The responsiveness of training participation to tax deductibility*

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Abstract

To stimulate investment in training by individuals, the Dutch tax system allows a deduction of direct training expenditures from taxable income. This paper investigates to what extent the resulting cost reduction encourages training investments. Two different identification strategies are used. The first strategy uses the progressive structure of the income tax scheme and compares groups with taxable income just above or just below kinks. The second strategy takes advantage of the 2001 tax reform, which implied a substantial change in marginal tax rates. These strategies exploit different sources of exogenous variation and are based on different identifying assumptions. Nevertheless, the results point in the same direction: tax incentives increase training participation.

1 Introduction

It is widely recognized that the level of human capital is an important determinant of countries' prosperity. Initial education and work-related training are the two main forms of human capital accumulation. Whereas governments intervene in initial education in many different ways, the set of available policy instruments in the market of work-related training is limited. Moreover, while many studies have addressed the (in)effectiveness of government interventions with regard to initial education, little is known about

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the effectiveness of the few instruments governments can use to influence the market for work-related training.

Investing in work-related training is primarily a matter to be decided upon by private parties (employers and employees). Yet, various theoretical and empirical studies stress that private parties may underinvest in work-related training and hence that governments might want to intervene to achieve the socially optimum investment level.

Possible instruments that governments can use to stimulate investments in work-related training include voucher schemes, individual learning accounts, certification of training (f.e. Acemoglu and Pischke, 2000), tax credits and tax allowances for firms (Leuven and Oosterbeek, 2004) and tax rebates and tax deductions for individuals.

The current paper focuses on this latter instrument that allows individuals to deduct training expenditures from their taxable income. Tax deduction of training expenditures is possible in various countries including Germany, Italy and The Netherlands (in Italy against the lowest marginal tax rate), but not in other countries such as France, Sweden, Norway and the UK (where it has recently been replaced by the now abandoned individual learning accounts). In some other countries including the United States, Canada and Australia training expenditures can be deducted as long as they are made to maintain existing skills. The differences across countries show that tax (non-)deductibility of training expenditures is a policy variable, which is used by some countries by not by others as an instrument to stimulate training participation.

This paper uses panel data to investigate to what extent tax deductibility of training expenditures affects training participation. This issue has not been addressed before and therefore fills a gap in the existing knowledge about the effectiveness of this policy instrument (cf. OECD, 2004).

Most closely related are studies by Rosen (1982) who deals with the total impact of taxation on training participation, and Dupor et al. (1996) who use results from a life-cycle human capital investment model to simulate the effect of tax deductibility of the direct costs of formal schooling (as opposed to training). A further discussion of related research follows in section 3.

We use panel data from the Dutch tax register covering the period 1996-2002. As was mentioned, in the Netherlands direct expenditures on training are tax-deductible. Furthermore, the marginal tax rates are (weakly) in-

creasing in taxable income. Consequently people who earn different taxable incomes pay different marginal tax rates and therefore incur different net costs of direct training expenditures.

A simple comparison of training participation among individuals who pay different marginal income tax rates would, however, produce a biased estimate. A first complication is that a person's marginal income tax rate is correlated with that person's income. This makes it difficult to separate the effect of marginal tax rates from the effect of income. This complication is relevant for almost every empirical study on people's responses to taxation (cf. Jappelli and Pistaferri 2003, 2004).

A second complication is that not only the costs of an investment in training are subject to taxation, but also the returns to these investments in the form of increased earnings are subject to taxation. Variations in the tax treatment of investment costs that are mirrored by variations in the tax treatment of returns to investment are will therefore give a blurred picture of the effect of tax deductibility of the costs. Notice that this complication is specific to applications dealing with tax deductibility related to costs of investment.

A final complication is that not only the direct costs of training but also its opportunity costs are tax deductible, and that the tax rate applicable to the deduction of direct training costs varies one to one with the tax rate applicable to the deduction of its opportunity costs. Hence any variation in training participation related to variation in the tax rate applicable to the deduction of direct training costs is also related to variation in the tax rate applicable to the deduction of opportunity costs of training.

In this paper we apply two distinct identification approaches. The first approach potentially addresses all three complications, whereas the second approach only addresses the first and second complications but not the third. As a result the second approach will give an overestimate of the effect of interest. We derive an expression which allows us to relate the ratio of the effects obtained from the two approaches to the ratio of direct training costs versus indirect training costs.

The first approach compares individuals around kink points of the income tax schedule due to jumps in marginal tax rates. In comparison with for instance the US income tax schedule, the Dutch income tax schedule has fairly large differences in the tax rates between adjacent tax brackets (see

below). Individuals with a taxable income just below a kink point therefore pay a substantially lower marginal tax rate than individuals with taxable income just above that kink point. Consequently, with tax deductible direct costs of training, individuals with very similar levels of income are confronted with quite different net costs of training. (This addresses the heterogeneity issue.) Moreover, the small differences in income between individuals with taxable incomes just below or above a kink, make it likely that their future incomes are also very similar and therefore subject to the same marginal tax rate. We will present evidence that this is indeed true. (This addresses the taxation of returns issue.) Finally in this local identification approach, we choose the sizes of the intervals around kinks such that on average the net opportunity costs of training for the group just above a kink is the same as that of the group just below a kink. (This addresses the taxation of opportunity costs issue.)

The second approach exploits a change in marginal tax rates due to a tax reform that took place in the Netherlands between 2000 and 2001. This tax reform changed the relevant marginal tax rate for everybody, but these changes were not the same for everyone. We use this in a difference-in-differences framework. Looking at changes in marginal tax rates for the same individuals addresses the heterogeneity issue. A complicating factor is that people who are more responsive to taxation may experience a different actual change in marginal tax rates than people who are less responsive. To tackle this, the actual change in marginal tax rates is instrumented by the predicted change in marginal tax rate predicted on the basis of pre-reform income.

If returns to human capital investments do not start to accrue within a year after the investment has been made then costs of investment made in 2000 are treated according to the old tax code, whereas costs of investment made in 2001 as well as returns to investments made in 2000 and 2001 are all treated according to the new tax code. Accordingly, there is a change in the tax treatment of investment costs between 2000 and 2001, whereas there is no such change in the treatment if returns to investment. (This addresses the taxation of returns issue.) Unfortunately, for the difference-in-differences strategy, we see no opportunity to separate the effect of the change in marginal tax rates on training participation through a change in the direct costs of training from the effect through a change in the opportu-

nity costs of training.

The results from the two approaches indicate that the level of the tax deductibility rate has a positive impact on the probability that employees spend money on training and on the amount they spend. A 10 percentage points increase in the rate against which employees can deduct their training expenditures raises the probability that employees spend money on training by about 0.3-0.8 percentage point (evaluated at a marginal tax rate of 0.4). Given that in any given year only around 4 percent of the taxpayers has deductible training expenditures, we consider this to be a substantial effect.

