax S-Gini indices of inequality, can then be expressed as

(3b) $$RE = SG_g(2) - SG_n(2) = RS - d$$

The inequality reducing properties of a tax depend on the inequality of the distribution of tax burdens as well as their size. Formally, it can be shown that

(4a) $$RE = k\frac{r}{1-r} - d$$

where

(4b) $$r = \frac{(\mu_g - \mu_n)}{\mu_g}$$

[16]Given v, tolerable efficiency losses increase with the rank difference of the two individuals. For $p_1 = 0.8$ and $p_2 = 0.2$, for instance, the tolerable losses for $v = 1.5$, $v = 2$ and $v = 3$ amount to 50 percent, 75 percent and 94 percent.

(4c) $$k = 2\int_0^1 p - C_t(p)dp - SG_g(2)$$

(4d) $$d = SG_n(2) - 2\int_0^1 p - C_n(p)dp$$

and r is the size of the tax instrument expressed as the relative difference between mean gross and net incomes μ_g and μ_n, k is the Kakwani progressivity index (Kakwani, 1977), and d is the above-mentioned re-ranking term measuring by how much vertical redistribution is reduced as a result of differences in the ordering of gross and net incomes (Atkinson, 1980; Plotnick, 1981).[17] $C_t(p)$ and $C_n(p)$ are, respectively, the cumulative proportions of total tax burdens and net incomes at point p where individuals are ordered in terms of gross incomes. Since the decomposition works analogously for $w \neq 2$, we can derive measures of redistribution (RE) and progressivity (k) using different "ethical" parameters v, a task I will return to in the following section.

6. Redistribution Before Inflation: Equalizing Properties of Tax Systems and Potential Sensitivity to Inflation

Table 1 summarizes the size and distribution of IT and (own) SIC in the three countries.[18] While these figures relate to the 1998 "baseline," all amounts are simulated using EUROMOD in order to be consistent with the simulations of the post-inflation scenarios explored below and because IT and/or SIC are not recorded in the Dutch and German data sources.[19] For comparative purposes, total revenues are normalized in terms of aggregate household disposable incomes (bottom panel). Relative to total household income, income taxes are largest in Germany and smallest in the Netherlands. Dutch households, however, pay the largest SIC rates and are also subject to the largest total (IT + SIC) burdens. Relative to total household incomes, SIC burdens in the U.K. are less than a third of their German and just over one fifth of their Dutch counterparts. Compared to the U.K., Dutch and German total tax burdens are almost twice as large.

The analysis below will utilize a range of suitable global measures of redistribution and progressivity as outlined in the previous section. However, given that

[17]Aronson *et al.* (1994) show that, since the unequal taxation of equal tax bases also reduces the equalizing properties of a tax, another term capturing classical horizontal inequity can further broaden the scope of a decomposition exercise although, in empirical analyses, this involves a rather arbitrary decision about the interval within which tax bases are to be considered "equal." An empirical study along these lines has been undertaken by Wagstaff *et al.* (1999).

[18]Throughout this paper, German IT figures include the "Solidarity Surplus Tax" (introduced to contribute to the financing of German unification), which, in 1998, amounted to 5.5 percent of each tax unit's income tax burden.

[19]While simulated totals match national revenue aggregates remarkably well one would, for a number of reasons, not expect them to correspond exactly. Reasons for deviations include differences in definitions of what is counted in a given tax category, tax evasion, less than perfect representation of tax rules in model algorithms and, importantly, shortcomings in the underlying micro-data such as underrepresentation of high income groups or missing information about tax deductible expenses. A detailed validation of model results against national and European aggregate and distributional statistics is provided by Sutherland (2001) and Mantovani and Sutherland (2003).

TABLE 1

INCOME TAX AND SOCIAL INSURANCE CONTRIBUTIONS: REVENUE AND DISTRIBUTION, 1998

	Germany		The Netherlands		UK	
	Income Tax	Own SIC	Income Tax	Own SIC	Income Tax	Own SIC
Annual Revenue Total, National Currency (billions)	357.0	299.3	55.1	85.0	70.0	23.2
Decile 1	0.1%	1.6%	1.0%	2.9%	0.0%	0.3%
2	0.8%	3.8%	1.5%	4.7%	0.5%	1.1%
3	1.9%	5.9%	2.0%	5.8%	1.1%	1.8%
4	2.9%	7.0%	2.9%	7.1%	2.7%	4.2%
5	4.7%	8.5%	4.0%	8.5%	4.5%	6.4%
6	7.0%	10.9%	5.2%	9.7%	6.7%	9.4%
7	9.1%	12.4%	7.7%	11.5%	9.5%	12.3%
8	14.1%	15.4%	9.2%	14.2%	13.0%	16.0%
9	19.8%	17.4%	16.3%	15.5%	19.0%	20.9%
Decile 10	39.7%	17.1%	50.2%	19.9%	43.1%	27.7%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
% Household Disposable Income (HDI) Total	20.6%	17.2%	15.8%	24.3%	16.7%	5.5%
Decile 1	0.5%	5.8%	3.7%	16.8%	0.0%	0.5%
2	2.8%	11.6%	3.9%	19.1%	1.7%	1.4%
3	6.0%	15.8%	4.7%	21.3%	3.1%	1.8%
4	8.2%	16.7%	6.5%	24.3%	6.9%	3.5%
5	12.0%	18.1%	8.0%	25.9%	10.0%	4.7%
6	15.7%	20.4%	9.3%	27.0%	12.6%	5.9%
7	17.9%	20.5%	12.0%	27.7%	15.1%	6.5%
8	24.1%	22.1%	11.7%	28.0%	17.4%	7.1%
9	27.9%	20.5%	17.5%	25.8%	20.8%	7.6%
Decile 10	37.6%	13.6%	35.9%	21.9%	28.8%	6.1%

Notes: "Own SIC" are social insurance contributions paid directly by employees, self-employed and benefit recipients. Decile groupings relate to individuals ranked according to equivalized HDI. The "modified OECD" scale is used for equivalizing incomes of households of different structure and size. The respective weights are 1 (first adult), 0.5 (subsequent adults) and 0.3 (children aged below 14).

