Most of public economics has the tendency to casually equate ‘utility’ with ‘well-being.’ This assumption is not presupposed by positive economics but is necessary for issuing policy prescriptions based on observed behavior alone. I derive optimal tax rules when government maximizes well-being, subject to individuals maximizing utility. Compared to a standard optimal tax formula, there is an additional term which depends on the difference between the well-being-based and the utility-based marginal rates of substitution (MRS). I use British life satisfaction data to estimate the well-being-based MRS of leisure for consumption and compare this measure with the utility-based MRS. Low-income workers tend to work ‘too little,’ while high-income workers work ‘too much,’ providing a motive for lower marginal tax rates at the bottom and higher rates at the top of the income distribution.

JEL: D01, D63, H21
Keywords: Optimal taxation, subjective well-being
‘Those who know anything about the matter are aware that every writer, from Epicurus to Bentham, who maintained the theory of utility, meant by it ... pleasure itself, together with exemption from pain.’
John Stuart Mill in Mill (1863, p.8)

‘The discrediting of utility as a psychological concept robbed it of its only possible virtue as an explanation of human behaviour in other than a circular sense, revealing its emptiness as even a construction.’
Paul A. Samuelson in Samuelson (1938, p.61)

‘In the standard approach, the terms “utility maximization” and “choice” are synonymous. A utility function is always an ordinal index that describes how the individual ranks various outcomes and how he behaves (chooses) given his constraints (available options).’
Faruk Gul and Wolfgang Pesendorfer in Gul and Pesendorfer (2008, p.7)

Historically, the concept of ‘utility’ has been defined in at least two different ways. The classical definition, implicit in the first quotation by John Stuart Mill, is intimately related to the well-being of its subject: utility is seen as the ultimate ‘good’ and, therefore, the natural aim of consequentialist public policy. The second definition, which is dominant in the field of economics since at least the seminal contribution on revealed preference theory by Paul A. Samuelson, and implicit in the second and third quotations, is directly related to individual behavior.1 In economics, utility is simply defined as that of which the maximization leads to behavior, i.e., it is a rationalization of behavior. Normative economics and, more specifically, public economics and the literature on optimal taxation usually implicitly insist that the two definitions perfectly overlap. That is, individual behavior follows from utility maximization, and this same measure of utility is taken to be the ultimate ‘good,’ the aim of optimal policy. The implicit assumptions are generally (1) that individuals behave in a way that is consistent with their own well-being, and (2) that individuals’ well-being ought to be the goal of public policy.

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1Later in life, especially since the publication of his Foundations of Economic Analysis in which he introduces the Bergson-Samuelson social welfare function (Samuelson, 1947), Samuelson came to view utility as more than the empty construct he alludes to in this quotation. For a historical account of his ideas on the Bergson-Samuelson function, see Backhouse (2013).
These assumptions are by no means uncontroversial, but criticism of either of the two assumptions follow from very different lines of reasoning. The latter assumption is a judgment based purely on moral and political philosophy, and is therefore a metaphysical judgment which I do not concern myself with in this paper. The former assumption, that behavior is consistent with maximizing well-being, is a judgment which can, in principle, be assessed empirically. Indeed, increasingly many studies reject the claim that voluntary choice is always and everywhere conducive to well-being. This rejection is based on a variety of insights from the fruitful interactions between economics and neuroscience (e.g., Camerer, Loewenstein, and Prelec, 2005), psychology (e.g., Rabin, 1998; Kahneman and Thaler, 2006), and happiness research (e.g., Clark, Frijters, and Shields, 2008), as well as on straightforward introspection. Moreover, the divergence between utility and well-being is increasingly stressed by scholars of economic methodology (e.g., Hausman, 2011).

Notice that such rejection in no way invalidates positive economic analysis, which seeks to describe and predict individuals’ economic behavior. It is true that, in much of the economic literature, individuals are represented as if they consciously maximize a certain utility function when making decisions. However, nothing in the positive economic analysis of behavior presupposes anything about the cognitive processes that underlie decision making. Economic analysis only presupposes that behavior could be captured in terms of maximizing a utility function. In reality, this could come about because individuals consciously maximize their well-being, because they are genetically wired to behave in such a way, or because they are led to their decisions by their social environment. The nature of the cognitive processes underlying human behavior are irrelevant for its economic analysis. This makes the transition from utility as a positive concept to utility as a normative concept, to put it lightly, non-trivial. If individuals are genetically wired to behave as they do, there is little reason to equate utility with ‘well-being’ or, indeed, with ‘the good.’ Thus, even if individuals’ decisions can be shown to be compatible with maximizing some function, it does not follow that this function

\footnote{Like most public economists, I am, however, convinced by and committed to a consequentialist moral philosophy that takes individuals’ well-being as its ultimate end. Nevertheless, most of the theoretical results in this paper could be reinterpreted in terms of a government that is motivated by other concerns than its subjects’ well-being.}
carries the moral import that public economics tends to ascribe to it.\textsuperscript{3}

The aim of the current paper is to reassess some standard results of optimal taxation by dropping the assumption that individuals necessarily maximize their own well-being. To avoid confusion, I use the concept of utility as defined in modern economics and refer to the aim of consequentialist government policy as well-being.\textsuperscript{4} Hence, social welfare is given by a sum of well-being which, like utility, is assumed to depend on the individual’s allocation of scarce goods. Individuals maximize utility, but not necessarily well-being. As a result, individuals tend to be away from their well-being-maximizing bliss point. Once I relax the assumption of well-being-maximizing agents, utility can no longer function as a moral guide and ordinary optimal tax calculations are flawed.\textsuperscript{5}

The first contribution of this paper is to derive optimal tax rates – direct and indirect, linear and nonlinear, on the intensive and extensive behavioral margin – and compare them with the standard case in which government maximizes utility. This yields optimal tax formulae that allow for straightforward interpretation. Taxes are set to equate marginal social costs and benefits, which are given by three separate terms: by (i) the social costs of an eroding tax base, (ii) the social benefits of increased redistribution, and (iii) the social costs or benefits of drawing people farther from or closer to their bliss point. The first term is identical to the distortive costs in the standard optimal tax formula. The second term is similar to the redistributive benefits in the standard formula, except that the benefits of redistribution are measured in terms of marginal well-being, rather than marginal utility. The third term is absent in the standard case when individuals are always

\textsuperscript{3}For a further discussion on the irrelevance of cognitive processes for positive economic analysis, see Gul and Pesendorfer (2008).

\textsuperscript{4}The distinction between utility and well-being is sometimes cast in terms of ‘decision utility’ versus ‘experienced utility,’ cf. Kahneman, Wakker, and Sarin (1997).

\textsuperscript{5}The notion that government should maximize well-being even if individuals themselves act against it is the subject of a long-standing debate. A literary reference would be Dostoyevsky’s Notes From The Underground, in which the Underground Man laments: “You ... want to cure men of their old habits and reform their will in accordance with science and good sense. But how do you know, not only that it is possible, but also that it is desirable to reform man in that way?” Bernheim and Rangel (2007) discuss the two schools of thought on this issue. One school strictly adheres to only using preferences revealed through observed behavior as a normative guide for policy evaluation. The second school, to which the current study obviously belongs, in principle allows for deviations from revealed preferences as a normative guide, provided it is firmly based on scientific evidence.
on their bliss point. If, from a well-being perspective, individuals work too much (or consume too much of a certain good), this increases the social benefits of taxation as higher marginal tax rates will draw people closer to their bliss point. On the other hand, if individuals work too little (consume too little of a good), the social benefits of taxation are lower since higher marginal tax rates exacerbate the preexisting ‘mistake’ in individual behavior.

The main insight generated by the optimal tax formulae is thus that tax rates should be adjusted to correct for suboptimal individual behavior. The extent of the necessary correction can be expressed in terms of the difference between a well-being-based marginal rate of substitution and a utility-based marginal rate of substitution (MRS). If utility coincides with well-being, the utility-based MRS of, say, leisure for consumption, naturally equals the well-being-based MRS. However, if the well-being-based MRS exceeds the utility-based MRS, substituting leisure for consumption improves well-being even though, by the individual’s first-order conditions, such substitution does not affect utility. Thus, a positive (negative) difference between the well-being based MRS and the utility based MRS of good A for good B provides a first-best motive for positive (negative) marginal tax rates on good B.

The second contribution of this paper is to determine empirically how important the corrective motive for income taxation is. For this, I determine individuals’ utility-based MRS and well-being based MRS of leisure for consumption. It is relatively straightforward to measure people’s utility-based MRS as it, by definition, equals net marginal wages. To measure the well-being based MRS, however, a direct measurement of well-being is necessary. For this, I use questionnaire data on subjective life satisfaction. Specifically, I use a panel dataset of British households to directly estimate well-being as a function of net income, proxying for consumption, and hours worked, among standard control variables and time- and person-fixed effects. Based on parametric and nonparametric estimation techniques I find that well-being is highly concave in consumption and single-peaked in working hours. On the basis of these estimations I construct a measure of the well-being based MRS of leisure for consumption. Comparison with the utility-based MRS indicates that low-income workers tend to work too little from a well-being perspective, whereas higher-income workers tend to work too
much. Because well-being is highly concave in income, the implications for the
optimal income tax schedule are especially pronounced for low-income workers.
Compared to standard optimal tax simulations, my analysis endorses much lower
marginal tax rates at the bottom of the income distribution.