Section 2 presents a simple theoretical model of the relation between tax rates and training decisions. Section 3 reviews related empirical studies. No earlier study has focused on the effect of tax deductibility of goods invested in human capital on human capital accumulation. Section 4 describes the Dutch income tax system along with the reform that took place in 2001. Section 5 presents the empirical specification and provides more information about the two identification strategies we use. It discusses in detail the assumptions that have to be satisfied in order to interpret the estimates as causal effects of the tax deductibility rate. Section 6 gives a description of the data. Section 7 presents the results for the local identification approach. Section 8 presents and discusses the results obtained from the approach that exploits the tax reform. Section 9 summarizes and concludes.

2 Theoretical framework

This section introduces a simple theoretical model of the relation between tax rates and training decisions (see Jacobs (2002) for a related model). The main aim of this exposition is to clarify the impact of various relevant tax rates on training participation. To this end we introduce a two-period model in which an individual can decide to invest in training maximizing utility $U(C_1, C_2)$, where C_t is period t consumption. The amount of available time per period is normalized to 1. The individual chooses which fraction s of his time in period 1 will be spend on training. Time in period 1 can only be spend on work and training, time in period 2 is fully devoted to working (we thus abstract from labor supply decisions).

Direct training expenditures are denoted by ps. Where p is the price of a unit of training in the market. Wages in period 1 are equal to w and

period 2 wages are equal to $wf(s)$, with $f(0) = 1$, $f' > 0$ and $f'' < 0$. We distinguish between four different tax rates:

- τ_1 is the marginal tax rate for labor income below a certain exogenous income threshold (Y_0);
- τ_2 is the marginal tax rate above that threshold, with $\tau_2 > \tau_1$;
- τ_r is the rate at which capital income is taxed; and
- τ_d is the tax rate relevant for the deduction of the direct training expenditures.

Substituting the budget constraints of each period into the utility function gives:

$$U(s) = U((1-\tau_1)(1-s)w - (1-\tau_d)ps - a, \\ (1-\tau_1)Y_0 + (1-\tau_2)(wf(s) - Y_0) + Ra) \quad (1)$$

where $R \equiv 1 + (1-\tau_r)r$, the net rate of return to investment in non-human capital. This expression assumes that $wf(s) > Y_0$: income in period 2 falls in the higher tax bracket when the amount of training is positive.[1] The first order conditions for maximum $U(s)$ equal:

$$\frac{\partial U}{\partial s} = U_1 \cdot (-(1-\tau_1)w - (1-\tau_d)p) + U_2 \cdot (1-\tau_2)wf' = 0 \quad (2)$$

$$\frac{\partial U}{\partial a} = -U_1 + U_2 \cdot R = 0. \quad (3)$$

where $U_t = \partial U / \partial C_t$, and combining them gives the following

$$\frac{(1-\tau_2)wf'}{w(1-\tau_1) + (1-\tau_d)p} = R$$

and solving it for s gives a solution for the optimal level of training s^*

$$s^* = \mathcal{S}(\tau_1, \tau_2, \tau_d, p, R, w) \quad (4)$$

[1] We make this assumption to keep the exposition simple. The key issue is that τ_2 is the marginal tax rate on returns to an investment in training, while τ_1 is the marginal tax rate relevant for the opportunity costs of such an investment.

where the functional form of $\mathcal{S}(.)$ is determined by the production function of human capital, but independent of preferences. If $\tau_1 = \tau_2 = \tau_d$ then the optimal s does not depend on the rate at which wages are taxed (e.g. Boskin, 1975; Eaton and Rosen, 1981).

Applying the implicit function rule gives that:

$$\frac{\partial s^*}{\partial \tau_1} = -\frac{wR}{(1-\tau_2)wf''} > 0, \tag{5}$$

$$\frac{\partial s^*}{\partial \tau_d} = -\frac{pR}{(1-\tau_2)wf''} > 0 \tag{6}$$

$$\frac{\partial s^*}{\partial \tau_2} = \frac{f'}{(1-\tau_2)f''} < 0 \tag{7}$$

$$\frac{\partial s^*}{\partial \tau_r} = -\frac{r\left(w(1-\tau_1)+p(1-\tau_d)\right)}{(1-\tau_2)wf''} > 0 \tag{8}$$

Where the inequalities follow from the second order condition for maximum utility ($\partial^2 U/\partial s^2 < 0$). Higher tax rates for (i) the opportunity costs, (ii) the deductible direct costs and (iii) the rate at which income from non-human capital is taxed, all lower the cost of investment and therefore boost investment incentives. On the other hand, a higher tax rate on the returns reduces investment incentives.

In practice tax codes may not treat τ_1 and τ_d as different elements. If direct training costs are fully deductible against the current marginal tax rate, e.g. $\tau_1 = \tau_d$, as is the case in the Netherlands, then the relation between the optimum positive investment level s^{**} and the deductibility rate is given by the expression:

$$\frac{\partial s^{**}}{\partial \tau_d} \equiv \frac{\partial s^{**}}{\partial \tau_1} = -\frac{(w+p)R}{(1-\tau_2)wf''} > 0. \tag{9}$$

It is important to stress the difference between equations (6) and (9). Equation (6) is the effect on training of a change of the tax deductibility rate keeping other tax rates (τ_1 and τ_2) constant. Equation (9) expresses the effect on training of a change in the tax rate applicable to all (direct and indirect) investment costs. The relation between these two parameters is the following

$$\frac{\partial s^{**}}{\partial \tau_d} = \frac{w+p}{p}\frac{\partial s^*}{\partial \tau_d} \tag{10}$$

This shows that if one is interested in the effect of τ_d only (equation (6)), but estimates the joint effect of τ_d and τ_1 (equation (9)), the effect of interest will be overestimated by factor $(w + p)/p$.

3 Related literature

Empirical work on the relation between taxation and training decisions is limited. To the best of our knowledge, Rosen (1982) is the only study which directly estimates the (total) effect of taxation on on-the-job training decisions. He regresses on-the-job training on the internal rate of return to training and on the marginal tax rate. On-the-job training equals one if tenure in an employee's present position falls short of the amount of time required to become fully qualified in the job. Otherwise on-the-job training equals zero. The pre-tax internal rate of return is obtained from Mincer type wage functions which are education specific. The marginal tax rate is predicted from a regression of an employee's actual marginal tax rate on age, number of children, education, non-labor income and region and type of town dummies.

Rosen reports significantly positive effects for both the internal rate of return and the marginal tax rate on on-the-job training. The positive sign for the internal rate of return is in accordance with theoretical predictions. He interprets the positive effect of the marginal tax rate as evidence that "the effect that dominates is the one which give the individual an incentive to substitute human for physical capital as a means for carrying consumption into the future".

Some remarks with regard to this early study are appropriate. First, the measure of on-the-job training is somewhat unfamiliar by current standards. Differences in training status as measured by Rosen are likely to mainly reflect differences between more and less demanding jobs. Second, none of the instruments for the marginal rate seem to meet the exclusion restriction. These two points together suggest that the reported positive effect may easily pick up a reversed causality; individuals holding more demanding jobs pay a higher marginal tax rate (and are older, have more children, are more highly educated etc.).

More recently Gentry and Hubbard (2004) analyze the effects of marginal tax rates and of tax rate progressivity on job turnover using the PSID.