Source: EUROMOD.

all such measures require weighing different observations' relative importance it is useful at the outset to briefly examine the distribution of tax burdens before collapsing this information into aggregate indices. The top part of Table 1 reveals a very progressive distribution of Dutch IT liabilities. The richest 10 percent (in terms of household disposable incomes) pay half of all IT revenues. IT liability progressivity in the U.K. is also considerable with 43 percent of taxes paid by the top decile group and none at all by people living in the lowest income groups. However, relative to household incomes, IT burdens are largest for rich German households since IT revenues as a whole are larger in Germany than in the Netherlands or the U.K. In addition, U.K. household incomes are distributed much less equally than in Germany (we will see this when discussing Table 2 below) with higher incomes in the top decile. As a result, total IT paid by the richest 10 percent in the U.K. are a relatively modest 29 percent of disposable incomes despite the fact that they pay more than 40 percent of total IT revenues. Turning to the

TABLE 2a

INEQUALITY, 1998

	Germany	The Netherlands	UK
S-Gini, before Income Tax and own SIC			
v = 2.0	0.3135	0.2946	0.3614
v = 1.5	0.2074	0.1972	0.2425
v = 3.0	0.4276	0.3999	0.4837
S-Gini, HDI (after Income Tax and own SIC)			
v = 2.0	0.2504	0.2489	0.3132
v = 1.5	0.1647	0.1634	0.2086
v = 3.0	0.3441	0.3439	0.4229

TABLE 2b

REDISTRIBUTION AND PROGRESSIVITY, 1998

	Germany		The Netherlands		UK	
	Income Tax	Own SIC	Income Tax	Own SIC	Income Tax	Own SIC
*Redistribution (RE = k * r/(1 − r) − d)*						
v = 2.0	0.0584	0.0047	0.0504	−0.0047	0.0421	0.0057
v = 1.5	0.0421	0.0006	0.0408	−0.0070	0.0310	0.0027
v = 3.0	0.0717	0.0118	0.0546	0.0014	0.0507	0.0095
Size of instrument (r)						
	0.1723	0.1270	0.1369	0.1744	0.1448	0.0462
Progressivity (k)						
v = 2.0	0.2973	0.0507	0.3303	−0.0132	0.2529	0.1231
v = 1.5	0.2149	0.0178	0.2687	−0.0266	0.1861	0.0598
v = 3.0	0.3625	0.1020	0.3545	0.0181	0.3053	0.2019
Reranking (d)						
v = 2.0	0.0035	0.0027	0.0020	0.0019	0.0007	0.0002
v = 1.5	0.0026	0.0020	0.0018	0.0014	0.0005	0.0002
v = 3.0	0.0038	0.0031	0.0016	0.0024	0.0010	0.0003

Notes: "Own SIC" are social insurance contributions paid directly by employees, self-employed and benefit recipients. *RE* is the equalizing effect (difference between before and after-tax Ginis); v is an "ethical" parameter that determines whether, in computing Ginis, low-income individuals receive greater ($v > 2$) or smaller ($v < 2$) weight than high-income individuals. See Section 5 for details.

Source: EUROMOD.

distribution of SIC we see that, while liabilities are generally higher for high-income groups, the impact on household incomes is clearly regressive for the top one or two deciles: as a result of upper contribution limits, the richest German households spend lower shares of their income on compulsory social insurance than households in the third-poorest decile group.

What is the overall effect on inequality of IT and SIC taken together? Household incomes before taxes are least equally distributed in the U.K. (Table 2a) where pre-tax S-Ginis are substantially higher than in both Germany and the Netherlands.[20] While country rankings are unaffected by the choice of v, the margin by which U.K. inequality exceeds the other two countries' increases when more weight is put on higher income groups (lower v) indicating considerable differences between higher income groups' relative before-tax income positions. For instance U.K. pre-tax income inequality is about 13 percent (17 percent) higher than in Germany for $v = 3$ ($v = 1.5$). After taxes, U.K. household incomes are still the least equal but Dutch and German values are now somewhat closer than before tax suggesting that the tax system is more redistributive in Germany than in the Netherlands. Indeed, the relative decrease in inequality is highest in Germany with about 25 percent followed by 15 percent in the Netherlands and 13 percent in the U.K. (all for $v = 2$). While IT and SIC together reduce inequality differences between Germany and the Netherlands, they cause a further divergence between these countries and the U.K.: after taxes, U.K. income inequality exceeds both the German and Dutch measures by about 25 percent ($v = 2$).

