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Income Taxes and Entrepreneurial Choice: Empirical Evidence from Germany

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ABSTRACT

Income Taxes and Entrepreneurial Choice: Empirical Evidence from Germany

Entrepreneurial activity is often regarded as an engine for economic growth and job creation. Through tax policy, governments possess a potential lever to influence the decisions of economic agents to start and close small businesses. In Germany, the top marginal income tax rates were reduced exclusively for entrepreneurs in 1994 and 1999/2000. These tax reforms provided two naturally defined control groups that enable us to exploit the legislation changes as "natural experiments". First, the tax rate reductions did not apply to freelance professionals (Freiberufler), and second, entrepreneurs with earnings below a certain threshold were not affected. Using data from two different sources, the SOEP and the Mikrozensus (LFS), we analyse the effect of the tax cuts on transitions into and out of self-employment and on the rate of self-employment. We apply a "difference-in-difference-in-difference" estimation technique within a discrete time hazard rate model. The results indicate that the decrease in tax rates did not have a significant effect on the self-employment decision.

JEL Classification: H24, H25, J23

Keywords: taxation, entrepreneurship, natural experiment, difference-in-difference-in-difference estimation

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1 Introduction

Do taxes play a role in the decision to become and to remain an entrepreneur? Extensive research exists on the individual determinants of being an entrepreneur, but the influence of taxes is less understood and controversial. Governments in Germany and elsewhere have discussed and implemented various policies to promote entrepreneurship, following the view that entrepreneurs are vital to the dynamism and innovative capacity of an economy. More specifically, entrepreneurship is often regarded as an engine to create new jobs and as a means to escape unemployment. This is of particular interest to the current policy debate in Germany and other countries with high rates of unemployment. As among the various potential determinants of entrepreneurship, taxation is under direct control of the government, tax policy is frequently suggested as an instrument to stimulate entrepreneurship. A better understanding of the impact of taxes on firm foundations and closures is crucial to evaluate these efforts.

Economic theory does not provide unambiguous guidelines with respect to taxation and entrepreneurship. On the one hand, Gentry and Hubbard (2000) argued that a progressive tax schedule decreases the expected after-tax return from a risky project and thus discourages entry into entrepreneurship. On the other hand, the classic view of Domar and Musgrave (1944) demonstrated that governments may encourage entrepreneurship by sharing risk through progressive taxation. Even if the tax system treats income from wage employment and self-employment differently, the ambiguity remains: Bruce (2002) illustrated that the effect of a differential tax treatment on the decision to be self-employed depends on individual preferences over return and risk.

The empirical literature has exploited tax reforms as natural experiments to analyse the effects of taxation with individual micro data since Feldstein (1995). Few empirical studies exist about taxation and entrepreneurship, though. Most of this literature only considers entries into self-employment or the propensity to being self-employed, and it is mostly limited to US data (e.g. Cullen and Gordon 2002; Moore 2004). Only Bruce (2002) studies exits from self-employment, also in the U.S.A..

We analyse two tax legislation changes in Germany that exhibit specific features which make them especially suitable to be exploited as natural experiments. These tax reforms were introduced as a tax relief for small and medium sized enterprises. In the first reform, the top marginal tax rate of the personal income tax schedule, which was 53% for all types of income, was limited to 47% exclusively for self-employment income from a trade business above a

certain threshold. This tax rate limit was further reduced in a second reform (in two steps down to 45% in 1999 and to 43% in 2000, combined with lower associated income thresholds). Importantly, the law makes two distinctions that naturally define treatment and control groups for our interpretation of the reforms as experiments. First, as mentioned before, only individuals with income from trade above the threshold defined by the law benefited from the limitation of the top marginal tax rate. Thus, tradesmen with income below the threshold serve as a control group. Second, the law does not apply to all self-employed individuals, but only to tradesmen (*Gewerbetreibende*) as opposed to so-called freelancers (*Freiberufler*). The latter are self-employed persons who have one of various professions that have traditionally been classified as freelance professions by the German income tax law, e.g. physicians, lawyers, architects, and journalists. This distinction enables us to track the freelancers as additional control group. Other influential factors, such as additional tax legislation changes that came into effect in the period under investigation, affected both the treatment and control groups. Thus, they do not distort our analysis under the assumption that the groups were influenced by these other factors in the same way.

In short, this paper provides four main contributions. Firstly, to draw a complete picture of the impact of taxation on entrepreneurship, firm start-ups, firm closures and the resulting number of entrepreneurs are of equal importance. This paper analyses entries into and exits from self-employment and the overall probability of being self-employed to provide this integrated view. Secondly, this is the first empirical study of entrepreneurial choice and taxation in Germany. It compares the results based on two different datasets: the German Socio Economic Panel (waves 1984-2001) and the Mikrozensus (Labour Force Survey; repeated cross-sections of 1996-2001). The third contribution is the econometric analysis of spell data and the application of a discrete time hazard model. This enables us to control for the important effect of the duration of an individual's self-employment spell on the decision to exit entrepreneurship, and equally for the effect of the employment or unemployment spell duration on the decision to enter entrepreneurship. Survival analysis has been applied to study entrepreneurial choice (Evans and Leighton 1989; Taylor 1999), but these studies did not consider the impact of taxes; Schuetze and Bruce (2004) pointed out that ignoring the survival of self-employed ventures has been a significant shortcoming of the existing tax related literature. The forth contribution of this paper stems from the fact that the two German tax reforms we analyse luckily provide two independent dimensions to define a control group. This allows us to apply a "difference-in-difference-in-difference" estimator (Gruber 1994) to

isolate the effect of the reforms. This method controls for reform-independent trends in a more robust way than the conventional difference-in-difference technique.

The remainder of the paper is organised as follows. The following section summarises prior studies about entrepreneurship and taxation. Section 3 explains the legislation changes that are relevant to this analysis. In section 4, we introduce the two German datasets we use, elaborate on the definition of the treatment and control groups, and provide descriptive statistics about entrepreneurship in Germany. Section 5 describes the econometric methods we apply. The results are presented and discussed in section 6, and section 7 concludes.

2 Literature Review

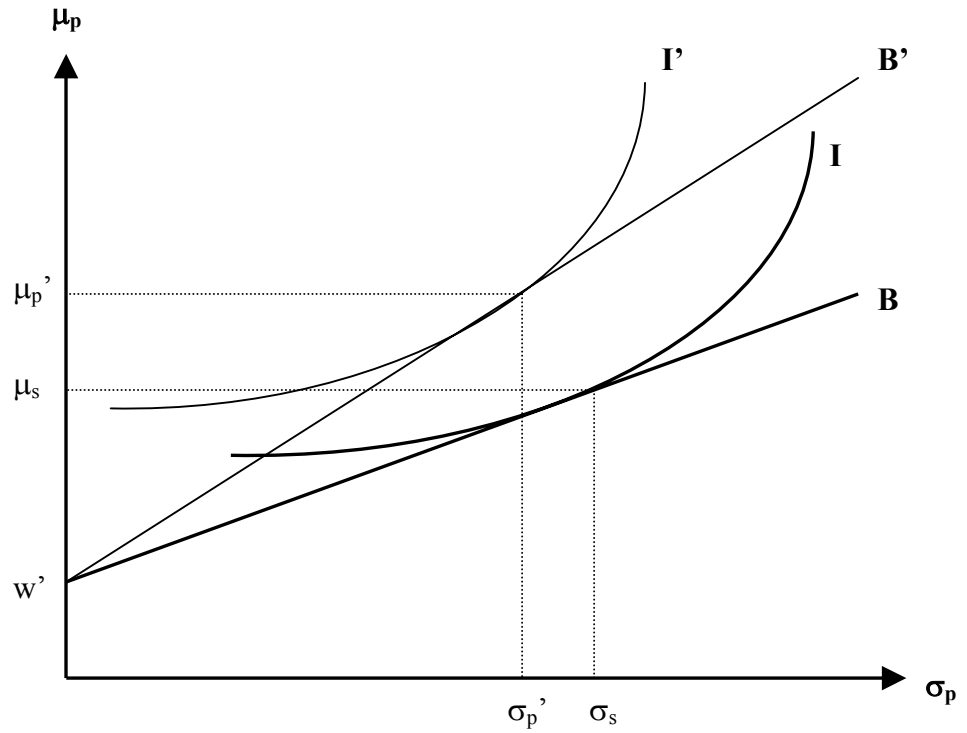
2.1 Theory

Theoretic approaches to the impact of taxes on entrepreneurial activity provide ambiguous results. Gentry and Hubbard (2000), on the one hand, assumed risk-neutral agents and argued that a progressive tax schedule is comparable to a "success tax" by lowering the expected after-tax return from a risky project. Domar and Musgrave (1944) provided a contrasting view, assuming risk-averse agents and imperfect financial markets with respect to risk-sharing: Through a progressive tax schedule, governments share risk with entrepreneurs by smoothing net profits and losses and thus encourage risky entrepreneurial activity. Cullen and Gordon (2002) added another argument for the view that higher income tax rates may increase the propensity to become self-employed in the U.S.A.. American firms always have the option to avoid high personal tax rates by incorporating ex post and being taxed at the lower corporate tax rate. Thus, a firm generating tax losses will prefer to be not incorporated so that the entrepreneur can deduct these losses against other personal income, while a profit generating firm will prefer to incorporate. This option to choose the organisational form based on the outcome can thus be interpreted as a net subsidy to risk taking. Better (legal) tax avoidance and (illegal) tax evasion opportunities available to the self-employed can also explain a positive relationship between the tax rate and the self-employment rate.

The tax reforms we consider in this study represent a reduction of the top marginal tax rates exclusively for self-employed tradesmen, but not for wage and salary employees. Thus, the legislation changes introduced a differential tax treatment of the two alternative sectors self-employment and dependent employment. Bruce (2002) provided a theoretical framework for the analysis of a tax system with differential treatment. In his simple portfolio choice model, which is similar to Tobin (1958), individuals can allocate some fixed amount of labour

between wage employment and self-employment. The gross return on wage employment w is assumed to be certain, whereas the gross return on self-employment s is uncertain with expected value μ_s and variance σ_s^2. For each labour supply portfolio p, i.e. for each combination of time allocated to wage employment and self-employment, one can calculate the expected return μ_p and variance σ_p^2. The individual can select the combination of expected return and risk that yields the highest utility level, subject to a budget constraint, which is given by the interrelationship between expected return and variance of the portfolio. The different tax rates τ_w for wage employment and τ_s for self-employment enter this budget constraint in such a way that they shift the budget line downward in comparison to a case without taxes, and they make the slope steeper if $\tau_w > \tau_s$, i.e. if the self-employed are tax-advantaged, as is the case in the tax reforms we study. Figure 1 depicts how an individual adjusts her labour supply after the tax rate for self-employment is decreased, while the tax rate for wage employment is left unchanged. B is the budget line before, and B' after the reform. *w'* represents the after-tax return to wage work, which is the same before and after the reform.

Figure 1: Effect of differential taxes on portfolio choice (example)



In the example shown in the figure, the individual devoted all of her time to self-employment before the reform ($\mu_p = \mu_s$, $\sigma_p = \sigma_{s,}$) but after the tax rate on self-employment is lowered, she shifts time from self-employment to wage employment. The actual direction and magnitude of the effect will be individual-specific, depending on individual tax rates and preferences over return and risk. This ambiguity does not change if individuals are restricted to boundary solutions, i.e. they supply all labour either to wage employment or to self-employment.

2.2 Empirical Literature

Various recent empirical studies about the impact of taxes on entrepreneurship have followed the approach to analyse individual taxpayer or income survey panels and to exploit changes in the tax legislation as natural experiments. The idea is to isolate the effect of the tax reform by comparing the activity of the same taxpayers before and after the reform, trying to control for other influential factors. This approach has been introduced by the new tax responsiveness literature, which studies the elasticity of taxable income with respect to income tax rates. Feldstein (1995) analysed the 1986 Tax Reform Act in the U.S.A., which reduced the income tax rates while broadening the tax base, and estimated a substantial elasticity of taxable income with respect to marginal tax rates. Gruber and Saez (2002) addressed identification problems faced by previous work and provided new evidence of a significant tax rate elasticity. Gottfried and Schellhorn (2003) studied the effect of the German income tax reform in 1990 using a taxpayer panel. The estimate they obtained for the elasticity of taxable income was very small when they used the whole sample. For the subgroup of self-employed taxpayers, however, the estimated elasticity was much higher than for other taxpayers, suggesting that entrepreneurs respond substantially to tax rates.

The empirical literature about the impact of taxation on entrepreneurship reflects the fundamental theoretical ambiguity that was described in the previous section. Most empirical studies examine either the decision to enter self-employment or the propensity of being self-employed, but ignore entrepreneurial survival. Nevertheless, even the effects of the tax system on the better studied entry and occupational choice decisions remain controversial. Using the Canadian Survey of Consumer Finances and the US Current Population Surveys for the period 1983-1994, Schuetze (2000) reported that higher income tax rates, as well as unemployment rates, were associated with an increase in the rates of male self-employment in Canada and the U.S.A.. Georgellis and Wall (2002) found a U-shaped relationship between marginal tax rates and entrepreneurship using a spatial panel approach. At low tax rates the relationship was negative, and at high rates it was positive. Bruce (2000 and 2002) studied the

effect of taxes on entering and also on exiting self-employment. Analysing the US Panel Study of Income Dynamics, he found that decreasing an individual's expected marginal tax rate on self-employment income reduced the probability of entry, while a similar decrease in the average tax rate increased this probability. Similarly, higher tax rates on self-employment income were found to reduce the probability of exit. Both of these studies involved the use of exogenous changes in tax rules to generate instrumental variables for addressing the possible endogeneity of individual-specific tax rates. Moore (2004) used repeated cross section data from the Survey of Consumer Finances in the USA and exploited the 1986 and 1993 tax rate reforms as natural experiments. This strategy allowed him to apply the difference-in-difference technique to account for the tax rate endogeneity. The results suggest that the marginal and average income tax rates are negatively related to the propensity to become self-employed. A recent cross-sectional study by Parker (2003) casted doubt on the importance of tax policy on the self-employment decision. By examining two 1994 cross sections of UK data he found no evidence that the decision to be self-employed is sensitive to taxes or opportunities for evasion.