Job turnover shares with training that it is an outcome with an investment dimension. Gentry and Hubbard estimate probit equations with job turnover as the dependent variable. The two key explanatory variables are the marginal tax rate and the convexity in the tax rate. The marginal tax rate is the predicted future tax rate based on household characteristics in year t and the tax code in year $t+1$, assuming 5 percent earnings growth. This tax rate is supposed to capture the marginal incentives for effort at the current level of earnings as well as *the relevant marginal tax rate for deductible expenses associated with job search.* Convexity in the tax rate is constructed as the change in tax rates resulting from a predicted three-years increase in taxable income. This predicted increase is based on the actual distribution of 3-years period (positive) wage growth for twenty different education-age groups.[2] Gentry and Hubbard find that both tax measures have a negative effect on the probability of job turnover. It is important to note that this is not a deductibility effect of the marginal tax rate, but rather a net effect which includes the effect of the marginal tax rate on effort (comparable to the effect of τ_2) which is predicted to be of opposite sign.[3] The only thing that can be concluded from the analysis with regard to the deductibility effect is that it is dominated by the effort effect. Second, the paper accounts for endogeneity problems by including a rich set of control variables.

Loosely related are the studies which show to what extent changes in the marginal tax rate affect taxable income (see: Feldstein, 1995; Gruber and Saez, 2002; Saez, 2003). Changes in taxable income may among other things result from changes in human capital investments. While Feldstein reported very substantial effects, later studies point to more modest responses.

Some studies have investigated the effect of tax deductibility on other types of expenditures. Examples include Reece and Zieschang (1985) and Glenday et al. (1986) who look at charitable contributions, Jappelli and Pistaferri (2003) who study the effect of tax deductibility on life insurance, and Jappelli and Pistaferri (2004) where the same authors investigate the

[2]The mean value of this constructed variable equals 2.95 percentage points with a standard deviation of 3.12 and minimum and maximum values of -14.78 and 26.31. For comparison, the mean value of the marginal tax rate is 29.17 percent.

[3]An increase in the marginal tax rate reduces the net costs of tax deductible job search activities but also reduces workers' net payoffs from an earnings increase associated with job turnover.

effect of tax deductibility on home mortgage interest. A fundamental difference between these types of expenditures and training expenditures is that the last is an investment whereas the others are not. This is important because it implies that we also have to be concerned with the taxation of the returns.

Finally, Leuven and Oosterbeek (2004) report estimates of the effect of a policy in which firms (instead of individuals) could deduct training expenditures from their tax. A specific feature of this policy was an extra deduction for training expenditures spent on workers age 40 or older. The effect of this age dependent deduction was evaluated using a regression discontinuity design. The results show a huge gap in training participation of workers just above 40 relative to workers just below 40. Further analysis suggests that this difference is mainly due to the postponement of training participation of younger workers and not to the stimulating effect of the extra deduction.

4 The Dutch income tax system

This section provides a brief description of the main elements of the income tax system during the period covered by our dataset (1996-2002). The income tax system was reformed in 2001. We first describe the system as it was in operation during the period 1996-2000, and then discuss the main changes that occurred in 2001. Section 5 discusses how we exploit elements of the system and of the reform to identify the effect of the tax-deductibility of training expenditures on investments in training.

In the Netherlands income tax is only levied by the central government. The basic structure of income taxation is as follows. Starting point is total gross income. This is the sum of incomes from various sources: labor, profit, capital and home ownership. To get from gross income to taxable income, gross income is reduced by a basic allowance, the size of which depends on household characteristics, and by deductions for expenditures on specific items. Expenditures on "study for career purposes" (i.e. training expenditures) is one category of expenditures that qualifies for a tax deduction. Others categories include home mortgage interest payments, alimony payments, charitable contributions and childcare expenditures. The amount of the deduction, and thereby the net costs of training expenditures, depends on the marginal tax rate. Taxable income is subject to a progressive tax

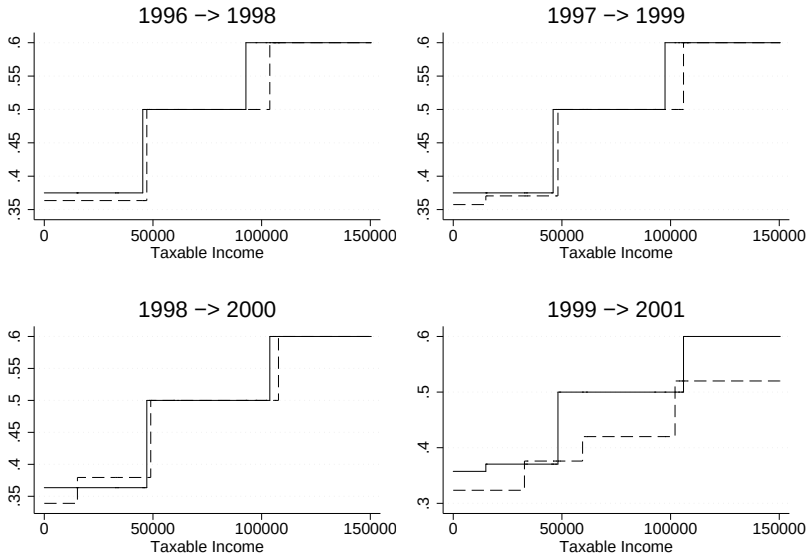

Figure 1: Marginal tax rates and kinks 1996-2002

scheme. Consequently, the net costs of a given amount of training expenditures is (weakly) lower for individuals with higher taxable income.

The main change induced by the 2001 tax reform is that different sources of income are no longer treated equally. Income generated by working and home ownership is still subject to a progressive tax scheme (with lower marginal rates). The progressive tax on capital income was changed into a flat rate tax on wealth; with the flat rate equal to 1.2% (a presumptive rate of return of 4% times a capital income tax rate of 30%).

Under the new system, training expenditures are deducted from gross income out of work and home ownership. Only if taxable income from these sources is below a certain threshold, the remaining amount can be deducted from the gross income generated by other sources.

Figure 1 shows the marginal tax rates and the kink points for the years covered by our dataset. For the pre-reform years (1996-2000) the rates pertain to taxable income from all sources. For the post-reform years (2001 and 2002) the rates pertain to taxable income out of work and home ownership. This means that the figure plots the marginal tax rates relevant for the tax deduction of training expenditures.

In 1996, 1997, and 1998 the tax schedule has three different marginal tax rates: a lowest level around 0.37, a second one equal to 0.50 and the top level of 0.60. From 1999 onwards the lower rate is replaced by two rates, which are almost identical and in the vicinity of 0.35. Besides treating different income sources differently, the 2001 tax reform lowered the two higher rates of 0.50 and 0.60 rates to 0.42 and 0.52. The location of the kinks remained at fairly similar income levels. In Figure 1, taxable income is measured in nominal terms; when measured in real terms the year-to-year differences in the location of kink points almost vanish.

The focus of this paper is on the effect of the tax deduction of training expenditures on investments in training. For the identification we exploit the fact that due to differences in marginal tax rates different people face different net costs for the same gross investment in training. We assume other tax deductions (including the basic allowance) not to be affected by the training expenditures. The relevant marginal tax rate is therefore the rate applicable to taxable income before the deduction of training expenditures but after the deduction of all other expenditures and the basic allowance.