To the best of my knowledge, this is the first attempt to calibrate optimal
tax formulae using data on life satisfaction. There is a number of studies that
determine optimal taxes when individuals’ and government’s preferences differ,
but they stop short of empirically determining this difference. Similarly, there is
a large number of studies on the determinants of well-being, but none of them
integrate their findings into a proper public-finance setting. My contribution to
the literature on optimal tax theory is closely related to the contributions by Kan-
bur, Pirttilä, and Tuomala (2006) and Blomquist and Micheletto (2006), which
both build on seminal work by Seade (1980). Kanbur, Pirttilä, and Tuomala, like
Seade, derive the optimal nonlinear income tax schedule in a Mirrlees (1971) set-
ing in which government maximizes something else than utility. Blomquist and
Micheletto do the same in the setting of Stiglitz (1982). The conclusions from
these studies are directly in line with mine, namely that the standard optimal tax
schedule is supplemented with an additional term which depends on the difference
between the individual’s and government’s MRS. I derive the same conclusion for a
wider range of settings, including indirect taxation and taxation of discrete labor-
supply decisions. In a broader context, this study is related to the literature on
optimal taxation in the presence of external effects (e.g., Sandmo, 1975; Jacobs and
De Mooij, 2015). Instead of an externality, individual behavior exhibits an inter-
nality, i.e., individuals do not take full account of their decisions’ consequences for
their own well-being. The optimal tax treatment of internalities, however, is very
much comparable to optimal corrective taxation in the presence of externalities.

Since I attempt to merge optimal tax theory with the empirical study of life
satisfaction, my paper is also related to the empirical literature on the determi-
nants of life satisfaction. This literature has recently been reviewed by Clark,
is of special interest as they attempt to measure individuals’ marginal well-being
of income, which is a crucial ingredient of optimal tax formulae. However, to
determine the nature of the trade-off between consumption and leisure, one also
needs to determine the marginal well-being of leisure. To my knowledge only few studies include work effort or hours in their analysis of the determinants of life satisfaction, and with mixed results. For example, Pouwels, Siegers, and Vlasblom (2008) conclude that hours worked negatively affects life satisfaction but estimate an equation in which hours worked enter logarithmically, thereby imposing a diminishing marginal well-being of working hours. Knabe and Rätzel (2010) argue that such functional form is counterintuitive but fail to discern an effect of working hours when estimating an equation in which working hours enter quadratically. Booth and Van Ours (2008), using the same data as I, fail to find any relationship between hours worked and life satisfaction. I conjecture that this might be caused by not controlling for job changes and promotions. Indeed, if a promotion improves well-being and is generally followed by longer working days, as one would expect, the regression coefficient on hours worked might capture both a positive promotion effect and a negative hours effect. Controlling for this I indeed find a robust single-peaked association between life satisfaction and working hours.

The remainder of the paper is organized as follows. The first three sections discuss optimal tax formulae when utility differs from well-being. The first section discusses linear income taxation, the second section nonlinear direct and indirect taxation, and the third section taxation of labor-market participation and education. The fourth section determines empirically the difference between the utility-based MRS and the well-being-based MRS and derives the implications for optimal nonlinear income taxation. The fifth section discusses the robustness of these results and the sixth and final section concludes.

1 Optimal linear income taxation

1.1 Individual utility maximization

To illustrate the basic intuition behind the optimal tax results, I first discuss optimal linear income taxation when government maximizes a sum of well-being. Optimal nonlinear taxation – which yields results very similar to the case of linear taxation – is left for the next section. Assume a mass-one population of individuals. Individuals are heterogeneous with respect to, and denoted by, their ability $n \in \mathbb{N}$. 
\( \mathcal{N} = [n, \bar{n}] \); they are distributed over \( \mathcal{N} \) according to cumulative distribution function \( F_n \equiv F(n) \), with density \( f_n \equiv F'(n) \). Utility of an individual \( n \) is denoted as \( u_n \), which might be different from his well-being, denoted as \( g_n \). Utility is assumed to be identical across individuals, and defined over consumption \( c_n \) and labor effort \( l_n \):

\[
(1) \quad u_n \equiv u(c_n, l_n), \quad u_c, -u_l > 0, \quad u_{cc} \leq 0, \quad u_{ll} < 0.
\]

I assume that utility is increasing and concave in consumption, and decreasing and concave in labor effort. Subscripts \( n \) indicate that, in equilibrium, consumption and labor effort, and thus utility, can be written as functions of ability \( n \). Individuals are constrained in their behavior by a budget constraint which stipulates that consumption should equal net income. I assume that ability corresponds to the gross wage rate per effective unit of labor, such that the budget constraint is given by:

\[
(2) \quad c_n = (1 - t)n l_n + T.
\]

Here, \( t \) is the income tax rate and \( T \) is a non-individualized lump-sum transfer from government. Standard utility maximization implies that the individual’s marginal rate of substitution (MRS) of leisure for consumption equals the net wage rate:

\[
(3) \quad \frac{-u_l}{u_c} = \left( \frac{-u_l(c_n, l_n)}{u_c(c_n, l_n)} \right) = (1 - t)n.
\]

Together with the budget constraint, this condition determines equilibrium values of consumption and labor effort for every individual \( n \in \mathcal{N} \) as functions of the tax instruments. Denoting equilibrium labor effort as \( l_n = l_n(t, T) \), I can define the Hicksian (compensated) labor supply elasticity as:

\[
(4) \quad \varepsilon^c_n \equiv - \left( \frac{\partial l_n}{\partial t} + n l_n \frac{\partial l_n}{\partial T} \right) \frac{1 - t}{l_n} > 0.
\]

Note that the elasticity \( \varepsilon^c_n \) is a compensated one in the sense that utility, not well-being, is assumed constant.
1.2 Social welfare maximization

I assume that individual well-being is, like utility, a function of consumption and labor effort and identical across individuals, such that it is given by:

\begin{equation}
    g_n \equiv g(c_n, l_n).
\end{equation}

I assume that social welfare, \( \mathcal{W} \), is given by the integral, over all individuals, of well-being:

\begin{equation}
    \mathcal{W} \equiv \int_N g(c_n, l_n) dF_n.
\end{equation}

The function \( g \) could be, but is not necessarily, equal to a concave function of utility. If it is, such that I can write \( g(c_n, l_n) = \hat{g}(u(c_n, l_n)) \), the model collapses to the standard exercise of optimal income taxation. Government income should equal expenditures and its budget constraint can thus be represented as:

\begin{equation}
    \mathcal{B} \equiv \int_N (tnl_n - T) dF_n = 0.
\end{equation}

Government sets the income tax rate \( t \) and the lump-sum transfer \( T \). Optimal policy follows from maximizing social welfare, (6), subject to budget constraint (7). Denoting the social marginal value of public funds as \( \lambda \), I can write for the optimum:

\begin{equation}
    \frac{d\mathcal{W}/\lambda}{dx} + \frac{d\mathcal{B}}{dx} = 0, \quad x \in \{t, T\}.
\end{equation}

I follow Diamond (1975) by defining \( \alpha_n \) as the monetarized social marginal well-being of income,\(^6\) i.e., the social gains associated with individual \( n \) receiving one unit of additional income:

\begin{equation}
    \alpha_n \equiv \frac{g_{c,n}}{\lambda} + tn \frac{\partial l_n}{\partial T} - \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}}{-u_{l,n}/u_{c,n} - 1} \right) (1 - t) n \frac{\partial l_n}{\partial T}.
\end{equation}

\(^6\)Where Diamond refers to social marginal utility of income, I refer to social marginal well-being of income to stress the fact that social welfare is defined over well-being, not utility.
The social marginal well-being of income consists of three elements. First, higher income leads to a direct welfare gain from higher consumption, \( g_{c,n}/\lambda \). Second, for a positive tax rate, \( t > 0 \), and negative income effects on labor supply, \( \partial l_n/\partial T < 0 \), higher income leads to a smaller tax base and thus a loss in tax revenue given by \( tn(\partial l_n/\partial T) \). Third, if the well-being-based MRS of leisure for consumption, \(-g_{l,n}/g_{c,n}\), exceeds the utility-based MRS, \(-u_{l,n}/u_{c,n}\), individual \( n \) supplies too much labor. In that case, the negative income effect on labor supply leads to an increase in well-being and thus to an increase in social welfare. Conversely if \(-g_{l,n}/g_{c,n} < -u_{l,n}/u_{c,n}\), individual \( n \) supplies too little labor and the negative income effect on labor supply leads to lower social welfare.