Rather than studying entrepreneurial entry and exit, other panel data studies examined the effect of taxation on the activity of entrepreneurs in business. Carroll et al. (2000a,b;2001) used taxpayer panel data from the Statistics of Income (SOI) Individual Tax Files for 1985 and 1988. Relying on exogenous variation provided by the Tax Reform Act of 1986, they examined how entrepreneurs' income tax situations affect the growth of small firms' receipts, the amount of labour they hire, and the volume of capital investment they undertake. The results suggest that higher marginal tax rates reduce overall firm growth (as measured by receipts), the probability of hiring employees, and mean investment expenditures. Harhoff and Ramb (2001) shed light on the effect of taxation on investment in Germany. Using firm-level balance sheet panel data provided by the Deutsche Bundesbank, they analysed the relationship between capital user costs and investment and obtained a negative user cost elasticity of investment. This result suggests that taxes, which also increase the user costs of capital, depress investments, and this way it seems plausible that they also influence the decision to found or close firms. The following section introduces the tax reforms we exploit in order to identify the effect of taxation on entrepreneurship.

3 Tax Reforms as Natural Experiments – The Location Preservation Act and the Tax Relief Act

To understand the effect of income taxes on entrepreneurial choice, we analyse specific legislation changes in Germany in the 1990s that reduced the top marginal income tax rates exclusively for self-employed tradesmen (*Gewerbetreibende*)[1]. These tax reforms make it possible to study the impact of income taxes on entrepreneurial choice without distortions from a simultaneous change in the tax environment in the alternative sector, i.e. wage and salary employment. The legislation changes we exploit as natural experiments are known as tax rate limitation for income from trade (*Tarifbegrenzung für gewerbliche Einkünfte*), enacted in § 32c of the income tax law (*Einkommensteuergesetz, ESt*). The context of these reforms was a reduction of the corporation tax (*Körperschaftsteuer*). These tax cuts were implemented with the intention to make Germany a more competitive business location in the globalised economy. However, a reduction of the corporation tax rate without complementary measures would have favoured corporations, which are typically relatively large, over not incorporated companies, e.g. sole proprietors and partnerships, which are typically small and medium sized. These businesses are not subject to corporation tax; the sole proprietors or partners pay progressive personal income taxes instead. Thus, the legislator decided to reduce the tax burden of not incorporated companies at the same time as lowering the corporation tax rate.

The first reform we analyse is the Location Preservation Act (*Standortsicherungsgesetz, StandOG*) of September 13th, 1993. It reduced the corporation tax rate for retention earnings from 50% to 45%. In the same act, by first introducing § 32c ESt, the general top marginal personal income tax rate of 53% was limited to 47% for earnings from trade businesses above DM 100,278 (€ 51,271). The law went into effect on January 1st, 1994. According to the financial report 1994 of the Federal Ministry of Finance, the limitation of the top income tax rate for tradesmen led to reduced tax earnings of € 716 million in the first year.

The second reform relevant to our analysis is the Tax Relief Act (*Steuerentlastungsgesetz, StEntG 1999/2000/2002*) of March 24th, 1999, which was put into effect retroactively on January 1st, 1999. It further reduced the corporation tax rate for retention earnings to 40% and limited the top marginal personal income tax rate for earnings from a trade to 45% (above DM 93,744 or € 47,931) in 1999 and to 43% (above DM 84,834 or € 43,375) in 2000. The fiscal impact of the tax rate limitation for tradesmen at 45% was a reduction in tax revenues of € 593 million in 1999, and the tax rate limitation at 43% further lowered tax revenues by

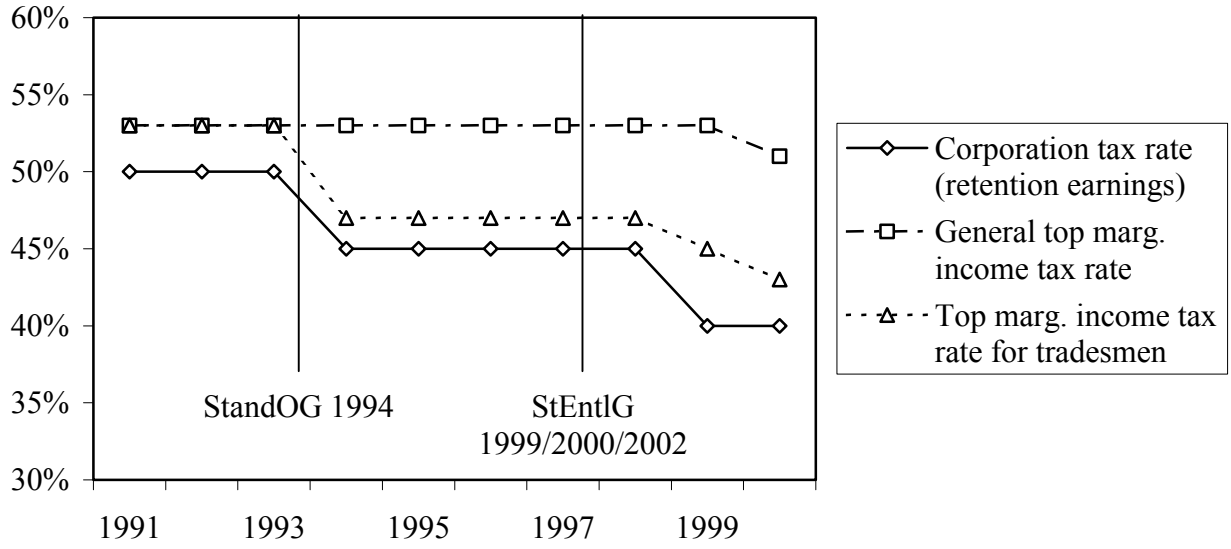
[1] The term tradesmen (*Gewerbetreibende*) is used to distinguish from freelancers (*Freiberufler*) – see section 4.3.

€ 700 million in 2000, according to the financial report 1999 of the Federal Ministry of Finance.

The general top marginal tax rate for all personal income other than from trade businesses, e.g. wages and salaries, was still left unchanged at 53% in 1999. Reductions of the general personal income tax rates were faded in in 2000 and continued in the following years (the top marginal income tax rate was reduced to 51% in 2000 and to 48.5% in 2001 – the latter reduction had been scheduled for 2002 by the aforementioned Tax Relief Act but was pulled forward by the Tax Reduction Act in 2000). The Tax Relief Act included a variety of complementary measures, partly intended to compensate parts of the fiscal impact. However, we do not expect these and other legislation changes to distort our analysis because there is no reason to belief that they affected the treatment group in a different way than the comparison group.

Figure 2 visualises how the two laws whose effects we analyse make the top marginal income tax rate for tradesmen depart from the general top marginal income tax rate to follow the reductions of the corporation tax rate on retention earnings.

Figure 2: Tax rate reductions for enterprises in Germany



Following these reforms, the Tax Reduction Act (*Steuersenkungsgesetz, StSenkG 2000*) of October 23rd, 2000 not only scheduled further personal income tax rate reductions for 2003 (top marginal rate: 45%) and 2005 (top rate: 42%), but also introduced a corporation tax reform at a larger scale, coming into effect on January 1st, 2001. Among other measures, the corporation tax rate for both retention earnings and distributed earnings was reduced to 25%.

For our analysis it is important to note that this reform replaced the limitation of the top personal income tax rate for tradesmen (§ 32c of ESt) with a different tax relief for the same group: § 32c of ESt was abolished, and in turn, tradesmen were granted a lump sum deduction of the community trade tax (*Gewerbesteuer*) from their personal income tax liability. Thus, the treatment group is affected in a different way than the control group by this reform. To avoid a bias of our analysis, we limit our data to observations prior to the time the Tax Reduction Act 2000 could influence the actors.

4 Data

4.1 Socio-Economic Panel and Mikrozensus

We base our analysis on two different annual micro data sets from Germany. The first data source is the German Socio-economic Panel (SOEP) provided by the German Institute of Economic Research (DIW Berlin). It is a representative panel survey containing detailed information about the socio-economic situation of about 5 to 12 thousand households in Germany and the individuals living in these households.[2] We are using 18 waves from 1984 (the first wave available) to 2001. The second data source is the Mikrozensus (micro census), which is provided by the Federal Statistical Office. It is an official representative household survey, similar to the Current Population Survey in the U.S.A. and the Labour Force Survey in the UK. The German part of the European Union's Labour Force Survey is organised as a sub-sample of the Mikrozensus. The Mikrozensus gives information about the German population and labour market, involving 1% of all households in Germany every year, i.e. about 370,000 households per year.[3] For scientific purposes, a scientific use file is available which is factually anonymised for reasons of data protection; it includes 70% of the records. We are drawing on 5 cross sections from 1996 to 2000. We are not including years before 1996 because that was the first year which includes a retrospective question on a respondent's employment status in the year prior to the interview (t-1), an information we need to identify transitions. Thus, using the Mikrozensus we can only analyse the second reform in 1999, while using the SOEP we can include the first reform of 1994 as well. The retrospective question on last year's employment status was only posed in a 45% sub-sample of the Mikrozensus (selected at random), so we base our analysis on this sub-sample.

[2] For a description of the SOEP see also Haisken-DeNew and Frick (2001).
[3] More information about the Mikrozensus can be found at http://www.destatis.de/themen/e/thm_mikrozen.htm.

We decided to use both the SOEP and the Mikrozensus for our analysis to exploit the advantages of each dataset and to ensure their specific disadvantages are not driving our results. The panel structure of the SOEP allows us to tract individuals over time and observe their spells in a certain employment status. This makes it possible to model the hazard of changing the employment state (e.g. leaving self-employment) controlling for duration dependence. The SOEP also includes retrospective questions about a respondent's age at his most recent occupational change and the age at his first job. This allows us to calculate the correct duration of an employment or self-employment spell even if the spell had begun before the respondent first entered the panel. Thus, we can account for left-censoring which is otherwise a typical problem in survival analysis using stock sample data. Moreover, the SOEP provides a rich variety of control variables. For example, retrospective questions about the individual employment history enable us to calculate a respondents' lifetime work and unemployment experience. The number of observations in the SOEP is limited, however, which becomes notable when we analyse to the self-employed and their transitions. It is also possible that entrepreneurs are underrepresented in the sample, because they often dispose of relatively little free time and may be less willing to answer the SOEP questionnaire over many consecutive years than other groups.

In comparison with the SOEP, the main advantage of the Mikrozensus is its larger sample size.[4] Furthermore, as the Mikrozensus is an official census, most questions in the Mikrozensus are subject to compulsory response. So there is no reason to expect that entrepreneurs, including those with high income, are underrepresented. On the other hand, the Mikrozensus only provides cross-sectional data. We have information about a respondent's employment status in the year prior to the interview from the retrospective question, so we can identify and model transitions, but we cannot observe the duration of individual employment or self-employment spells, and thus cannot control for duration dependence.[5] Another disadvantage of the Mikrozensus is that only information on net income is available, coded in 18 categories until 1999 and in 24 categories from 2000 onward; the SOEP, in contrast, provides gross and net incomes measured on metric scale, and income from self-employment can be distinguished from wage and salary income.[6]

[4] For example, the unweighted number of exits from (entries into) self-employment within the treatment group in the observation period after the 1999 reform is 134 (1,679) in the SOEP and 1,729 (17,276) in the Mikrozensus.
[5] There is a retrospective question asking what year the respondent entered his current occupational position, but this information does not enable us to determine the spell duration *before* a transition.
[6] Respondents are asked to state what their average monthly income in both employment types was in the year prior to the interview.

4.2 Sample Design

The SOEP dataset is converted into person-year format, i.e. one record is created for every year a person is interviewed in. The Mikrozensus dataset is organised similarly (here, each person is only observed in a single year). In both datasets, we restrict the sample to individuals between 18 and 65 years of age and exclude those currently in education, vocational training, or military service, and civil servants. The excluded individuals presumably have a limited occupational choice set, or at least they have different determinants of occupational choice that could distort our analysis.

Like in most empirical studies about entrepreneurial choice, we use self-employment as a measurable proxy for the concept of entrepreneurship. Individuals are classified as self-employed when they report self-employment as their primary activity.[7] We exclude farmers and family members who help in a family business from the datasets, because we assume the former have different determinants of occupational choice than other entrepreneurs, and helping family members are not entrepreneurs in the sense that they run their own business.

In this study, first of all we are interested in transitions into and out of self-employment. In the SOEP, we can identify a transition when we observe the same individual over two consecutive years t and t+1, and in t+1, the individual has a different employment status than in t. Interviews for the SOEP are carried out from January to September, with most interviews being conducted during the first three months of the year. Thus, it is more likely that the transition actually occurred in t, and we set a transition dummy equal to one in year t (see Figure 3). The first legislation change we analyse, the Location Preservation Act, was passed in September 1993 and came into effect on January 1st 1994. Most transitions we assign to year 1993 (i.e. transitions between the interview periods in 1993 and 1994) are probably not influenced by the reform, taking into account that adjusting expectations and eventually changing occupation as a reaction to the reform took some time. In contrast, transitions we assign to 1994 are potentially influenced by the reform. Consequently, all observations from 1994 onward are marked by a "post 1994 reform" dummy. The second reform, the Tax Relief Act 1999/2000/2002, was passed in March 1999. The more generous top marginal tax rate limitation went into effect in two steps, on January 1st 1999 (retroactively) and January 1st 2000. We assume that actors perceived both steps as a single reform and adjusted their expectations and behaviour after the bill was passed. Thus, most transitions we observe in

[7] In principle, with this approach we should also be able to catch conversions of the legal form of a company as a reaction to the tax reforms: An unincorporated firm is run by a self-employed sole proprietor or by various self-employed partners, but in an incorporated firm, which is a legal entity, the managers are employees. It is not entirely clear, though, if all respondents make this distinction correctly when answering the question.

