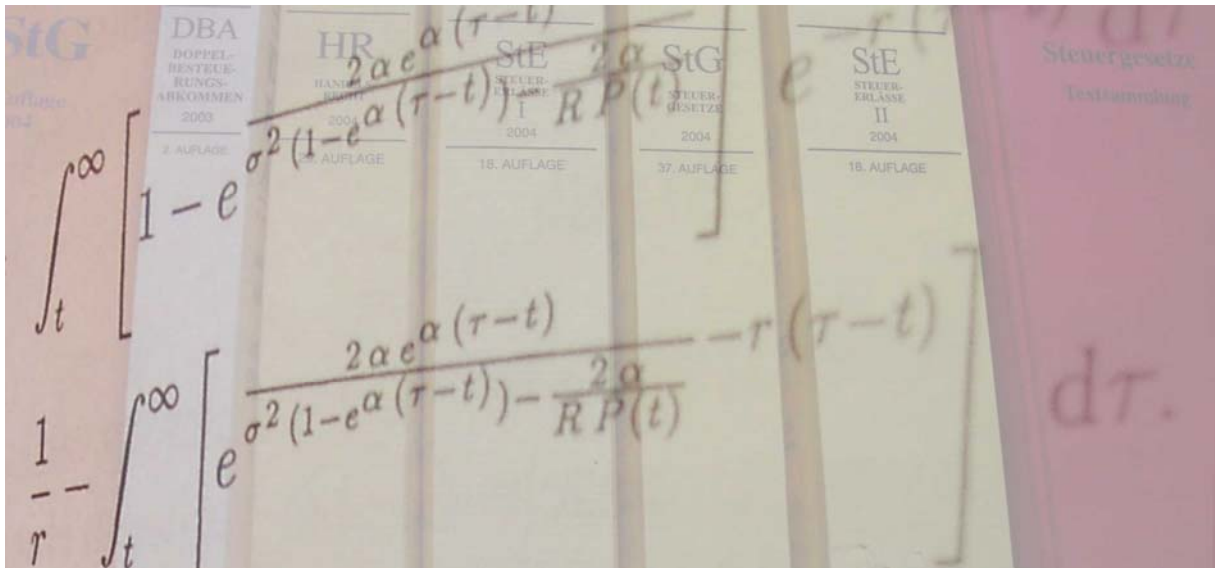# arqus

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How Well Does a Cash-Flow Tax on Wages
Approximate an Economic Income Tax
on Labor Income?

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How Well Does a Cash-Flow Tax on Wages Approximate an Economic Income Tax on Labor Income?

Martin Weiss[†]

Summary

The recent German discussion has witnessed increasing interest in the Dual Income Tax. The analysis of its merits, as opposed to those of a comprehensive income tax, is usually conducted with the main argument of the increasing mobility of financial capital in mind. This article pursues an alternative route of reasoning, arguing that the composition of the tax base of labor income entails a differentiation of the tax rates on capital and labor income. The time effect inherent in this dualism causes allocational distortions of unknown magnitude. It is modeled employing effective tax rates. The extent of the divergence is determined empirically, using German cross-sectional data from the 2004 wave of the Socio-Economic Panel[‡]. The uneven distribution of this advantage across differently educated brackets of society is uncovered. The paper concludes with proposals to remedy the situation and a tentative endorsement of the Dual Income Tax.

Keywords:	Comprehensive Income Tax, Dual Income Tax, Effective Tax Rates, Wage Equation
JEL classification:	H21, H24, J24, J31

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Contents

List of Abbreviations

AwP_t	Award Points in t (for pensions)
CF_t	Cash-Flow in t
$contb_t$	Pension Contribution in t
DIT	Dual Income Tax
Edp_t	Economic Depreciation in t
Ep_t	Economic Profit in t
$EStG$	German Income Tax Code (Einkommensteuergesetz)
ETR	Effective Tax Rate
ETR^{DIT}	Effective Tax Rate for the Dual Income Tax
ETR^{EP}	Effective Tax Rate for the Tax on Economic Profit in t
EV_t	Economic Value in t
$EX_{t,j}$	Labor Market Experience of Individual j at Point in Time t
FV	Final Value
G_j	Gender Dummy
i	Interest Rate
IN_t	Interest Part of an Annuity
IRR	Internal Rate of Return
j	Index for Individuals
m	Multiplier for Tax Rates under the DIT
NPV	Net Present Value before Tax
NPV_τ	Net Present Value after Tax
NPV_τ^{DIT}	Net Present Value after Tax for the Dual Income Tax
NPV_τ^{EP}	Net Present Value after Tax for Taxation of the Economic Profit
RE_t	Repayment Part of an Annuity
s_j	Schooling in Years
$SOEP$	Socio-Economic Panel (Sozio-ökonomisches Panel)
t	Time Index
T	Lifetime of an Individual in Years
τ	Constant Tax Rate
τ_c	Constant Tax Rate on Capital Income for the DIT
τ_l	Constant Tax Rate on Labor Income for the DIT
TB_t^{EP}	Tax Base for the Tax on Economic Profit in t
$Y_{t,j}^m$	Monthly Income in Year t for Individual j

1 Introduction

The recent German discussion has revitalized the interest in the Dual Income Tax first aroused by the introduction of such a tax in the Nordic countries during the 1990s. *Wissenschaftlicher Beirat beim BmF* (2004) and *Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung* (2006) constitute major contributions to the domestic political discussion. From an academic point of view, *Keuschnigg and Dietz* (2007) build an elaborate model to assess the likely impact of the Dual Income Tax on Swiss and German macroeconomic performance. *Radulescu and Stimmelmayr* (2005) conduct experiments concerning the likely welfare effects of a German switch to the Dual Income Tax: They find a positive effect on capital accumulation, GDP and household consumption. Their experiment leads to a welfare gain of 0.8% in the long run.

The case for a possible switch to a Dual Income Tax is conventionally buttressed by a line of argumentation that runs as follows (*Sørensen*, 1994): the continuing integration of international capital markets has rendered high taxes on capital income untenable. The introduction of a Dual Income Tax is seen as a reaction to these exogenous forces. Its primary goal is to maintain or improve the competitive position of a country and keep as much capital as possible within its borders[1]. These arguments are also pursued by *Cnossen* (1999, p. 24), *Eggert and Genser* (2005, p. 42) and *Schratzenstaller* (2004, p. 28).

Only very few articles advance different arguments. *Nielsen and Sørensen* (1997, p. 312) argue that the tax base of labor income is essentially made up of cash-flows so that the rate of return on investments in human capital is not reduced by taxation and the investment is consequently extended too far in comparison with other sources of income. Similarly, *Kaplow* (1994, 1996) and *Wagner* (2000) cite the differences in the determination of the tax bases of labor and capital income as a major reason to apply different tax rates to them. Recent contributions to the subject at the very least do not overemphasize this point. *Sørensen* (2005, p. 563) mentions it briefly.

Yet the consequences of the fact that the tax base of labor income is mostly made up of cash-flows should not remain uninvestigated. A *comprehensive income tax* lumps these cash-flows together with accounting profits derived from physical capital and returns from financial capital and applies a common tax schedule to the sum. Under the Dual Income Tax, these streams are separated along the lines of labor income on the one hand and capital or residual income on the other hand[2].

Still, the mere insight into the necessity of a discrimination between labor and capital income taxation naturally prompts one to investigate the *optimal* difference between the relevant tax rates. This process should logically proceed in three distinct steps:

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[1] This argumentation rests on the Public Finance insight that the factor that is supplied more inelastically should be taxed more heavily (*Salanié*, 2003, p. 20). *Trostel* (1993) conducts a policy experiment where he exposes an economy to an unexpected permanent increase in the income tax rate. He finds (*Trostel*, 1993, p. 337) that a 1 percent increase in the tax rate translates into a long-run decline in the human capital stock by 0.39 percent whereas physical capital shrinks by 1.37 percent. Physical capital is thus deemed to be over three times more sensitive to changes in taxes and should therefore be treated more *leniently* for tax purposes.

[2] The recent German discussion has been marred by a wrongheaded attempt to shift the demarcation line to the question of income generation within and outside of enterprises (*Stiftung Marktwirtschaft*, 2006). For this distinction, there is no theoretical basis. It merely derives its popularity from a deep-rooted popular uneasiness with the idea of a reduction in the tax burden for entrepreneurs.

- First of all, optimality can only be determined with regard to a "yardstick", thus when there is clarity as to the tax system that is ultimately desired. Here, the old dogfight between income and consumption taxation comes into play again.

- Then, one needs some measure of the different tax burdens currently weighing on labor and capital under the prevailing comprehensive income tax. To this end, the present paper lays out a strategy to assess the extent of the disparity of tax burdens on capital and labor income in Germany on the basis of effective tax rates (ETRs). To derive empirical results, the latest wave of the Socio-Economic Panel is employed.

- In conclusion, a technique is required to align the tax burden on capital and labor.

Empirically, the revenue derived from the German tax system is heavily tilted towards labor income taxation. *Müller* (2004, p. 77) reports statistics for Germany that show the overwhelming contribution of taxes on labor income to the German tax base: 79.9% of the aggregate tax base is made up of taxes on labor. On page 80, *Müller* reinforces this importance, reporting that 91.0% of taxpayers actually pay income tax on labor income as opposed to only 14.2% paying any taxes on capital income[3].

Human capital is one of the major research topics in economics. At the same time, there is a fair degree of uncertainty about the very nature of human capital. While it is clear that it is not tangible like physical capital, it is also more elusive than financial capital in that its size is not immediately ascertainable. The struggle to define human capital can be observed in *Rimmler* (2005). While *Rimmler* defines it as "the stock of knowledge and abilities of individuals…" (p. 6), he later arrives at a more hands-on definition (p. 8): The "value of an individual human capital stock can at any point in time be determined as the present value of future returns from human capital".