Whereas income taxation in the Netherlands is individualized, some deductions can be shifted from one partner in the household to the other. This is also true for the tax deduction on study for career purposes. Consequently, if someone deducts training expenses it is not certain that this person and not this person's partner undertook some training. Households that minimize their tax burden will shift the training expenses to the partner with the highest marginal tax rate. For this reason, we exclude observations from people who live in a household with someone with a higher marginal tax rate.[4]

5 Empirical implementation

5.1 Specification

The analysis aims to estimate the extent to which the rate at which individuals can deduct training expenditures affects the decision to invest in human

[4]In the sample of individuals who have no partner with a higher marginal tax rate on average 3.2% has a positive training tax deduction during a year (see also Section 6). In the excluded group of individuals living with a partner with a higher marginal tax rate this percentage is 0.6%, whereas it would have been zero if households minimize their tax burden.

capital. Following equation (4) we estimate probit models that are specified as follows:

$$s_{it} = \delta \ln(1 - \tau_{it}) + \alpha_1 E_t \ln(1 - \tau_{i,t+1}) + \alpha_2 \ln R_{it} + \lambda_i + \alpha_t + e_{it} \qquad (11)$$

where $\ln(1 - \tau_{it})$ corresponds to $\tau_1 = \tau_d$, and $E_t \ln(1 - \tau_{i,t+1})$ to τ_2 in the model of section 2. λ_i, α_t and $e_{it}$are unobserved components that vary across individuals, time, and individuals and time. In the analysis s_{it} equals 1 if individual i deducted a positive amount for training expenditures from his income taxes, s_{it} equals 0 otherwise. We are interested in estimating (11) and recover unbiased estimates of δ. The main challenge for the identification of these tax deductibility effects on on training decisions is to find a source of variation in $\ln(1 - \tau_{it})$ (the marginal tax rate that affects the tax deductibility of training expenditures) that does not at the same time correlate with the other left hand side terms in equation (11). For the interpretation of our parameters as tax deductibility effects it is important to control for these left hand terms.

5.2 Identification

The first strategy is based on a comparison of individuals with taxable income (before the deduction of training expenditures) either just below or just above a kink point in the tax schedule. Subsection 5.2.1 elaborates on this approach. The second method exploits the changes induced by the 2001 tax reform. Subsection 5.2.2 discusses the details of this method.

5.2.1 Local identification approach Our first approach compares individuals with taxable income levels just above and just below kink points in the income tax schedule which are due to jumps in marginal tax rates. This corresponds to a so-called sharp regression discontinuity design (cf. Angrist and Lavy 1999; Hahn et al. 2001; Leuven and Oosterbeek 2004). Around a kink point between two tax brackets, individuals with very similar incomes face different marginal tax rates. For example, an individual who has taxable income equal to 45,000 guilders in 1996 has a marginal tax rate of 0.375, whereas someone with taxable income equal to 47,000 guilders has a marginal tax rate of 0.50 (cf. 1). Consequently, if both persons make a (gross) training investment worth 1000 guilders, the first person pays a

(net) price of 625 guilders and the second person pays a (net) price of 500 guilders. Hence, this discontinuity in the tax scheme causes a difference in the net costs of training of 25 percent between two persons whose taxable income only differ 4 percent.

Comparing training expenditures between individuals with taxable incomes just above and just below the kinks in the tax schedule, may thus inform us about the effect of the tax-deductibility of training expenditures on investments in training. This requires, however, that three assumptions are fulfilled.

To discuss these assumptions, we define the following indicator variable:

$$d_{it}^{k}(\mu) = \begin{cases} 1 & y_{it} \in [y^{kt},\, (1+\mu)y^{kt}) \\ 0 & y_{it} \in ((1-\mu)y^{kt},\, y^{kt}) \end{cases}$$

so that $d_{it}^{k}(\mu)$ equals 1 if individual i is at most μ percent above tax kink k in year t, and 0 if the individuals is at most μ percent below the kink.

The first assumption for the local identification approach to give an unbiased estimate of the effect of tax deductibility on training participation, is that the difference in tax-deductibility is not mirrored by an off-setting difference in the taxation of the returns to training:

$$E_t[\ln(1-\tau_{i,t+1})|d_{it}^{k}(\mu)=0] = E_t[\ln(1-\tau_{i,t+1})|d_{it}^{k}(\mu)=1]$$

In terms of the previous example: Suppose that the returns to training for the person who pays the higher price of 625 guilders are completely taxed at a rate of 0.375, and that the returns to training for the person paying the lower price of 500 guilders are completely taxed at a rate of 0.50. In that case the difference in training expenditures between people with taxable incomes around the kink points will not identify the separate effect of the tax-deductibility but the joint effect of the tax-deductibility and the different taxation of the returns.

Given, however, that the persons with taxable incomes below the kink points have their incomes close to the persons with taxable income just above the kink points, it is very likely that these groups are confronted with the same marginal tax rates in future years. In Subsection 7 we provide evidence that this assumption is fulfilled. For example, whereas the difference in marginal tax rates between the groups that are just below and just above

a kink point in 1996 equals on average 0.11, the difference in marginal tax rates between these same groups is only 0.06 in 1997 and equals less than 0.01 from the year 2001 onwards. The same reasoning applies to the net-rate of return to capital income:

$$E_t[\ln R_{it}|d_{it}^k(\mu)=0] = E_t[\ln R_{it}|d_{it}^k(\mu)=1]$$

We also need to assume that the groups around the kinks are not systematically different in (observed and unobserved) characteristics.

$$E_t[\lambda_i|d_{it}^k(\mu)=0] = E_t[\lambda_i|d_{it}^k(\mu)=1]$$

This is the usual identifying assumption in a regression discontinuity framework. To illustrate, consider for instance the kink in the 1996 tax schedule at a taxable income of 45,325 guilders. There is no reason to assume that individuals with taxable incomes in the range of $(1-\mu)$45,325-45,325 guilders are systematically different from people with taxable incomes in the range of 45,325-$(1+\mu)$45,325 guilders when μ is small. The only potential threat here is that taxable incomes are manipulated with the purpose of having a higher tax deduction of the training expenditures. One way to examine whether such behavior occurs is by investigating whether taxable incomes bunch around kink points. In section 7 we report evidence that suggests the absence of bunching around kink points.

A final assumption, often implicitly made in tax studies, is that individuals know their relevant marginal tax rate when they make training investments. We share this assumption with all other empirical (and theoretical) tax studies. We realize, however, that especially for individuals with taxable incomes close to a kink point this assumption may be a strong one. This implies that the estimate obtained from the local identification approach possibly underestimates the true effect because individuals that are unaware of their treatment status cannot act upon it, and therefore could represent a lower bound on the true effect.