1998 are not assumed to be influenced by the reform, but most transitions in 1999 are, and a "post 1999 reform" dummy is assigned to all observations from 1999 onward. For the joint estimation of the effects of the two reforms, we convert the "post 1994 reform" to a "post-1994, pre-1999 reform" dummy variable that is zero for all observations from 1999 onward to avoid an overlap of the two reform dummy variables. Regarding the interpretation of the "difference-in-difference-in-difference" estimators this implies the coefficients associated with the second reform measure the cumulated effect of the two reforms.

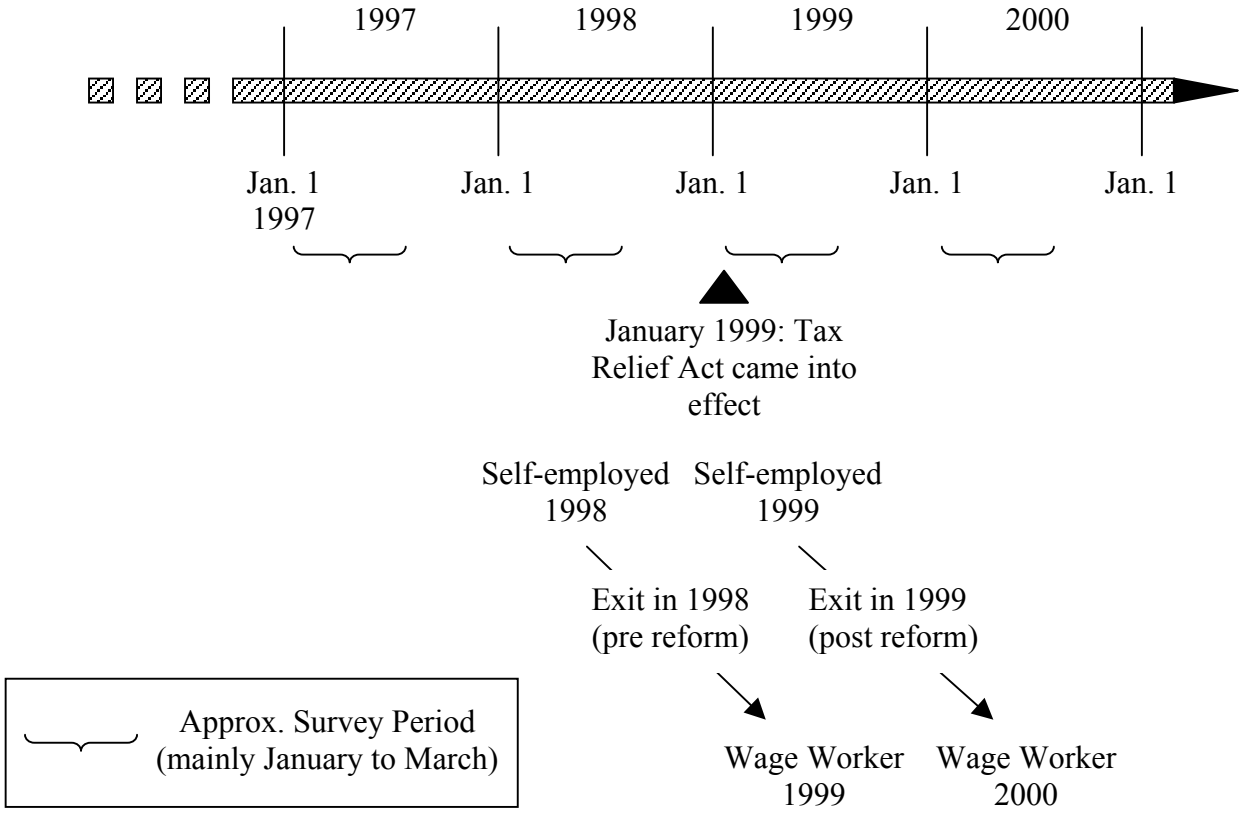
We decided not to include observations that are potentially influenced by the Tax Reduction Act 2000, because this reform affected tradesmen in a different way than freelancers, as mentioned in section 3, and is likely to have affected people differently across income classes, as shown by Haan and Steiner (2005). The bill was passed on October 23rd, 2000, and the corporate tax reform came into effect on January 1st, 2001. Transitions we observe in 2000 are most likely not to be influenced by the reform, especially taking into account the time lag before agents adjust their behaviour, but transitions in 2001 are likely to be influenced. Thus, we exclude the years 2001 and later. The 2001 wave is only used to determine if individuals had a transition in 2000 and to obtain retrospective information about their incomes in 2000.

Additionally to analysing transitions, we also want to study the prevalence of self-employment. Thus, we estimate the probability that someone is observed being self-employed in a particular year (point in time). For this estimation we have to shift the time scale one year. A person observed in the state of self-employment can only have been influenced by a reform after having had the opportunity for a transition. Thus, the "post 1994, pre 1999 reform" dummy ranges from 1995 to 1999 in this model, and the "post 1999 reform" dummy now starts no earlier than in 2000. Following the same logic, the last year we include for this estimation is 2001. The first year is 1985, because we include last year's employment status as an explanatory variable here. This information must be inferred from the wave in the previous year, and 1984 was the first SOEP wave.

In the Mikrozensus, we observe each person only in a single year t, but the person's employment status in the previous year t-1 can be derived from a retrospective question, which was included in all cross-sections since 1996. Thus, we set the transition variable in year t to one if an individual's employment status in year t-1 differs from the status in year t. The reference week of the employment status question is always the last week in April, so the transition is actually more likely to have occurred in t-1. Taking this into consideration, the "post 1999 reform" dummy has to span the cross-sections 2000 and 2001, that means transitions occurred after April 1999 and before April 2001. We exclude later cross-sections

to avoid interactions with the Tax Reduction Act 2000. We can use the same sample for the estimation of the probability of being of self-employed.

Figure 3: SOEP sample construction



4.3 Definition of the Treatment and Control Groups

The tax reforms we chose to study, described in section 3, provide two dimensions along which the treatment and control groups can be distinguished. First, the legislation changes were only applicable to tradesmen (*Gewerbetreibende*) as opposed to freelancers (*Freiberufler*). Second, only individuals with a gross income above a certain threshold were affected by the reforms. Table 1 sketches the definition of the treatment group.

Table 1: Treatment and control groups

	Gross income below threshold	Gross income above threshold
Tradesmen (*Gewerbetreibende*)	*Control Group*	*Treatment Group*
Freelancers (*Freiberufler*)	*Control Group*	*Control Group*

The distinction between tradesmen and freelancers is simple in the analysis of self-employment spells using the SOEP data, because self-employed individuals are classified as freelancers or "other self-employed" individuals here. As we excluded farmers, we can classify "other self-employed" as tradesmen.[8] Classification gets more difficult when we study transitions from dependently or not employed to self-employed individuals, or the individual propensity to be self-employed. In these models we also have to assign a label "potential tradesman" or "potential freelancer" for dependently employed and not working individuals. Thus, we classify all the professions individuals can report into trade and freelance professions according to the catalogue in the German income tax law and the prevailing jurisdiction.[9] That means, we label someone as a "potential freelancer" if he reports a profession that would be a freelance profession if he were self-employed, no matter if he is actually self-employed or not. For example, a physician can be employed in a hospital, unemployed/not working, or self-employed. In the latter case she would be a freelancer in the sense of the law. Thus, we interpret all physicians as "potential freelancers", i.e. she would be a freelancer if she decided to become self-employed. All individuals not classified as "potential freelancers" are labelled as "potential tradesmen". We apply the same procedure for the Mikrozensus data; here, we apply the procedure for the analysis of self-employment spells as well, because the Mikrozensus does not provide the information if a self-employed person is a freelancer.

This approach is only valid under the assumption that individuals do not change their profession between potential freelance professions and potential trade professions when they decide to enter or exit self-employment, because that would mean individuals are switching from control to treatment group or vice versa. We are confident that this assumption is realistic, though, because most professions require specific education and work experience; this is especially true for freelance professions which are usually specialised academic professions. Some exceptions may exist, but should not bias our estimates because there is no reason to expect that switchers follow a systematic rule.

In both datasets we use, individuals who are unemployed and those not participating in the labour force usually do not report a profession. So our data does not provide obvious criteria to determine if they are likely to become a tradesman or a freelancer if they become self-

[8] To be precise, in the German tax legislation it is also possible to be self-employed without being tradesman, freelancer, or farmer, e.g. private asset managers and executors of a will. These infrequent professions are neither coded in the SOEP nor in the Mikrozensus, however, and because of their small number, they can be neglected in our analysis.

[9] Table A 1 in the appendix lists the professions we classify as "potential freelance professions"; all other professions are classified as "potential trade professions". Note that classification is sometimes ambiguous, so this can only be an approximation.

employed. By assumption, we label them as "potential tradesmen". This somewhat arbitrary classification will not distort our estimation of the effect of the tax reforms, however, because it is unlikely that the income of formerly unemployed or not working individuals will be above the threshold in the first year of starting up their own business. Thus, they are part of the control group anyway and the distinction between tradesman and freelancer is not relevant here.

Apart from distinguishing between tradesmen and freelancers, the second dimension for separating out the treatment group requires determining if the individuals' gross income from self-employment are above the threshold defined by the income tax law, since only tradesmen with income above the threshold benefited from the top marginal tax rate limitations. As the threshold first set in 1994 was reduced in 1999 and 2000 (see section 3 for the exact nominal thresholds), we create a dummy variable indicating if an individual's income is above the 1994 threshold and another one indicating if it is above the 2000 threshold. We do not treat the 1999 threshold separately, first because it is not substantially different from the 2000 threshold, and second, because the two steps of the second reform (1999 and 2000) were part of the same act, the Tax Relief Act 1999/2000/2002, and we treat the act as a single reform. In 1999, when the act was passed, agents already knew about the threshold and tax rate they would face in 2000, and it is likely that they adjusted their expectations and their behaviour with respect to the legislation in 2000, and not to the temporary situation in 1999.

For the self-employed, we observe their income from self-employment directly.[10] For the dependently employed, unemployed and not working individuals, we have to estimate the counter-factual income they would earn if they decided to be self-employed. Both using the SOEP and the Mikrozensus, we select the self-employed and estimate Mincer-type earnings regressions of income from self-employment on a set of demographic and human capital and work related variables. More precisely, we choose education dummies, age and its square, number of children, dummies indicating marital status, and regional dummies as explanatory variables; using the SOEP, we can also include lifetime experience in full-time and part-time employment and unemployment, the duration of the self-employment spell and its square, and firm size and industry dummies[11]; using the Mikrozensus, we also include dummies indicating the city size. We estimate these earnings regressions separately for males and females and for each year. Then we use the estimated equations to predict counter-factual income from self-

[10] To use the Mikrozensus, we have to make the assumption that the self-employed do not have additional wage and salary or capital income.

[11] The industry dummies are normalised in such a way that the base category represents the average industry effect. This allows to predict earnings accurately for the unemployed and not working individuals as well, for whom we do not observe an industry, by assigning them the average effect across all industries.

employment for those who are not self-employed.[12] In the model of the probability of being self-employed, we also use predicted income from self-employment for the self-employed in order to treat all observations in the same way.

The Mikrozensus has two limitations concerning the income information: First, only net income is given; and second, the information is only available in form of a categorical variable with 18 net income classes until 1999 and 24 classes from 2000 onward. To deal with the second problem, we approximate a self-employed person's net income by the interval midpoint of his income class and use it as the dependent variable in the regression of self-employment earnings described above. To address the other problem, we use a simple function to compute a proxy for gross income from the predicted net income. As we are not interested in an individual's exact income, but only need to know if the gross income exceeds the threshold, we consider these approximations to be sufficient. Bach, Corneo and Steiner (2005) calculated average income tax rates for different income deciles in Germany for the year 1998. The thresholds we are interested in lied in the 8th income decile, where the average income tax rate was 14.5% (including the so-called solidarity surcharge – *Solidaritätszuschlag*). The other way round, net earnings have to be multiplied by 1.168 to calculate gross earnings. For our analysis it does not matter that the true progressive tax schedule is flatter for income deciles at the bottom of the distribution and steeper for top deciles. As we are only interested in determining if an individual's gross income is above the threshold, we can replace the true monotonically increasing function, which calculates gross income from net income, by any other monotonically increasing function, as long as it crosses the gross income threshold at the same value of net earnings as the true function. This condition is satisfied by the linear function with the slope 1.168 which replicates the average tax rate of the 8th decile. In a future refined version of this research, however, a more accurate tax function that takes into account the marital status and other influential individual factors should be applied. Note that using the SOEP, the problem of calculating gross income does not occur, as gross income is directly provided.

We have to make a choice whether to use real or nominal incomes. As the income threshold defined by the tax law refers to nominal income, at first sight it seems reasonable to use nominal incomes in order to decide who is really affected by the law. If we used nominal incomes, however, individuals would creep up from the low income group to the high income group with time just due to inflation. Haan and Steiner (2005) showed that this bracket creeping effect is quite strong in the German tax system. For the application of the difference-

[12] The regression and prediction results are available from the authors upon request.

in-difference estimation method, such a systematic flow from the control group to the treatment group has to be avoided. What really matters for the analysis is a split between richer and poorer individuals, and we need a definition that is consistent and stable over time. Thus, we decide to deflate all incomes (and also the thresholds defined by the law) using the Consumer Price Index.