In the case of human capital, investments are often called "education". Yet fundamentally, education exhibits all the properties of an investment: someone engaging in education deprives himself of consumption opportunities today in order to get back *at least* the same consumption possibilities tomorrow, adjusted for the passage of time by some rate of time preference. The only obvious – but economically meaningless – difference is that education does not necessitate substantial cash payouts. Instead, most of its costs to the individual[4] come as *opportunity costs*: students forgo wage income during their university studies. Direct cash outlays (for tuition fees, books etc.) pale in comparison (*Nielsen and Sørensen*, 1997, p. 322). Thus, there is no reason to alter substantially the instruments used to analyze decisions on human capital investments from the ones used for physical capital.

From these facts, it is apparent that the attention devoted by the literature to tax effects concerning capital income is not warranted: the smaller pie has received an undue amount of attention while the larger one has been neglected. On top of that, far too little interest has been stirred by the *interplay* between the taxation of physical and financial capital on the one hand and human capital on the other hand. This paper sets out to

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[3] For the American discussion, *Davies and Whalley* (1989, Appendix A) compare different approaches to the correct measurement of the economy wide human capital stock (some ranging as high as 96 % of the entire capital stock) and arrive at the conclusion that the human capital stock is at the very least "substantially larger in aggregate value than the physical capital stock" (*Davies and Whalley*, 1989, p. 50).

[4] Society expends significant amounts of money on education, but this investment is not part of the individual decision to acquire an additional unit of human capital.

provide an approximation to a *unifying treatment of human and physical capital* while maintaining the notion of a comprehensive income tax[5].

The rest of the paper is organized as follows: Section 2 seeks answers to the question why an adjustment of taxes on human capital payoffs to the taxation of financial capital under the current income tax makes sense. Section 3 derives the effective tax rates needed to tackle the problem. Section 4 assesses the quality of the approximation and proposes several possible remedies to rectify the situation. Section 5 concludes. An appendix provides mathematical derivations.

2 Why Approximate Income Taxes?

2.1 The Desirability of a Comprehensive Income Tax

The properties of a theoretical *comprehensive income tax* have been discussed more than extensively in the last decades. Omitting the usual reference to *von Schanz* (1896), *Haig* (1921) and *Simons* (1938), the recent literature defines its tax base as one "that includes the market value of consumption plus changes in net wealth on an accrual basis" (*Owens*, 2006). The practical implementation of this seemingly simple concept usually takes the following form:

- For financial capital, at least for a standard investment[6], the economic profit is taxed.

- For physical capital, accrual taxation at least aims in the direction of the economic profit, without any a priori assurance of hitting it.

- For human capital, tax law does not even bother to ask for economic profits, but takes cash-flows as its tax base.

Even if tax law calls the resulting sum "income", this term is *deprived of its meaning* by the odd mixture of different elements just enumerated.

On top of these practical problems, academic research provides ample analyses of the deficiencies of income taxation with regard to notions of neutrality. Two infringements of neutrality stick out in particular:

- Neutrality with regard to consumption choices: an income tax levies a tax burden on interest and thus distorts agents' distributions of consumption over time.

- Neutrality with regard to investment choices: an income tax distorts the pre-tax ranking between investment projects.

Under a comprehensive income tax, only the latter demand can be met, by the taxation of economic profits Ep_t as first described by *Johannson* (1969) and *Samuelson* (1964), where the tax base TB_t^{Ep} is made up of the economic value of future cash-flows EV_{t-1} times the prevailing interest rate i or, equivalently, cash-flows minus economic depreciation charges Edp_t

$$TB_t^{Ep} = iEV_{t-1} = Ep_t = CF_t - Edp_t \tag{1}$$

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[5] A more comprehensive treatment of the subject matter can be found in *Weiss* (2007).
[6] As represented by a coupon bond.

where the depreciation charges are defined as

$$Edp_t = EV_{t-1} - EV_t \tag{2}$$

and the economic value at time t is defined as

$$EV_t = \sum_{k=t+1}^{T} CF_k \left(1+i\right)^{-k+t} \tag{3}$$

The uncertainty regarding future cash-flows needed to derive EV_t renders the application of an actual income tax on economic profits impossible. Yet as a theoretical construct, the taxation of economic profits has served as a "yardstick" of "optimal" income taxation for over three decades.

The distortions in the intertemporal distribution of consumption introduced by an income tax have led to calls for the introduction of consumption taxes, namely cash-flow taxes as described by *Brown* (1948) and the allowance for corporate equity (*Boadway and Bruce*, 1982, 1984; *Wenger*, 1983).

2.2 Consistency of an Economic Income Tax

Wenger (1999) argues that the whole notion of an economic income tax collapses once economic rents are taxed. When looking at a project that just about earns its capital costs, i.e. whose net present value equals zero, the economic value EV_t equals zero for all periods $t \in [-\infty; -1]$ so taxation can set in at point in time $t = 0$ since there is no tax base prior to this point, as is apparent from equation (1). Once the project becomes profitable, this cozy arrangement is destroyed as the economic value can now be traced back into the infinite past: the formation of a positive economic value no longer coincides with the first cash-flow. As another year goes by, the cash-flows draw a little nearer and thus generate economic income. Under a comprehensive income tax, this income is taxable. A profitable project thus has to carry a tax burden in the infinite past.

While the very idea of going back into infinity for tax purposes may seem far-fetched, a consistent comprehensive income tax must see to it that it imposes the same present value of taxes on projects with the same net present value before taxes, no matter when the first cash-flow occurs. *Wenger* (1999, p. 53) shows that this attempt can go either way:

1. If tax law does not make up for its failure to tax past income, the whole setup turns out to be a cash-flow tax as mentioned in subsection 2.1.

2. If tax law does aim to make up for the failure, it must apply a confiscatory tax rate of 100 percent to the economic rent.

This inconsistency should not pose too big a problem in the case of physical capital where competitive pressure holds economic rents close to zero on average. Yet for the case of human capital, this assumption cannot be justified. Net present values of labor earnings are generally large, and the criticism uttered by *Wenger* (1999) is consequently highly relevant for the discussion.

The whole notion of income taxation thus *lacks a proper theoretical foundation*. The implications of this sentence are staggering: the literature has been using the taxation of the economic concept of profit as a *calibration mark*[7] to assess the quality of different

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[7] *Schreiber* (2005, p. 549) uses the "neutral income tax" as a gauge of tax effects.

regimes of income taxation (*Niemann et al.*, 2003; *Treisch*, 2000). The papers by *Kaplow* (1994, 1996) and *Wagner* (2000) take the "ideal income taxation" as their *point of reference*. *Kaplow* (1994, p. 1479) states that "...the present analysis asks how an ideal income tax would treat human capital".

This paper does not attempt to incorporate this criticism into its derivation of the optimal difference between the labor and capital income tax rate: the public discussion of tax reforms is focused almost entirely on income taxation and is thus unlikely to be swayed by arguments favoring the abolition of income taxation on account of its theoretical inconsistency. Yet it should be born in mind as a caveat that all results derived henceforth are rendered shaky – to say the least – by the contribution of *Wenger* (1999).

3 Effective Tax Rates on Human Capital in Germany

3.1 Estimation of the Wage Equation

3.1.1 The Wage Equation

To measure effective tax rates, one needs to investigate the empirical distribution of human capital payoffs over time. To this end, a conventional Mincer-type earnings function (*Mincer*, 1974; *Harmon et al.*, 2003) is estimated. Equation (4) describes the basic setup

$$\ln\left(Y_{t,j}^m\right) = \beta_0 + \beta_1 G_j + \beta_2 s_j + \beta_3 EX_{t,j} + \beta_4 EX_{t,j}^2 + \varepsilon_{t,j} \tag{4}$$

where the logarithmic (monthly) income $Y_{t,j}^m$ of the jth individual at point in time t is explained by G_j, a gender dummy[8], s_j, the years of schooling enjoyed by individual j, and $EX_{t,j}$, the experience in the labor market gained by individual j up to point in time t[9].

Equation (4) is by some measures the most frequently estimated equation in econometrics. Yet, one should not pretend that it is a flawless measure of earnings power: From an econometric point of view, the regressors in an ordinary-least-squares (OLS) regression must be exogenous, that is uncorrelated with the error term. In equation (4), this cannot be guaranteed:

- The "ability" of an individual is not a regressor in equation (4), but an omitted variable. Abilities impact both income and decisions to engage in education. Thus, schooling and the error term are likely to be positively correlated.

- Misreported data can induce a further bias as individuals are known to underestimate their schooling regularly.

This problem leads to a bias in the estimation output from an OLS regression. A part of the income increases is wrongly attributed to schooling, while in reality it is due to innate abilities. All else equal, the coefficient of the schooling variable is thus *overestimated*.

Consequently, the results emanating from equation (4) must be viewed with a grain of salt. The problems[10] mentioned above can be remedied by using instrumental variable

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[8] Set equal to 1 for men.

[9] Cf. *Franz* (2003, p. 91) for the derivation.

[10] On top of these problems, the regressand "income" represents a hash of different economic decisions. $Y_{t,j}^m$ can be calculated as hours worked times the prevailing wage rate. While the former is a labor supply decision, the latter describes, in most cases, a labor demand outcome, since most jobs are offered on a "take-it-or-leave-it"-basis (*Greene*, 2003, p. 52).

techniques (*Greene*, 2003, p. 74). The dataset, as described in subsection 3.1, does not contain such variables so that the results obtained from the regressions in table 4 on page 8 are valid as rough approximations only.