Substituting the derivatives of the welfare function and government’s budget constraint into equation (8), and substituting for \( \alpha_n \), yields the following optimality condition for the lump-sum transfer:

\[
(10) \quad \bar{\alpha} \equiv \int_{\mathcal{N}} \alpha_n dF_n = 1.
\]

Thus, the average social marginal well-being of income, \( \bar{\alpha} \), should equal 1, which is the public resources required to marginally increase the lump-sum transfer. This result only differs from the standard result for the optimal lump-sum transfer in that the social marginal well-being of income includes an additional term associated with suboptimal individual behavior.

The optimality condition for the income tax rate \( t \) can be written as:

\[
(11) \quad \int_{\mathcal{N}} n l_n \left( 1 - \alpha_n - \frac{t}{1 - T} \varepsilon_{c,n} + \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n} - 1} \right) \varepsilon_{c,n} \right) dF_n = 0.
\]

The equation is entirely standard, except for the last term within brackets. This term gives the direct welfare gains of lower labor effort, resulting from a marginal increase of the tax rate. Naturally, if the welfare function is only a function of the utility function, then \(-g_{l,n}/g_{c,n} = -u_{l,n}/u_{c,n}\), and the final term disappears.
1.3 Interpretation of the optimal income tax rate

I can now identify three sources of social costs and benefits from above optimality condition: a mechanical effect, a behavioral effect on the tax base, and a behavioral effect which corrects or worsens a possibly suboptimal labor supply decision by individuals. The first two effects are standard (e.g., Piketty and Saez, 2013), the last one originates from the assumption that individuals do not maximize well-being.

Mechanical effect – The first mechanical effect of a marginal increase in the labor income tax consists of the revenue gain and is given by \( nl_n \), which is the first term within brackets in equation (11). The second mechanical effect constitutes the direct welfare loss associated with the drop in individuals’ net income due to a higher income tax. This effect is given by the second term in brackets, \( -nl_n \alpha_n \). The overall mechanical effect of a higher tax rate is thus given by \( nl_n (1 - \alpha_n) \).

Behavioral effect on the tax base – An increase in the income tax rate leads individuals to substitute leisure for consumption, eroding the tax base. This represents a welfare loss as long as the income tax rate is positive, \( t > 0 \). A one percentage-point increase in the tax rate leads to a compensated change in labor supply of \( -\varepsilon_n/(1 - t) \) percent; a one percent increase in labor supply leads to a change in tax revenue equal to \( tnl_n \). Thus, the welfare effect associated with the behavioral effect on the tax base is measured by the product of the two, \( -nl_n \frac{t}{1-t} \varepsilon_n \), which, in equation (11), is the third term within brackets.

Behavioral effect on individuals’ suboptimal labor supply – The substitution of leisure for consumption leads to an additional welfare gain (loss) by drawing individuals closer to (farther from) their well-being optimal labor supply. Again, a one percentage point increase in the tax rate leads to a compensated change in labor supply of \( -\varepsilon_n/(1 - t) < 0 \) percent; a one percent increase

\(^7\text{Here I somewhat stretch the meaning of ‘mechanical’ to include all effects that are not due to substitution effects. Naturally, } \alpha_n \text{ represents in part the welfare consequences of any income effects of a tax change.}\)
in labor supply leads to a social welfare gain of higher consumption equal to \((1 - t)n l_{n} g_{c,n}/\lambda\), and a social welfare loss of higher labor supply equal to \(l_{n} g_{l,n}/\lambda\). Thus, the welfare effect associated with the behavioral effect on individuals’ suboptimal labor supply is measured by the product of the behavioral effect and the net welfare gain. Some straightforward rearranging yields the final term in equation (11). This welfare effect of a higher tax rate is positive if individuals supply too much labor, such that on average \(-g_{l,n}/g_{c,n} > -u_{l,n}/u_{c,n}\). In that case a higher tax rate corrects the suboptimal behavior as it leads him to work less. The opposite holds if workers supply too little labor, such that \(-g_{l,n}/g_{c,n} < -u_{l,n}/u_{c,n}\). In that case, higher taxation exacerbates individuals’ suboptimal behavior as it incentivizes people to work even less. Naturally, this welfare effect disappears if well-being and utility coincide, such that the well-being based MRS equals the utility-based MRS.

In the tax optimum, these three effects, summed over the entire population \(N\), should equal zero such that no further increase or decrease in the income tax rate could lead to an increase in social welfare. This is exactly what is stated by condition (11). To rewrite the optimality condition in a more familiar form, I define the wedge on the labor supply of individual \(n\) as follows:

\[
\omega_{n} \equiv \frac{t}{1 - t} - \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n}} - 1 \right).
\]

The wedge equals the difference between the monetized social welfare gains and private utility gains of one additional hour of labor, as a proportion of the net wage. It consists of two terms. The first is standard and represents the tax revenue of an additional labor hour. The second term represents the move towards, or away from, the individual’s bliss point. I define the income-weighted average of the labor wedge as:

\[
\bar{\omega} \equiv \frac{\int_{N} n l_{n} \omega_{n} dF_{n}}{\int_{N} n l_{n} dF_{n}}.
\]

Following Feldstein (1972), I define the distributional characteristic of the income tax base as the negative of the normalized covariance between labor income \(nl_{n}\).
and the social marginal well-being of income:

\[ \xi \equiv -\frac{\text{cov}[n_l, \alpha_n]}{\int_N n_l dF_n \int_N \alpha_n dF_n} = 1 - \frac{\int_N n_l \alpha_n dF_n}{\int_N n_l dF_n} \in [0, 1], \]

where I made use of the first-order condition of the transfer to substitute for \( \int_N \alpha_n dF_n = 1 \). Since the distributional characteristic is a normalized covariance, it is necessarily the case that \(-1 \leq \xi \leq 1\). However, as the social marginal well-being of income, \( \alpha_n \), is likely to be decreasing with income, \( n_l \), one could expect \( \xi \) to be positive. The larger the distributional characteristic of labor income, and hence the stronger the covariance between \( \alpha_n \) and \( n_l \), the larger the redistributive gains from taxing labor income.

Substituting for \( \omega_n \) and \( \xi \) into (11) and rearranging yields:

\[ \frac{\int_N n_l \omega_n \varepsilon c_n dF_n}{\int_N n_l dF_n} = \xi. \]

Furthermore, assuming that the Hicksian labor supply elasticity is equal for all individuals, such that \( \varepsilon c_n = \varepsilon c \), I can write:

\[ \bar{\omega} = \frac{\xi}{\varepsilon c}. \]

The formula for the optimal wedge on labor income is virtually identical to the standard formula for the optimal linear income tax derived under the assumption of well-being-maximizing individuals. The optimal labor wedge is determined by the redistributive gains of higher taxation, given by \( \xi \), divided by the magnitude of the substitution effect, given by \( \varepsilon c \). The only difference is that the wedge now includes a term that indicates the average difference between individuals’ actual and well-being-maximizing labor supply. For a given optimal labor wedge, if individuals provide too much labor, taxes should be higher; if individuals provide too little labor, taxes should be lower.

Above derivation suggests a broader implication, which is confirmed in further analysis below. The standard calculation of optimal wedges largely carries over to the case in which well-being does not correspond to utility. However, the total wedge consists of the degree of suboptimal behavior, as well as the tax wedge.
2 Optimal non-linear taxation

2.1 Direct taxation – single good

In this section I derive optimal non-linear tax formulae in the case that utility does not necessarily correspond to well-being. Utility is still the same function of consumption and labor effort, given by equation (1). I assume taxes are conditioned on labor income \( nl_n \), such that the taxes that an individual \( n \) pays are given by \( T(nl_n) \). His budget constraint is therefore given by:

\[
(17) \quad c_n = nl_n - T(nl_n).
\]

Utility maximization implies that the individual’s utility-based marginal rate of substitution of leisure for consumption equals the marginal net wage rate:

\[
(18) \quad -\frac{u_l(c_n, l_n)}{u_c(c_n, l_n)} = (1 - T'(nl_n))n,
\]

where \( T'(\cdot) \) denotes the marginal tax rate. Together with the budget constraint, and for a given tax schedule \( T(\cdot) \), this equation gives consumption and labor supply as a function of ability \( n \).