4.4 Descriptive Statistics

In this study, we analyse the rates of transitions into and out of self-employment and the overall rate of self-employment as an occupational choice. The mean annual entry and exit rates and the average self-employment rate, based both on the SOEP and the Mikrozensus samples, are shown in Table 2. The exit rates are given as percentages of self-employed persons, whereas the entry rates are given as percentages of employed, unemployed and inactive people. As the latter group is much larger in size, the entry rates are naturally much smaller then the exit rates.

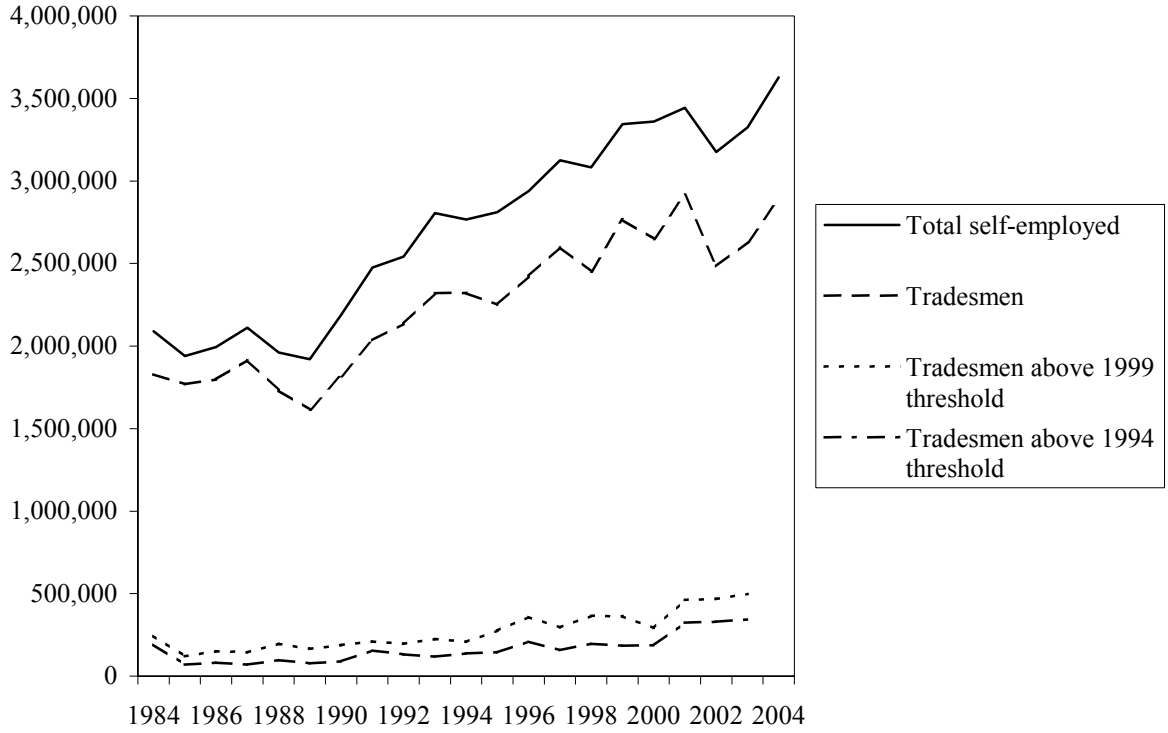
Table 2: Mean yearly transition and self-employment rates (in %)

Outcome variable	Weighted mean value (percent)	Size of sub-sample (person-years)
SOEP 1984-2001		
Yearly exit rate from self-employment	12.47	4,103[1]
Yearly entry rate into self-employment	1.31	95,942[2]
Self-employment rate	6.16	92,079[3]
Mikrozensus 1996-2001		
Yearly exit rate from self-employment	12.07	40,289[4]
Yearly entry rate into self-employment	1.15	662,617[5]
Self-employment rate	6.57	741,545

[1] currently self-employed individuals, waves 1984-2000
[2] individuals who are not currently self-employed, waves 1984-2000
[3] individuals whose employment status in the previous year (*t*-1) is observed, waves 1984-2001
[4] individuals who were self-employed in the previous year (*t*-1)
[5] individuals who were dependently employed, unemployed or inactive in the previous year (*t*-1)

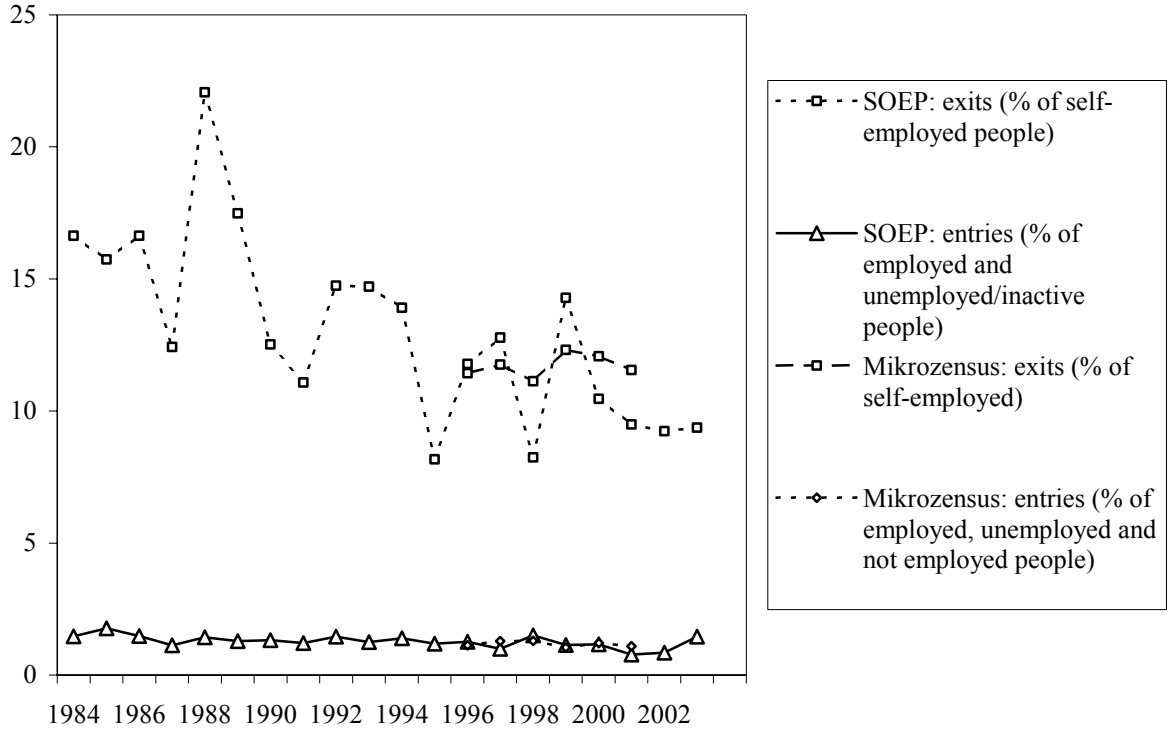
From the static view we move on to a dynamic view. Figure 4 shows the development of self-employment in Germany between 1984 and 2003, based on the weighted SOEP data. The most evident finding is that the number of self-employed persons has increased significantly during the last 20 years. The growing importance of self-employment in the German labour market has been described in other studies, e.g. by Duschek et al. (2003), who investigated the period 1985 to 2001 using the Mikrozensus, and is backed by official statistics provided by the Federal Agency for Employment (Bundesagentur für Arbeit 2004). Figure 4 also depicts the numbers of self-employed tradesmen and of those with income above the thresholds defined by the tax law (see section 3), revealing that these sub-groups follow roughly the same trend.

Figure 4: Number and composition of self-employed persons in Germany (SOEP, weighted)



The development of the transition rates into and out of self-employment over the years is shown in Figure 5, based on weighted SOEP data for all years and weighted Mikrozensus data for 1996-2001 only. Again, the exit rates are much higher than the entry rates, because the exit rates are measured relative to the small number of self-employed persons, whereas the entry rates are measured relative to the large number of employed, unemployed and inactive people. For the years 1996-2001, the figure also shows that the rate of exit from self-employment is much more volatile when measured using the SOEP than when measured using the Mikrozensus, which can be explained by the larger standard error in the SOEP due to the much smaller sample size. The directions of the movements of the exit rates based on the two datasets are the same in all these years, however, which graphically confirms that both datasets actually reflect the same process, where the SOEP sample just has a greater standard error.

Figure 5: Transition rates into and out of self-employment (weighted)



Do self-employed people differ in observable characteristics from those in the alternative employment states, i.e. dependent employment or unemployment/inactivity, and how? Extensive literature suggests that there are significant differences; one reason might be that entrepreneurship requires specific human capital (see, for example, Lazear 2004 and Blanchflower 2004). Table 3 and Table 4 show descriptive statistics based on the SOEP and the Mikrozensus, respectively, and confirm that there are important differences between the groups.[13] Among the self-employed, the share of females is much smaller (30-34%, depending on the dataset) than among the employees (44-47%), and it is highest among the inactive and unemployed persons (63-78%). With a mean of 44-45 years, self-employed people are on average older than employees, who are on average 40-41 years old. Self-employed individuals are most likely to have a university degree, and unemployed/inactive people are the least likely. Among the three groups, employees most often completed an apprenticeship. In the SOEP data, we can observe if the father is or was self-employed, which is true for 23% of the self-employed persons, but only for 10% of those not self-employed. Using the Mikrozensus, we also evaluate information about the spouse's working status and income. 52% of the self-employed have a spouse who is working, but only 45% of the

[13] Differences between the two *datasets* can in part be explained by the different period of observation, which is 1984-2000 in case of the SOEP and 1996-2001 in case of the Mikrozensus; another reason are different definitions of some variables. For the exact definitions of the variables in the two datasets, see Table A 2 and Table A 3 in the appendix.

employees and only 33% of the unemployed/inactive people. In spite of this, the average spouse's income is highest in the group of inactive and unemployed people, probably because a married person is more likely to opt out of working if the spouse has a high income.

The retrospective question about last year's employment status available in the Mikrozensus provides some interesting insights. 78% of self-employed persons were already self-employed the year before, indicating a substantial state dependence. This finding strongly suggests that it is necessary to control for duration dependence in the econometric model (see section 5.2). 12% of the self-employed were dependently employed in the year before, but only 1.5% were unemployed and another 1.5% were inactive; transitions from employment to self-employment seem to be the most relevant route of entry into self-employment. Employment and unemployment/inactivity also exhibit strong state dependence: 88% of employees were already employees the year before, and 85% of the unemployed/inactive were in the same state before (15.9% were unemployed and 69.4% were inactive).

Based on our finding that observable differences between the three employment state groups are evident in the two datasets, we can conclude that it is necessary to control for these observable characteristics in the empirical model (see section 5.1).

Table 3: Weighted mean characteristics by employment status (SOEP 1984-2000)

Variable	Unit	Self-employed persons[1)]	Employees	Unemployed/ inactive persons
Female	%	33.59	44.32	78.27
East Germany	%	11.42	14.61	12.80
High school	%	33.06	17.28	9.95
Apprenticeship	%	41.25	51.23	42.62
Higher technical college	%	27.89	19.83	17.53
University	%	25.90	13.63	6.95
Age	years	44.06	40.54	43.73
Full time work experience	years	17.11	15.26	10.30
Part time work experience	years	1.47	1.64	1.48
Unemployment experience	years	0.35	0.40	1.13
Disabled	%	3.64	5.90	9.42
German	%	95.38	90.80	87.82
Children under 17 in household	number	0.62	0.57	0.78
Married	%	65.79	62.13	75.59
Separated	%	3.03	1.75	1.97
Divorced	%	9.67	7.95	7.04
Self-employed father	%	22.62	9.99	9.53
Home ownership	%	55.34	40.40	42.77
Employment status spell duration	years	6.61	8.37	3.46
Person-year observations[2)]	number	8831	107169	39185

1) Individuals are classified as self-employed when they report non-farm self-employment as their primary activity (excluding help in family business)

2) Individuals between 18 and 65 years

Table 4: Weighted mean characteristics by employment status (Mikrozensus 1996-2001)

Variable	Unit	Self-employed[1] persons	Employees	Unemployed/ inactive persons
Female	%	29.57	46.74	62.99
East Germany	%	20.23	22.13	25.06
Age	years	44.58	40.14	49.57
Secondary school: no answer	%	6.20	5.73	11.69
Sec. school: Gymnasium	%	29.43	15.04	8.23
Sec. school: Realschule	%	34.58	39.62	24.68
Sec. school: Hauptschule	%	29.79	39.61	55.39
Professional qualification: no answer	%	15.26	17.92	36.48
Apprenticeship	%	41.02	63.52	53.72
Master craftsman	%	17.92	7.04	4.03
Advanced technical college	%	7.60	4.79	2.39
University	%	18.20	6.72	3.37
German	%	94.36	93.68	91.04
Children under 18 in household	number	0.65	0.63	0.50
Married	%	70.35	63.67	71.18
Spouse's income per month	€ 1,000	0.917	0.707	0.955
Spouse's working status: no answer	%	32.95	38.81	31.21
Spouse is working	%	52.25	44.95	32.60
Spouse is not working	%	14.80	16.24	36.19
Other household income per month	€ 1,000	1.180	1.102	1.208
City size: up to 20,000	%	45.02	45.43	42.86
City size: 20,000-500,000	%	37.61	40.11	41.75
City size: more than 500,000	%	17.37	14.47	15.39
Empl. status previous year: no answer	%	7.10	5.58	3.36
Employee in previous year	%	12.40	88.31	10.85
Self-employed in previous year	%	77.53	0.84	0.53
Unemployed in previous year	%	1.47	2.87	15.85
Not employed in previous year	%	1.50	2.39	69.41
Person-year observations[2]	number	71344	616087	356772

1) Individuals are classified as self-employed when they report non-farm self-employment as their primary activity (excluding help in family business)

2) Individuals between 18 and 65 years

In section 4.3 we described how we defined treatment and control groups to be able to interpret the tax reforms we analyse as natural experiments. Table 5 presents descriptive statistics for the treatment group "tradesmen with income above the 1999 (reform) threshold" and the control groups "tradesmen with lower income" and "freelance professionals". To get a picture of the characteristics of the actual self-employed tradesmen and freelancers, we base this analysis on the sub-sample of the self-employed. We use the SOEP to derive the statistics, because the SOEP directly distinguishes between self-employed tradesmen and freelancers, so there is no ambiguity in separating the groups in contrast to the Mikrozensus, where we have to base the group assignment on the reported profession (see section 4.3).