3.1.2 The Dataset

The dataset used to estimate the wage equation is taken from one of the latest waves of the Socio-Economic Panel (SOEP), conducted in 2004 by the DIW[11]. Information on the SOEP[12] is delivered by *Haisken-DeNew and Frick* (2005, p. 16):

> "The SOEP was started in 1984 as a longitudinal survey of private households and persons in the Federal Republic of Germany. The central aim of this panel study is to collect representative micro-data on persons, households and families in order to measure stability and change in living conditions by following principally a micro-economic approach enriched with sociology and political science variables, mainly determined by the 'Social Indicator' movement."

The enormous size of the original dataset can be whittled down to eight variables for the purposes of this paper. These are enumerated in **table 1**.

Table 1

Original variables used in the estimation of the wage equation

Variable Name	Variable Content
Personal Characteristics	
up13901	Gender
up13902	Year of birth
Education	
ubilzeit	Duration of education, in years
upbbil01	Vocational degree received
upbbil02	Completed college education
upsbil	Highest school degree obtained
Employment	
up09	Employment status
Income	
up5901	Gross income last month

All variable names start with a "u", indicating the 2004 wave of the SOEP.

Once the dataset has been restricted to these eight variables, additional variables are generated. These are listed in **table 2** on the next page.

After the generation of these variables, the file has to be further restricted to the working age population[13] ($age \leqslant 65$) and to those in full or part-time employment at

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[11] Deutsches Institut für Wirtschaftsforschung, Berlin.

[12] Further comprehensive information on the SOEP project and detailed descriptions of all the variables in the dataset can be found at http://panel.gsoep.de/soepinfo2003/soepinfo2003.html.

[13] The youngest person in the dataset is 17 years old, so there is no need to adjust for too young a worker.

Table 2

Variables generated for the estimation of the wage equation

Variable Name	Variable Content	Calculation
age	Age	2004 minus year of birth
exp	Labor Market Experience	Age minus ubilzeit minus six
exp_2	Experience squared	Experience taken to the square
gender	Dummy for gender	Set to 1 for men, 0 for women
ln_income	Logarithmic income per month	Logarithm of up5901

the time of the survey. Following these modifications, the sample size drops to 9,414 observations per variable.

To derive results for specific subgroups of workers, the dataset can be divided along the lines of the highest school degrees as contained in the variables *upsbil* and *upbbil02*. Among the possible combinations of school and vocational degrees, only prominent ones with more than 400 observations are picked. These are enumerated in **table 3**.

Table 3

Combinations used in the regressions in subsection 3.2.3

Combination	Description
A	Overall (Whole Dataset)
B	Secondary School (Hauptschule) degree holders with subsequent apprenticeship
C	Intermediate School (Realschule) degree holders with subsequent apprenticeship
D	Upper Secondary School (Abitur) degree holders with subsequent apprenticeship
E	Upper Secondary School (Abitur) degree holders with subsequent university studies

German degree names in brackets

3.1.3 Estimation Results

The results[14] of the estimation of equation (4) are displayed in **table 4** on the next page. As usual in a semilog specification, the coefficient for schooling can be interpreted as the percentage change in wages (numerator in equation (5)), given a one-unit increase in schooling (denominator in equation (5)).

$$\frac{\partial \ln Y_{t,j}^m}{\partial s_j} = \frac{\partial \ln Y_{t,j}^m \frac{\partial Y_{t,j}^m}{\partial Y_{t,j}^m}}{\partial s_j} = \frac{\frac{\partial Y_{t,j}^m}{Y_{t,j}^m}}{\partial s_j} = 0.0913 \tag{5}$$

As schooling is measured in years, this coefficient gives the return to an additional year of schooling for the average individual. At 9.13%, this estimate finds itself right in

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[14] Robust standard errors are used throughout the paper.

the middle of empirical estimates in the literature[15].

The significance of the coefficient estimates is high across the board, with the exception of the squared experience term. The gender dummy is significant as well, indicating some wage discrimination on account of gender in the dataset. The R^2 measure ranges from 20-odd percent to over 30 percent for the whole dataset (combination A), which is quite satisfactory in a cross-sectional regression.

Table 4

Results of the earnings equation regression (equation (4))

Combination	A	B	C	D	E
Schooling	0.0913**	0.0801**	0.1232**	0.1060**	0.0746**
Experience	0.0361**	0.0182**	0.0124*	0.0349**	0.0656**
Experience^2	-0.0006**	-0.0002†	-0.0001†	-0.0005†	-0.0012**
Gender	0.5430**	0.6898**	0.4776**	0.3185**	0.4781**
Intercept	5.7631**	6.0003**	5.6951**	5.6462**	5.8328**
Nobs	9,386	1,497	1,835	488	1,423
R^2	32.4%	28.6%	20.7%	22.8%	21.8%

Significance levels :   † : 10%   ∗ : 5%   ∗∗ : 1%

3.2 Derivation of Effective Tax Rates

3.2.1 Effective Tax Rates

Effects of taxation are customarily divided into three categories (*Wagner*, 2005, p. 454):

Time Effects Time effects are only relevant in a multiperiod context. They arise because investment alternatives with the same undiscounted sum of tax bases feature different distributions of those tax bases over time, thus triggering different tax payments at different points in time. Investors care c.p. less about later tax payments than earlier payments due to the time value of money.

Tax Base Effects Tax base effects arise because alternatives are subject to discriminatory treatment under tax law. Typically, some alternatives are taxed because they are carried out within a firm while private transactions of the same kind are not subject to taxation[16].

Tax Rate Effects Tax rates can differ across alternatives because tax law stipulates different tax rates for different economic activities. For example, the idea to apply final withholding taxes to interest income causes a tax rate effect against the backdrop of otherwise progressive tax rates.

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[15] *Belzil and Hansen* (2002, fn.2) cite estimates around 15% as "not uncommon". *Psacharopoulos and Layard* (1979) find a return of 9.7% for English and Welsh men in 1972. *Bellmann and Gerlach* (1984) calculate a more mundane return of 7% for German men at the end of the 1970s.

[16] German Income Tax Law allows private capital gains stemming from a stake below the legal threshold of 1 % to be realized tax-free once a certain period of time has elapsed (§§17,23 EStG).

The method employed in this paper to gauge the discrimination in tax burdens is the concept of *effective tax rates* as introduced at the beginning of the 1980s by *Auerbach and Jorgenson* (1980) and *Bradford and Fullerton* (1981), further developed by *King and Fullerton* (1984) and extended from coverage of only marginal to lucrative investments by *Devereux and Griffith* (1999). It is meant to condense the three tax effects mentioned above into one number. The yardstick to measure an equal tax burden across both human and physical capital is assumed to be the taxation of financial capital under a comprehensive income tax, i.e. full taxation of interest.

Effective tax rates are designed to measure the tax-related reduction in the degree to which investors reach their goals or the "share of value-added generated by an economic decision that is taken in tax" (*Heady*, 2003, p. 2). Thus, the broadest expression of an effective tax rate is given by

$$\frac{\text{Economic goal before tax} - \text{economic goal after tax}}{\text{Economic goal before tax}} = \frac{\text{Tax wedge}}{\text{Economic goal before tax}} \tag{6}$$

Equation (6) does not make reference to a specific criterion for the economic goal that investors pursue. There is a whole array of suitable candidates (*Knirsch*, 2002, p. 8), among them the net present value, NPV, and the Internal Rate of Return, IRR.

The advantages and disadvantages of the criteria have been discussed extensively in the literature. *Collins and Davies* (2003) use the IRR as their criterion in their analysis of ETRs on human capital in Canada. The main drawback here is that decisions based on IRRs are only valid if there are no interim cash-flows. Yet human capital is the main asset of most households and is precisely *meant to yield interim cash-flows*. The present paper chooses the net present value of the cash-flow from human capital as the relevant criterion, so that equation (6) turns into

$$ETR = \frac{NPV - NPV_\tau}{NPV} \tag{7}$$

where the NPV is defined as the present value of future human capital payoffs CF_t,

$$NPV = \sum_{t=1}^{T} \frac{CF_t}{(1+i)^t} \tag{8}$$

where T denotes the end of the lifetime of the individual concerned. The after tax value NPV_τ is, under the prevailing income tax, defined as

$$NPV_\tau = \sum_{t=1}^{T} \frac{(1-\tau)\, CF_t}{(1+i\,(1-\tau))^t} \tag{9}$$

where taxation takes a bite to the tune of the constant tax rate τ out of both the cash-flow in the numerator of equation (9) and the constant interest rate i in the denominator, representing opportunity costs.

3.2.2 Assumptions of the Calculations

To derive the actual ETRs, one needs an assumption concerning the length of the education spells of the individuals in the dataset to measure s_j in equation (4). Some standard durations of schooling and occupational training for different groups are provided by *Haisken-DeNew and Frick* (2005, p. 69) and displayed in **table 5** on the next page.

Table 5

Conversion of degrees into imputed educational times

English Name	German Name	Imputed Duration	
Imputed Schooling Times			
Lower School Degree	Hauptschule	9	Years
Intermediary School Degree	Realschule	10	Years
High School Degree*	Hochschulreife	13	Years
University	Universität	5	Years
Apprenticeship	Lehre	1.5	Years
Imputed Professional Experience			
Apprenticeship	Lehre	1.5	Years

Source: *Haisken-DeNew and Frick* (2005, p. 69)

* Imputed duration for "High School Degree" is taken to be 13 years across the board, although some German states are currently switching to 12 years.

Once individuals have concluded their education, their education times become a constant and the only variable left in the earnings function is the labor market experience[17]. The imputed times contained in table 5 are entered into equation (4) together with the estimation results in table 4.