The social welfare function is still given by equation (6). Government maximizes social welfare subject to a budget constraint and an incentive compatibility constraint. The budget constraint can be written as:

\[
(19) \quad B \equiv \int_N T(nl_n) dF_n = \int_N (nl_n - c_n) dF_n = 0,
\]

where the second equation follows from substituting the individual’s budget constraint. I solve for the government’s maximization problem by deriving the optimal second-best allocation, which is decentralized by means of the optimal non-linear income tax schedule.\(^8\) Incentive compatibility follows from the individual’s first-order condition (18). Eliminating the marginal tax schedule from this condition

\(^8\)As proved by Mirrlees (1976), feasibility of the implementation requires the adoption of additional assumptions on the allocation and the utility function. Denoting gross labor earnings as \( z_n \equiv nl_n \), and the marginal rate of substitution of gross labor earnings for consumption as \( s(c_n, z_n, n) \equiv -u_l(c_n, z_n/n)/mu_c(c_n, z_n/n) \), I assume that the following necessary conditions
by substituting in the derivatives of the budget constraint and the utility function, I can rewrite the incentive compatibility constraint as:

\[
\frac{du_n}{dn} = -u_l(c_n, l_n)\frac{l_n}{n}.
\]  

The optimal allocation is obtained by maximizing social welfare, (6), with respect to \(c_n\) and \(l_n\), subject to the budget constraint, (19), and the incentive compatibility constraint, (20). This can be seen as a problem of optimal control with control variables \(c_n\) and \(l_n\), and state variable \(u_n\). The Hamiltonian associated with this maximization problem is given by:

\[
H = (g(c_n, l_n) + \lambda(nl_n - c_n))f_n - \theta_n\frac{-u_{i,n}(c_n, l_n)l_n}{n} + \mu_n(u_n - u(c_n, l_n)).
\]  

Here, \(\lambda\), \(\theta_n\), and \(\mu_n\), are the shadow prices that belong to the resource constraint, the incentive compatibility constraint, and the constraint on utility. The first-order conditions are obtained by taking derivatives of the Hamiltonian. Together with the boundary conditions on \(\theta_n\), and after rearranging, they are given by:

\[
\frac{\partial H}{\partial c_n} = 0 : \left(\frac{g_{c,n} - \lambda}{u_{c,n}}\right)f_n - \theta_n\frac{-u_{i,n}(c_n, l_n)l_n}{n} = \mu_n,
\]

\[
\frac{\partial H}{\partial l_n} = 0 : \left(\frac{g_{l,n} + \lambda n}{u_{l,n}}\right)f_n + \theta_n\frac{n}{u_{c,n}}\left(1 + \frac{u_{i,n}l_n}{u_{l,n}}\right) = \mu_n,
\]

\[
\frac{\partial H}{\partial u_n} = \frac{d\theta_n}{dn} : \frac{d\theta_n}{dn} = \mu_n,
\]

\[
\lim_{n \to \mu} \theta_n = \lim_{n \to \pi} \theta_n = 0.
\]

hold:

\[
\frac{\partial s(c_n, z_n, n)}{\partial n} < 0;\quad \frac{dz_n}{dn} > 0.
\]

The first condition is the single-crossing condition which ensures that the marginal rate of substitution of gross income for consumption, evaluated at a fixed bundle of income and consumption, is decreasing in ability. The second, monotonicity, condition requires that, at the optimal allocation, gross income is monotonically increasing with ability.

\(^9\)That is, total differentiating the utility function yields \(du_n = u_c(c_n, l_n)dc_n + u_I(c_n, l_n)dl_n\). Total differentiating the budget constraint yields \(dc_n = (1 - T'(nl_n))(ndl_n + l_ndn)\). Using this to substitute for \(dc_n\) in the derivative of the utility function, and substituting for \((1 - T'(nl_n))n\) from the first order condition yields the incentive compatibility constraint.
Combining equations (22) and (23), and substituting in the individual first-order condition, (18), yields, after some rearranging, an expression for the optimal marginal income tax schedule:

\[
\frac{T'(nl_n)}{1 - T'(nl_n)} = \frac{u_{c,n} \theta_n}{nf_n} \left( \frac{d \ln(u_{l,n}/u_{c,n})}{d \ln l_n} \right) + \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n} - 1} \right).
\]

Hence, the optimal tax schedule is additive in two terms. The first term is identical to the optimal tax schedule in the case that individuals maximize well-being, and represents both the behavioral responses of higher taxation, and the redistributive gains. For a detailed interpretation of this first term, see Mirrlees (1971), Tuomala (1990), or Saez (2001), among others. The second term, which vanishes in the standard optimal tax exercise, is the term of interest for the current paper. This term is familiar from the case of linear taxation (e.g., from equation (12)), and indicates whether from a well-being perspective individual \( n \) works too much or too little. If \( -g_{l,n}/g_{c,n} > -u_{l,n}/u_{c,n} \), an individual works too much, and the second term in equation (26) is positive, providing a motive for higher marginal income taxes to ‘correct’ individual behavior. On the other hand, if \( -g_{l,n}/g_{c,n} < -u_{l,n}/u_{c,n} \), workers work too little, providing a motive for lower marginal tax rates.

Analogous to equation (12) for linear taxation, I can write the wedge on labor as:

\[
\omega_n = \frac{T'(nl_n)}{1 - T'(nl_n)} - \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n} - 1} \right),
\]

such that I can write for the optimal wedge on labor:

\[
\omega_n = \frac{u_{c,n} \theta_n}{nf_n} \left( 1 + \frac{d \ln(u_{l,n}/u_{c,n})}{d \ln l_n} \right).
\]

Hence, the optimal labor wedge is virtually identical to the optimal marginal tax schedule derived in, e.g., Mirrlees (1971). The difference, if individuals do not maximize well-being, is that the wedge on labor includes both a tax wedge and a wedge due to suboptimal labor supply decisions.

An additional implication of condition (28) is that nonzero marginal income tax rates are optimal even in a first-best world in which government has full informa-
tion on individuals’ ability and markets are complete. If government can observe individuals’ ability the incentive compatibility constraint is slack such that $\theta_n = 0$. Hence, by equation (28), optimal wedges in the first best equal zero. This implies that marginal taxes are set to perfectly correct individuals’ suboptimal behavior. Thus, even if the second fundamental theorem of welfare economics holds, such that any feasible Pareto-efficient allocation can be implemented by means of individualized lump-sum taxes and transfers only, nonzero income-dependent taxation might still be optimal. After all, if individuals make decisions that do not correspond with their own well-being, Pareto efficiency ceases to be a compelling normative requirement.\footnote{Here I implicitly defined a Pareto-efficient allocation as one in which no person’s utility can be increased without decreasing anyone else’s utility. Naturally, one can alternatively define a Pareto-efficient allocation as one in which no person’s well-being can be increased without decreasing anyone else’s well-being. In that case, Pareto efficiency would still be a compelling normative requirement. However, that would imply a refutation of the fundamental theorems of welfare economics as complete markets, perfect competition, and local nonsatiation of preferences, in the absence of taxation, would no longer lead to a Pareto-efficient allocation.}

### 2.2 Indirect taxation – multiple goods

It is relatively straightforward to extend the model to include multiple taxable goods, yielding results which are similar in spirit to the ones derived under direct linear and non-linear taxation. For simplicity, I consider an additional good, $x_n$, upon which a nonlinear commodity tax $t_x = t_x(x)$ can be conditioned. Utility is now given by:

$$u_n \equiv u(c_n, x_n, l_n).$$

The budget constraint takes account of the additional good purchases and taxation:

$$c_n + x_n + t_x(x_n) = nl_n - T(nl_n),$$

which, together with the following two first-order conditions, describes equilibrium values for $c_n$, $x_n$, and $l_n$: 
\begin{align}
\frac{-u_l(c_n, x_n, l_n)}{u_c(c_n, x_n, l_n)} &= (1 - T'(nl_n))n, \\
\frac{u_x(c_n, x_n, l_n)}{u_c(c_n, x_n, l_n)} &= 1 + t'_x(x_n).
\end{align}

Individuals’ well-being is described by \( g(c_n, x_n, l_n) \), such that welfare is given by:

\begin{equation}
W = \int_N g(c_n, x_n, l_n) dF_n,
\end{equation}

which, to obtain optimal tax formulae, is maximized subject to a budget constraint and an incentive compatibility constraint:

\begin{align}
B &\equiv \int_N (T(nl_n) + t_x(x_n)) dF_n = \int_N (nl_n - c_n - x_n) dF_n = 0, \\
\frac{du_n}{dn} &= -\frac{u_l(c_n, x_n, l_n)}{l_n}.
\end{align}

Denote the wedge on consumption of good \( x_n \) as follows:

\begin{equation}
\omega_n^{x} \equiv \frac{t'_x(x_n)}{1 + t'_x(x_n)} + \frac{g_{c,n}}{\lambda} \left( \frac{g_{x,n}/g_{c,n}}{u_{x,n}/u_{c,n}} - 1 \right).
\end{equation}

Notice that, if \( g_{x,n}/g_{c,n} > u_{x,n}/u_{c,n} \), individual \( n \) consumes too little of good \( x_n \). Marginally substituting consumption of \( x_n \) for \( c_n \) leaves utility unchanged while improving well-being. Thus, even in the absence of indirect taxation, the wedge on \( x_n \) is positive if the individual consumes too little of the good, and negative if he consumes too much. Solving the maximization problem in the usual way yields the following expressions for the optimal wedges:

\begin{align}
\omega_n &= \frac{u_c \theta_n / \lambda}{n f_n} \left( 1 + \frac{d \log(u_{l,n}/u_{c,n})}{d \log l_n} \right), \\
\omega_n^x &= \frac{u_c \theta_n / \lambda}{n f_n} \left( -\frac{d \log(u_{x,n}/u_{c,n})}{d \log l_n} \right).
\end{align}

The optimal wedge on labor is given by the first equation and simply corresponds to
equation (28). The optimal wedge on consumption of good $x_n$ is given by the second equation. The right-hand side is the standard result for the optimal marginal tax schedule (e.g., Atkinson and Stiglitz, 1976). It indicates that the wedge on good $x_n$ is proportional to the degree in which the marginal rate of substitution of $x_n$ for $c_n$ changes with labor effort – that is, to the relative complementarity of good $x_n$ with labor. However, even though this is the case for the optimal total wedge, the optimal tax schedule also depends on whether individuals consume too much or too little of good $x_n$. If utility is weakly separable between consumption and leisure, such that the right-hand side of equation (38) vanishes (Atkinson and Stiglitz, 1976), the optimal tax wedge on consumption good $x_n$ might still be nonzero. More specifically, if individuals consume too much of good $x_n$, the optimal tax wedge is strictly positive, $t'_x(x_n)/(1-t'_x(x_n)) > 0$, whereas if individuals consume too little of it, the optimal tax wedge is negative, $t'_x(x_n)/(1-t'_x(x_n)) < 0$.