The table reveals important differences between the treatment and the control groups. Only 9% of the treatment group members are female, whereas 39% of the tradesmen with income below the threshold and 35% of the freelancers are women. 63% of the freelancers have a university degree, but only 24% of the tradesmen above the income threshold and even only 13% of those below the threshold. The reason is that almost all freelance professions are academic professions, whereas many of those we call tradesmen are craftsmen, shopkeepers etc. Those in the treatment group are also more likely to have a self-employed father (26% vs. 19% in the two control groups). Not surprisingly, home ownership is more common among the high-income treatment group than among the other groups.

Table 5: Weighted mean characteristics by treatment and control groups (self-employed persons[1)] in the SOEP 1984-2000)

Variable	Unit	Tradesmen with income above 1999 threshold	Tradesmen with lower income	Freelance professionals
Female	%	9.07	38.88	35.13
East Germany	%	6.30	14.78	11.88
High School	%	28.09	21.56	65.31
Apprenticeship	%	47.42	47.12	22.60
Higher Technical College	%	32.75	29.77	18.86
University	%	24.07	13.23	62.63
Age	years	43.89	43.43	42.19
Full Time Work Experience	years	20.22	17.26	12.22
Part Time Work Experience	years	0.23	1.73	1.95
Unemployment experience	years	0.32	0.45	0.36
Disabled	%	4.59	2.86	1.45
German	%	96.34	96.40	95.45
Children	number	0.67	0.65	0.73
Married	%	67.04	67.39	61.05
Separated	%	2.56	2.11	3.93
Divorced	%	11.62	8.86	13.20
Self-employed Father	%	26.03	18.99	19.44
Home Ownership	%	61.82	54.56	47.62
Employment Status Spell Duration	years	8.04	6.59	5.88
Actual Weekly Work Hours	hours	54.90	47.78	39.63
Person-year observations[2)]	number	782	3252	1288

1) Individuals are classified as self-employed when they report non-farm self-employment as their primary activity (excluding help in family business)
2) Individuals between 18 and 65 years

5 Empirical Methodology

In this section, we describe the econometric methods we rely on to analyse the effect of the tax rate reductions on entrepreneurial choice. Our identification strategy for the treatment effect, the difference-in-difference-in-difference (DDD) technique, is described in section 5.1. To control for observable covariates, most notably the important effect of the duration of an employment spell on the decision to switch employment state, we employ the DDD method within a discrete time hazard rate model, which will be derived in section 5.2. Additionally, we apply a selection model for the probability of being self-employed (section 5.3). In section 5.4, we describe which control variables we chose and the motivation for this choice.

5.1 Identification

In this study we follow the "natural experiment approach". As researchers cannot study the effects of taxation in a laboratory experiment, the basic idea of this strategy is to interpret a legislation reform itself as an experiment. It is crucial to find a naturally occurring comparison group which can mimic the properties of the control group in a randomized laboratory setting. If such a comparison group can be identified, one can compare the difference in average behaviour of the eligible group before and after the reform with the difference in behaviour of the comparison group. This "difference in difference" represents the average treatment effect on the treated, i.e. the average effect of the reform on those affected by the reform (see, for example, Blundell and Costa Dias 2000).

The two tax reforms we exploit as natural experiments in this study were described in section 3. These legislation changes affected tradesmen with incomes above a certain threshold defined by the tax law and provided naturally identified comparison groups, namely freelance professionals and individuals with incomes below the threshold (see section 4.3). The outcome variables we are interested in are transitions into and out of self-employment and the decision to be self-employed. Applying the "difference-in-difference" (DD) approach in this context means to compare the difference in the average outcome variables of the high-income tradesmen before and after each reform with the before and after contrast of the comparison groups to measure the average effect of the reforms on the high-income tradesmen, which is the average treatment effect on the treated. As the tax reforms we study provide two independent dimensions to distinguish the treatment group from the control groups, i.e. the separations by profession and by income, we can go beyond the simple DD approach and apply a "difference-in-difference-in-difference" (DDD) estimator (Gruber

1994). We implement the method in a regression framework to be able to control for observable covariates that affect the outcome variables of interest. This way we can account for observable differences between treatment and control groups (see section 4.4) and for changing compositions of these groups, and the efficiency of the estimated treatment effects is improved. The following regression equation for the linear probability model illustrates the DDD estimator:

$$\begin{aligned}\text{Prob}\left(y_{it}=1\middle|a_{it},b_t,c_{it},d_t,e_{it},X_{it}\right)= \alpha \\ &+\delta_1 a_{it}+\delta_2 b_t+\delta_3 c_{it} \\ &+\delta_4(a_{it}\times b_t)+\delta_5(b_t\times c_{it})+\delta_6(a_{it}\times c_{it}) \\ &+\delta_7(a_{it}\times b_t\times c_{it}) \\ &+\delta_8 d_t+\delta_9 e_{it} \\ &+\delta_{10}(a_{it}\times d_t)+\delta_{11}(d_t\times e_{it})+\delta_{12}(a_{it}\times e_{it}) \\ &+\delta_{13}(a_{it}\times d_t\times e_{it}) \\ &+X_{it}\beta+\varepsilon_{it}\end{aligned} \qquad (1)$$

In this equation, i indexes individuals and t indexes years. Prob(·) is the response probability (the outcome variable y_{it} is a dummy indicating transition into or out of self-employment, or being self-employed, depending on the model). α is the intercept, X_{it} is the row vector of covariates, β is the corresponding column vector of coefficients, and ε_{it} is the error term. a to e denominate dummy variables (= 0 in the base case):

a_{it} = 1 if i is classified as a potential tradesman in t.

b_t = 1 if t is after the 1994 reform and before the 1999 reform.

c_{it} = 1 if i's income in t is above the threshold defined in 1994.

d_t = 1 if t is after the 1999 reform.

e_{it} = 1 if i's income in t is above the threshold defined in 1999.

The second-level interactions control for differences in the behaviour of the treatment and control groups that are not due to the tax reforms we study. The linear effects in the interactions with b and d capture reform-independent differential time trends that affect all tradesmen or all high-income individuals, and the other interactions control for time-invariant differences between high-income tradesmen and other people. The coefficient of the third-level interaction, δ_7, is the DDD estimate of the impact of the 1994 reform. It captures the effect of the 1994 reform on the response probability of the treated, i.e. tradesmen with income above the 1994 threshold. To measure the impact of the 1999 reform as well, we include d and e and their interactions. δ_{13} is the DDD estimate of the cumulative effect of the 1994 and the 1999 reforms. It represents the change in the response probability of tradesmen with income above the 1999 threshold after the 1999 reform. Using the Mikrozensus, we can

only analyse the second reform because cross-sections in years before 1996 did not have information crucial to the analysis (see section 4.1).

The identifying assumption of the DDD estimator is comparably weak: It requires that there be no time trend that affects tradesmen with income above the threshold in a different way than tradesmen and high income individuals in general. That means, if a contemporaneous shock affects all tradesmen, *or* if it affects all individuals with high income, our assumption is *not* violated, because the DDD method controls for such shocks. Other legislation changes that concerned companies, for example, affected all self-employed individuals and thus do not bias the DDD estimator. The identifying assumption includes the requirement that there be no systematic composition changes within the treatment and comparison groups. In our setting, these groups can change composition; individuals can switch groups when their income moves across the threshold, for example. There is no reason, though, to suspect such composition changes are systematic. More importantly, we can statistically control for composition changes due to observable characteristics in our regression framework.

In principle, given these identifying assumptions, the model given by equation (1) could be estimated by the "ordinary least squares" (OLS) method. This approach has various shortcomings, however. The estimation of the coefficients would be inefficient because of the inherent heteroscedasticity of the error terms due to the binary dependent variable, and the data-coherency condition would be violated, since expected values of the dependent variable would fall outside the 0/1 interval. These limitations could be overcome by applying logit or probit models, but even then, the model would not be appropriate to study transitions between employment states since it does not account for censoring of observation periods.

5.2 Econometric specification

Instead of the simple linear probability model given above for illustration, we implement hazard rate models to explain the transitions into and out of self-employment. This enables us to estimate the probability of a transition conditional on the duration of the current spell in self-employment, employment or unemployment/inactivity. Conceptually, the duration of these spells can be any integer number of days. We use yearly data, because interviews for both the SOEP and the Mikrozensus are conducted once a year, and the covariates are not available on a higher frequency. As the hazard rate is still small even in intervals of a year (see Table 2), a discrete time logistic hazard model based on years can be interpreted as an approximation for an underlying continuous time model in which the within-year durations follow a log-logistic distribution (Sueyoshi 1995).

We model exit from self-employment and entry into self-employment analogously; in the following, a spell refers to a self-employment spell in the exit model and to an employment or unemployment/inactive spell in the entry model. Individuals can experience multiple spells in the observation period. The discrete non-negative random variable T_{ik} describes the duration of the *k*-th spell of individual *i*. When a spell terminates in year *t* (measured from the beginning of the spell), T_{ik} takes on the value $T_{ik} = t$. The hazard rate $\lambda_{ik}(t)$ is defined as the probability that spell *k* of person *i* ends in period *t*, i.e. a transition occurs[14], conditional on survival until the beginning of *t*:

$$\lambda_{ik}\left(t\middle|X_i(t),\varepsilon\right)=P\left(T_{ik}=t\middle|T_{ik}\geq t,X_i(t),\varepsilon\right). \qquad (2)$$

where $X_i(t)$ is a vector of characteristics of individual *i* in interval *t*, including the DDD dummy variables *a*-*e* and their interactions as described in section 5.1, and ε is a time-invariant individual effect.

The probability of remaining in the current spell ("survival") in period *t*, conditional on having survived until the beginning of *t*, is the complementary probability

$$P\left(T_{ik}>t\middle|T_{ik}\geq t,X_i(t),\varepsilon\right)=1-\lambda_{ik}\left(t\middle|X_i(t),\varepsilon\right). \qquad (3)$$

The survivor function, which gives the *unconditional* probability of remaining in the current spell until the end of period *t*, can be written as the product of the survival probabilities in all periods before and in *t*:

$$S\left(t\middle|X_i,\varepsilon\right)=P\left(T_{ik}>t\middle|X_i,\varepsilon\right)=\prod_{\tau=1}^{t}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right). \qquad (4)$$

Consequently, the unconditional probability of a transition in period *t* is the probability of survival until the beginning of period *t* multiplied by the hazard rate in period *t*:

$$P\left(T_{ik}=t\middle|X_i,\varepsilon\right)=\lambda_{ik}\left(t\middle|X_i(t),\varepsilon\right)\prod_{\tau=1}^{t-1}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right). \qquad (5)$$

We employ the maximum likelihood method to estimate the model. For a spell completed with a transition into or out of self-employment (in the entry or exit model, respectively), the contribution to the likelihood function is given by equation (5). For a right-censored spell, i.e. we only know that a person "survived" till the end of the observation period, but do not know when the spell will end, the likelihood contribution is given by the survivor function (4). Combining these two cases, the likelihood contribution of a spell *k* of an individual *i* can be written as

[14] In the entry model, a transition from employment to unemployed/inactive or vice versa is treated as censored, because we are only interested in transitions to self-employment.

$$L_{ik}^{\text{not left-censored}}\left(param.\middle|c_i,X_i,\varepsilon\right)=\left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}\right]^{c_{ik}}\prod_{\tau=1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right) \quad (6)$$

where c_{ik} is a censoring indicator defined such that $c_{ik} = 1$ if a spell is completed and $c_{ik} = 0$ if a spell is right-censored. If a spell is left-censored in the SOEP, i.e person *i* enters the panel after the spell *k* has already lasted u_{ik} years, we have to condition on survival up to the end of period u_{ik}, which means dividing expression (6) by $S(u_{ik})$. Then the likelihood contribution of the spell is

$$\begin{aligned}L_{ik}\left(parameters\middle|c_i,X_i,\varepsilon\right)&=\left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}\right]^{c_{ik}}\frac{\prod_{\tau=1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right)}{\prod_{\tau=1}^{u_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right)}\\&=\left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}\right]^{c_{ik}}\prod_{\tau=u_{ik}+1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right)\end{aligned} \quad (7)$$

Note that this more general notation includes equation (6) for spells that are not left censored ($u_{ik}=0$). In the SOEP, the retrospective employment history questions enable us to recover u_{ik} for self-employment and employment spells, so we do not have a left-censoring problem.[15]

The overall likelihood contribution of an individual *i* is the product of the likelihood contributions of the K_i spells he experienced in the observation period, and the sample likelihood function is given by the product of the individual likelihood contributions:

$$L\left(parameters\middle|c,X,\varepsilon\right)=\prod_{i=1}^{N}\prod_{k=1}^{K_i}L_{ik} \quad (8)$$

The log-likelihood function is

$$\begin{aligned}&\log L\left(parameters\middle|c,X,\varepsilon\right)=\sum_{i=1}^{N}\sum_{k=1}^{K_i}\log L_{ik}\\&=\sum_{i=1}^{N}\sum_{k=1}^{K_i}c_{ik}\log\left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_i(t_{ik}),\varepsilon\right)}\right]+\sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\log\left[1-\lambda_{ik}\left(\tau\middle|X_i(\tau),\varepsilon\right)\right]\end{aligned} \quad (9)$$

We define a new binary indicator variable $y_{ik\tau} = 1$ if person *i* completes spell *k* in period τ, and $y_{ik\tau} = 0$ otherwise. The $y_{ik\tau}$ correspond to the transition dummy variables introduced in section 4.2. Effectively adding some zeros to the sum, we can write

[15] For unemployment spells, however, we do not know how much time the unemployment period has lasted if a person is already unemployed when first entering the panel, so here a potential left censoring problem remains. For simplification, we assume the unemployment spell starts with entry into the panel in these cases. Moreover, if a person switched jobs within dependent employment or self-employment before entering the panel, the only information we have is the time passed since the job change, but not the duration of the overall spell in dependent employment or self-employment, respectively. We assume such job changes without changing the employment state did not occur in the partly observed spells before entering the panel.

$$\log L\left(parameters\middle| y, X, \varepsilon\right)$$
$$= \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}} y_{ik\tau}\log\left[\frac{\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon\right)}{1-\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon\right)}\right]+\sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\log\left[1-\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon\right)\right] \qquad (10)$$
$$= \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\left(y_{ik\tau}\log\left[\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon\right)\right]+(1-y_{ik\tau})\log\left[1-\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon\right)\right]\right)$$

The last expression has exactly the same form as the standard likelihood function for a binary regression model in which $y_{ik\tau}$ is the dependent variable and in which the data is organised in person-period format. This derivation represents a generalisation of the "easy estimation method" available for discrete time hazard models (see Jenkins, 1995) with respect to multiple spell data.

