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ABSTRACT

Personal Bankruptcy Law, Wealth and Entrepreneurship: Theory and Evidence from the Introduction of a "Fresh Start"*

A personal bankruptcy law that allows for a "fresh start" after bankruptcy reduces the individual risk involved in entrepreneurial activity. On the other hand, as risk shifts to creditors who recover less of their credit after a debtor's bankruptcy, lenders may charge higher interest rates or ration credit supply, which can hamper entrepreneurship. Both aspects of a more forgiving personal bankruptcy law are less relevant for wealthy potential entrepreneurs who still risk losing their wealth, but tend not to face higher interest rates because they provide collateral. This paper illustrates these effects in a model and tests the hypotheses derived by exploiting the introduction of a "fresh start" policy in Germany in 1999 as a natural experiment, based on representative household panel data. The results indicate that the insurance effect of a more forgiving personal bankruptcy law exceeds the interest effect and on balance encourages less wealthy individuals to enter into entrepreneurship.

JEL Classification: K35, G33, L26

Keywords: personal bankruptcy law, insolvency, entrepreneurship, fresh start

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1 Introduction

As income from entrepreneurial activity is considerably more uncertain than income from wage employment, entrepreneurship implies a greater risk of bankruptcy. For entrepreneurs owning unincorporated businesses, business debts are personal liabilities. Personal bankruptcy law can, therefore, be expected to play an important role in the decisions to become and to remain an entrepreneur. Stimulating entrepreneurship is now a major policy objective in many countries with the intent to promote innovation, competitiveness, and job creation. From an economic point of view, the main policy leeway in personal bankruptcy law is between more creditor friendly procedures and more debtor friendly ones. The former ensures that creditors recover as much of their credit as possible in case of a debtor's bankruptcy ("absolute priority rule" of creditors over equity holders); while the later provides a discharge from debt when certain conditions are met, thus giving the bankrupt person the chance to start anew. Such "fresh start" policies are widely considered to promote small business entrepreneurship, because relief from debt burden allows entrepreneurs to start a new business after a failure. This is the main argument put forward by Germany's Merkel led government, which intends to cut the time to discharge from debt after personal bankruptcy from six down to three years.

A simple model developed in this paper illustrates, however, that a more forgiving bankruptcy law has two opposing effects on entrepreneurial activity. On the one hand, it may make entrepreneurship more attractive, as entrepreneurs do not risk losing as much wealth and future income in case of bankruptcy. On the other hand, however, risk is shifted to lenders, who recover less in case of debtor bankruptcy, and they may react by charging higher interest rates or rationing credit supply. This may hamper entrepreneurship, which depends on capital. The model further shows that both aspects of personal bankruptcy law are less relevant for wealthy potential entrepreneurs. A debtor-friendly bankruptcy law does not

decrease their risk as much, because they still risk losing their wealth; and it does not increase the interest rate they face as much either, because they provide collateral.

The hypothesized difference in the effect of personal bankruptcy law depending upon wealth level is tested in an empirical investigation. In 1999, Germany introduced its Insolvency Code, which provided a "fresh start" policy for the first time in Germany. Using representative household panel data, I exploit this policy reform as a natural experiment and estimate its effects on entry into and exit out of self-employment and on the probability of being self-employed by wealth level. The results indicate that the introduction of a "fresh start" on balance made entrepreneurship more attractive, especially for less wealthy entrepreneurs. The explanation offered by the model is that the insurance effect of the more forgiving personal bankruptcy law outweighs the effect of an increasing interest rate.

The small empirical literature on personal bankruptcy law and entrepreneurial activity focuses on differences in bankruptcy procedures across different countries or states in the USA. Fan and White (2003) exploit variation in the homestead exemption across US states,[2] finding that the probability of owning a business is 35% higher in states with unlimited rather than low exemptions. Armour and Cumming (2008) use aggregated data from 15 countries and report that entrepreneur-friendly bankruptcy laws increase self-employment rates. Both results are qualitatively consistent with this paper's findings, which are derived using a completely different empirical strategy and data. Using the same source of variation as Fan and White (2003), Agarwal et al. (2005) further find that the likelihood of small business owners filing for bankruptcy increases with higher exemption levels.