The actual ETRs are calculated as in equation (7) through equation (9), with T set equal to the statistical life expectation in Germany, as reported in *Statistisches Bundesamt* (2006), where men are assumed to live for 76 years. To cover the period between retirement and life expectancy T, a simplified pension scheme, designed to mimic the German pay-as-you-go scheme, is introduced.

- A 10% pension contribution on the gross income of the employee is applied[18]. This monthly contribution earns the employee award points (AwP) that give him a legal claim to a pension once he hits the retirement age of 65 years.

- The award points represent the fraction of the gross earnings divided by the statutory average income which is taken to be[19] 30,000 €.

- The contributions are capped at a contribution ceiling of 60,000 €. Therefore, the employee can earn a maximum of two award points per year.

- As for the tax treatment of pensions, full deductibility of the contributions and full taxability of the benefits is assumed, as this is in line with the future system currently being phased in in Germany.

- The beneficiary is entitled to a pension that is calculated by multiplying the award points accumulated upon reaching the retirement age with the prevailing "pension value" which is fixed at 26 €.

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[17] As mentioned above, the dataset has been restricted to individuals that work either full or part-time. The assumption is that there are no unemployment spells in the job biography so that experience can simply be measured as "age minus age at graduation".

[18] This contribution is matched by an equally sized contribution from the employer which is factored into the eventual pension payments.

[19] Inflation is ignored throughout the paper.

For a male secondary school (Hauptschule) degree holder with subsequent apprenticeship (Combination B in table 3), the approach is illustrated in **figure 1** on the next page.

Figure 1

Time bar for combination B in table 3 (Male "Hauptschule" degree holder with apprenticeship)

3.2.3 Results

Table 6 on the following page shows the ETRs resulting from the coefficients estimated in table 4. The following derivation shows the calculation for a male upper secondary degree holder with subsequent university studies[20].

To this end, equation (4) is transformed and the results from the last column of table 4 are entered to yield

$$E\left(Y_{t,j}^m \,\middle|\, s_j, EX_{t,j}\right) = \exp\left(5.833 + \underbrace{0.478}_{Gender\ Dummy} + 0.075 s_j + 0.066 EX_{t,j} - 0.001 EX_{t,j}^2\right) \quad (10)$$

Compared with equation (4), the error term ϵ_t drops out of the calculation as equation (10) returns the *expected monthly gross wage*, conditional on the exogenous variables gender, schooling and labor market experience. The ETRs are calculated by fitting this expectation into equation (8) and equation (9). Equation (7) then yields the desired effective tax rate.

From table 6, a tendency towards lower ETRs for the more highly educated brackets of society is obvious. Generally, the ETRs rarely exceed the statutory tax rate and, for increasing interest rates, heavily undercut it.

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[20] Combination E in table 3.

Table 6

ETRs for male workers, for selected education brackets (combinations from table 3 in brackets), for different interest rates i and tax rates τ

		Hauptschule with apprenticeship (B)					Realschule with apprenticeship (C)		
	i	**1%**	**3%**	**5%**		i	**1%**	**3%**	**5%**
τ	**10%**	14.7%	8.7%	3.7%	τ	**10%**	14.6%	8.5%	3.4%
	15%	17.6%	8.5%	0.7%		**15%**	17.6%	8.3%	0.3%
	20%	20.7%	8.7%	-2.1%		**20%**	20.7%	8.4%	-2.6%
	25%	24.1%	9.1%	-4.7%		**25%**	24.0%	8.8%	-5.4%
	30%	27.5%	9.9%	-7.1%		**30%**	27.5%	9.5%	-7.9%
	35%	31.2%	11.1%	-9.1%		**35%**	31.1%	10.7%	-10.1%
	40%	35.1%	12.7%	-10.7%		**40%**	35.0%	12.3%	-11.8%
		Abitur with apprenticeship (D)					Abitur with university studies (E)		
	i	**1%**	**3%**	**5%**		i	**1%**	**3%**	**5%**
τ	**10%**	14.4%	7.8%	1.9%	τ	**10%**	14.3%	7.4%	1.1%
	15%	17.3%	7.2%	-2.0%		**15%**	17.2%	6.7%	-3.1%
	20%	20.4%	7.0%	-5.8%		**20%**	20.2%	6.3%	-7.3%
	25%	23.6%	7.0%	-9.4%		**25%**	23.4%	6.2%	-11.4%
	30%	27.0%	7.4%	-12.8%		**30%**	26.8%	6.4%	-15.3%
	35%	30.6%	8.3%	-15.9%		**35%**	30.4%	7.1%	-18.8%
	40%	34.4%	9.6%	-18.5%		**40%**	34.2%	8.3%	-21.8%

4 Assessment of the Approximation

4.1 Quality of the Approximation

As a yardstick to gauge discrimination or privilege of human capital under an ideal income tax, the ETR on human capital should be equal to the nominal tax rate τ. To see this, note that under an ideal income tax the net present value after tax is equal to

$$NPV_\tau^{Ep} = \underbrace{-\tau \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t}}_{tax\ on\ EV_0} + \underbrace{\sum_{t=1}^{n} \frac{CF_t - \tau(CF_t - Edp_t)}{(1+i(1-\tau))^t}}_{taxation\ of\ Ep_t\ for\ t=1...n} = (1-\tau) \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} = (1-\tau)\,NPV$$

$$\underbrace{\phantom{-\tau \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t} + \sum_{t=1}^{n} \frac{CF_t - \tau(CF_t - Edp_t)}{(1+i(1-\tau))^t}}}_{PV\ after\ tax\ under\ taxation\ of\ Ep}$$

(11)

for which the proof is found in the appendix in section A. Equation (11) assumes that the taxation of economic profits includes the taxation of the initial appreciation at the point in time $t = 0$ as taxable *income*[21].

Using this result, equation (7) thus turns into

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[21] Here, the contribution by *Wenger* (1999) comes into play again, as discussed in subsection 2.2. As mentioned there, it is simplified to the assumption of one initial appreciation at t=0. This assumption has its detractors. *Wagner* (2000) does not include it in his calculations. The

$$ETR^{Ep} = \frac{NPV - NPV_\tau^{Ep}}{NPV} = \frac{NPV - (1-\tau)\,NPV}{NPV} = \tau \tag{12}$$

Equation (12) shows that any ETR falling short of the nominal tax rate τ indicates a tax privilege compared to the taxation of physical and financial capital. Table 6 then drives home the point that for the most realistic case of a 5% interest rate[22], human capital is substantially *privileged* under the current income tax system.

The results in subsection 3.2 serve to highlight the fact that the current income taxation is uneven – not only between different types of capital, but also within human capital: the big winners under the current system are the highly educated holders of a degree of the upper secondary schools, possibly with subsequent university studies.

Following the customary division of effects of taxation into time, tax base and tax rate effects[23], it is apparent that for the upper education brackets in Germany, the tax rate and time effects combine[24] comfortably:

1. Higher average tax rates for this group take a bite out of both the numerator and denominator of equation (9).

2. At the same time, the longer education spell for this group defers the onset of taxation into the future. The increases in the economic value of future human capital payoffs accruing during the period of education are not taxed under the current income tax while they would be part of the tax base under the ideal income tax. The current cash-flow taxation thus ends up benefiting those that policymakers often want to burden most. The *progressivity* of the income tax is *turned on its head*.

The last point warrants further elaboration. The time effect is due to the fact that over time, the undiscounted sum of cash-flows and of the economic profits is equal[25], i.e.

$$\sum_{t=0}^{T} CF_t \overset{!}{=} \sum_{t=0}^{T} Ep_t \tag{13}$$

where the initial appreciation takes place at $t = 0$ as in equation (11). Yet investors take their decisions based on the discounted sums: under a cash-flow tax, taxation is deferred until there is a realization event whereas the ideal income tax adds accruals to the tax base. As the cash-flow tax spares the worker the taxes due on the appreciations of his human capital, he is better off: the initial appreciations are discounted less than

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consequence for equation (11) would be that the first part of the formula would have to be dropped. The net present value before and after taxes would coincide and equation (12) would yield a constant value of zero. The unambiguous result of a privilege for human capital under the current income tax would no longer hold. Instead, low tax and interest rates would then produce a substantial disadvantage in terms of taxation for human capital.

[22] When discussing interest rates in this model setup, it is worth mentioning that inflation is not part of the discussion and that *nominal* and *real* interest rates consequently coincide. A value of 5% is thus quite high. On the other hand, a constant interest rate implies a flat yield curve: with the time horizon stretching out over 75 years into the future, that is a bold assertion that is not backed up by any real capital market experience. Thus, overall, 5% seems to be a sensible choice to balance both factors.

[23] Cf. subsection 3.2.1 on page 8.

[24] The interplay between these effects and the progressivity of the income tax are discussed comprehensively in *Weiss* (2007, p.69 and fig. 3.14).

[25] Equation (13) is proved in the appendix in section B.

the later depreciations. The *failure* to tax the former is more precious to the worker than the *denial* of deductions for the latter.

This argument – and the distortions between differently educated workers caused by it – can be made yet more transparent by highlighting the development of the economic value of future wages implied by the results in table 4 for the combinations B and E. **Figure 2** traces the development of this value along the lines of increasing labor market experience[26].