To actually conduct the regression discontinuity analysis, we need to operationalize the meaning of the phrases "just above" and "just below". Although there is a trade-off between on the one hand achieving that people are more similar and on the other hand obtaining a sufficient number of observations, we have an additional consideration to make because we would

like to estimate the effect of τ_d keeping τ_1 constant (i.e. equation (6)). In this case we need to compensate for the fact that the net opportunity cost $(1-t)ws$ are higher below the kink than above the kink. We try to achieve this by choosing μ such that:

$$\int_{(1-\mu)Y_0}^{Y_0}(1-\tau_{1B})ydF(y) = \int_{Y_0}^{(1+\mu)Y_0}(1-\tau_{1A})ydF(y)$$

Where τ_{1B} and τ_{1A} are the tax rates relevant for the deductibility of the opportunity costs (and the direct training expenditures) just below and above a kink. Assuming that income is approximately uniformly distributed around the kink this implies that

$$\mu = \frac{(1-\tau_{1B})-(1-\tau_{1A})}{[(1-\tau_{1B})+(1-\tau_{1A})]/2}$$

the bandwidth around the kink equals the difference in net-of-tax rates below and above the kink divided by the average net-of-tax rate. By doing this separately for all 18 quasi-experiments we guarantee that the average income difference between these groups offsets the (net) difference in opportunity cost.

5.2.2 Using the 2001 tax reform In our second identification strategy we exploit a tax reform that was enacted in 2001. The 2001 tax reform changed the marginal tax rate relevant for the deduction of training expenditures. The change in the net costs of training caused by the tax reform is not the same for all individuals. People with a large share of income from capital and profits are likely to be confronted with a larger reduction than people without such income sources. Also, as Figure1 reveals, the change in marginal tax rates depends on pre-reform taxable income.

Since this approach exploits changes in marginal tax rates due to the tax reform to identify the effect of tax-deductibility of training expenditures on investments in training, we difference (11) where t is the post reform year (2001) and $t-1$ the pre-reform year (2000):

$$\Delta s_{it} = \delta\Delta\ln(1-\tau_{it}) + \alpha_1\Delta E_t\ln(1-\tau_{i,t+1}) + \alpha_2\Delta\ln R_{it} + \Delta\alpha_t + \Delta e_{it}$$

we can simplify this equation since interest income is subject to a flat

rate after the reform. This implies that

$$\Delta \ln R_{it} = -\ln R_{i,t-1} = -\ln(1 + (1 - \tau_{i,t-1})r_t) \approx -(1 - \tau_{i,t-1})r_t$$

since R_{it} will be absorbed by the time effects $\alpha'_t = \Delta\alpha_t$.

Since returns to training undertaken just before the tax reform will be subject to the same tax schedule as returns from training undertaken after the reform, we assume that $E_t \ln(1 - \tau_{i,t+1}) = E_{t-1} \ln(1 - \tau_{i,t})$ so that $\Delta E_t[\ln(1 - \tau_{i,t+1})] = 0$. We will therefore estimate the following equation.

$$\Delta s_{it} = \delta \Delta \ln(1 - \tau_{it}) + \alpha_{2t}\tau_{i,t-1} + \alpha'_t + \Delta e_{it} \tag{12}$$

If people respond to tax incentives, it is likely that their post-reform income is partially determined by such responses. This induces a potential endogeneity problem: the change in marginal tax rates may correlate with people's responsiveness to taxation which in turn may correlate with their training decision. To address this problem, we present results in which the actual change in marginal tax rates is instrumented by the predicted change in marginal tax rate given pre-reform income: $\Delta \ln(1 - \tilde{\tau}_{it})$. The predicted tax rate $\tilde{\tau}_{it}$ is calculated based on the pre-reform income $y_{i,t-1}$ and the post-reform tax schedule.[5] The identifying assumption is thus that $E[\Delta e_{it} \Delta \ln(1 - \tilde{\tau}_{it})] = 0$; the predicted change in marginal tax rate is exogenous conditional on the pre-reform tax rate, the pre-reform training decision and the other included observables.

It is important to stress that δdoes not estimate the impact of a change of the deductibility rate of direct training expenditures on training participation (τ_d), but rather the impact of a change of the tax rate applicable to both direct training expenditures and opportunity costs of training (τ_d and τ_1). Where we can disentangle the two components in the local identification approach by our choice of bandwidth around kinks, there is no equivalent solution available for the reform approach. The consequence of

[5] A practical problem for the instrumentation is that we do not have information on all separate income sources in the pre-reform years. More specifically, we know individuals' pre-reform income out of work but do not know their pre-reform income out of home ownership (the other income source determining the taxable income from which training expenditures can be deducted). However, for the post-reform years the correlation between the actual marginal tax rate and the marginal tax rate predicted on the basis of income from work equals 0.87. The omission of data on income out of home ownership therefore does not appear to be a serious problem.

this is that estimates based on the reform approach will overestimate the effect of interest. According to the theoretical model in section 2, the effect of interest is overestimated by factor $(w + p)/p$.

6 Data

The data used in this paper come from the Dutch tax office.[6] They are the tax files of a 1.5 percent representative sample of the Dutch population for the period 1996-2002. The data are longitudinal and track individuals (and their households) from year to year.

Our two identification methods exploit variation in marginal tax rates. Because marginal tax rates are related to income and we do not want our analyses to pick up variation in income, we will condition in some of the specifications for level of income. In order not to demand too much from this control, we exclude beforehand from our analyses observations with exceptionally low (below 5000 guilders) or high (above 150,000) incomes.

The dataset is rich on tax information. For the Netherlands it is the only source with reliable information at an individual level of taxable income and various tax deductions including the amount of any deduction related to training expenditures. Because a vast majority (over 95%) of the observations those not deduct training expenditures we capture this information into a binary variable taking the value one if training expenditures have been deducted and zero otherwise. With the small number of observations with positive deductions it is not feasible to conduct a separate analysis to examine the effect of taxation on the amount of the deduction.

The dataset is very limited in terms of relevant background information. It does contain information about gender, age, marital status, size of the household and economic activity, but has no information on for instance level of formal education, occupation or firm characteristics. For confidentially reasons it is also not permitted (or possible for researchers) to merge the data from the tax register to other data sources. Moreover, the data provide no details about the training or courses related to the tax deduction.

An audit by the Dutch tax office of 2,625 individuals who deducted training expenditures provides some limited information about the kind of

[6]The dataset is not publicly available. Permission for use of the data was granted to us in relation to a research project commissioned by the Dutch ministry of Financial Affairs.

Table 1: Sample summary statistics by year

	N	marginal rate	fraction with positive deduction	deduction if >0	Age	Female
1996	39,177	0.425	0.031	2298	41.3	0.29
1997	41,364	0.423	0.031	2450	41.3	0.31
1998	42,309	0.405	0.030	2528	41.4	0.32
1999	43, 064	0.410	0.030	2499	41.5	0.33
2000	43,676	0.413	0.029	2595	41.8	0.35
2001	46,597	0.390	0.025	2567	42.1	0.40
2002	38,819	0.390	0.020	2206	42.2	0.41

training expenditures that were deducted. Almost two thirds fall in the category of tuition fees, another 22 percent is spent on materials (books, computer software). The remaining part relates to travelling costs and conference accommodation.