There is also evidence of the reaction by banks to more forgiving personal bankruptcy laws. Berkowitz and White (2004), again using homestead exemption variation across US states, report that small firms in states with more generous exemptions face higher interest

[2] A homestead exemption makes personal bankruptcy law more forgiving, as homeowners may keep their home up to a certain threshold after personal bankruptcy (Chapter 7 of US personal bankruptcy law).

rates or do not obtain the desired amount of credit. Similarly, but not focusing on entrepreneurship, Gropp et al. (1997) find that more generous exemptions reduce the availability and amount of credit to low-asset households and, at the same time, increase the amount of credit held by high-asset borrowers. Davydenko and Franks (2008) compare the effects of bankruptcy law in France, Germany, and the UK, using firm data. The results indicate that banks respond to creditor-unfriendly codes, with, for example, stricter collateral requirements.

The theoretical literature highlights that greater creditor protection preserves incentives for entrepreneurs to succeed before bankruptcy, whereas a more forgiving code maintains incentives to exert effort after bankruptcy. Ayotte (2006) analyses this trade-off in a principal-agent model and argues that "fresh start" policies generate social gains by preserving an entrepreneur's post-bankruptcy incentives. Two working papers come to opposing conclusions. Mankart and Rodano (2010) develop a quantitative general equilibrium model and conclude that higher wealth exemptions would increase entrepreneurship in the US. A key feature is that they distinguish between unsecured and secured credit. In contrast, Meh and Terajima (2008), who do not make this distinction, develop and calibrate a quantitative overlapping-generations model and conclude that eliminating bankruptcy exemptions would lead to a modest increase in the fraction of entrepreneurs.

This paper highlights the role played by personal wealth in the link between personal bankruptcy law and entrepreneurial activity. A sizable literature shows that wealth has a positive effect on the probabilities of entry into entrepreneurship and on being an entrepreneur. Most studies explain this by the presence of credit constraints, which are less binding for more wealthy potential entrepreneurs (e.g. Evans and Jovanovic, 1989; Blanchflower, 1998; Holtz-Eakin et al., 1994; Nykvist, 2008).[3] Similarly, the model

[3] Hurst and Lusardi (2004) express doubt, however, because they find a positive relationship between wealth and the probability of entry into self-employment only for the top 5% of the wealthiest households.

developed in this paper illustrates that because less wealthy people provide less collateral, lenders demand higher interest rates from them as a risk premium, and this makes entrepreneurship more costly and therefore less attractive for the less wealthy.

The remainder of this paper is organized as follows. Section 2 provides the institutional background by detailing the introduction of a "fresh start" policy in Germany in 1999. Section 3 develops the theoretical model of personal bankruptcy law, wealth, and entrepreneurship, and derives hypotheses to be tested. Section 4 outlays the empirical strategy to analyze the 1999 policy reform as a natural experiment. The empirical results appear in section 5, and section 6 concludes the analysis.

2 Introduction of a "fresh start" in the German personal bankruptcy law

In Germany, a new insolvency law, the Insolvency Code (*Insolvenzordnung*), came into effect January 1, 1999.[4] The new law allows private persons to open insolvency proceedings.[5] In particular, for the first time in Germany, the reform provides the possibility of a "fresh start" after insolvency. Specifically, after seven years of "good behavior", remaining debt is discharged (the time to discharge was reduced to six years in December 2001). During these seven (six) years, the person who filed for insolvency must pay any income exceeding an exemption threshold of net income to the creditors. This threshold is considered the minimal cost of living and is about 990 euro per month for a person without dependents. Before the reform, according to the former bankruptcy law which dated back to 1877,[6] there was almost no chance for a discharge from debt for personal debtors, so after bankruptcy they had the

[4] For an English translation of the German Insolvency Code and a commentary, see Braun (2006).
[5] With the reform, German bankruptcy law became more similar to US law, where Chapters 7 and 13 regulate personal bankruptcy (cf. White, 2007).
[6] The relevant laws before 1999 were the Bankruptcy Code (*Konkursordnung*) from 1877, which describes a compulsory liquidation procedure, and the Forced Settlement Act (*Vergleichsordnung*) from 1935, which describes court composition as a restructuring procedure for corporations (cf. Davydenko and Franks, 2008).