Figure 2

Development of the economic value of future wages for combinations B and E in table 3 on page 7, i = 7%, without pensions
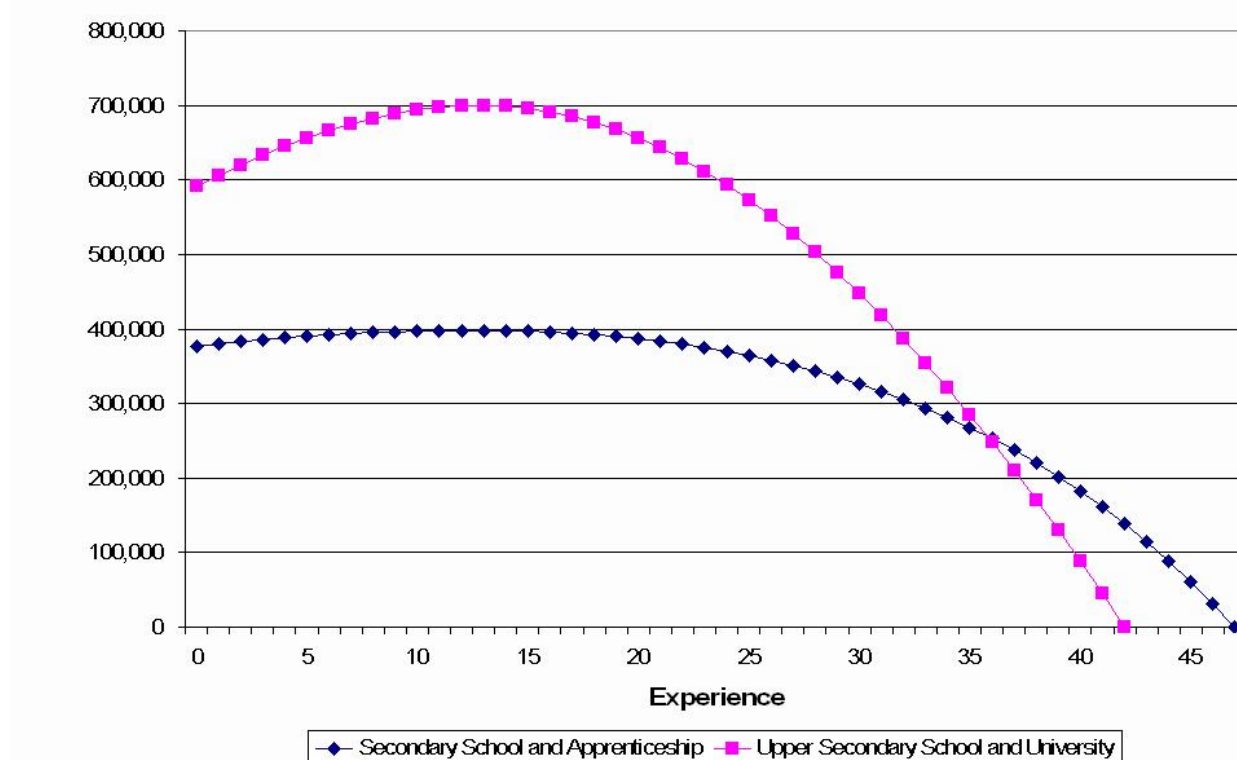
It is easily inferred that the appreciations are far more pronounced in the case of the university degree holder and that he stands to gain more from the failure of current tax law to tax them. For the combination B type of worker, the almost complete absence of appreciation charges implies that he cannot profit from this deficiency.

4.2 Remedies for the Approximation

As the discussion in subsection 4.1 has shown, the taxation of physical and financial capital on the one hand and human capital on the other hand is far from uniform. This fact has managed to go unnoticed in the discussion of tax reforms in Germany and elsewhere. In those countries that did introduce a Dual Income Tax, it rarely featured among the most salient arguments.

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[26] This implies that the individuals in figure 2 have different ages at any one point along the x-axis as the labor market participation only sets in at the age of 23 for the group E students.

The list of possible remedies includes, but is not restricted to, the Dual Income Tax.

- Among the more radical proposals, the replacement of the current income tax with a cash-flow tax would solve the problem once and for all[27]. Its introduction would, at the same time, be tantamount to an acknowledgement that – as mentioned in section 2 – the overwhelming majority of the German tax revenue derives from wage – i.e. cash-flow – taxation anyway. Under a cash-flow tax, the neutrality with regard to consumption and investment choices would be guaranteed. The ETR would always be equal to the nominal tax rate τ, regardless of the distribution of cash-flows over time.

- Accrual treatment of human capital would be the correct way to treat human capital payoffs under an income tax. It would involve the estimation of future cash-flows and thus introduce a fair amount of uncertainty into taxation[28].

- Quite another idea involves the application of multipliers to the tax base in order to level the playing field between physical and human capital[29]. This proposal must be viewed as a compromise that manages to salvage the traditional taxation of interest while still balancing out the different tax burdens weighing on human and physical capital. It can take either of two forms:

  - The multipliers can be determined as *age-dependent*. The tax base or tax rate would therefore have to exceed the current one for young workers and fall below the current one for older workers, i.e. the multiplier would have to be set above one initially and then slide below one during the lifetime of the worker[30]. **Figure 3** on the following page drives home this point for a university graduate. It plots the development of the economic profit and cash-flows, as connected in equation (1). The connection is established through the economic depreciations which are also plotted. To align cash-flows and economic profits, a fourth plot gives the necessary multipliers. While in section A of figure 3 the multipliers are set above one, they drop almost to zero during the approach to retirement. These multipliers are specific to a particular lifetime profile of wages.

  - Alternatively, tax law can set a *constant* tax rate for human capital payoffs that sees to it that in present value terms, human capital pays the taxes that would be due under an *ideal income tax while maintaining its cash-flow tax base*. This idea will now be pursued further.

4.3 Multipliers for the Cash-Flow Tax Base

As tax law currently leaves human capital at a substantial advantage, constant multipliers would have to be set above one. The goal of the alignment should be to lift the ETR to the level of the assumed neutral taxation, i.e. the nominal tax rate τ.

[27] Equivalently, the allowance for corporate equity could be used, as mentioned in subsection 2.1.

[28] Lurking in the background is the problem that even if cash-flows were known with certainty, it would not be necessary to go to great lengths to tax accruals as cash-flows could be taxed directly.

[29] Cf. *Kaplow* (1994, fn. 76) and *Wagner* (2000) for the earliest attempts at this solution.

[30] While approaching retirement, economic depreciation charges set in that drag the tax base lower than under the current income tax.

Figure 3

Development of cash-flows, economic profits, economic depreciations (left axis) and age-dependent multipliers (right axis) for a upper secondary school degree holder with subsequent university studies, i=5%
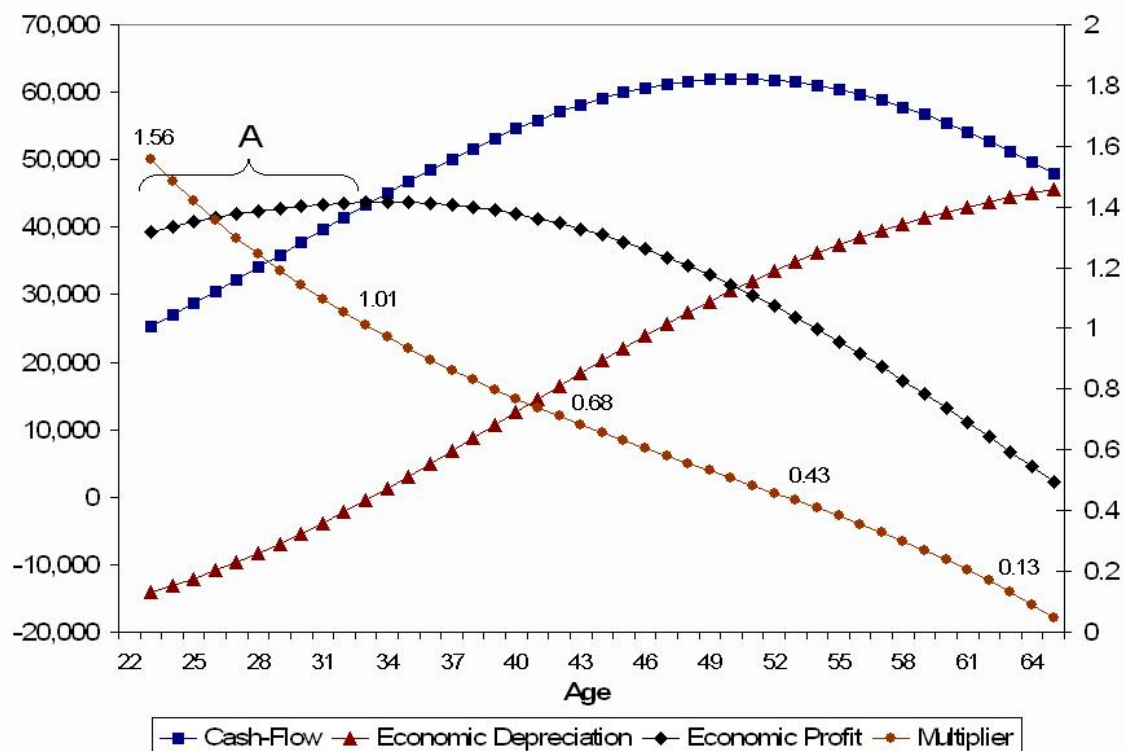
While this may be a rather technical description, the reasoning behind the correction is quite important for the economic well-being of societies: an uneven taxation leads to misallocations in the economy whose costs are largely hidden and hard to measure (*Wagner*, 2000, p. 432). Income generation from human capital is extended too far in comparison to income generation from financial capital. In other words: The smartest way for young people to save – from the point of view of taxation – would be to invest in their human capital instead of putting the money in the bank.

This is not to say that human capital creation is not welcome in this globalized world. It has been known to have desirable externalities on economic growth and development for a long time (*Nielsen and Sørensen*, 1997; *Keuschnigg and Dietz*, 2007). The trouble is that *taxation distorts the decision* to engage in human capital creation. And it does not distort in an equivalent manner across the board: Some groups profit more from the unevenness of the taxation than others. If government comes to the conclusion that agents do not engage in enough human capital accumulation and it wants to promote the creation, it can give direct subsidies, such as student loans with favorable interest rates or grants, or provide more teachers to schools. But under the current dualism of cash-flow based taxation on the one hand and accrual based taxation on the other hand, government can never be sure whether it is deploying the best measures for its worthy aims as the playing field is skewed in the first place.