Decomposing the *RE* redistribution measure along the lines discussed in Section 5 above, we see a confirmation of the results from Table 1 with average IT rates, measured in terms of r, largest in Germany and smallest in the Netherlands (Table 2b).[21] However, with a much more progressive income tax, IT are clearly more redistributive in the Netherlands than in the U.K., both in absolute terms and, even more so, relative to pre-tax income inequality. The progressivity of German IT falls in between the Dutch and U.K. values except for $v = 3$: once sufficient weight is given to the income position of low-income individuals, German IT burdens are the most progressively distributed (partly as a result of the steep tax-rate structure at the bottom to which I will return below). As expected, SIC have a much smaller redistributive effect than IT.[22] In Germany and the U.K. both size (r) and liability progressivity (k) of SIC are considerably smaller than for IT. Progressivity is larger for larger values of v since more weight is then given to the progressive lower part of SIC schedules relative to the regressive features at the top (upper contribution limits). In the Netherlands, these upper limits render SIC

[20]S-Ginis and their components are computed for household incomes equivalized using the "modified OECD" equivalence scale giving a weight of 1 to the first adult, 0.5 to each further adult and 0.3 to children under 14. In computing inequality measures, individuals are counted (i.e. a household of four is counted as four separate observations each entering with the same equivalized household income) and weighted using household population weights provided in the underlying survey data. Post-tax Ginis are computed for cash disposable incomes (= market incomes *plus* state cash benefits *plus* private cash transfers *minus* income and property taxes *minus* own social insurance contributions). Pre-tax income is post-tax income plus income taxes and contributions.

[21]Results diverge from other studies using similar indicators due to a range of conceptual and definitional differences, including reference period and data sources, the choice of units of analysis and equivalence scales or the scope of relevant income definitions. For instance, while Wagstaff *et al*. (1999), who limit their analysis to income taxes before subtraction of any tax credits, also base their calculations on the household unit of analysis, they use a different equivalence scale and data from earlier periods and different sources.

[22]In computing redistribution measures for more than one sequential policy instrument, one needs to decide a sequence for comparing pre- and post-instrument income inequalities. In the calculations shown here, SIC are assumed to be subtracted from people's incomes *before* IT since this corresponds to the actual sequence in two of the countries (Germany and the Netherlands, where own SIC are tax deductible and therefore have to be computed first).

as a whole regressive for $v = 1.5$ and $v = 2$ (negative k). However, with k values close to zero, their total redistributive impact is small despite SIC revenues exceeding IT receipts by more than 50 percent.

If tax functions are not adjusted for inflation, an increase in prices and incomes amounts to an upward shift of incomes subject to tax in relation to nominally defined tax function parameters. To see how sensitive tax burdens might be towards such a shift, it is useful as a first step to consider the initial distribution of incomes subject to tax. Figure 1 shows kernel densities of incomes subject to IT and SIC in relation to 1998 rate schedules. We note that the German marginal IT rate schedule (dark dashed line) is continuous rather than step-shaped. As a result, an upward shift of taxable incomes leads to rising marginal tax rates for the majority of taxpayers. In addition, the lowest marginal rate (about 26 percent) is higher than in both the other two countries. The Dutch IT rate schedule is steep, but relative to the distribution of taxable incomes, the largest increase in marginal tax rates occurs only at rather high levels of taxable income. The U.K. schedule is the flattest among the three. All three SIC systems (lighter dashed lines) exhibit regressive characteristics, albeit to differing extents. Note, however, that lower contribution limits exist for most types of social insurance contributions, rendering the relevant rate schedules progressive for lower income ranges. Overall SIC rates are lowest in the U.K. and highest in the Netherlands, where contributions to the flat-amount citizen pension are particularly sizable and are levied on the same tax base as IT.

Turning to the distribution of IT bases (dark solid lines) we clearly see the widest (least equal) distribution of taxable incomes in the U.K. while Germany, where "split" tax bases are shown for spouses in married couples subject to joint taxation, exhibits the least dispersed distribution.[23] Taxable incomes (reduced by a number of deductions with potentially equalizing effects), are distributed more equally than incomes subject to SIC (lighter solid lines) in Germany and the U.K. but not in the Netherlands. The difference is largest in Germany, where income tax splitting has an equalizing effect on taxable incomes whereas SIC are paid on an individual basis. We also see the much lower wages subject to SIC in Eastern Germany (thin grey line).

It is evident from the kernel densities that there is considerable scope for inflation to push people out of the tax-free range of the relevant schedules. In particular, there are very large numbers of individuals with incomes subject to SIC below the relevant thresholds. In fact, the densities show local maxima just below SIC thresholds in both Germany and the Netherlands.[24] The same is true for taxable incomes, particularly for the U.K. where calculations (not reported)

[23]National currencies are shown in order to allow readers to relate the graphs to national policy parameters. Yet, it turns out that the chosen scales are nevertheless roughly comparable across countries as maximum values shown on the horizontal axes would be approximately the same for the three graphs if converted to a single currency.

[24]This "bunching" observed in any one particular period is consistent with the existence of behavioural reactions to prevailing tax rules but does not, by itself, establish the existence or extent of such responses. The distribution may be determined by factors other than the tax system and tax band limits may, in turn, be set intentionally so as to exempt substantial numbers of people from paying tax. Evidence of "bunching" in a U.S. context and the behavioral elasticities consistent with this evidence are discussed by Saez (1999).