Table 1 gives the mean values for the main variables by year for the sample remaining after applying the rules explained above. In all years the average marginal tax rate is around 0.40. Interestingly, the tax reform of 2001 which lowered the top rates by 0.08, reduced the average marginal tax rate by 0.02. The fraction of people with a positive tax deduction for training expenditures is around 0.03 during the period 1996-2000, and decreased after the tax reform to 0.02 in 2002. The differences in training rates between the pre-reform and post-reform periods are significant at the 1%-level. The absolute amount of the training tax deduction is also fairly constant over the entire period and does not after the reform. With regard to age and gender, we observe that the average age increases over the sample period, the same is true for the fraction of women.

After the reform, the average marginal tax rate decreases and the share of individuals with a positive deduction for training expenditures decreases, suggesting that a lower marginal tax rate reduces training expenditures. This alludes already to the analysis which exploits the change in tax rates due to the reform. But whereas the patterns in table 1 may also be attributed to other factors that changed between 2000 and 2001, the analysis in section 8 compares training expenditures across individuals who were confronted

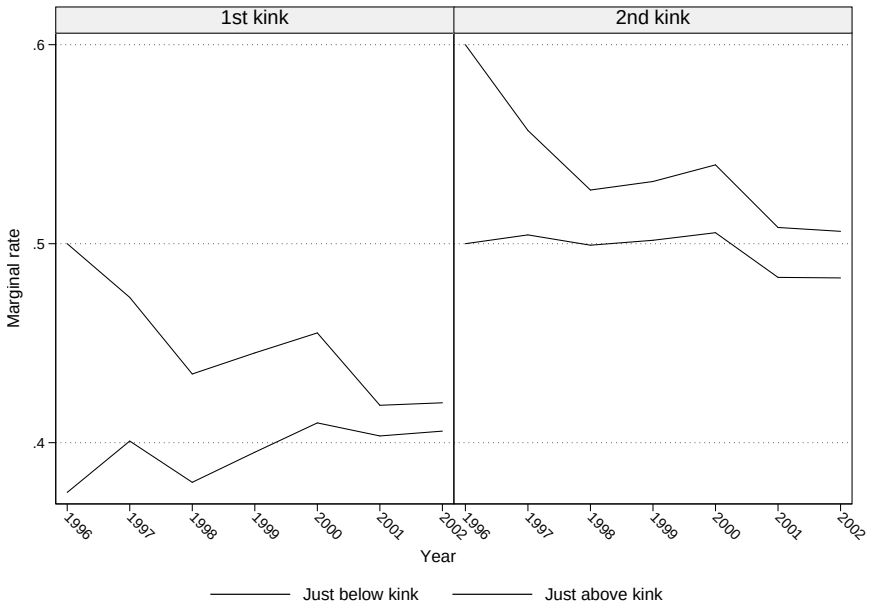

Figure 2: Average marginal tax rates for the 1996 "just above" and "just below" groups

with larger and smaller changes in their marginal tax rates between pre-reform and post-reform years.

7 Results from the local identification approach

7.1 Assumption checks

The local identification approach builds on the assumption that the difference in tax-deductibility between people with taxable incomes just below and just above kinks in the tax schedule, is not mirrored by an off-setting difference in the marginal tax rates that apply to the returns to training. Figure 2 shows that this assumption is indeed to a large extend satisfied. In 1996 the average difference in marginal tax rates between the groups above or below the first kink in the tax schedule equals 0.11. Following the same observations during the subsequent years 1997-2002 reveals that much of this difference in tax rates has gone after two years. We see this for both kinks, and especially for the second kink. A very similar picture emerges when we take later starting years (not shown here).

A second assumption underlying the local identification approach is that

the groups that are compared (i.e. the groups around the kinks), are not systematically different in (observed and unobserved) characteristics. This is the usual identifying assumption in a regression discontinuity framework. The threat here is that taxable incomes are manipulated with the purpose of having a higher tax deduction of the training expenditures. To examine whether this occurs, we investigated whether taxable incomes bunch just above kink points. We do not find any indication of bunching just above (or just below) any of the kinks for the various years, a finding consistent with results reported by Saez (2002).

7.2 Results

Each kink in the tax schedule in each of the seven years included in our dataset constitutes a quasi-experiment. This gives a total of 18 quasi-experiments. Table 2 reports the effects of tax rates on training rates. The groups are defined such that the bandwidth around the kinks equals net wage rates (e.g. the opportunity costs of training) above and below the kinks separately for all 18 quasi-experiments. Results are reported for three different specifications. In the first specification no controls are included, the second specification includes controls for age, age squared, gender, marital status and economic activity. The third also controls for (the log of) taxable income.

The estimates from the separate quasi-experiments are too imprecise to infer anything about the sign and the magnitude of the effect. Only six of the 54 reported effects are negative and significantly different from zero; three of these are obtained from the quasi-experiment around the second kink in 2002. This is due to the fact that the numbers of observations located close enough around the kinks is small relative to the size of the effect. Consequently, there is a need to aggregate the information from the different quasi-experiments.

A crude way to aggregate the information is by observing that only 4 out of 18 effects in the first and in the second specification have a positive sign. The probability that no more than 4 effects a positive sign when in fact the odds of a negative and a positive sign are equal is only 0.015. In the final specification 5 out of 18 effects have a positive sign; the probability that no more than 5 effects a positive sign when in fact the odds of a negative and a positive sign are equal is only 0.146. These results already hint at a negative

Table 2: Effect of tax rate on training incidence - Local estimates

	kink	low rate	high rate	coef	s.e.	coef	s.e.	coef	s.e.	N
1996	1	0.375	0.500	-0.011	(0.014)	-0.024	(0.013)	-0.002	(0.015)	13,536
	2	0.500	0.600	-0.004	(0.030)	-0.012	(0.028)	-0.011	(0.029)	3,626
1997	1	0.375	0.500	-0.019	(0.014)	-0.035	(0.013)	0.003	(0.016)	14,062
	2	0.500	0.600	0.010	(0.032)	0.005	(0.031)	-0.000	(0.032)	3,390
1998	1	0.363	0.500	-0.027	(0.013)	-0.039	(0.012)	-0.011	(0.014)	13,603
	2	0.500	0.600	0.077	(0.040)	0.075	(0.040)	0.072	(0.040)	2,436
1999	1	0.357	0.370	-0.377	(0.642)	-0.218	(0.357)	-0.217	(0.359)	329
	2	0.370	0.500	-0.006	(0.014)	-0.015	(0.013)	-0.004	(0.015)	13,257
	3	0.500	0.600	0.025	(0.037)	0.020	(0.036)	0.016	(0.036)	2,673
2000	1	0.339	0.380	-0.125	(0.115)	-0.094	(0.098)	-0.021	(0.069)	994
	2	0.380	0.500	-0.009	(0.015)	-0.016	(0.014)	0.002	(0.017)	12,822
	3	0.500	0.600	-0.049	(0.032)	-0.050	(0.031)	-0.029	(0.031)	2,741
2001	1	0.324	0.376	0.014	(0.060)	0.031	(0.047)	0.036	(0.046)	2,941
	2	0.376	0.420	-0.136	(0.057)	-0.135	(0.052)	-0.137	(0.053)	6,241
	3	0.420	0.520	-0.020	(0.027)	-0.027	(0.026)	-0.019	(0.031)	5,979
2002	1	0.324	0.379	-0.048	(0.048)	-0.026	(0.040)	-0.024	(0.042)	2,667
	2	0.379	0.420	-0.059	(0.055)	-0.060	(0.050)	-0.041	(0.050)	5,107
	3	0.420	0.520	-0.047	(0.027)	-0.054	(0.026)	-0.017	(0.034)	4,853
Controls for X				no		yes		yes		
Controls for income				no		no		yes		
A. Average (w=N)				-0.024	(0.007)	-0.030	(0.006)	-0.012	(0.007)	111,257
B. Average (w=Eff.)				-0.016	(0.005)	-0.025	(0.005)	-0.005	(0.006)	111,257

impact of the (log) net of tax rate on training participation.