To derive the actual multiplier m, the formerly constant nominal tax rate τ is now

divided into a rate levied on capital income τ_c and a rate on labor income τ_l.

$$\tau_l = m\tau_c \tag{14}$$

To this end, the separation of the pension payments into deferred labor income and capital income becomes important. The return implicit in the pensions is determined as the internal rate of return of the pension contributions and benefits. The pension payments are treated as an annuity, where the typical pattern is that of interest payments falling and of capital paybacks rising.

Upon retirement, the future beneficiary has accumulated a *notional* capital stock which is equal to the future value of the pension contributions $contb_t$ at t=65, compounded annually at the IRR.

$$FV_{t=65} = \sum_{t=1}^{65} contb_t \left(1 + IRR\right)^{65-t} \tag{15}$$

From the future value in equation (15), the annuity is paid. The interest part (IN_t) of the annuity is subject to the tax rate τ_c, while the rest of the pension (RE_t) is treated as labor income and subject to τ_l, as is the gross income minus pension contributions (CF_t) during the labor market participation of the worker. The interest part of the annuity is fixed at 27%, using the legal provision in the German Income Tax Code in force until 2004 which fixed the interest part of the pension benefit at that level.

The net present value under the Dual Income Tax is determined as

$$NPV_\tau^{DIT} = \sum_{t=1}^{65} \frac{CF_t\left(1-\tau_l\right)}{\left(1+i\left(1-\tau_c\right)\right)^t} + \sum_{t=66}^{76} \frac{IN_t\left(1-\tau_c\right) + RE_t\left(1-\tau_l\right)}{\left(1+i\left(1-\tau_c\right)\right)^t} \tag{16}$$

Entering equation (16) and equation (14) into equation (6) and setting the ETR equal to the desired level τ_c gives

$$ETR^{DIT} = \frac{NPV - NPV_\tau^{DIT}}{NPV} =$$
$$1 - \frac{\sum_{t=1}^{65} \frac{CF_t(1-m\tau_c)}{(1+i(1-\tau_c))^t} + \sum_{t=66}^{76} \frac{IN_t(1-\tau_c)+RE_t(1-m\tau_c)}{(1+i(1-\tau_c))^t}}{\sum_{t=1}^{65} \frac{CF_t}{(1+i)^t} + \sum_{t=66}^{76} \frac{IN_t+RE_t}{(1+i)^t}} \overset{!}{=} \tau_c \tag{17}$$

The final goal is to determine m from equation (17). This job is carried out using an iteration algorithm that raises τ_l, starting from τ_c, until the ETR^{DIT} hits τ_c. **Table 7** on the following page reports results for the multiplier m, according to the prevailing interest rate. **Figure 4** on page 19 highlights the relationship graphically.

The same experiment is conducted for the holders of upper secondary school degrees with subsequent university studies (combination E in table 3). The results in **table 8** on the following page and **figure 5** on page 20 show that the multipliers for this highly educated group are higher across the board.

Overall, the computations result in *substantial surcharges* to the capital income tax rate τ_c. The Dual Income Tax brings with it distributional problems if the labor tax rate is set uniformly across all taxpayers: setting too high a rate causes the *lower income brackets* to pay over the odds, while setting too low a rate unduly benefits the *upper end of the labor income scale*. The central distributional issue for the Dual Income Tax thus pits those rich in *human capital* against those poor in it, or, to put it differently, those with high growth rates in labor income against those with low growth rates.

Table 7

Multipliers m and tax rates on labor income τ_l under a Dual Income Tax for a male secondary school degree holder (combination B in table 3), for variable interest rate i and capital income tax rates $\tau_c = 18\%, 27\%$

i	0%	2%	4%	6%
m	1.00	1.64	2.07	2.37
τ_l	18.00%	29.50%	37.21%	42.59%
m	1.00	1.55	1.90	2.14
τ_l	27.00%	41.91%	51.37%	57.67%

On the other hand, the fact that the rate on labor income is set above that on capital income reflects the insight gained in this article that the differences in the determination of the tax bases between labor income and capital income warrant this step. In any event, the sensitivity of the rate τ_l to the interest rate remains high. A sensible choice in this area is pivotal for the distributional "equity" of the Dual Income Tax.

Table 8

Multipliers m and tax rates on labor income τ_l under a Dual Income Tax for a male upper secondary school degree holder (combination E in table 3), for variable interest rate i and capital income tax rates $\tau_c = 18\%, 27\%$

i	0%	2%	4%	6%
m	1.00	1.69	2.18	2.54
τ_l	18.00%	30.47%	39.32%	45.80%
m	1.00	1.60	1.99	2.26
τ_l	27.00%	43.09%	53.77%	61.15%

Figure 4

Tax rates on labor income under a Dual Income Tax for a male secondary school degree holder (combination B in table 3), for capital income tax rates $\tau_c = 18\%, 27\%$
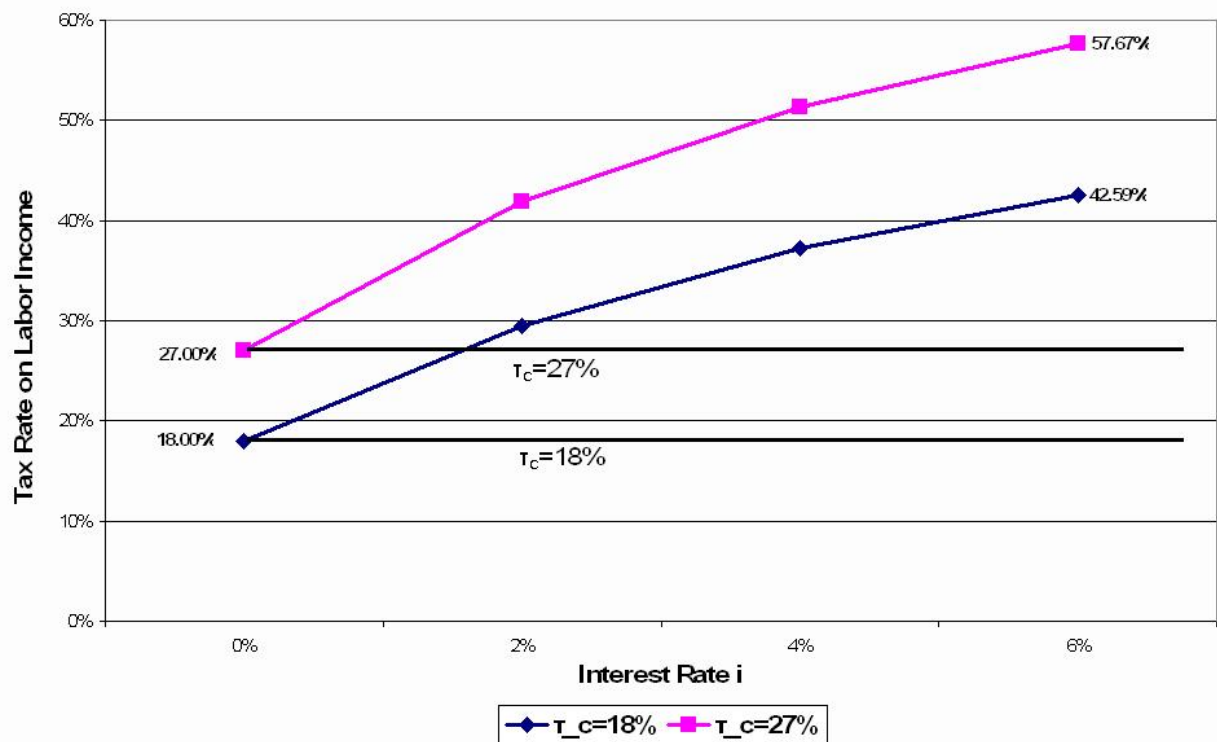
Figure 5

Tax rates on labor income under a Dual Income Tax for a male upper secondary school degree holder with subsequent university studies (combination E in table 3), for capital income tax rates $\tau_c = 18\%, 27\%$
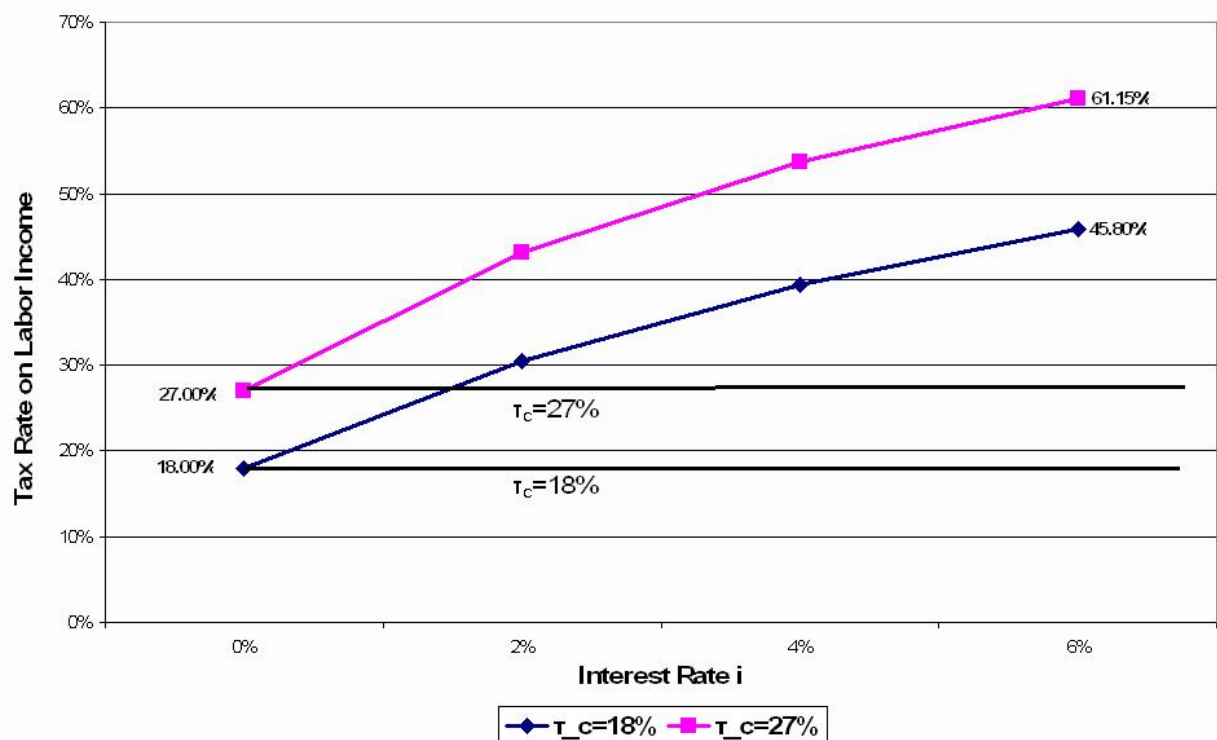
5 Conclusion