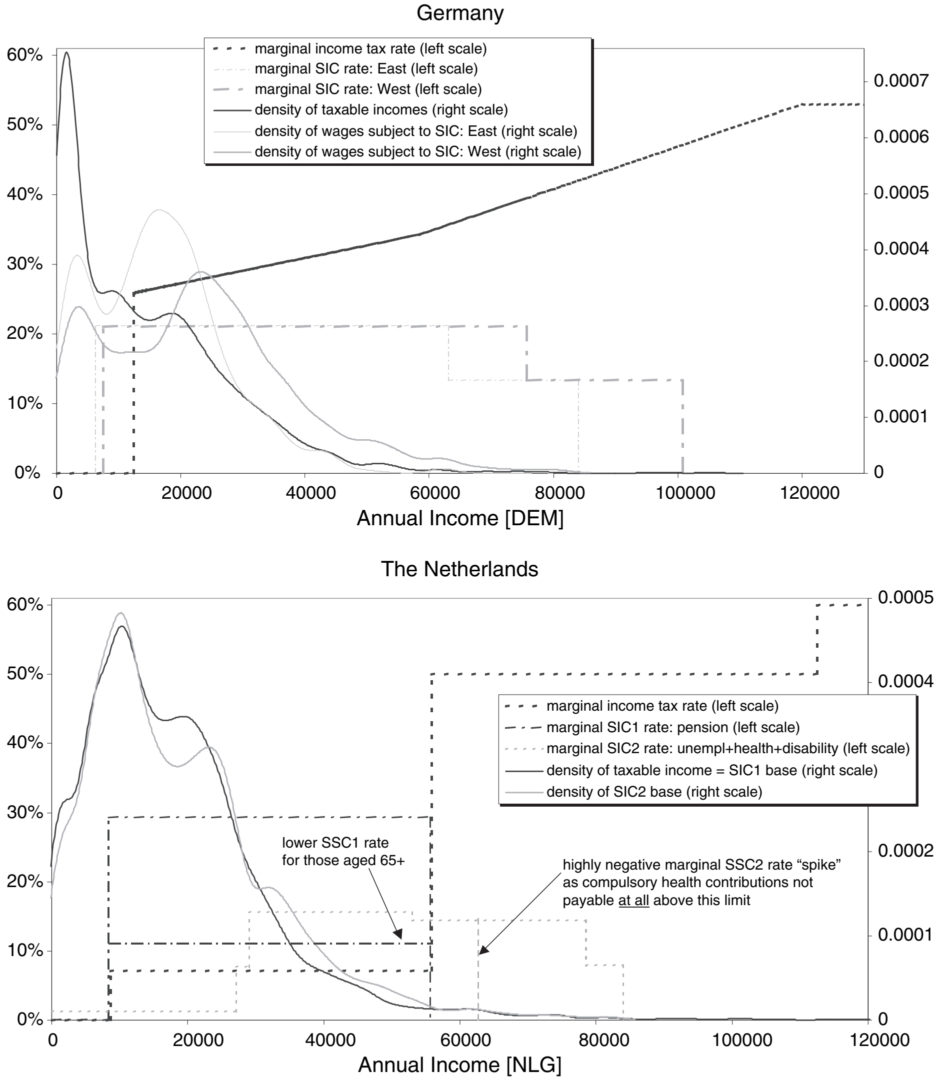

Figure 1. Income Tax (IT)/Social Insurance Contribution (SIC) Schedules and Distribution of Incomes Subject to Tax, 1998

Source: EUROMOD.

Note: Rates shown exclude the German "Solidarity Surplus Tax" which is, however, included in all simulated IT figures shown in this paper.

show that for 2.4 percent of those with positive taxable income, income tax bases are less than 10 percent below the tax threshold. In Germany the fraction is lower but still considerable at about 1.3 percent (or 700,000 tax units) while the proportion of IT taxpayers in the population is similar to the U.K. (just over 40 percent). In the Netherlands, where more than 60 percent of the population pay income tax, the number of people located just below the lowest rate threshold is much smaller.

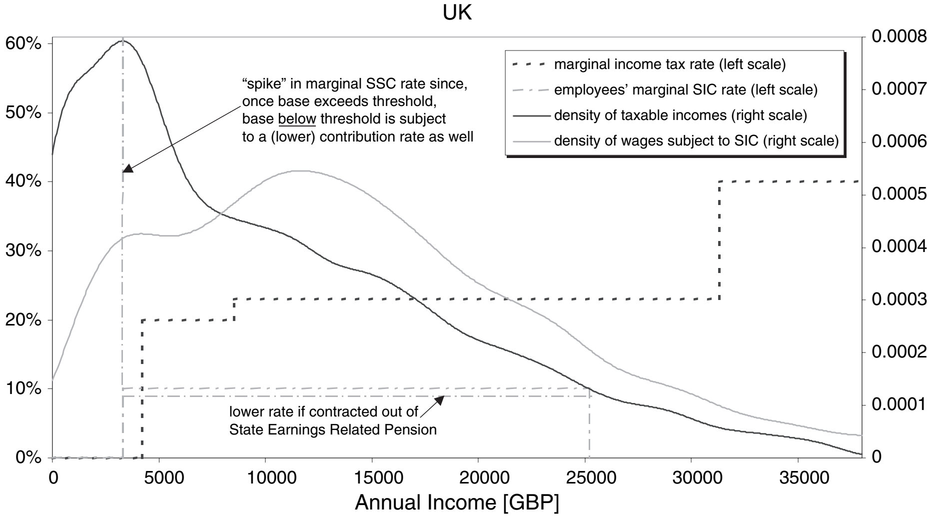

Figure 1. (*continued*)

The plots of taxable income distributions in relation to tax band limits provide a useful description of rate schedules and an illustration of the mechanisms of "bracket creep" in terms of the effects on the rate schedule *s*(.). However, they are less useful for visualizing the impact of inflation on the tax function *t*(.) as a whole. This is because, at least in the case of incomes subject to IT, tax bases as shown in Figure 1 will not generally move up or down in line with inflation as they are in part determined by deductions and other adjustments *a*(.). Since these can be eroded by inflation as well, nominal taxable incomes can increase by more than inflation. In addition, any erosion of the values of tax credits *c*(.) will have to be considered as well. Finally, it is not sufficient to look at fiscal units if we are interested in how inflation affects the distribution of household incomes. I therefore now turn to analyzing the net effect of inflation on the distributional properties of IT and SIC.