The results can also be aggregated by taking a weighted average of the estimates reported in Table 2. The bottom two rows of the table report such estimates. First the separate estimates have been weighted by sample fractions (number of observations of each quasi-experiment divided by total number of observations in all 18 quasi-experiments), as in Card and Sullivan (1988). The next row reports the average effects when the separate estimates have been weighted by the inverse of their variances. This minimizes the variance of the aggregate estimate and is thus the most efficient estimator.[7]

The aggregate estimates using sample fractions as weight are for all three specifications larger than the aggregate estimates using inverse variances as weights. Adding controls increases the size of the effect estimates from the first to the second specification, but they get smaller when taxable income is added as a control. All aggregate estimates have the predicted negative sign and five out the six estimates is significantly different than zero. The effect size is around -0.02; evaluated at a marginal tax rate of 0.40, this implies that a 10 percentage point increase in the deduction rate, increases training participation by 0.33 percentage points.

The information from the 18 quasi-experiments can also be combined by pooling the data rather than the estimates. The conventional approach is to pool the data from all the discontinuity samples, and run OLS regressions with training participation as the dependent variable and the marginal tax as the key explanatory variable. Table 3 reports the results.

The first three columns report the results from probit models. The final three columns report the results of instrumental variable probit estimations where the tax rate was instrumented with the indicator variable that equals one for individuals just above a kink and zero for those just below a kink. All models include year dummies, dummies for the first, second and third kinks and year*kink-interactions. The results are very similar to those in table 2, all suggest a positive effect of the tax deduction rate on training participation. Including covariates for gender, age, age squared and marital status lead to an increase of the effect estimate (columns (2) and (5)). If we also include (the log of) taxable income as a control variable, the estimate is somewhat attenuated.[8] Note that the normal probit estimates are much

[7] Appendix A describes how the standard errors of these estimates have been calculated.

[8] The results in columns (3) and (6) remain the same when we allow the effects of

Table 3: Marginal effects based on pooled (IV-)probit models - Regression discontinuity sample (N=111,257)

	Probit			IV-probit		
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(1-\tau_{it})$	−0.014	−0.023	−0.009	−0.019	−0.027	−0.013
	(0.006)**	(0.006)***	(0.006)	(0.006)***	(0.006)***	(0.007)**
Age		−0.001	−0.001		−0.001	−0.001
		(0.000)***	(0.000)***		(0.000)***	(0.000)***
Female		−0.004	−0.003		−0.004	−0.003
		(0.002)***	(0.002)		(0.002)***	(0.002)
Household Size		−0.001	−0.002		−0.001	−0.002
		(0.001)**	(0.001)***		(0.001)**	(0.001)***
ln(Gross Income)			0.019			0.019
			(0.004)***			(0.004)***

Note: All regressions also include year dummies, dummies for the first, second and third kinks of the tax schedule and year*kink-interactions.

more sensitive to the inclusion of income.

The results based on the pooled sample also consistently indicate that a 10 percentage points increase in the rate against which individuals can deduct their training expenditures raises the probability that they spend money on training by about 0.33 percentage point (with an average tax rate of 0.4).

8 Results from the tax reform

This section reports the results exploiting the changes in marginal tax rates caused by the tax reform. As we argued above, the reform changed the marginal tax rates relevant for the costs of a training investment between 2000 and 2001, whereas the marginal tax rates relevant for the returns to a training investment were unaffected. Hence relating changes in training decisions between 2000 and 2001 to changes in marginal tax rates between these years will inform us about the effect of the deductibility of training costs on training participation. We do this by estimating various specifications of equation (12).

The analysis is conducted separately for individuals who (i) did not train, and (ii) did train just before the tax reform (in 2000). The reason is that the margin by which a change in the deduction rate pushes individuals into training is likely to differ from the margin by which such a change pushes individuals out of training. Fixed costs for example could generate substantial persistence in training participation which is not taken into account if both groups are merged.

Tables 4 and 5 present the estimation results for the two groups. The first three columns of both tables are based on probit equations where (the change in) training incidence is regressed on the change is the marginal tax rate and various sets of covariates. Endogeneity of the post reform rate might, however, be a problem, and columns (4)-(7) show results from probit models where the change of the marginal tax rate is instrumented by the change of the marginal tax rate predicted on the basis of pre-reform gross income as explained above.[9]

Table 4 shows the results for the sub-population who trained in 2000.

taxable income to vary across years.

[9]The instrument in highly significant in the first-stage for all the results shown here; the value of the F-test statistic is never below 62.

Table 4: Tax reform results; Previous state trained (N=1,144)

	Probit			IV-Probit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta \ln(1-\tau_{i,t-1})$	-0.0487	-0.0459	-0.0140	0.1953	0.1578	0.1607	0.1259
	(0.2309)	(0.2351)	(0.2441)	(0.2487)	(0.2616)	(0.2800)	(0.3045)
$\tau_{i,t-1}$	0.0715	0.0576	0.0355	-0.0963	-0.0941	0.0904	−0.0321
	(0.3146)	(0.3373)	(0.3404)	(0.2425)	(0.2668)	(0.2957)	(0.3320)
Age		0.0006	0.0006		0.0007	0.0007	0.0008
		(0.0018)	(0.0018)		(0.0019)	(0.0018)	(0.0019)
Female		-0.0229	-0.0234		-0.0243	−0.0247	−0.0249
		(0.0350)	(0.0351)		(0.0347)	(0.0330)	(0.0353)
Household Size		-0.0219	-0.0217		-0.0217	−0.0215	−0.0208
		(0.0119)*	(0.0119)*		(0.0121)*	(0.0116)∗	(0.0122)∗
$\ln y_{i,t-1}$			0.0315			0.0431	
			(0.0594)			(0.0591)	
$\ln\hat{y}_{i,t-1}$							0.1787
							(0.1370)

Table 5: Tax reform results; Previous state untrained (N=36,394)