This article has sought to answer the question how well the taxation of labor income currently in force approximates the theoretical tax treatment due under an ideal income tax. This question prompted a more fundamental review of the whole notion of income taxation and whether, at least under the condition of perfect foresight and a perfect and complete capital market, it can be salvaged. As it turns out, the contribution by *Wenger* (1999) has shattered the *cozy world of income tax fans* to its core. As the *calibration mark* of the concept of economic profits, necessary to spot discriminatory or privileged treatment under tax law, itself is shaky, analysis based on it carries a whiff of shakiness.

The use of a very recent dataset rendered possible a realistic estimation of incomes over the lifetime of differently educated groups. The analysis in subsection 3.2 showed that ETRs for the German population are uneven and lowest among the most highly educated groups. Most importantly, under the assumptions made, they rarely come close to the *assumed* neutral yardstick of the *economic concept of profit*. In most cases, the ETR declines monotonically for increasing interest and tax rates. This effect can be traced back to the fact that the tax base under the current comprehensive income tax is the sum of a hash of different definitions of "income", as shown in subsection 2.1. Compared to a consistent treatment, labor gets a favorable deal.

The results give *tentative* support for the Dual Income Tax. The dualism of accrual and non-accrual based tax bases under the current income tax is untenable. Raising the tax rate on wages can be a remedy for the resulting distortion between investments in financial and human capital. This insight has not taken hold as much as one might hope for. The dualism of the tax bases under the *current* tax law is regularly ignored.

Any choice for the spread between the capital and labor income tax rate has serious distributional implications and thus contains the potential for conflicts between differently educated groups of workers. Quite another, more enticing option would be to replace income taxes with taxes on consumption. Such a move would render the topic of this article moot as the distribution of the wages over the lifetime would not impact the effective tax rate anymore. Recent German discussions make it unlikely that a fundamental overhaul of the German tax system could end up in a switch to a consumption tax. The abolition of interest taxation that is the hallmark of such a system is not easily conveyed in the political process and invites myopic opponents to stab the proposal in the back. Yet enforcement of taxation of capital income has been weak under the current comprehensive income tax. A more consistent taxation at a lower rate might be both politically feasible and more lucrative than the current mess. The Dual Income Tax represents a welcome compromise between income and consumption based tax systems.

Important caveats for the Dual Income Tax remain:

- The relative size of the capital and labor tax rate is crucially dependent on assumptions about the long-term real interest rate.

- Other economic effects can play a role and make the case for the Dual Income Tax more or less convincing (*Sørensen*, 1993). A rationale based entirely on time and tax rate effects might fall short of the requirements of a comprehensive overhaul of the tax system. The presence of important distortions in the labor market has the potential to destroy many of the gains from the Dual Income Tax.

- The interlinkage between taxation on the corporate and personal level constitutes the "Achilles heel of the Dual Income Tax" (*Sørensen*, 1994, p. 73). Particularly the

taxation of small businesses, where profits must be split between capital and labor income, is a source of endless conflicts in the Nordic countries (*Alstadsæter*, 2003; *Hagen and Sørensen*, 1998; *Mutén*, 1996).

On the German political front, the issue confronted in this article is currently a hot potato. The introduction of a final withholding tax[31] that is planned for the year 2009 would represent a first important step toward a Dual Income Tax in all but name.

Overall, the low approximation quality of the current cash-flow based taxation of labor income for the economic income tax should provide ample reason to renew the discussion on this subject. It may thus be hoped that the project "Dual Income Tax" gains traction in Germany.

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[31] Within the European Union, Germany's neighbors have been toying with some form of Dual Income Taxation for the last ten years. Final withholding taxes on interest and dividend income were introduced in Austria, Belgium and Italy. Greece and the Netherlands have also adopted special regimes applicable to capital income (*Eggert and Genser*, 2005, p. 47).

A   Derivation of Equation (11)

$$-\tau \sum_{t=1}^{n} \frac{CF_t}{\underbrace{(1+i)^t}_{q^t}} + \sum_{t=1}^{n} \frac{CF_t - \tau\,(CF_t - Edp_t)}{\underbrace{(1+i\,(1-\tau))^t}_{q_\tau^t}} \overset{!}{=} (1-\tau) \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t}$$

$$\sum_{t=1}^{n} \frac{CF_t}{q_\tau^t} - \sum_{t=1}^{n} \frac{\tau\,(CF_t - (CF_t - iEV_{t-1}))}{q_\tau^t} = \sum_{t=1}^{n} \frac{CF_t}{q^t}$$

$$\sum_{t=1}^{n} CF_t \left(q_\tau^{-t} - q^{-t}\right) = \sum_{t=1}^{n} i\tau EV_{t-1} q_\tau^{-t}$$

$$\sum_{t=1}^{n} CF_t \left(q_\tau^{-t} - q^{-t}\right) = \sum_{t=1}^{n} \sum_{j=t}^{n} i\tau CF_j q^{t-j-1} q_\tau^{-t}$$

$$\sum_{t=1}^{n} CF_t \left(q_\tau^{-t} - q^{-t}\right) = \sum_{t=1}^{n} CF_t \sum_{j=1}^{t} i\tau q_\tau^{-j} q^{j-t-1}$$

As the limits of the outer sums in the last line match, it is a sufficient condition for the whole sums to yield equal values that every single element be equal. Thus,

$$q_\tau^{-t} - q^{-t} \overset{!}{=} \sum_{j=1}^{t} i\tau q_\tau^{-j} q^{j-t-1}$$

$$q_\tau^{-t} - q^{-t} = i\tau q^{-t-1} \sum_{j=1}^{t} \left(\frac{q}{q_\tau}\right)^{j}$$

$$q_\tau^{-t} - q^{-t} = i\tau q^{-t-1} \frac{\frac{q}{q_\tau} - \left(\frac{q}{q_\tau}\right)^{t+1}}{1 - \frac{q}{q_\tau}}$$

$$q_\tau^{-t} - q^{-t} = i\tau q^{-t-1} \frac{1 - \left(\frac{q}{q_\tau}\right)^{t}}{\frac{1+i(1-\tau)-(1+i)}{q}}$$

$$q_\tau^{-t} - q^{-t} = q_\tau^{-t} - q^{-t} \quad (q.e.d)$$

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B   Derivation of Equation (13)

$$\sum_{t=0}^{T} CF_t = \sum_{t=0}^{T} Ep_t$$

$$\Leftrightarrow \sum_{t=0}^{T} CF_t = \sum_{t=0}^{T} (CF_t - Edp_t)$$

$$\Leftrightarrow \sum_{t=0}^{T} Edp_t = 0$$

$$\Leftrightarrow \underbrace{- \sum_{t=1}^{T} \frac{CF_t}{(1+i)^t}}_{Appreciation\ t=0} + \sum_{t=1}^{T} EV_{t-1} - EV_t = 0$$

$$\Leftrightarrow - \sum_{t=1}^{T} \frac{CF_t}{(1+i)^t} + \sum_{t=0}^{T-1} EV_t - \sum_{t=1}^{T} EV_t = 0$$

$$\Leftrightarrow \underbrace{- \sum_{t=1}^{T} \frac{CF_t}{(1+i)^t}}_{-EV_0} + EV_0 - \underbrace{EV_T}_{=0} = 0$$

$$\Leftrightarrow 0 = 0 \quad (q.e.d)$$

References

ALSTADSÆTER, A. (2003): The Dual Income Tax and Firms' Income Shifting Through the Choice of Organizational Form and Real Capital Investments. CESifo Working Paper 1018

AUERBACH, A. J. AND JORGENSON, D. W. (1980): Inflation-Proof Depreciation of Assets. *Harvard Business Review*, vol. 58, pp. 113–118

BELLMANN, L. AND GERLACH, K. (1984): Einkommensfunktionen für Männer und Frauen mit individuellen und strukturellen Bestimmungsfaktoren. In: BELLMANN, L., GERLACH, K. AND HÜBLER, O. (Eds.), *Lohnstruktur in der Bundesrepublik Deutschland. Zur Theorie und Empirie der Arbeitseinkommen*, pp. 190–295. Campus, Frankfurt, New York

BELZIL, C. AND HANSEN, J. (2002): Unobserved Ability and the Return to Schooling. Discussion Paper 508, IZA

BOADWAY, R. AND BRUCE, N. (1982): A General Proposition on the Design of a Neutral Business Tax. Discussion paper, Department of Economics, Queen's University