7. Redistribution after Inflation

7.1. *No Inflation Adjustments of Tax Rules*

Isolating the effects of "bracket creep" from other changes such as economic growth, unemployment, population structure or policy reforms is difficult when looking at macro- or micro-data from different periods. Using a tax-benefit model, however, it is straightforward to show the tax burdens that result for a given inflation scenario when keeping tax parameters nominally constant. Table 3 presents income distribution indicators for a range of inflation rates. These results are computed in a similar way to the baseline figures discussed in the previous section; the only difference being that all income values are inflated prior to computing taxes.

Results in the first column illustrate the earlier point that the extent of fiscal drag is related to liability progressivity: the most elastic IT revenue is found in the

TABLE 3

SIZE OF INSTRUMENTS, REDISTRIBUTION AND PROGRESSIVITY AFTER INFLATION: NO INFLATION ADJUSTMENTS

	Income Tax								Own SIC							
			$v = 2.0$		$v = 1.5$		$v = 3.0$				$v = 2.0$		$v = 1.5$		$v = 3.0$	
Inflation	Revenue, % 1998, real terms	*r*	*k*	*RE*	*k*	*RE*	*k*	*RE*	Revenue, % 1998, real	*r*	*k*	*RE*	*k*	*RE*	*k*	*RE*
									Germany							
1998	100.0%	0.1723	0.2973	0.0584	0.2149	0.0421	0.3625	0.0717	100.0%	0.1270	0.0507	0.0047	0.0178	0.0006	0.1020	0.0118
4%	103.1%	0.1777	0.2917	0.0593	0.2105	0.0427	0.3565	0.0729	99.6%	0.1265	0.0466	0.0041	0.0147	0.0001	0.0976	0.0111
8%	106.1%	0.1828	0.2867	0.0602	0.2066	0.0433	0.3510	0.0741	98.9%	0.1256	0.0434	0.0036	0.0122	–0.0002	0.0942	0.0105
12%	109.1%	0.1877	0.2823	0.0610	0.2032	0.0439	0.3461	0.0752	98.2%	0.1246	0.0403	0.0031	0.0098	–0.0005	0.0909	0.0100
16%	111.9%	0.1923	0.2783	0.0618	0.2002	0.0445	0.3417	0.0763	97.5%	0.1236	0.0376	0.0027	0.0076	–0.0008	0.0882	0.0095
									The Netherlands							
1998	100.0%	0.1369	0.3303	0.0504	0.2687	0.0408	0.3545	0.0546	100.0%	0.1744	–0.0132	–0.0047	–0.0266	–0.0070	0.0181	0.0014
4%	105.0%	0.1436	0.3246	0.0522	0.2622	0.0420	0.3510	0.0570	99.2%	0.1729	–0.0204	–0.0062	–0.0315	–0.0080	0.0088	–0.0006
8%	110.0%	0.1501	0.3191	0.0540	0.2559	0.0431	0.3474	0.0593	98.2%	0.1710	–0.0266	–0.0075	–0.0356	–0.0087	0.0008	–0.0024
12%	115.1%	0.1567	0.3135	0.0557	0.2498	0.0442	0.3437	0.0615	97.1%	0.1691	–0.0326	–0.0087	–0.0396	–0.0095	–0.0071	–0.0041
16%	120.1%	0.1631	0.3077	0.0572	0.2437	0.0451	0.3395	0.0636	96.0%	0.1669	–0.0380	–0.0097	–0.0432	–0.0101	–0.0142	–0.0056
									United Kingdom							
1998	100.0%	0.1448	0.2529	0.0421	0.1861	0.0310	0.3053	0.0507	100.0%	0.0462	0.1231	0.0057	0.0598	0.0027	0.2019	0.0095
4%	102.4%	0.1482	0.2495	0.0427	0.1833	0.0314	0.3019	0.0515	99.6%	0.0460	0.1188	0.0055	0.0562	0.0025	0.1981	0.0093
8%	104.8%	0.1515	0.2464	0.0432	0.1807	0.0317	0.2986	0.0523	99.0%	0.0457	0.1146	0.0052	0.0528	0.0024	0.1943	0.0090
12%	107.1%	0.1547	0.2434	0.0437	0.1782	0.0320	0.2956	0.0530	98.3%	0.0454	0.1106	0.0050	0.0495	0.0022	0.1907	0.0088
16%	109.3%	0.1579	0.2406	0.0443	0.1760	0.0324	0.2926	0.0537	97.5%	0.0450	0.1064	0.0048	0.0462	0.0020	0.1868	0.0085

Notes: "Own SIC" are social insurance contributions paid directly by employees, self-employed and benefit recipients. *RE* is the equalizing effect (difference between before and after-tax Ginis), *r* is the size of the tax, *k* is the Kakwani progressivity index and *v* is an "ethical" parameter that determines whether, in computing Ginis, low-income individuals receive greater ($v > 2$) or smaller ($v < 2$) weight than high-income individuals (see Section 5 for details).