Even conditional on the explanatory variables, all observations for a given individual, both within and between spells, can be expected to be correlated due to the individual effect ε, which represents the unobserved heterogeneity in the population that is not controlled for by the included control variables. This unobserved heterogeneity could, for example, relate to the ability to be an entrepreneur, attitude towards risk and the motivation to be independent. We specify the individual effect ε in a nonparametric way and assume an arbitrary discrete probability distribution with a small number M of mass points ε_m with the probabilities $P(\varepsilon_m)$ (cf. Heckman and Singer, 1984, and Steiner, 2001). Here, we assume M = 2 mass points for each model. The following conditions have to be satisfied:

$$E(\varepsilon)=\sum_{m=1}^{M}P(\varepsilon_m)\varepsilon_m=0 \quad \text{(zero expected value assumption);}$$
$$\sum_{m=1}^{M}P(\varepsilon_m)=1 \quad \text{(probabilities sum up to unity);} \qquad (11)$$
$$E\left(\varepsilon X\right)=0 \quad \text{(indiv. effect is uncorrelated with explanatory var.).}$$

We estimate the mass points ε_m and their probabilities $P(\varepsilon_m)$ jointly with the parameters of the model by adjusting the likelihood function:

$$L\left(parameters\middle| y, X\right)=$$
$$\prod_{i=1}^{N}\sum_{m=1}^{M}P\left(\varepsilon_m\right)\prod_{k=1}^{K_i}\prod_{\tau=u_{ik}+1}^{t_{ik}}\left(\left[\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon_m\right)\right]^{y_{ik\tau}}\left[1-\lambda_{ik}\left(\tau\middle| X_i(\tau),\varepsilon_m\right)\right]^{(1-y_{ik\tau})}\right) \qquad (12)$$

This maximum likelihood function is valid under the assumption that all observations are independent conditional on the explanatory variables and the individual effect.

We still have to specify the functional form of the hazard rate. We choose a logistic hazard model. As mentioned before, this model is consistent with an underlying continuous time

model in which the within-interval durations follow a log-logistic distribution. The hazard rate is specified as

$$\lambda_{ik}\left(t\middle|X_i(t),\varepsilon\right)=\frac{\exp\left(f(t)+X_i(t)\beta+\varepsilon\right)}{1+\exp\left(f(t)+X_i(t)\beta+\varepsilon\right)}, \qquad (13)$$

where the function f(t) represents the dependence of the hazard rate on the spell duration (baseline hazard) which we specify as a polynomial function of the third degree. Given the logit specification of the hazard rate, the likelihood function (12) can be maximised with respect to the coefficients of the baseline hazard, the explanatory variables, and the mass points and their respective probabilities, subject to the constraints on the individual effects, by standard numerical optimisation procedures.[16]

As mentioned in section 4.1, using the Mikrozensus, no information about the duration of a spell is available. Hence, in contrast to the SOEP, we have to assume that the hazard rate does not depend on spell duration, i.e. the coefficients of the baseline hazard are assumed to be zero. Moreover, as we observe each individual in a single cross-section only, we do not need to control for individual heterogeneity and exclude ε from the model specification. As a result, the model estimated on the basis of the Mikrozensus is equivalent to a simple binary logit model.

5.3 Self-employment Selection Model

We use the hazard rate models described above to estimate transition rates into and out of self-employment. In principle, the long-term equilibrium self-employment rate can be calculated based on the flows into and out of self-employment. As a consistency check of our estimations of the transition rates, we decided to additionally estimate the probability of *being* self-employed in a given year. This enables us to estimate the short term effect of the variables, especially the DDD variables, on the self-employment rate directly.

For the analysis of the probability of being self-employed, we include the dependently employed, the self-employed, the unemployed and the inactive individuals in the sample. We specify a logit model of binary choice. Using the SOEP, again we control for individual unobserved heterogeneity nonparametrically with two mass points, as described in section 5.2. As additional explanatory variables we include dummies indicating the employment status in the year prior to the interview.

[16] We use the Stata programme gllamm version 2.3.10. for the estimations. A descriptions of gllamm is provided by Rabe-Hesketh and Skrondal (2004).

5.4 Motivation of Variables

The descriptive statistics in section 4.4 revealed that there are important observable differences between the treatment and comparison groups. It is thus necessary to control for these differences in the econometric models, as explained in section 5.1. Due to different sample designs in the SOEP and the Mikrozensus, some of the variables we include are defined differently in the two datasets, and some variables are only included in one of the datasets; see Table A 2 and Table A 3 in the appendix for a list of the chosen explanatory variables and their exact definitions. In both datasets, we include age and its square, the number of children, and dummy variables indicating gender, location in eastern Germany, marital status, education and professional qualification. Using the SOEP, we generate variables representing full time and part time work experience and unemployment experience in years and their square terms. By including this information, we account for the view that work experience builds up human capital, while unemployment experience might devaluate it. Importantly, these effects might have a different impact on self-employment than on dependent employment (Niefert 2005). Using the Mikrozensus, we add some different control variables: employment status of the respondent's spouse and the spouse's income (if the respondent is married), other household income, and the size of the respondent's residence city in the year prior to interview (to avoid the potential endogeneity of the city size).[17]

In the SOEP-based hazard rate models of transition into and out of self-employment, we include the duration of the spell in the current employment state (see section 5.2). In the Mikrozensus, the only information provided is the employment state in the previous year. Note that in the model of exit from self-employment, the current spell is necessarily a self-employment spell, while in the model of entry into self-employment, we distinguish between the possible spell types before entering self-employment: "employed" or "unemployed/inactive", as the base category, in the SOEP; and "employed", "inactive", or "unemployed", as the base category, in the Mikrozensus.

In the model of the probability of being self-employed, the sample additionally contains those who were self-employed in the year prior to the interview, and those for whom no information about last year's employment status is available (in the Mikrozensus). Using the Mikrozensus, this means the categories "self-employed in the previous year" and "no information" are

[17] Liquidity constraints are another potentially important factor in the decision to be an entrepreneur, as pointed out by an extensive literature, e.g. Evans and Jovanovic (1989) and Schäfer and Talavera (2005). Neither the SOEP nor the Mikrozensus provide unproblematic information about a respondent's wealth, however. Home ownership could be used as a proxy for wealth, for example, but we decide not to include this or similar variables because such wealth indicators are potentially endogenous.

added to the categories already included in the entry model. Using the SOEP, for this model we include dummy variables indicating the employment state in the previous year ("employed" and "self-employed", "unemployed/inactive" is the base category) instead of the spell duration variables.[18]

6 Estimation Results

As described above, we estimated three models: The probability of exit from self-employment, the probability of entry into self-employment and the probability of being self-employed. Each model was estimated both with the SOEP and the Mikrozensus datasets. Table 6 reports the results based on the SOEP, and Table 7 the results based on the Mikrozensus. The left three columns of the tables show the logit coefficients of the three different models (exit, entry and self-employed status) and their robust standard errors. The right three columns provide the estimated marginal effects for the three models, evaluated at the respective sample means. The marginal effects indicate the change in the estimated probabilities in percentage points ("0.01" in the table means "1%"), given an increase of the corresponding explanatory variable by one unit if the variable is measured on a metric scale; for dummy variables, the "marginal" effects measure the probability change corresponding to a discrete switch of the variable from zero to one.[19] When interpreting the economic significance of the marginal effects, it is useful to relate them to the magnitude of the overall probabilities. The corresponding means of the outcome variables in the two data samples are given in Table 2. For the exact definitions of the explanatory variables, see Table A 2 and Table A 3 in the appendix.

[18] Consequently, here we can only include person-year observations for which another observation of the same individual in the previous year is available. This introduces left truncation in the model of the probability of being self-employed using the SOEP, which means that those who frequently switch between employment states are potentially underrepresented in this model.

[19] The interaction effects are calculated as double or triple differences, as pointed out by Ai and Norton (2003). The corresponding standard errors are found by applying the Delta method.

Table 6: Self-employment transition and state probabilities: Logit estimation results and marginal effects (SOEP 1984-2001)

	exit: logit coeff.	entry: logit coeff.	state: logit coeff.	exit: marg. eff.	entry: marg. eff.	state: marg. eff.
a: tradesman[1]	-0.261	0.222	-1.299	-0.026	0.002	-0.028
	(0.243)	(0.293)	(0.191)***	(0.025)	(0.002)	(0.007)***
b: after 94 reform[1]	0.437	0.373	-0.417	0.044	0.004	-0.004
	(0.448)	(0.394)	(0.282)	(0.046)	(0.004)	(0.003)
c: threshold 94[1]	-0.044	-0.005	0.516	-0.004	-0.000	0.007
	(0.961)	(0.419)	(0.295)	(0.092)	(0.004)	(0.005)
a x b[2]	-0.144	-0.178	0.375	-0.020	-0.002	0.012
	(0.348)	(0.362)	(0.244)	(0.038)	(0.004)	(0.008)
b x c[2]	-0.329	-0.934	-0.286	-0.034	-0.009	-0.006
	(1.279)	(0.893)	(0.472)	(0.120)	(0.007)	(0.006)
a x c[2]	0.235	0.320	-0.259	0.023	0.004	-0.020
	(1.093)	(0.460)	(0.326)	(0.113)	(0.004)	(0.016)
a x b x c (DDD 94)[2]	0.320	0.791	0.270	0.039	0.006	0.017
	(1.436)	(0.939)	(0.512)	(0.149)	(0.007)	(0.018)
d: after 99 reform[1]	0.594	0.280	0.266	0.062	0.003	0.003
	(0.452)	(0.493)	(0.312)	(0.050)	(0.005)	(0.004)
e: threshold 99[1]	-2.483	0.673	0.170	-0.172	0.008	0.002
	(0.795)**	(0.380)	(0.270)	(0.038)***	(0.006)	(0.003)
a x d[2]	-0.241	-0.375	-0.125	-0.033	-0.004	-0.009
	(0.385)	(0.471)	(0.295)	(0.044)	(0.005)	(0.012)
d x e[2]	-0.155	-0.643	-0.388	-0.064	-0.008	-0.005
	(1.020)	(0.700)	(0.422)	(0.063)	(0.009)	(0.005)
a x e[2]	0.826	-0.692	0.413	0.051	-0.008	0.002
	(0.888)	(0.407)	(0.289)	(0.038)	(0.006)	(0.010)
a x d x e (DDD 99)[2]	-0.314	0.796	0.542	0.019	0.009	0.019
	(1.205)	(0.745)	(0.455)	(0.066)	(0.009)	(0.016)
female[1]	0.453	-0.425	-0.828	0.046	-0.004	-0.010
	(0.194)*	(0.086)***	(0.077)***	(0.020)*	(0.001)***	(0.001)***
east[1]	-0.533	-0.361	0.026	-0.048	-0.003	0.000
	(0.213)*	(0.102)***	(0.079)	(0.018)**	(0.001)***	(0.001)
highschool[1]	-0.324	0.252	0.445	-0.031	0.003	0.006
	(0.227)	(0.112)*	(0.092)***	(0.021)	(0.001)*	(0.001)***
apprenticeship[1]	0.102	0.106	0.131	0.010	0.001	0.001
	(0.212)	(0.091)	(0.081)	(0.021)	(0.001)	(0.001)
highertechncol[1]	-0.337	0.424	0.537	-0.032	0.005	0.007
	(0.236)	(0.108)***	(0.090)***	(0.021)	(0.001)***	(0.001)***
university[1]	0.207	0.460	0.149	0.021	0.005	0.002
	(0.247)	(0.126)***	(0.102)	(0.025)	(0.002)**	(0.001)
age	-0.181	0.214	0.096	-0.018	0.002	0.001
	(0.073)*	(0.033)***	(0.030)**	(0.007)*	(0.000)***	(0.000)**
agesq	0.002	-0.003	-0.001	0.000	-0.000	-0.000
	(0.001)*	(0.000)***	(0.000)***	(0.000)*	(0.000)***	(0.000)***
ftexp10	-0.508	-0.011	0.333	-0.049	-0.000	0.004
	(0.334)	(0.152)	(0.129)*	(0.032)	(0.001)	(0.001)*
ftexpsq100	0.037	-0.012	-0.025	0.004	-0.000	-0.000
	(0.075)	(0.040)	(0.030)	(0.007)	(0.000)	(0.000)
ptexp10	-0.258	1.427	0.915	-0.025	0.013	0.010
	(0.631)	(0.278)***	(0.228)***	(0.061)	(0.003)***	(0.003)***
ptexpsq100	-0.127	-0.718	-0.295	-0.012	-0.007	-0.003
	(0.316)	(0.168)***	(0.118)*	(0.031)	(0.002)***	(0.001)*
unemexp10	2.986	0.608	-1.718	0.290	0.006	-0.020
	(1.422)*	(0.634)	(0.527)**	(0.139)*	(0.006)	(0.006)**
unemexpsq100	-1.712	-1.450	0.007	-0.166	-0.014	0.000
	(2.075)	(1.008)	(0.781)	(0.202)	(0.009)	(0.009)
disabled[1]	0.035	-0.323	-0.538	0.003	-0.003	-0.005
	(0.465)	(0.172)	(0.151)***	(0.046)	(0.001)*	(0.001)***
german[1]	-0.105	0.039	0.089	-0.010	0.000	0.001
	(0.321)	(0.139)	(0.131)	(0.033)	(0.001)	(0.001)
nchild	-0.010	0.089	-0.014	-0.001	0.001	-0.000
	(0.090)	(0.038)*	(0.035)	(0.009)	(0.000)*	(0.000)
married[1]	0.227	0.096	-0.181	0.022	0.001	-0.002
	(0.222)	(0.104)	(0.091)*	(0.021)	(0.001)	(0.001)
separated[1]	0.150	0.566	0.361	0.015	0.007	0.005
	(0.461)	(0.217)**	(0.200)	(0.048)	(0.003)*	(0.003)
divorced[1]	0.466	-0.055	0.073	0.049	-0.001	0.001
	(0.306)	(0.168)	(0.133)	(0.035)	(0.001)	(0.002)
fatherse[1]	-0.592	0.637	0.638	-0.053	0.008	0.010
	(0.206)**	(0.108)***	(0.090)***	(0.017)**	(0.002)***	(0.002)***