	Probit			IV-Probit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta \ln(1-\tau_{i,t-1})$	-0.0505	-0.0528	-0.0483	-0.0453	-0.0506	−0.0556	−0.0507
	(0.008)***	(0.008)***	(0.0082)***	(0.0100)***	(0.0099)***	(0.0088)***	(0.0100)***
$\tau_{i,t-1}$	0.0944	0.1119	0.1091	0.0762	0.0934	0.1000	0.0986
	(0.0106)***	(0.0109)***	(0.0110)***	(0.0095)***	(0.0100)***	(0.0103)***	(0.0107)***
Age		-0.0008	-0.0008		-0.0007	−0.0008	−0.0008
		(0.0001)***	(0.0001)***		(0.0001)***	(0.0001)***	(0.0001)***
Female		-0.0002	-0.0003		-0.0010	−0.0008	−0.0007
		(0.0013)	(0.0013)		(0.0012)	(0.0012)	(0.0013)
Household Size		-0.0004	-0.0004		-0.0004	−0.0004	−0.0004
		(0.0005)	(0.0004)		(0.0005)	(0.0004)	(0.0004)
$\ln y_{i.t-1}$			0.0058			0.0059	
			(0.0018)***			(0.0018)	
$\ln\hat{y}_{i,t-1}$							−0.0070
							(0.0053)

The estimates in columns (1) to (3) are all negative but none of these effects is precisely estimated. Instrumenting the change in the rate at which training is subsidized leads to estimates with a positive sign, all highly insignificant despite a very strong first stage.

Table 5 shows the results for the sub-population who did not train in 2000. Note that the sample size is much larger than in table 4. The first-differenced probit regression results are all negative. Adding additional controls does not change the points estimates which are all strongly significant. Columns (4)-(7) show the results when the change in the rate at which training is subsidized is instrumented. Compared to the normal probit estimates the instrumental variable probit estimates hardly change and are all significant.

The results in Table 5 indicate that people respond to changes in the net costs of training brought about by changes in the tax rates against which training costs can be deducted. The estimated effect on incidence is in the vicinity of -0.05; with an average marginal tax rate of 0.4 this implies that, on average, an increase in the tax rate at which people can deduct training costs of 10 percentage points induces an increase in the training rate of 0.8 percentage points. This is a fairly substantial effect given that average training incidence is around 3 percent.

Recall from our discussion in section 5 that the change in marginal tax rates affects both the deductibility of direct training expenditures and the deductibility of opportunity costs of training. According to the model set out in section 2, the ratio of the effect from the reform analysis and the effect from the local identification approach is equal to $(w + p)/p$. This suggests that the opportunity costs of training participation is 1.5 times as large as the direct training expenditures.

9 Conclusion

To stimulate training investments by individuals, governments can to provide a tax deduction to individuals who make such investments. Government in some countries do so, while governments in other countries don't. Until now, little is known about the actual effect of this instrument making it hard to tell whether countries that offer tax deductions for training expenditures follow a wise policy.

We evaluated the deductibility of direct training expenditures from taxable income using two different approaches. The main challenge is to isolate the effect of tax deductibility of direct training expenditures from the (implicit) tax deductibility of opportunity costs of training investment and the taxation of returns to training investments.

The first method exploits differences in deductibility rates around kinks in the tax schedule. By choosing the intervals around the kinks such that average net wage rates are equal, we get rid of the tax deductibility of opportunity costs. We also show that future marginal tax rates for individuals who are above and below kinks in a given year are very similar. This eliminates differences in taxation of returns to training. To the extent that some differences in the taxation of returns still remain, this method underestimates the true effect of tax deductibility of direct training expenditures. Results based on the first approach indicate that a 10 percentage point increase in the tax deductibility rate of direct training expenditures increase training participation by 0.33 percentage points (which is a 10 percent increase of the training rate).

The second method takes advantage of the 2001 tax reform, which implied a substantial change in marginal tax rates. Investment costs in 2000 (before the reform) were subject to the old tax code, while investment costs in 2001 (after the reform) were subject to the new tax code. Because returns to training do not materialize with some delay, return to investment made in 2000 and 2001 were both subject to the new tax code. Accordingly, this method isolates changes in taxation of costs from changes in taxation of returns. It does not, however, isolate tax deductibility of direct training expenditures from tax deductibility of opportunity costs. This method identifies the joint effect of these two deductibility rates, and since these operate in the same direction, it will overestimate the effect of interest. Results based on the second approach indicate that a 10 percentage point increase in the tax deductibility rate of training costs increase training participation by 0.8 percentage points (which is a 25 percent increase of the training rate).

According to the theoretical model we presented in this paper, the ratio of the results from the two methods are informative about the ratio of the opportunity costs of training investments and the direct expenditures of training investments. The results imply that opportunity costs are 1.5 times as large as the direct expenditures.

There is, however, reason to suspect that the true effect of tax deductibility of direct training expenditures is somewhere in between the estimates from the two methods. As we already argued, to the extent that the local identification approach does not fully neutralize differences in the taxation of returns, the estimates based on this method underestimate the true effect. Moreover, this method assumes that individuals are fully aware of the marginal tax rate applicable to their training expenditures. If this assumption does not hold for some individuals with incomes close to a kink, these individuals will not act on their tax treatment and their responsiveness will this be zero. This also biases the estimate from the local identification method downwards.

On the other hand, we interpret the estimate from the reform method as the joint effect of tax deductibility of direct training expenditures and tax deductibility of opportunity costs. The underlying economic model assumes that an individual's opportunity costs of an hour spent on training changes abruptly if this person's taxable income passes a kink in the tax schedule. For people who work full-time (as most people with incomes at least just below the first kink will do) and have little scope to adapt their working hours marginally, this assumption implies that these persons experience an abrupt change in the valuation of their leisure. To the extent that one is unwilling to believe this, a larger share of the effect estimate from the reform approach is attributable to the tax deductibility of direct training expenditures.

The reported effect sizes are evaluated at an average marginal tax rate equal to 0.4. If we assume that effects are constant over tax rates, we can calculate which share of the average training rate of 3 percent is attributable to the tax deductibility of direct training expenditures. Using the low estimate of 0.33 percentage point change in training participation per 10 percentage point change in deductibility rate, suggests that abandoning the tax deductibility of direct training expenditures reduces the share of individuals who spend money on training for career purposes by almost one half: from 3 percent to 1.7 percent. Using the high estimate of 0.8 percentage point change in training participation per 10 percentage point change in deductibility rate, even suggests that without direct training expenditures being tax deductible no one would spend money on training for career purposes. In any case, tax deductibility of direct training expenditures appears

to be a fairly effective instrument to enhance human capital accumulation. At a marginal tax rate of 0.40, every guilder invest by the government in the form of a tax deduction, leads to $\frac{3}{4}$ to $1\frac{1}{2}$ guilders of private expenditures on training investments.

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A Combining estimates

We aggregate our local Wald estimates into one (average) estimate

$$\hat{b} = \sum_i w_i \hat{b}_i$$

The w_i that minimize the variance of $\hat{b}$ are

$$w_i = \text{var}(b_i)^{-1} / \sum_i \text{var}(b_i)^{-1}$$

This gives the following expression for the variance of $\hat{b}$

$$\text{var}(\hat{b}) = 1 / \sum_i \text{var}(b_i)^{-1}$$

Alternatively, the local estimates can be weighted with their sample fractions (as in Card and Sullivan, 1988).