Source: EUROMOD.

Netherlands where we have also seen the most progressive distribution of IT burdens. Note that percentage changes in revenues are expressed in real terms, i.e., 4 percent inflation in Germany would lead to a 3.1 percent real increase in IT revenues and a 0.4 percent real decrease in SIC receipts. These changes relate to a given year. So if nominal German prices and incomes increase by, say, around 4 percent annually over a period of four years then the cumulative inflation rate will be $1.04^4 - 1 \approx 17\%$ and real IT revenues will exceed baseline-year revenues by around 12 percent *in that year*. Additional real revenues generated by the fiscal drag *during the entire four-year period* will sum to about 30 percent or just under a third of 1998 revenues, illustrating how infrequent inflation adjustments can cause very significant revenue changes in-between adjustments. Clearly, these numbers capture only the mechanical effects of bracket creep and do not take into account any behavioral adjustments. So while the shown revenue changes should not be interpreted as revenue projections (particularly over the longer-term), the rather large effects do establish the extent to which inflation can potentially distort existing redistributive mechanisms by altering transfers between households and governments.

Who pays for the tax revenue increases and who benefits from any decreases in contribution burdens? The most obvious result from Table 3 is that inflation reduces IT progressivity (k) in all countries (for all values of the "ethical" parameter v). Moreover, the reductions in progressivity are substantial with nominal income increases of 12 percent reducing k by between 3 percent (Netherlands, $v = 3$) and 7 percent (Netherlands, $v = 1.5$). SIC progressivity is also reduced (or regressivity increased). In the Netherlands where, in 1998, the balance of progressive SIC thresholds and regressive upper contribution limits turns out progressive only if sufficient weight is attributed to low-income groups ($v = 3$), the impact of inflation-induced erosions is in this case strong enough to change the distribution of SIC burdens from progressive to regressive. The very clear results showing falling degrees of progressivity over the entire range of countries and "ethical" parameters are not surprising considering the distribution of tax bases relative to the most progressive features of rate schedules seen in Figure 1 earlier. The erosion of the tax-free limits will push large numbers of households into paying tax. Any possibly progressivity-increasing effects discussed in Section 3 (through larger absolute reductions of tax deductions for people with higher marginal tax rates as well as increasing elasticities ε as a result of increasing marginal rates for those with positive tax burdens) cannot offset the resulting equalizing effect on tax burdens.

While inflation reduces progressivity, and thus the degree to which tax burdens increase with rising incomes, we have seen that total IT amounts go up considerably. For all countries and values of v, the increase in r is sufficiently large to cause the redistribution measures *RE* to go up despite decreasing k. In fact, the country ranking of relative *RE* changes is driven by the elasticity of r. In the Netherlands, where IT burdens (but also degrees of progressivity) are most sensitive to inflation, we also find the largest relative increases in *RE*: between 11 percent ($v = 1.5$) and 17 percent ($v = 3$) for the 16 percent inflation scenario.

For SIC, on the other hand, both k and r are reduced resulting in declining redistributive capacities. As the equalizing effect of SIC is much lower than that of IT to start with, inflation causes *RE* to turn negative in Germany and the

Netherlands for certain v. For instance if, as in the case of $v = 1.5$, we wish to put more weight on the contribution of higher-income groups to inequality then any inequality-reducing properties of German SIC burdens disappear once inflation exceeds around 6 percent.

Overall, inflation strengthens the equalizing properties of IT and SIC taken together (the sum of *RE* for IT and SIC increases slightly). Household incomes after inflation are lower following considerable increases in total tax burdens. Given the—on balance—progressive character of these tax burdens, this increase causes household incomes to be slightly more equally distributed than before inflation despite the inflation-induced erosion of tax progressivity.

7.2. *Existing Automatic Inflation Adjustments*

So far, we have analyzed how inflation would affect the redistributive mechanisms built into IT and SIC systems under the assumption of unadjusted tax functions $t(.)$. Where $t(.)$ are adjusted (or "indexed") to inflation in some way, the effects will obviously be different. Given that relevant tax rules are exogenous parameters of the tax-benefit model used here, it is possible to repeat the earlier analysis with tax parameters that resemble existing indexing mechanisms.

In practice, when looking at how tax rules have changed over time, it is difficult to separate inflation adjustments from policy measures introduced for other reasons. This section therefore only considers statutory and automatic adjustment mechanisms. Any discretionary adjustments made during that period are ignored. The inflation rates we consider are those that were observed during the five-year period from 1998 to 2003. The aim is to establish the effectiveness of statutory and automatic inflation adjustments in protecting existing redistributive mechanisms from inflation over that period.

Among the three countries considered, only Germany has no statutory income tax indexing regime in place. Table 4 shows inflation rates for all three countries along with the uprating factors d used to automatically adjust most IT and SIC parameters in the Netherlands and the U.K.[25] In the absence of discretionary inflation adjustments, the effects of German inflation rates can be inferred from the results shown for the hypothetical inflation rates in Table 3 above. For the Netherlands and the U.K., cumulative adjustments over the five-year period (12.9 percent and 11.5 percent, respectively) are close to total inflation rates (15.1 percent and 11.7 percent). A priori, we would therefore not expect any substantial changes in tax revenues or distributional characteristics.