3 The tax treatment of discrete decisions

So far, I only considered labor supply decisions on the intensive margin. The idea that well-being diverges from utility, and thus that individuals make well-being suboptimal decisions, might very well apply to discrete decisions as well. Especially decisions that are difficult to reverse and of a once-and-for-all nature – to follow higher education, to participate in the labor market, occupational choice – might not be made with all consequences for well-being in mind. Adolescents' decisions on higher education – on both participation in and type of higher education – is an obvious example (e.g., Benjamin et al., 2014). Both utility and well-being functions are likely to be affected by the decision, as well as an individual’s intertemporal budget constraint. Such effects of education are difficult, if not impossible, to comprehend, which makes it plausible that revealed preferences for higher education bear little relation to actual well-being orderings.

In the Appendix, I derive optimal labor participation taxes and education subsidies when individuals do not necessarily maximize well-being. The implications for optimal tax policy are, given the analyses of the previous two sections, theoretically straightforward. Imagine individuals underestimate, on a net basis, the well-being benefits of participation in the labor market or of higher education.
This provides a motive to stimulate these discrete decisions by lower participation taxes and higher education subsidies. These motives are separate from and in addition to the standard motives for participation taxes and education subsidies.

4 How far away from their bliss point are people?

Thus far I have established that, if individuals do not behave in a way that maximizes their well-being, optimal tax rules are adjusted in a straightforward manner. The formulae for the optimal wedges are largely in line with the standard formulations of optimal tax schedules. The crucial difference is that the wedge consists of the marginal increase in well-being, as well as the marginal increase in tax revenue, associated with an increase in labor effort (or consumption, participation, education). Thus, the total wedge consists of the sum of the tax wedge and the wedge between the well-being-based MRS and the utility-based MRS. While similar results have been obtained in a comparable context (e.g., Kanbur, Pirtilä, and Tuomala, 2006; Blomquist and Micheletto, 2006), none of these studies came to a quantification of the latter wedge. The aim of this section is to do just that.

On the one hand, it is relatively straightforward to obtain empirical measures of the utility-based MRS as it by definition equals net relative marginal prices. On the other hand, to obtain a measure of the well-being-based MRS one first needs to determine what constitutes well-being, an issue likely to be contentious. I use survey data on people’s subjective life satisfaction as approximation of their well-being. Using panel data on life satisfaction, I estimate a well-being function to determine the well-being-based MRS of leisure for consumption and compare it to the utility-based MRS. This provides an indication of whether individuals work too much or too little and how far away they are from their bliss points.

Naturally, the assumption that subjective life satisfaction perfectly corresponds with well-being can and should be subjected to criticism. Indeed, Kőszegi and Rabin (2008) argue that both life-satisfaction measures and choice-based measures (i.e., utility) contain unique information on a person’s true well-being. The ideal measure of well-being would therefore make use of both types of data. But while
there are already numerous studies on optimal taxation that take utility as the sole measure of well-being, there are none that focus on subjective well-being. Thus even if subjective life satisfaction is not the ideal measure of well-being, I consider the analysis of this section as a useful first step towards evaluating income taxes on the basis of a more holistic welfare criterion.

The focus of the empirical analysis is on the case of direct nonlinear taxation, discussed in Section 2.1. I am therefore interested in the wedge of equation (27). More specifically, I focus on two related empirical results. First I determine the extent to which individuals tend to work too much, which I denote as $\Delta_n$:

$$\Delta_n \equiv \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n}} - 1.$$  

Notice that $\Delta_n$ is part of the second term of the wedge in equation (27). It has a straightforward interpretation: recall that $-u_{l,n}/u_{c,n}$ equals the net marginal wage rate of individual $n$, whereas $-g_{l,n}/g_{c,n}$ is the wage rate that individual $n$ should have earned to justify the actual amount of hours that he or she is working. Hence, $\Delta_n$ gives the marginal wage rate an individual should have earned given his labor supply decision, relative to his actual marginal wage rate. If, say, $\Delta_n = \frac{1}{2}$, individual $n$ works too much: he works as if he is earning fifty percent more than what he actually earns. On the other hand, if $\Delta_n = -\frac{1}{2}$, individual $n$ works too little: he works as if his wage was only half his actual wage. Thus, $\Delta_n$ is a natural measure of the extent to which individuals work too much from a well-being point of view.

Second, I am interested in the total wedge on labor income, $\omega_n$, the definition of which I repeat for convenience:

$$\omega_n \equiv \frac{T'(nl_n)}{1 - T'(nl_n)} - \frac{g_{c,n}}{\lambda} \left( \frac{-g_{l,n}/g_{c,n}}{-u_{l,n}/u_{c,n}} - 1 \right).$$

I am especially interested in the extent to which the total wedge deviates from the tax wedge on labor income, $T'/ (1 - T')$. This provides an indication of the

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11In principle, the same type of analysis could be carried out for the wedges in the case of direct linear taxation, (12), indirect taxation, (36), participation taxation, (51), or education subsidies, (52).
extent to which wedges on labor income are habitually over- or underestimated by assuming that utility coincides with well-being. On the basis of preceding sections, I concluded that the full wedge, $\omega_n$, rather than only the tax wedge, should be taken into account when judging the optimality of a tax system. The analysis below thus provides a qualification to studies that draw conclusions on the optimality of current tax systems on the basis of the tax wedge alone.

4.1 Data and strategy

4.1.1 Dataset and sample selection

The empirical analysis uses data from the British Household Panel Survey (BHPS), which includes information on numerous variables for a representative sample of individuals over consecutive years. Data are available for every year between 1991 and 2008, but a question on subjects’ well-being has been available since 1996, with the exception of 2001. Thus, I am able to use data for the years 1996 to 2000 and 2002 to 2008, making for a raw sample of 27,699 unique individuals over a period of up to 12 years, with on average 6.2 years of data per individual.

In order to obtain a relatively homogeneous group of people without losing too many observations, and to limit the likelihood of omitted variable biases in my empirical analysis, I impose further restrictions on this sample. For homogeneity, I restrict the sample to heads of household, who are employed, without children, and of prime working-age between 25 and 59 years old. In addition, I only include people if they have the same job function as in the preceding year, i.e., I exclude people whose function has changed, whether this was due to promotion or demotion, due to a change of company, or because of new entrance into the labor market. I do this because job changes are likely to have a direct impact on life satisfaction, while at the same time affecting the number of hours worked. As a result, without controlling for job changes, the effect of those changes on life satisfaction would be absorbed by the coefficient of the number of working hours.

\footnote{For the definition of the head of household, the BHPS follows the General Household Survey, i.e., the principal owner or renter of property, and (where there is more than one), the male taking precedence, and (where there is more than one potential head of household of the same sex), the eldest taking precedence.}

\footnote{Instead of excluding job changers from the sample, I also directly controlled for changes in
Indeed, failure to control for changes of job function might well be an important reason why some previous studies on life satisfaction did not find a significant effect of hours worked (e.g., Booth and Van Ours, 2008). The remaining sample contains 4,194 unique individuals, with an average of 3.2 observations per individual.

4.1.2 Measuring well-being

An individual’s well-being is measured by the response when asked about satisfaction with his or her life. The specific question asked is:

How dissatisfied or satisfied are you with your life overall?

Possible answers range from 1 to 7, with 1 labeled “Not satisfied at all,” and 7 labeled “Completely satisfied.” As discussed above, I assume that the answer to this question reflects the well-being of the person answering the questionnaire, and is thus taken to be the empirical measure of $g_n$. Figure 1 contains two panels that describe the data contained in the life satisfaction variable. The first panel illustrates the frequency at which a certain life-satisfaction score is given as answer. The second panel illustrates the average life-satisfaction score for each decile of net household income. Even without controlling for any other variables and without using any fixed effects, there appears to be a clear concave relationship between well-being and net household income.