BOADWAY, R. AND BRUCE, N. (1984): A Proposition on the Design of a Neutral Business Tax. *Journal of Public Economics*, vol. 24, pp. 231–239

BRADFORD, D. F. AND FULLERTON, D. (1981): Pitfalls in the Construction and Use of Effective Tax Rates. In: HULTEN, C. R. (Ed.), *Depreciation, Inflation and the Taxation of Income from Capital*, pp. 251–278. Washington

BROWN, E. (1948): Business-Income Taxation and Investment Incentives. In: METZLER, L. AND DOMAR, E. (Eds.), *Income, Employment and Public Policy. Essays in honor of Alvin H. Hansen*, pp. 300–316. New York

CNOSSEN, S. (1999): Taxing Capital Income in the Nordic Countries: A Model for the European Union? *Finanzarchiv*, vol. 56(1), pp. 18–50

COLLINS, K. A. AND DAVIES, J. B. (2003): Measuring Effective Tax Rates on Human Capital: Methodology and an Application to Canada. CESifo Working Paper 965

DAVIES, J. AND WHALLEY, J. (1989): Taxes and Capital Formation: How Important Is Human Capital? NBER Working Paper 2899

DEVEREUX, M. P. AND GRIFFITH, R. (1999): The Taxation of Discrete Investment Choices (Revision 2). Working Paper W98/16, The Institute for Fiscal Studies

EGGERT, W. AND GENSER, B. (2005): Dual Income Taxation in EU Member Countries. In: *CESifo Dice Report 1/2005*, pp. 41–47. Ifo-Institute

FRANZ, W. (2003): *Arbeitsmarktökonomik*. Springer, Berlin, Heidelberg, 5th ed.

GREENE, W. H. (2003): *Econometric Analysis*. Prentice Hall, Upper Saddle River, NJ, 5th ed.

HAGEN, K. P. AND SØRENSEN, P. B. (1998): Taxation of Income from Small Businesses: Taxation Principles and Tax Reform in the Nordic Countries. In: SØRENSEN, P. B. (Ed.), *Recent Innovations in Nordic Tax Policy: From the Global Income Tax to the Dual Income Tax*, pp. 28–71. Macmillan, Basingstoke

HAIG, R. (1921): *The Federal Income Tax*. New York

HAISKEN-DENEW, J. P. AND FRICK, J. R. (2005): Desktop Companion to the German Socio-Economic Panel (SOEP). Tech. document, DIW Berlin, Downloadable at http://www.diw.de/deutsch/sop/service/dtc/dtc.pdf. Retrieved 5/18/2007

HARMON, C., OOSTERBEEK, H. AND WALKER, I. (2003): The Returns to Education: Microeoconomics. *Journal of Economic Surveys*, vol. 17(2), pp. 115–156

HEADY, C. (2003): The "Taxing Wages" Approach to Measuring the Tax Burden on Labour. CESifo Working Paper 967

JOHANNSON, S. (1969): Income Taxes and Investment Decisions. *Swedish Journal of Economics*, vol. 71, pp. 104–110

KAPLOW, L. (1994): Human Capital under an Ideal Income Tax. *Virginia Law Review*, vol. 80(7), pp. 1477–1514

KAPLOW, L. (1996): On the Divergence between "Ideal" and Conventional Income-Tax Treatment of Human Capital. *American Economic Review*, vol. 86(2), pp. 347–352

KEUSCHNIGG, C. AND DIETZ, M. D. (2007): A Growth Oriented Dual Income Tax. *International Tax and Public Finance*, vol. 14(2), pp. 191–221

KING, M. A. AND FULLERTON, D. (1984): *The Taxation of Income from Capital*. Chicago, London

KNIRSCH, D. (2002): Neutrality-Based Effective Tax Rates. Tübinger Diskussionsbeitrag 249, Wirtschaftswissenschaftliche Fakultät der Eberhard Karls Universität Tübingen

MINCER, J. (1974): *Schooling, Experience and Earnings*. National Bureau of Economic Research, New York

MÜLLER, H. (2004): *Das Aufkommen der Steuern vom Einkommen in Deutschland*. Deutscher Universitäts-Verlag, Wiesbaden

MUTÉN, L. (1996): Dual Income Taxation: Swedish Experience. In: MUTÉN, L., SØRENSEN, P. B., HAGEN, K. P. AND GENSER, B. (Eds.), *Towards a Dual Income Tax? Scandinavian and Austrian Experiences*, pp. 7–22. Kluwer Law International

NIELSEN, S. B. AND SØRENSEN, P. B. (1997): On the Optimality of the Nordic System of Dual Income Taxation. *Journal of Public Economics*, vol. 63(3), pp. 311–329

NIEMANN, R., BACHMANN, M. AND KNIRSCH, D. (2003): Was leisten die Effektivsteuersätze des European Tax Analyzer? *Die Betriebswirtschaft*, pp. 123–137

OWENS, J. (2006): Fundamental Tax Reform: An International Perspective. *National Tax Journal*, vol. 59, pp. 131–164

PSACHAROPOULOS, G. AND LAYARD, R. (1979): Human Capital and Earnings: British Evidence and a Critique. *The Review of Economic Studies*, vol. 46(3), pp. 485–503

RADULESCU, D. M. AND STIMMELMAYR, M. (2005): Implementing a Dual Income Tax in Germany: Effects on Investment and Welfare. ifo Institute Working Paper 20

RIMMLER, M. R. (2005): *Die steuerliche Behandlung von Humankapitalinvestitionen im Rahmen der Einkommensteuer.* Peter Lang Verlag, Frankfurt am Main

SACHVERSTÄNDIGENRAT ZUR BEGUTACHTUNG DER GESAMTWIRTSCHAFTLICHEN ENTWICKLUNG (2006): Reform der Einkommens- und Unternehmensbesteuerung durch die Duale Einkommensteuer. Downloadable at http://www.sachverstaendigenrat-wirtschaft.de/download/press/dit_gesamt.pdf. Retrieved 5/2/2007

SALANIÉ, B. (2003): *The Economics of Taxation.* MIT Press, Cambridge, Mass.

SAMUELSON, P. A. (1964): Tax Deductibility of Economic Depreciation to Ensure Invariant Valuations. *Journal of Political Economy*, vol. 72, pp. 604–606

SCHRATZENSTALLER, M. (2004): Towards Dual Income Taxes – A Country-Comparative Perspective. In: *CESifo Dice Report 3/2004*, pp. 23–30. Ifo-Institute

SCHREIBER, U. (2005): *Besteuerung der Unternehmen.* Springer Verlag, Berlin, Heidelberg

SIMONS, H. C. (1938): *Personal Income Taxation: The Definition of Income as a Problem of Fiscal Policy.* University of Chicago, Chicago

SØRENSEN, P. B. (1993): Human Capital Investment, Government, and Endogenous Growth. *Finanzarchiv*, vol. 50(1), pp. 73–93

SØRENSEN, P. B. (1994): From the Global Income Tax to the Dual Income Tax: Recent Tax Reforms in the Nordic Countries. *International Tax and Public Finance*, vol. 1, pp. 57–79

SØRENSEN, P. B. (2005): Dual Income Taxation: Why and How? *Finanzarchiv*, vol. 61(4), pp. 559–586

STATISTISCHES BUNDESAMT (2006): Perioden-Sterbetafeln für Deutschland. Tech. document, Statistisches Bundesamt, Wiesbaden

STIFTUNG MARKTWIRTSCHAFT (2006): Steuerpolitisches Programm der Kommission "Steuergesetzbuch". Downloadable at http://www.stiftung-marktwirtschaft.de/module/Steuerpolitisches_Programm30.1.06.pdf. Retrieved 1/3/2007

TREISCH, C. (2000): Entscheidungsneutralität der Besteuerung. *Steuer & Studium*, pp. 368–374

TROSTEL, P. A. (1993): The Effect of Taxation on Human Capital. *Journal of Political Economy*, vol. 101(2), pp. 327–350

VON SCHANZ, G. (1896): Der Einkommensbegriff und die Einkommensteuergesetze. *Finanzarchiv*, vol. 13, pp. 1–87

WAGNER, F. W. (2000): Korrektur des Einkünftedualismus durch Tarifdualismus – Zum Konstruktionsprinzip der Dual Income Taxation. *Steuer und Wirtschaft*, pp. 431–441

WAGNER, F. W. (2005): Besteuerung. In: BITZ, M., DOMSCH, M., EWERT, R. AND WAGNER, F. W. (Eds.), *Vahlens Kompendium der Betriebswirtschaftslehre*, Band 2, pp. 407–477. Verlag Vahlen, München, 5th ed.

WEISS, M. (2007): *Labor Taxation – A Hidden Privilege.* Shaker Verlag, Aachen

WENGER, E. (1983): Gleichmäßigkeit der Besteuerung von Arbeits- und Vermögenseinkünften. *Finanzarchiv*, vol. 41, pp. 207–252

WENGER, E. (1999): Warum die Finanzwissenschaft mit der Suche nach einem theoretischen Ideal der Einkommensteuer scheitern musste. In: SMEKAL, C., SENDLHOFER, R. AND WINNER, H. (Eds.), *Einkommen versus Konsum - Ansatzpunkte zur Steuerreformdiskussion*, pp. 37–63. Physica-Verlag, Heidelberg

WISSENSCHAFTLICHER BEIRAT BEIM BMF (2004): Flat Tax oder Duale Einkommensteuer? Gutachten für das Bundesministerium der Finanzen. Downloadable at http://www.bundesfinanzministerium.de/lang_de/DE/Service/Downloads/ Downloads_4/25706_0,templateId=raw,property=publicationFile.pdf. Retrieved 3/3/2007

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