This is confirmed in Table 5, which indicates that any changes are mainly driven by time-lags built into the indexing scheme. Given these lags, adjustments under/over-compensate during times of increasing/decreasing inflation (the

[25]Unfortunately, the adjustment rules of Dutch SIC are not as explicit so we have to find a reasonable approximation of actual adjustments to consider in the simulations. In practice, adjustments are largely expenditure-based. That is, they depend on the amounts of benefits to be paid (i.e. if unemployment is down, unemployment insurance contributions decrease, etc.). Since all simulations in this paper assume that all income components, including insurance benefits, increase in line with inflation, a reasonable modelling assumption, and the one adopted here, is to also hold all Dutch SIC parameters constant in real terms.

TABLE 4

INFLATION (p) AND AUTOMATIC ADJUSTMENT FACTORS (d)

	Germany		The Netherlands		UK	
%	*p*	*d*	*p*	*d*	*p*	*d*
1999	0.6	–	2.2	2.1	1.6	3.2
2000	1.5	–	2.4	1.7	3.0	1.1
2001	2.0	–	4.2	1.8	1.5	3.3
2002	1.4	–	3.3	3.1	2.1	1.7
2003	1.0	–	2.1	3.6	2.8	1.7

Notes: Inflation is measured as the relative change in average consumer price indices (CPI, all items) over a 12 month period. Average CPIs are computed in relation the fiscal year (January to December in Germany and the Netherlands; April to March in the U.K.). In the Netherlands, d is the factor used for adjusting income tax parameters and is computed in relation to the so-called "derived" CPI, which excludes a number of indirect taxes: d is equal to the average index during the 12 months from the 7th to 18th month before the tax year divided by the average index of the 19th to 30th month before the tax year. In the U.K., d is the relative change in the Retail Price Index during the 12 months preceding the month of September before the tax year.

Source: OECE Main Economic Indicators; Statistics Netherlands; Office for National Statistics.

relevant lags in the Netherlands are much longer than in the U.K.; see notes to Table 4). Less than perfect adjustments in the Netherlands can also result from deviations of the definition of adjustment factors (which excludes a number of indirect taxes) from the consumer price index. Upon first inspection, it is surprising that revenues from Dutch SIC differ slightly from their 1998 level despite the modeling assumption that relevant policy rules are up-rated in parallel with current inflation (see footnote 25). The reason for this is an inter-dependence between income tax and mandatory pension contributions: The income base on which these contributions are computed is the same as for income tax. Any income tax deductions and tax-free allowances are therefore subtracted from the contribution base as well. Since the up-rating factor used for adjusting income tax rules generally does not fully compensate for inflation, it follows that the contribution *base* is reduced by deflated deductions and allowances, leading to rising contributions even though the contribution *schedule* remains unchanged in real terms (and vice versa in 2003 where the income tax adjustment factor exceeds inflation).

8. CONCLUSIONS

I have used a new multi-country tax-benefit model to analyze distributional consequences of inflation-induced distortions of income tax and social insurance contribution schedules in Germany, the Netherlands and the U.K. In a second step, the paper has tested the performance of automatic indexing regimes used in two of the countries. The following conclusions can be drawn.

Real income tax burdens rise and social insurance contribution burdens fall when nominally defined tax rules are not adjusted for inflation. The potential

TABLE 5

SIZE OF INSTRUMENTS, REDISTRIBUTION AND PROGRESSIVITY: OBSERVED INFLATION RATES AND EXISTING STATUTORY INFLATION ADJUSTMENTS

	The Netherlands															
	Income Tax								Own SIC							
	Revenue, % 1998, real terms		v = 2.0		v = 1.5		v = 3.0		Revenue, % 1998, real		v = 2.0		v = 1.5		v = 3.0	
		r	k	RE	k	RE	k	RE		r	k	RE	k	RE	k	RE
1998	100.0%	0.1369	0.3303	0.0504	0.2687	0.0408	0.3545	0.0546	100.0%	0.1744	–0.0132	–0.0047	–0.0266	–0.0070	0.0181	0.0014
Unadjusted																
1999	102.8%	0.1407	0.3264	0.0514	0.2646	0.0414	0.3515	0.0558	99.6%	0.1738	–0.0179	–0.0057	–0.0297	–0.0076	0.0122	0.0002
2000	105.8%	0.1447	0.3231	0.0524	0.2607	0.0421	0.3495	0.0572	99.1%	0.1728	–0.0220	–0.0066	–0.0325	–0.0082	0.0068	–0.0010
2001	111.2%	0.1518	0.3170	0.0543	0.2539	0.0433	0.3456	0.0597	98.0%	0.1707	–0.0283	–0.0079	–0.0367	–0.0090	–0.0015	–0.0029
2002	115.7%	0.1576	0.3117	0.0557	0.2482	0.0442	0.3420	0.0616	97.0%	0.1690	–0.0335	–0.0089	–0.0401	–0.0096	–0.0083	–0.0043
2003	118.6%	0.1614	0.3082	0.0565	0.2446	0.0447	0.3395	0.0628	96.3%	0.1677	–0.0366	–0.0095	–0.0422	–0.0099	–0.0125	–0.0052
Adjusted																
1999	100.2%	0.1372	0.3301	0.0505	0.2684	0.0409	0.3544	0.0547	100.0%	0.1745	–0.0134	–0.0048	–0.0267	–0.0070	0.0179	0.0014
2000	101.1%	0.1385	0.3290	0.0509	0.2671	0.0411	0.3537	0.0552	100.2%	0.1748	–0.0140	–0.0049	–0.0271	–0.0071	0.0170	0.0012
2001	104.3%	0.1431	0.3251	0.0521	0.2628	0.0419	0.3514	0.0568	100.8%	0.1758	–0.0161	–0.0054	–0.0284	–0.0074	0.0141	0.0006
2002	104.6%	0.1435	0.3248	0.0522	0.2624	0.0420	0.3511	0.0569	100.9%	0.1759	–0.0163	–0.0054	–0.0285	–0.0075	0.0139	0.0005
2003	102.7%	0.1407	0.3271	0.0515	0.2650	0.0415	0.3526	0.0560	100.6%	0.1754	–0.0150	–0.0051	–0.0277	–0.0073	0.0157	0.0009