Table 6 continued

	exit: logit coeff.	entry: logit coeff.	state: logit coeff.	exit: marg. eff.	entry: marg. eff.	state: marg. eff.
empl[1]		-0.130	-1.320		-0.001	-0.021
		(0.173)	(0.092)***		(0.002)	(0.002)***
selfemplpy[1]			4.720			0.394
			(0.093)***			(0.021)***
duration	-0.127	-0.411		-0.012	-0.004	
	(0.055)*	(0.126)**		(0.005)*	(0.001)***	
dur_sq	0.008	0.038		0.001	0.000	
	(0.004)*	(0.021)		(0.000)*	(0.000)	
dur_p3	-0.000	-0.001		-0.000	-0.000	
	(0.000)	(0.001)		(0.000)	(0.000)	
dur_e		0.088			0.001	
		(0.131)			(0.001)	
dur_sq_e		-0.021			-0.000	
		(0.021)			(0.000)	
dur_p3_e		0.001			0.000	
		(0.001)			(0.000)	
_cons	2.928	-8.783	-4.746			
	(1.371)*	(0.671)***	(0.588)***			
ε_1	-0.882	-0.326	-0.790	0.054	0.004	0.004
	(0.159)***	(0.077)***	(0.169)***	(0.009)***	(0.001)***	(0.000)***
π_1[3]	0.670	1.954	0.452			
	(0.268)*	(0.263)***	(0.306)			
ll	-1403.94	-5962.26	-6858.07	-1403.94	-5915.88	-6858.07
N	4103[4]	95970[5]	92079[6]	4103[4]	95970[5]	92079[6]

Robust standard errors in paranthesis. Year dummies also included, but not shown for brevity.
[1] marginals for discrete change of dummy variable from 0 to 1
[2] marginals are double difference (triple difference, respectively)
[3] log-odd of probability $P(\varepsilon_1)$
[4] currently self-employed individuals, waves 1984-2000
[5] individuals who are not currently self-employed, waves 1984-2000
[6] individuals whose employment status in the previous year (*t*-1) is observed, waves 1984-2001
* p<0.05, ** p<0.01, *** p<0.001

Table 7: Self-employment transition and state probabilities: Logit estimation results and marginal effects (Mikrozensus 1996-2001)

	exit: logit coeff.	entry: logit coeff.	state: logit coeff.	exit: marg. eff.	entry: marg. eff.	state: marg. eff.
a: tradesman[1]	1.036	-1.006	-1.058	0.068	-0.013	-0.022
	(0.080)***	(0.046)***	(0.036)***	(0.004)***	(0.001)***	(0.001)***
d: after 99 reform[1]	0.016	0.038	-0.019	0.001	0.000	-0.000
	(0.132)	(0.077)	(0.060)	(0.011)	(0.001)	(0.001)
e: threshold 99[1]	-0.651	-0.158	0.028	-0.045	-0.001	0.000
	(0.175)***	(0.078)*	(0.061)	(0.010)***	(0.001)*	(0.001)
a x d[2]	0.172	-0.019	-0.055	0.018	-0.001	-0.000
	(0.128)	(0.076)	(0.059)	(0.007)**	(0.001)	(0.002)
d x e[2]	-0.175	0.109	0.062	-0.009	0.001	0.001
	(0.308)	(0.116)	(0.092)	(0.018)	(0.001)	(0.001)
a x e[2]	-0.506	-0.021	-0.131	-0.061	0.002	-0.002
	(0.200)*	(0.092)	(0.071)	(0.007)***	(0.001)	(0.002)
a x d x e (DDD 99)[2]	-0.045	-0.203	-0.127	-0.019	-0.002	-0.003
	(0.348)	(0.145)	(0.110)	(0.012)	(0.002)	(0.003)
female[1]	0.469	-0.765	-0.743	0.042	-0.006	-0.010
	(0.036)***	(0.028)***	(0.020)***	(0.003)***	(0.000)***	(0.000)***
east[1]	-0.147	-0.449	-0.267	-0.012	-0.003	-0.003
	(0.043)***	(0.033)***	(0.022)***	(0.003)***	(0.000)***	(0.000)***
age	-0.224	0.118	0.176	-0.018	0.001	0.002
	(0.012)***	(0.010)***	(0.007)***	(0.001)***	(0.000)***	(0.000)***
agesqr	0.002	-0.001	-0.002	0.000	-0.000	-0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
schoolna[1]	-0.456	0.454	0.464	-0.032	0.004	0.007
	(0.094)***	(0.057)***	(0.037)***	(0.005)***	(0.001)***	(0.001)***
gymnasium[1]	-0.348	0.686	0.564	-0.027	0.007	0.009
	(0.062)***	(0.047)***	(0.035)***	(0.004)***	(0.001)***	(0.001)***
realschule[1]	-0.283	0.384	0.334	-0.023	0.003	0.005
	(0.041)***	(0.034)***	(0.023)***	(0.003)***	(0.000)***	(0.000)***
qualifna[1]	0.050	0.206	0.090	0.004	0.002	0.001
	(0.051)	(0.040)***	(0.028)**	(0.004)	(0.000)***	(0.000)**
mastercraft[1]	-0.791	0.780	0.796	-0.054	0.009	0.015
	(0.054)***	(0.038)***	(0.027)***	(0.003)***	(0.001)***	(0.001)***
advtechncol[1]	0.174	0.265	0.124	0.015	0.002	0.002
	(0.072)*	(0.054)***	(0.041)**	(0.007)*	(0.001)***	(0.001)**
university[1]	-0.024	0.507	0.399	-0.002	0.005	0.006
	(0.076)	(0.053)***	(0.041)***	(0.006)	(0.001)***	(0.001)***
german[1]	-0.123	0.001	0.106	-0.011	0.000	0.001
	(0.065)	(0.050)	(0.038)**	(0.006)	(0.000)	(0.000)**
nchild17	0.016	0.053	0.031	0.001	0.000	0.000
	(0.019)	(0.015)***	(0.011)**	(0.002)	(0.000)***	(0.000)**
married[1]	0.299	-0.589	-0.484	0.023	-0.005	-0.007
	(0.418)	(0.452)	(0.267)	(0.031)	(0.004)	(0.004)
spouseinc1000	-0.018	0.088	0.083	-0.001	0.001	0.001
	(0.020)	(0.011)***	(0.009)***	(0.002)	(0.000)***	(0.000)***
spouseworkna[1]	-0.310	-0.120	0.041	-0.024	-0.001	0.001
	(0.418)	(0.453)	(0.268)	(0.031)	(0.003)	(0.004)
spouseworking[1]	-0.876	0.418	0.538	-0.075	0.003	0.007
	(0.044)***	(0.038)***	(0.026)***	(0.004)***	(0.000)***	(0.000)***
othrinc1000	0.015	0.010	-0.006	0.001	0.000	-0.000
	(0.014)	(0.012)	(0.008)	(0.001)	(0.000)	(0.000)
medcity[1]	0.109	-0.006	-0.080	0.009	-0.000	-0.001
	(0.036)**	(0.026)	(0.019)***	(0.003)**	(0.000)	(0.000)***
bigcity[1]	0.227	0.164	0.034	0.020	0.001	0.000
	(0.047)***	(0.034)***	(0.025)	(0.004)***	(0.000)***	(0.000)
employedpy[1]		-0.285	-0.260		-0.002	-0.003
		(0.043)***	(0.041)***		(0.000)***	(0.001)***
notemplpy[1]		-1.078	-1.077		-0.007	-0.011
		(0.058)***	(0.055)***		(0.000)***	(0.000)***
emplstatepyna[1]			1.751			0.054
			(0.043)***			(0.003)***
selfemplpy[1]			5.936			0.772
			(0.041)***			(0.007)***
_cons	2.792	-5.533	-7.129			
	(0.498)***	(0.493)***	(0.308)***			
ll	-13223.18	-38477.41	-62883.84	-13223.18	-38477.41	-62883.84
N	40289[3]	662617[4]	741545	40289[3]	662617[4]	741545

Robust standard errors in paranthesis. Year dummies also included, but not shown for brevity.
[1] marginals for discrete change of dummy variable from 0 to 1
[2] marginals are double difference (triple difference, respectively)
[3] individuals who were self-employed in the previous year (*t*-1)
[4] individuals who were dependently employed, unemployed or inactive in the previous year (*t*-1)
* p<0.05, ** p<0.01, *** p<0.001

The variables of primary interest are the interaction dummy variables whose coefficients are the DDD estimates of the tax reform effects. For the 1994 tax reform, the relevant interaction variable is *a x b x c (DDD 94)* (available only in the SOEP estimation), and for the 1999 reform, it is the variable *a x d x e (DDD 99)*. The coefficients of these variables capture the average treatment effect on the treated, i.e. the impact of the top marginal tax rate limitation on tradesmen with income above the threshold. The coefficient of the *a x d x e (DDD 99)* variable represents the cumulative effect of both the 1994 and the 1999 reforms, because the dummy variables for the periods after the 1994 and the 1999 reforms are defined consecutively and do not overlap. Formally, to calculate the additional effect of the 1999 reform, one has to subtract the marginal effect of the *a x b x c (DDD 94)* dummy from the marginal effect of the *a x d x e (DDD 99)* dummy.

In none of the estimations, any of the coefficients of the DDD variables are significant at the 10% level. The two DDD coefficients corresponding to the reforms in 1994 and 1999 in the SOEP models are not jointly significant either (p-values 46% and more). We cannot reject the null hypothesis that the two tax reforms had no effect on the entry rate, the exit rate or the overall self-employment rate of those affected by the reforms. In case of the SOEP, it could be argued that the significance tests fail due to the relatively small sample size; especially the number of transitions per year in the treatment group is small. The Mikrozensus, however, provides a large number of observations, and the effects remain insignificant. This adds evidence to the conclusion that the tax reforms did not affect transitions into and out of self-employment and thus also had no significant effect on the total number of the self-employed.[20]

Our general finding that taxes are insignificant for entrepreneurial choice is in line with two recent studies: Schuetze and Bruce (2004) reviewed the literature and concluded that there is little support for the view that lower taxes for the self-employed promote entrepreneurship; and Parker (2003) also re-assessed the existing literature and additionally analysed British micro-data, concluding that "it could not even be robustly established that the self-employed respond to pecuniary incentives generally, let alone tax-related ones specifically". Our

[20] As an additional robustness test, we repeated the three estimations using the full sample of the Mikrozensus; as mentioned before, the retrospective question about last year's employment status is only available in the 45% sub-sample used in the remainder of this paper. The coefficients of the DDD variables in the estimations of exits and entries remain insignificant. Only in the estimation of the probability of being self-employment, the coefficient of the DDD variable becomes positive and significant at the 5% level, but not at the 1% level, with a marginal effect of 0.2 percentage points. Given that the sub-sample is selected at random, and considering that the flows remain insignificant, we have no explanation for this finding.

empirical finding is also a plausible reflection of the theoretical ambiguity regarding the effect of a differential tax treatment on entrepreneurial choice, as outlined in section 2.1.

The estimation results indicate that personal characteristics other than taxation are more important determinants of the decision to be self-employed. Everything else equal, higher *age* both increases the probability of entering into self-employment and the probability of being self-employed (until a certain age, with decreasing marginal rates). Both the positive linear and the negative square terms are significant at least at the 1% level based on both the SOEP and the Mikrozensus. The hazard of exit from self-employment is found to decrease with age (until a certain age again, with decreasing absolute margins). The significance level is 0.1% using the Mikrozensus and 5% using the SOEP; the lower significance level in the SOEP could be explained by the fact that the "work experience" and "spell duration" covariates, which are correlated with age, are also included, and by the smaller sample size.