4.1.3 Explanatory variables

Since ultimately I want to obtain a measure of the well-being based MRS of leisure for consumption, the most important explanatory variables are measures of consumption and work effort. As an approximation of consumption I choose to follow Layard, Mayraz, and Nickell (2008) by using total real net household income. Naturally, one would like to use permanent income when explaining overall life satisfaction. However, in the absence of data on permanent income I need to rely on current income. Some, but most likely not all, of the bias that originates job function. This does not change results much. I prefer excluding these observations from the analysis entirely, because I cannot observe the reason for the job change, e.g., whether it was due to a promotion or a demotion, which is potentially important.
from my reliance on current income is eliminated by the sample restrictions on age. Income is measured at constant household costs, and includes income from labor, investments, benefits, pension, and transfers, net of taxes. I choose not to normalize the income variable by using equivalence scales to correct for the size of the household. The reason I do not do this is because the choice of the particular equivalence scale is always a controversial issue, and because for my main specification, in which income enters the well-being equation logarithmically, the equivalence scale is in any case absorbed by the marital-status dummies. The first panel in Figure 2 illustrates the density of net weekly household income.

The second crucial explanatory variable measures the number of hours a person works in a normal week. The second panel in Figure 2 illustrates the density of these weekly hours worked. Not surprisingly, the amounts of working hours are mostly concentrated around forty hours of work per week. Other explanatory variables I use include age dummies, subjective health evaluation dummies (answers ranging from 1, “very poor”, to 5, “excellent”), year dummies, and marital status dummies. On top of that I include person-fixed effects to capture the influence of all person-specific time-invariant variables.
4.1.4 Empirical strategy

The empirical strategy of this section largely conforms with that of Layard, Mayraz, and Nickell (2008). The main results follow from estimating the following linear equation:

\[
g_{it} = a_0 \ln c_{it} + a_1 l_{it} + a_2 l_{it}^2 + \sum_j b_j x_{jit} + \gamma_t + \gamma_i + v_{it},
\]

where subscripts \(i\) and \(t\) denote individual \(i\) at time \(t\), \(g_{it}\) denotes life satisfaction, \(c_{it}\) real net household income, and \(l_{it}\) hours worked. Furthermore, \(x_{jit}\) are control variables, \(\gamma_t\) are time-fixed effects, \(\gamma_i\) individual-fixed effects, and \(v_{it}\) is the error term. Note that I assume that the functional form of well-being is, apart from a constant, identical across persons and additive in nature. Moreover, it is assumed to be logarithmic in income and quadratic in hours worked. The latter assumptions on functional form are relaxed when I turn to semi-parametric analysis in the next section, which is devoted to testing the robustness of my results. Crucially, I assume that observed changes in income and working hours are exogenous to life satisfaction. Naturally, this latter assumption is a source of concern in the absence of a proper quasi-experimental design. As discussed above, I tried to address these concerns by restricting my sample to exclude the most obvious cases of endogeneity.

Figure 2: Densities of real net household income and hours worked
The well-being based MRS of leisure for consumption is given by:

\[ -\frac{g_{l,it}}{g_{c,it}} = \left( -\frac{a_1}{a_0} + 2\frac{-a_2}{a_0} l_{it} \right) c_{it}, \]  

Hence, the estimation of equation (i) provides the first ingredient of the extent to which people work too much, \( \Delta_{it} \), and thus of the wedge on labor effort, \( \omega_{it} \). The second ingredient is given by the utility-based MRS. I assume that individuals’ budget lines are smooth, such that the marginal calculus of previous sections is valid. In that case, equation (18) indicates that the utility-based MRS is given by a person’s net marginal wage rate:

\[ -\frac{u_{l,it}}{u_{c,it}} = (1 - T'(n_{it} l_{it})) n_{it}. \]

The wage rate \( n_{it} \) is calculated by dividing the individual’s gross labor income by the number of hours worked. The marginal tax rate is obtained by the following procedure. First, total taxes are determined by taking the difference between households’ gross and net labor income, including income-dependent transfers and subsidies. Next, the resulting variable is smoothed over gross income and a numerical derivative is taken. This numerical derivative is taken to be the marginal tax rate. It is thus implicitly assumed that effective labor taxes are a function of household labor income. While this assumption is less accurate for moderate-to-high income workers as the income tax system in the United Kingdom is individual based, it is more accurate for low-income workers as eligibility for transfers and benefits generally depend on household income (see, e.g., Brewer, Saez, and Shephard (2010)).

Figure 3 depicts the total tax schedule (first panel) and the marginal tax schedule (second panel). Due to the phasing out of transfers and benefits, marginal taxes are relatively high for low-income levels.

This provides all the ingredients needed to calculate \( \Delta_{it} \). To arrive at a measure for the total wedge, \( \omega_{it} \), notice that \( \Delta_{it} \) is weighted by a factor \( g_{c,it}/\lambda \) relative to the tax wedge. In determining these weights, I assume there are no income transfers and benefits are taken into account. However, the general results of this section remain entirely intact.

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\(^{14}\)I also performed the exact same analysis while focussing on individual taxation. As expected, this resulted in much lower marginal tax rates at the bottom, since the phasing out of household-income dependent transfers and benefits are not taken into account. However, the general results of this section remain entirely intact.
effects such that $\lambda$ equals the simple average of the marginal well-being of income:

$$\lambda = \frac{\sum_{i,t} g_{c,it}}{N}$$

where $N$ is the total number of individuals.

### 4.2 Evidence on suboptimal behavior and the wedge on labor

The results of estimating equation (i) are given in Table 1. The first column shows results for the entire sample, while the second and third columns show the results of separate regressions for male and female respondents. For all regressions the coefficient on income is significant and around 0.18, which is to say that a percentage increase of net household income is associated with an increase in life satisfaction of (approximately) a hundredth of 0.18 point. While this effect seems rather small, it is in fact comparable to earlier results, for example from Layard, Mayraz, and Nickell (2008). As can be seen from the first column, the coefficient on the linear working hours term is positive while the coefficient on the quadratic term is negative. This is suggestive of an inverted-‘U’ shaped relationship between life satisfaction and hours worked. It is easily verified that the top of this parabola is around 30 hours of work, after which every additional working hour is associated with decreased life satisfaction. These findings are confirmed when the sample is restricted to male respondents, but loses its statistical significance when the sample is restricted to female respondents. The insignificant result for female respondents
Table 1: Estimation results for equation (i)

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>log income</td>
<td>0.182***</td>
<td>0.146***</td>
<td>0.217***</td>
</tr>
<tr>
<td></td>
<td>(0.0332)</td>
<td>(0.0392)</td>
<td>(0.0641)</td>
</tr>
<tr>
<td>hours</td>
<td>0.00762**</td>
<td>0.00953**</td>
<td>0.00137</td>
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<tr>
<td></td>
<td>(0.00346)</td>
<td>(0.00384)</td>
<td>(0.00790)</td>
</tr>
<tr>
<td>hours squared</td>
<td>-0.000126***</td>
<td>-0.000158***</td>
<td>-7.72e-06</td>
</tr>
<tr>
<td></td>
<td>(4.62e-05)</td>
<td>(5.05e-05)</td>
<td>(0.000111)</td>
</tr>
<tr>
<td>Observations</td>
<td>13,529</td>
<td>9,908</td>
<td>3,621</td>
</tr>
<tr>
<td>R-squared (within)</td>
<td>0.033</td>
<td>0.031</td>
<td>0.065</td>
</tr>
<tr>
<td>Number of individuals</td>
<td>4,194</td>
<td>2,942</td>
<td>1,252</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1

Dependent variable: life satisfaction. All regressions include age dummies, subjective health dummies (on a scale from 1 to 5), year dummies, and marital status dummies, as well as person-fixed effects.

might well be due to the small sample size, especially considering the fact that, in the remaining sample, the average number of sampled years per person is less than three.

By using equation (40) and the estimation results of Table 1, I can determine the well-being based MRS of leisure for consumption for every individual in the sample. Substituting this and the empirical observation of the utility-based MRS into equation (39), I obtain for every person and year in my sample a value for \( \Delta_{it} \). As discussed above, this value indicates the extent to which he or she works too much. If positive, the person works too much from a well-being point of view; if negative, the person works too little. Since (corrective) taxation is conditioned on labor income, it is most informative to show how \( \Delta_{it} \) varies over gross household labor income. The smoothed values of \( \Delta_{it} \) are depicted in the first panel of Figure 4. This graph illustrates that up to a weekly gross labor income of around £850, individuals tend to supply too little labor. Conversely, individuals that earn more than that tend to supply too much labor from a well-being perspective.

Now I can readily determine the total wedge on labor effort, \( \omega_{it} \), as given in equation (27), by substituting for the empirical marginal tax schedule, the measure
Figure 4: Overwork and wedges, full sample

Figure 5: Overwork and wedges, male subsample
of overwork $\Delta u$, and the marginal welfare weights $g_u/\lambda$. The smoothed values of
the total wedge are illustrated by the blue line in the second panel of Figure 4. The red line shows the tax wedge, which is normally taken as the total wedge on labor effort by studies that do not distinguish between utility and well-being. Naturally, the actual wedge is larger than the tax wedge for people that work too little, and smaller than the tax wedge for people that work too much. As the marginal welfare weights, $g_u/\lambda$, are rapidly decreasing with income, the difference is more pronounced for low-income workers than for high-income workers. Low-income workers could increase their own well-being by simply working more, but somehow fail to maximize their own well-being. For them, the total wedge, which measures the social welfare gain of increased labor effort, exceeds the tax wedge. For high-income workers the opposite holds: they work too much from a well-being perspective. While increased labor effort from high-income workers would raise tax revenue, it would also decrease their well-being. Therefore the total wedge for high-income workers is lower than the tax wedge alone would suggest.