TABLE 5 (*continued*)

	UK															
	Income Tax								Own SIC							
	Revenue, % 1998, real terms		$v = 2.0$		$v = 1.5$		$v = 3.0$		Revenue, % 1998, real		$v = 2.0$		$v = 1.5$		$v = 3.0$	
		r	*k*	*RE*	*k*	*RE*	*k*	*RE*		*r*	*k*	*RE*	*k*	*RE*	*k*	*RE*
1998	100.0%	0.1448	0.2529	0.0421	0.1861	0.0310	0.3053	0.0507	100.0%	0.0462	0.1231	0.0057	0.0598	0.0027	0.2019	0.0095
Unadjusted																
1999	101.0%	0.1462	0.2516	0.0423	0.1849	0.0311	0.3039	0.0511	99.8%	0.0462	0.1213	0.0056	0.0584	0.0027	0.2004	0.0094
2000	102.8%	0.1487	0.2490	0.0427	0.1829	0.0314	0.3014	0.0516	99.5%	0.0460	0.1181	0.0054	0.0557	0.0025	0.1974	0.0092
2001	103.7%	0.1500	0.2478	0.0430	0.1818	0.0315	0.3001	0.0519	99.2%	0.0459	0.1165	0.0054	0.0544	0.0024	0.1960	0.0091
2002	105.0%	0.1519	0.2460	0.0433	0.1804	0.0317	0.2983	0.0524	98.9%	0.0457	0.1142	0.0052	0.0525	0.0023	0.1940	0.0090
2003	106.8%	0.1543	0.2439	0.0437	0.1786	0.0320	0.2961	0.0529	98.3%	0.0454	0.1113	0.0050	0.0500	0.0022	0.1914	0.0088
Adjusted																
1999	99.0%	0.1433	0.2544	0.0418	0.1873	0.0308	0.3069	0.0504	100.1%	0.0463	0.1249	0.0058	0.0613	0.0028	0.2036	0.0096
2000	100.0%	0.1448	0.2528	0.0421	0.1860	0.0310	0.3052	0.0507	99.8%	0.0462	0.1227	0.0057	0.0595	0.0027	0.2016	0.0095
2001	98.9%	0.1432	0.2544	0.0418	0.1873	0.0308	0.3068	0.0503	100.0%	0.0462	0.1244	0.0058	0.0609	0.0028	0.2032	0.0096
2002	99.1%	0.1435	0.2541	0.0419	0.1870	0.0308	0.3065	0.0504	100.1%	0.0463	0.1240	0.0058	0.0606	0.0028	0.2027	0.0095
2003	99.7%	0.1444	0.2532	0.0420	0.1862	0.0309	0.3057	0.0506	100.1%	0.0463	0.1230	0.0057	0.0597	0.0027	0.2019	0.0095

Notes: "Own SIC" are social insurance contributions paid directly by employees, self-employed and benefit recipients. *RE* is the equalising effect (difference between before and after-tax Ginis), *r* is the size of the tax, *k* is the Kakwani progressivity index and *v* is an "ethical" parameter that determines whether, in computing Ginis, low-income individuals receive greater ($v > 2$) or smaller ($v < 2$) weight than high-income individuals (see Section 5 for details).

Source: EUROMOD.

revenue effects can be substantial, even at lower rates of inflation. While theoretical results do not provide unambiguous answers about how inflation-induced erosions of tax band limits, deductions and tax credits combine to alter the degree of progressivity built into tax systems, simulations show that, in unadjusted tax systems, overall progressivity is reduced in all three countries. Despite this flattening of the distribution of tax burdens, the equalizing properties of income tax and social insurance contributions combined are enhanced as a result of increasing total tax burdens. That is, fiscal drag reduces real household incomes but, due to the overall progressive nature of tax burdens, causes them to be more equally distributed than before inflation.

Existing inflation adjustment schemes in the Netherlands and the U.K. perform well in immunizing tax systems' distributional and revenue-generating properties from inflation-induced distortions. The size of these corrections suggests that these properties can be seriously affected in countries where no automatic inflation adjustments exist. Discretionary adjustments will only be effective in preventing these changes if implemented on a regular, or quasi-automatic, basis.

The scenarios considered here have assumed that all incomes increase in line with inflation. Given these assumptions, estimates of the extents of fiscal drag and the resulting reduction of progressivity are likely to be conservative. One reason is that social transfers may not in fact be fully indexed to the price level so that those depending on benefit payments may be particularly hard-hit. And second, average incomes may increase at a faster rate than prices, and thereby further accelerate a decline in progressivity—even if comprehensive inflation-adjustment mechanisms are in place.

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