Gender effects are also evident and consistent in all models (dummy variable *female*). Women have lower probabilities of both entering self-employment and being self-employed, and self-employed women are shown to have a higher probability of leaving self-employment. All these effects are highly significant[21] except for exit from self-employment in the SOEP estimation, which is significant only at the 5% level. The marginal effects at the sample means indicate the economic significance. Ceteris paribus, the probability of entering self-employment is 0.4 percentage points lower for women than for men estimated on the SOEP, and 0.6 percentage points lower estimated on the Mikrozensus. Compared to the average probability of entering self-employment in a given year of 1.31 % and 1.15 %, respectively, these are relatively large effects.[22]

Having a *university* degree c.p. highly significantly increases the propensity of entering self-employment by 0.5 percentage points in both datasets. In the Mikrozensus, the probability of being self-employed is also positively influenced by a university degree; in the SOEP, this is not significant.

Key variables in the hazard rate models are those related to the duration of the spell in the current employment state. This information is only available in the SOEP. In the model of exit from self-employment, the coefficient of the *duration* variable is negative and significant and that of its square term *dur_sq* is positive and significant, indicating that the hazard of exit first

[21] With "highly significant" we refer to a significance level of 0.1%.

[22] Note that marginal effects may differ between the two datasets because mean values of explanatory variables are, in some cases, quite different in magnitude in the SOEP and the Mikrozensus, partly due to different observation periods. Differences in marginal effects could, however, also be related to misspecification of the models estimated on the Mikrozensus data, because due to data limitations we cannot control for duration dependence effects.

decreases with the duration of the self-employment spell and later increases. The term of the duration variable to the power of three (*dur_p3*) is not significant.[23]

In the model of entry into self-employment, the individuals at risk can be in one of two different spell types: they can be dependently employed or unemployed/inactive, where unemployed/inactive is the base category. The dummy variable *empl* equals one if an individual is dependently employed. The *duration*, *dur_sq* and *dur_p3* variables capture the spell duration, regardless of whether the spell is an employment or an unemployment/inactive spell. The variables *dur_e, dur_sq_e* and *dur_p3_e* are interaction variables of the respective duration variables and the *empl* dummy. The estimation results reveal that the coefficient of the *duration* variable is negative and significant, which indicates state dependence. The interactions with *empl* are insignificant. Thus, irrespective of whether a spell is an employment or an unemployment/inactive spell, the more years a person has stayed in a certain state, the less likely he or she is to enter self-employment.

In the SOEP model of the probability of being self-employed in year *t*, instead of the duration variables we included variables indicating the employment state in the previous year *t*-1, where unemployed/inactive is the base category. The coefficient of *selfemplpy*, the dummy indicating that the individual was self-employed in *t*-1, is positive and highly significant, indicating state dependence of self-employment. The coefficient of the dummy variable *empl*, which indicates that the individual was dependently employed in *t*-1 in this model, is negative and highly significant, showing that employees in *t*-1 are c.p. less likely to be self-employed in *t* than those unemployed or inactive in *t*-1.

In the Mikrozensus data, we do not observe the duration of spells in a certain employment state, but only the employment state in *t*-1, so we included corresponding dummy variables in the Mikrozensus models. In the model of entry into self-employment, the possible employment states in *t*-1 are dependent employment (dummy variable *employedpy*), inactivity (dummy *notemplpy*) and unemployment (base category). The coefficients of the *employedpy* and *notemplpy* dummies are negative and highly significant, indicating that entry from employment and inactivity is less likely than from unemployment, everything else equal. This is a different result than that of the SOEP model of entry, where the *empl* dummy and its interactions are insignificant, perhaps due to the smaller sample size. In the Mikrozensus model of the probability of being self-employed in *t*, two more employment state categories in *t*-1 are possible, "self-employment" (dummy variable *selfemplpy*) and "no information" (dummy *emplstatepyna*); again, unemployment is the base category. All dummy variables

[23] The sign and significance level of the linear duration effect do not change if the terms of higher order are excluded from the estimation.

indicating the employment status in *t*-1 are highly significant. The sign of the *selfemplpy* dummy is positive, confirming the finding in the SOEP model that self-employment is state dependent. The signs of the *employedpy* and *notemplpy* dummies are negative, which is consistent with the results of the entry model which showed that entry from employment or inactivity is c.p. less likely than from unemployment, and also with the SOEP model of the probability of being self-employed.

7 Conclusion

In this paper we have studied the impact of taxation on entrepreneurship by providing an integrated view on the probability of entry into self-employment, exit from self-employment, and the resulting overall propensity of being self-employed. We exploited two German tax reforms in 1994 and 1999/2000 as natural experiments to identify responses to taxes. These legislative changes represented tax rate limitation for income from trade (*Tarifbegrenzung für gewerbliche Einkünfte*) and were implemented to promote small and medium sized enterprises. The top marginal income tax rates were limited exclusively for self-employed tradesmen, but not for the alternative sector, i.e. wage and salary employment, introducing a differential tax treatment. Moreover, the tax reforms provided two naturally defined comparison groups which were not affected by the reforms, the so-called freelance professionals and tradesmen with income below a certain threshold defined by the tax law, enabling us to apply a "difference-in-difference-in-difference" estimator to isolate the effect of the reforms. We used two different large and high quality datasets from Germany: the German Socio Economic Panel (SOEP) and the Mikrozensus (Labour Force Survey). Using the SOEP, we applied discrete time hazard models to control for the important effect of the duration of a spell in the certain employment state.

The results based on both datasets consistently show that the two German tax reforms did not have a significant effect on transition rates into or out of self-employment, or on the overall self-employment rate. Thus, the tax reforms do not seem to have fostered entrepreneurship. In contrast, individual characteristics, such as age, gender and education, have significant effects in most cases. Duration dependence is shown to be an important factor. The hazard of exit from self-employment decreases during the first years of being self-employed. Likewise, longer employment, unemployment or inactivity spells reduce the probability of entry into self-employment.

Intuitively, the finding that the differential tax treatment of the self-employed does not significantly influence the choice between self-employment and dependent employment might be surprising. Both theoretical and empirical literature, however, indicate that the direction of the effect is ambiguous, if there is an effect at all. On the one hand, proportional taxes may harm entrepreneurship by reducing the expected return on a risky entrepreneurial project, but on the other hand, they may encourage entrepreneurship by serving as insurance against the uncertainty of income from self-employment. If the effect of taxation depends on individual preferences such as attitude towards risk, it is possible that the aggregate effect is zero. Recent reviews of the existing literature about the impact of taxation on entrepreneurship are also in line with our results. Parker (2003) concluded that the self-employed do not seem to respond to tax-related incentives, and Schuetze and Bruce (2004) came to the conclusion that "the literature appears to provide little support for the common view that taxes should be lower for the self-employed".

For policy makers who wish to promote entrepreneurship, these results may suggest that taxation is not a suitable policy instrument to meet the intended objective; alternative instruments may be required. As the results in this research area are still tentative, more research is needed to provide clear evidence-based policy advice with regard to taxes and entrepreneurship. A better understanding of the roles played by the influence of taxes on the average return and on the risk associated with entrepreneurial activity may help clarify the picture of the impact of taxation on entrepreneurship.

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Appendix

Table A 1: Freelance professions

In the SOEP, we classify the following professions as freelance professions:

ISCO-88 Code	Profession(s)
2113	Chemists
2121	Mathematicians and related professionals
2141	Architects, town and traffic planners
2142	Civil engineers
2148	Cartographers and surveyors
2149	Architects, engineers and related professionals not elsewhere classified
2211	Biologists, botanists, zoologists and related professionals
2221	Medical doctors
2222	Dentists
2223	Veterinarians
2230	Nursing and midwifery professionals
2411	Accountants
2419	Business professionals not elsewhere classified
2421	Lawyers
2441	Economists
2444	Philologists, translators and interpreters
2445	Psychologists
2451	Authors, journalists and other writers
2452	Sculptors, painters and related artists
2453	Composers, musicians and singers
2454	Choreographers and dancers
2455	Film, stage and related actors and directors
3131	Photographers and image and sound recording equipment operators
3144	Air traffic controllers
3226	Physiotherapists and related associate professionals
3232	Midwifery associate professionals
3241	Traditional medicine practitioners

In the Mikrozensus, we classify the following professions as freelance professions:

Value Number	Profession(s)
600	Engineers without further specification
603	Civil engineers
604	Cartographers and surveyors
608	Other engineers
609	Architects
611	Chemists and method engineers
753	Accountants and related professionals
757	Business consultants and related professionals
813	Legal representatives and advisors
821	Publicists
822	Translators and interpreters
831	Musicians
832	Visual artists and singers
833	Artists (fine art)
834	Artists (applied art)
835	Professions related to stage, image and sound
837	Photographers and cinematographers
841	Medical doctors
842	Dentists
843	Veterinarians
851	Alternative practitioners
852	Masseurs, balneotherapists and physiotherapists
853	Nursing and midwifery professionals
863	Educators
875	Teacher of arts
880	Scientists
886	Psychologists

Table A 2: Definition of variables (SOEP)

Variable	Definition
DDD variables:	
a	Dummy for individuals classified as a potential tradesman in t
b	Dummy for years after the 1994 reform and before the 1999 reform
c	Dummy for individuals whose income in *t* is above the threshold defined in 1994
d	Dummy for years after the 1999 reform
e	Dummy for individuals whose income in *t* is above the threshold defined in 1999
Other covariates:	
female	Dummy for females
east	Dummy for individuals who live in one of the 5 new eastern federal states or East Berlin
highschool	Dummy for individuals who have a high school degree ("Fachhochschulreife" or "Abitur")
apprenticeship	Dummy for individuals who finished an apprenticeship ("Lehre")
highertechnical	Dummy for individuals who finished a higher technichal college or similar ("Berufsschule", "Schule Gesundheitswesen", "Fachschule", "Meister", "Beamtenausbildung", or "Sonstige Ausbildung")
university	Dummy for individuals who have a university degree
age	Age of individual
agesqr	Age squared
ftexp10	Years of full time work experience. Uses information from the lifetime empoyment history in the SOEP (see text for details). Divided by 10.
ftexpsq100	Fill time work experience squared and divided by 100
ptexp10	Years of part time work experience. Uses information from the lifetime empoyment history in the SOEP (see text for details). Divided by 10.
ptexpsq100	Part time work experience squared and divided by 100
unemexp10	Years of unemployement experience. Uses information from the lifetime empoyment history in the SOEP (see text for details). Divided by 10.
unemexpsq100	Unemployment experience squared and divided by 100
disabled	Dummy for handicapped / physically challenged individuals
german	Dummy for German nationality
nchild	Number of children under 17 in the household
married	Dummy for married and not separated individuals. Omitted category for marital status is "single"/"widowed".
separated	Dummy for married, but separated individuals
divorced	Dummy for divorced individuals
fatherse	Dummy for individuals whose father is/was self-employed
empl	Entry model: Dummy for individuals who are employed in *t* Self-employment state model: Dummy for individuals who were employed in *t*-1
selfemplpy	Dummy for individuals who were self-employed in *t*-1
duration	Duration of current spell (self-employment or employment). Uses information from lifetime job biography in the SOEP (see text for details).
dur_sq	Square of duration variable
dur_p3	Duration variable to the power of 3
dur_e	Interaction variable of duration and empl
dur_sq_e	Interaction variable of dur_sq and empl
dur_p3_e	Interaction variable of dur_p3_e and empl

Dummy variables are equal to one if condition holds and zero otherwise.

Table A 3: Definition of variables (Mikrozensus, if different from SOEP)

Variable	Definition
Highest school leaving degree achieved	
schoolna	Dummy for no information, or not applicable
gymnasium	Dummy for individuals with university entrance diploma ("Fachabitur" or "Abitur")
realschule	Qualification for entrance in advanced technical college ("Allg. polytech. Oberschulabschluss (ehem. DDR)", "Realschulabschluss", or "Fachhochschulreife")
hauptschule	Dummy for individuals with other high school diploma ("Hauptschulabschluss" or "Volksschulabschluss"). Omitted category for school leaving degree.
Highest professional qualification	
qualifna	Dummy for no information, or not applicable
mastercraft	Dummy for master craftsmen and technicians ("Meister", "Techniker")
advtechncol	Dummy for individuals who graduated from an advanced technichal college ("Fachhochschulabschuss")
university	Dummy for individuals who graduated from a university
apprenticeship	Dummy for individuals who finished an apprenticeship ("Anlernausbildung", "Lehrausbildung", or "Fachschule ehem. DDR"). Omitted category for professional qualification.
Employment status of spouse	
spouseworkna	Dummy for no information, or not applicable
spouseworking	Dummy for individuals whose spouse is working
spsnotworking	Dummy for individuals whose spouse is not working. Omitted category for employment status of spouse.
Employment status in previous year	
emplstatepyna	Dummy for no information, or not applicable
selfemplpy	Dummy for individuals who were self-employed in the previous year
employedpy	Dummy for individuals who were employed in the previous year
notemplpy	Dummy for individuals who were inactive in the previous year
unemplpy	Dummy for individuals who were unemployed in the previous year. Omitted category for employment status in the previous year.
City size	
medcity	Dummy for cities between 20,000 and 500,000 inhabitants (previous year)
bigcity	Dummy for cities with more than 500,000 inhabitants (previous year)
village	Dummy for cities with up to 20,000 inhabitants (previous year). Omitted category for city size.
east	Dummy for individuals who live in one of the 5 new eastern federal states or Berlin
nchild	Number of children under 18 in the household
married	Dummy for married individuals
spouseinc1000	Spouse's net income in € 1000 in April (0 if unmarried)
otherinc1000	Other net household income in € 1000 in April (= net household income in April - net individual income in April, if positive)

Dummy variables are equal to one if condition holds and zero otherwise.