Figure 5 illustrates the extent of overwork (first panel) and the total wedge on labor effort (second panel) if the analysis is restricted to male workers only. As is apparent, the previous results more or less carry over to a male-only sample. This time, however, only people with a very low income work too little from a well-being perspective, whereas the rest works far too much. As a result, the total wedge on labor effort for median-to-high income workers is much lower than the tax wedge alone. In fact, the total wedge hovers around zero for a significant range of the income distribution. For these income groups, the tax revenue gain associated with an increase in working hours would be completely offset by well-being losses. As a result, since the marginal dead-weight loss of taxation is proportional to the wedge on labor effort, the distortions associated with higher marginal taxes are negligible for these income groups.

4.3 Discussion of the results

The results in Figure 4 convey a potentially important implication for applied studies of optimal taxation. If we do not distinguish between utility and well-being, which indeed we usually do not, we might misappreciate the actual wedge on labor
effort by focussing solely on the marginal tax revenue gains of labor effort. The standard approach to applied optimal taxation is to determine the optimal wedge and compare this to the actually observed tax wedge. Policy recommendations are distilled from the difference between the optimal wedge and the actual tax wedge. However, as the analysis of Sections 1-3 shows, the optimal wedge should in fact be compared to the actual total wedge, not just the actual tax wedge. The results in Figures 4 and 5 suggest that standard applied studies of optimal taxation underestimate the actual wedge for low-income workers and overestimate the actual wedge for high-income workers. As a result, their recommendations understate the required tax decrease for low-income workers, as well as the required tax increase for high-income workers.

As a concrete example, consider the tax reforms that have recently been suggested by Brewer, Saez, and Shephard (2010) and Blundell and Shephard (2012) for the United Kingdom. Both studies call for a reduction of marginal tax rates for low-to-moderate earners. They conclude that marginal tax rates for low-income workers are currently so high that the distortions on intensive labor supply are too large to be justified by any redistributive gains. Taking into account the results from Figure 4, these recommendations hold a fortiori. After all, since low earners work too little from a well-being point of view, the actual total wedge on labor is even larger than the actual tax wedge. Consequently, marginal tax rates should be lowered even further than above studies suggest.

So far I did not pay much attention to the specific mechanism that leads to the apparent differences between well-being and utility. One possible interpretation of the results in this section, and indeed an often-discussed reason for suboptimal behavior, is that individuals might exhibit time-inconsistent preferences. For example, Bénabou and Tirole (2004) uses the concept of time-inconsistent preferences to provide micro foundations to both undersupply of effort and oversupply of effort or ‘workaholism.’ If individuals have insufficient willpower to resist the instant gratification of slacking at work, thereby discounting the longer-run benefits of working at a too high rate, they might end up working too little from a well-being point of view. On the other hand, if individuals have imperfect knowledge of their own willpower, a strong-willpower individual refuses to slack at work in

\[15\] On workaholism, also see Hamermesh and Slemrod (2008).
order to retain the self-confidence that he is in fact a strong-willpower individual, even when slacking would be well-being optimal – e.g., because of a family situation that more urgently requires his attention. A possible interpretation of my results in the light of Bénabou and Tirole (2004) is thus that low-income workers correspond to weak-willpower individuals that slack too much at work, whereas high-income workers correspond to strong-willpower workaholics that slack too little. Readjustment of the monetary rewards of working might cause the former to slack less and the latter to slack more.

However, as usual, multiple interpretations are possible. Like the vast majority of optimal-tax studies,\(^\text{16}\) I assumed that the labor market is supply driven – that individuals can freely decide how much to work. This naturally leads to the interpretation that low-income workers for some reason refuse to make more hours even though it would enhance their well-being. An alternative explanation, however, is that low-income workers face demand restrictions due to above market-clearing wages, e.g., minimum wages, union wages, efficiency wages, or some other form of downward wage rigidity.\(^\text{17}\) In that case, lowering marginal tax rates on the supply side is not useful as the induced labor-supply increase would not affect labor demand and therefore not translate in more actual hours worked. Instead, in a demand-driven labor market, marginal tax rates should be lowered on the demand side (i.e., the firm’s side) of the payroll to stimulate working hours of low-income workers.

5 Robustness

Potentially crucial to the above analysis is the specific functional form of the well-being function. In the previous section I simply assumed that well-being was additive in its arguments, logarithmic in income, and quadratic in working hours. In this section, I retain the assumption on additivity but attempt to determine the sensitivity of the results to the way in which income and working hours enter

\(^{16}\)But see Landais, Michaillat, and Saez (2013) and Gerritsen (2013) for recent examples of optimal taxation with demand-driven labor markets.

\(^{17}\)In this light, it is worthwhile to reiterate the fact that the latest observations in the dataset stem from 2008, which is before the recent crisis caused involuntary unemployment rates to soar.
the well-being function. As theoretically very little can be said on the functional form of well-being, I apply semi-parametric regression techniques that allow for a large degree of flexibility with respect to the specific functional form.

5.1 Income

I first try to get a better understanding of the relationship between life satisfaction and income. For this, I estimate the following partially linear model:

\[ g_{it} = \phi(c_{it}) + a_1 l_{it} + a_2 l_{it}^2 + \sum_j b_j x_{jit} + \gamma_t + \gamma_i + u_{it}, \]

where all variables are the same as before, and \( \phi(\cdot) \) is an unspecified function. The equation is estimated using the algorithm developed by Lokshin (2006), who applies a locally weighted scatterplot smoothing (lowess) estimator to determine \( \phi(c_{it}) \). The resulting values of \( \phi(c_{it}) \), for different levels of \( c_{it} \), are shown in the first panel of Figure 6. The blue line illustrates the estimated values for both male and female, and the green (red) line illustrates the estimated values if the sample is restricted to males (females) only. These results are suggestive of a concave relationship between well-being and income, although seemingly linear for females.

However, even if the relationship between well-being and income is concave, it...
Figure 7: Overwork and wedges based on equation (iii), for $\rho = 0.1$ (upper panels), $\rho = 0.5$ (middle panels), and $\rho = 1.5$ (lower panels)
does not follow that a logarithmic specification is the correct one. For example, Layard, Mayraz, and Nickell (2008) find in a similar setup that the relationship is slightly more concave than a logarithmic relation would imply. To determine whether the results of Section 4 are sensitive to the degree of concavity, I estimate the following equation:

\[(iii) \quad g_{it} = a_0 \left( \frac{c_{it}^{1-\rho} - 1}{1 - \rho} \right) + a_1 l_{it} + a_2 l_{it}^2 + \sum_j b_j x_{jit} + \gamma_t + \gamma_i + u_{it},\]

for various values of \(\rho\), allowing for varying degrees of concavity. On the basis of these estimations I derive the degree of overwork, \(\Delta_{it}\), and the total wedge, \(\omega_{it}\). Results for \(\rho = \{0.1, 0.5, 1.5\}\) are depicted in Figure 7.\(^{18}\) As can be seen, the conclusions on overwork and the total wedge remain in line with those of Section 4. Low-income workers work too little, while high-income workers work too much. Consequently, the total wedge on labor for low-income workers exceeds the tax wedge, whereas the total wedge for high-skilled workers is smaller than the tax wedge. Only in the case of a very low degree of concavity (\(\rho = 0.1\)), even the moderately poor seem to be working too much.

5.2 Working hours

Next, I further determine the results’ sensitivity to the way working hours enter the well-being function. I estimate the following equation:

\[(iv) \quad g_{it} = a_0 \ln c_{it} + \phi_h(l_{it}) + \sum_j b_j x_{jit} + \gamma_t + \gamma_i + u_{it},\]

with \(\phi_h(\cdot)\) an unspecified function to be estimated non-parametrically. The resulting estimated values for \(\phi_h(l_{it})\), separately for the full sample (blue), and the male (green) and female (red) subsamples, are shown in the second panel of Figure 6. For both the full sample and the male subsample, the relationship between life satisfaction and working hours appears to resemble an inverted ‘U’. This corroborates the results of the parametric regressions in which the quadratic specification

\(^{18}\)To save on space, I only depict the results for these three values of \(\rho\). The results remain broadly the same for any other positive value of \(\rho\) that I tried.
of working hours indicated a similar relationship. For female respondents no clear relationship is visible, which also corroborates earlier findings.

Even if the semi-parametric estimation indicates an inverted-‘U’ shaped pattern, this does not imply that the quadratic specification is correct. To test the robustness of my results, I therefore determine the marginal well-being of labor hours, $g_{l, it}$, by numerically taking the derivative of the estimated values of $\phi_h(l_{it})$. Together with the estimated value of $g_{c, it}$ from equation (iv), this allows me to determine values for $\Delta_{it}$ and $\omega_{it}$. These values are illustrated in Figure 8. As before, low-income workers appear to be working too little, whereas high-skilled workers are working too much. Hence, the results of Section 4 appear insensitive to the way in which income and working hours enter the well-being function.

6 Concluding remarks

To the best of my knowledge, this is the first study to integrate the large empirical literature on the determinants of subjective well-being with the rigorous study of public finance. It is based on the notion that utility and well-being are not necessarily the same. Taking serious the potential divergence between utility and well-being, I find that the resulting optimal wedge on labor (or a specific good,
labor participation, or education) is virtually identical to the one derived under conventional studies. However, the wedge itself now consists of the well-being consequences of drawing an individual farther from or closer to its well-being bliss point, as well as the standard tax wedge. Optimal marginal tax rates should be higher for workers that work too much from a well-being perspective, and lower for workers that work too little.

Using data on life satisfaction as a measure of a person’s true well-being, I estimate the effect of income and working hours on well-being for a large panel of British individuals. On the basis of this estimation I conclude that low-income workers work less than optimal from a well-being point of view. Higher-income workers, on the other hand, work too much. Moreover, this finding is robust to varying assumptions on the functional form of well-being. Compared to standard derivations of optimal tax rates, these results thus endorse lower marginal tax rates at the lower end of the income distribution, and higher marginal tax rates at the higher end of the income distribution. Recommendations of recent studies, calling for a reduction of marginal tax rates for low earners in the United Kingdom, therefore hold a fortiori.

Perhaps more important, this study shows that it is possible to combine the rigor and emphasis on incentives that is typical for the theory of optimal taxation, with an alternative measurement of well-being. My hope is that this might contribute to (i) more attention to economic incentives and optimal policy within applied studies of the determinants of subjective well-being, and (ii) a less dogmatic approach to well-being within public finance.

Appendix

In this Appendix I derive optimal labor participation taxes and eduction subsidies when individuals do not necessarily maximize well-being. I do so by developing a simple model that encompasses participation and schooling decisions. See Gerritssen and Jacobs (2014) for a more extensive model that also incorporates intensive labor supply decisions and involuntary unemployment but in which well-being and utility are assumed to be identical.
Individual utility maximization

Assume individuals can decide between three alternatives: (i) to be voluntarily unemployed and earn unemployment benefits $b$, (ii) to be a low-skilled worker, earn income $w_L$, pay taxes $t_L$, and incur disutility of participation $q_L(n)$, or (iii) to be a high-skilled worker, earn income $w_H$, pay taxes $t_H$, and incur disutility of schooling $q_H(n)$. Thus, disutility of labor is a function of individuals’ ability. I assume $q_H'(n) < q_L'(n) < 0$. Thus, disutility is decreasing in ability, and at a faster rate for high-skilled workers than for low-skilled workers, which is sufficient for participation and education decisions to be well-behaved. Utility for each separate decision is given by:

$$u_U \equiv u(b),$$

$$u_L \equiv u(w_L - t_L) - q_L(n),$$

$$u_H \equiv u(w_H - t_H) - q_H(n).$$

(42)  
(43)  
(44)

There are two critical ability levels. An individual with ability level $n_L$ is indifferent between being non-participant or low-skilled; an individual with ability level $n_H$ is indifferent between being low-skilled or high-skilled. Hence, these critical levels are determined by the following two conditions:

$$n_L : \quad q_L(n_L) = u(w_L - t_L) - u(b),$$

$$n_H : \quad q_H(n_H) - q_L(n_H) = u(w_H - t_H) - u(w_L - t_L).$$

(45)  
(46)

In equilibrium, individuals $n \in [n_l, n_H]$ are unemployed, individuals $n \in [n_L, n_H]$ are low-skilled, and individuals with $n \in [n_H, \overline{n}]$ are high-skilled. Thus, the number of unemployed, low-skilled, and high-skilled are given by $F_{n_L}$, $F_{n_H}$, and $1 - F_{n_H}$. I furthermore define the following semi-elasticities:

$$\eta_{Li} \equiv \frac{dF_{n_L}/F_{n_L}}{di}, \quad \eta_{Hi} \equiv -\frac{dF_{n_H}/(1 - F_{n_H})}{di}, \quad i \in \{b, t_L, t_H\}.$$ 

(47)

19It is convenient to model disutility of work, rather than labor earnings, as a function of ability. This way, all individuals of the same labor type earn the same income and I can ignore within-group income redistribution.
Thus, $\eta_{Li}$ gives the relative change in the number of unemployed due to a marginal change in tax instrument $i$, and $\eta_{Hi}$ gives the relative change in the number of high-skilled workers.

### Social welfare maximization

For simplicity I assume that the utility of consumption $u(\cdot)$ corresponds to well-being. However, the disutility of participation $q_L(\cdot)$ and of education $q_H(\cdot)$ might not correspond to well-being. The well-being losses of participation and education are denoted $h_L(\cdot)$ and $h_H(\cdot)$. I denote the difference between utility and well-being losses as:

\begin{equation}
\Delta_i(n) \equiv q_i(n) - h_i(n), \quad i \in \{L, H\}. \tag{48}
\end{equation}

If this difference is positive, individuals behave as if the well-being costs of participation (or education) are larger than they actually are. The social welfare function is thus given by:

\begin{equation}
W \equiv \int_{n_L} u(b) dF_n + \int_{n_L}^{n_H} (u(w_L - t_L) - h_L(n)) dF_n + \int_{n_H}^{\pi} u(w_H - t_H) - h_H(n) dF_n. \tag{49}
\end{equation}

Government’s budget constraint is given by:

\begin{equation}
B \equiv -\int_{n_L} b dF_n + \int_{n_L}^{n_H} t_L dF_n + \int_{n_H}^{\pi} t_H dF_n = 0. \tag{50}
\end{equation}

I again denote the marginal social value of public funds $\lambda$. The wedges on participation and education measure the social welfare gains associated with a marginal increase in participation and education:

\begin{equation}
\omega_L \equiv \left( t_L + b + \frac{\Delta_L(n_L)}{\lambda} \right), \tag{51}
\end{equation}

\begin{equation}
\omega_H \equiv \left( t_H - t_L + \frac{\Delta_H(n_H) - \Delta_L(n_H)}{\lambda} \right). \tag{52}
\end{equation}

Thus, the wedge on participation, $\omega_L$, includes the tax benefits of an increase in participation, $t_L + b$, and the monetized difference between the utility costs and
well-being costs of participation, $\Delta_L(n_L)/\lambda$. To understand why the latter term enters the wedge on participation, note from equation (45) that the utility costs of participation are set to equal the gains of increased consumption. If, for individual $n_L$, the well-being costs are smaller than the utility costs of participation, such that $\Delta_L(n_L) > 0$, the well-being gains outstrip the well-being losses of participation. Similarly, the wedge on education, $\omega_H$, includes the tax benefits of increased education, $t_H - t_L$, and the monetized difference between the utility costs and the well-being costs of education, $(\Delta_H(n_H) - \Delta_L(n_H))/\lambda$.

Maximizing social welfare, (49), subject to the budget constraint, (50), with respect to $b$ and $t_H$, and substituting in wedges, (51) and (52), and elasticities, (47), yields the following formulae for the optimal wedges:

\begin{align*}
\omega_L &= \left(\frac{u'(b)}{\lambda} - 1\right)/\eta_{Lb}, \\
\omega_H &= \left(1 - \frac{u'(w_H - t_H)}{\lambda}\right)/(-\eta_{Ht_H}).
\end{align*}

The optimal wedge in condition (53) consists of two terms. The first term in brackets measures the social welfare gain of distributing an additional unit of income to the unemployed, minus the resource costs of doing so. The second term gives the semi-elasticity of the number of unemployed with respect to the unemployment benefit. Thus, the optimal wedge is set according to a familiar logic (cf. Gerritsen and Jacobs, 2014), and equals the redistributive gain of a participation tax, divided by the magnitude of the behavioral response. The same logic applies to the optimal wedge on education, given by condition (54). It equals the social benefits of redistributing away from the high-skilled (the bracketed term), divided by the negative semi-elasticity of the number of high-skilled with respect to an increase of the high-skilled tax.

As was the case in previous sections, however, participation and education wedges consist not only of the net participation tax and the net tax on high-skilled workers. They also take into account the difference between the well-being based and the utility-based assessment of participation and education. If net well-being

\footnote{Naturally, to fully solve for all three separate tax instruments ($b$, $t_L$, and $t_H$), I would need the first-order condition for $t_L$ as well.}
of participation exceeds net utility of participation, too few people are participating in the labor market, providing a motive for lower participation taxes. If net well-being of education exceeds net utility of education, too few people become high-skilled, providing a motive for lower taxes on the high-skilled (or higher education subsidies).

References


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