prospect of ceding all income exceeding the threshold to the creditors until all debt was paid back, sometimes for the rest of their life. The new personal bankruptcy law is of special relevance for entrepreneurs owning unincorporated firms (proprietorships and partnerships), because all business debts, which are typically large in comparison to consumer credits, are personal liabilities of the business owner, so these entrepreneurs may file for personal bankruptcy and enjoy the possibility of the "fresh start".

In many countries the financial and economic crisis, which culminated in 2008 and 2009, triggered a new policy debate around the economic consequences of bankruptcy law. As the number of bankruptcies has risen, policymakers have suggested changes in bankruptcy laws with the intention of facilitating the restructuring and recovery of insolvent firms to limit the consequences of the crisis, including the loss of jobs. This discussion has not been limited to, but has included, *personal* bankruptcy law because of its relevance for small businesses.

In Germany the policy debate about bankruptcy law also has taken center stage, even though the increase in personal bankruptcies during the crisis has not been dramatic.[7] The coalition government, led by Angela Merkel, agreed to work out a reform of bankruptcy law (coalition agreement between CDU, CSU, and FDP, 2009). The minister of justice, Sabine Leutheusser-Schnarrenberger (2010), said in a speech that "the reform of insolvency law is the most important project in business law". Specifically, concerning personal bankruptcy law, she intends to cut the time to discharge from six years down to three. She argues that this would allow "business founders, but also over indebted consumers to bounce back after a false start". As the supposed link between personal bankruptcy law and entrepreneurial activity is so central to policy debate in Germany and elsewhere, this paper intends to contribute to clarifying thought and gathering evidence on potential effects.

[7] Germany counted 32,687 insolvencies by enterprises in 2009, this was 11.6% more than in 2008. 18,045 of these were for unincorporated firms (whose owners are subject to personal bankruptcy law), 5.2% more than the year before. In addition, 127,412 private persons filed for insolvency, up 3.0% from 2008. 26,310 of these were previously self-employed, which represents an increase of 3.1% over 2008 (Federal Statistical Office, 2010).

3 Theory of personal bankruptcy law, wealth, and entrepreneurship

In this section I develop a simple model of bankruptcy law and entrepreneurial activity that is similar to Fan and White (2003), but further elaborates on the role of personal wealth, deriving differences in effects by wealth level, and adapts the model to the German situation. Wealth is crucial as personal bankruptcy law is expected to be more relevant for entrepreneurial decisions by less wealthy households, as mentioned in the introduction.

The model describes an agent's decision to work as a wage worker or as an entrepreneur. She will make her choice between these two alternatives in period t depending on which activity yields the higher expected wealth in period t+1. In period t, the potential entrepreneur disposes of wealth w, which is the sum of current assets and the net present value of expected future income from regular employment after period t+1.[8] Starting a business requires taking out a fixed amount of debt b>0, which is due with interest in period t+1. If a potential entrepreneur decides to start a firm, she will receive an uncertain return z in period t+1; suppose that the density of z is $f(z)$.

In period t+1, entrepreneurs owe $b\,r$, where r is the interest factor (one plus the interest rate). Entrepreneurs may file for personal bankruptcy in t+1. Suppose x is the net present value of future income that cannot be seized by creditors.[9] Before 1999, this was the net present value of the legally guaranteed minimum cost of living until all debt was repaid, and of full income only thereafter (if complete repayment was reached before death). Since the introduction of the "fresh start", x has increased to the net present value of the minimum cost

[8] Returning to wage work is assumed to be a safe fallback option that yields a safe income, so it makes sense that both potential entrepreneurs and lenders take the associated value into account.

[9] Bankruptcy costs potentially reduce x, as they may decrease future disposable income after filing for insolvency. For an explicit consideration of bankruptcy costs see Fan and White (2003).

of living in the initial six years after filing for insolvency[10] and of *all* future income after this period, as all remaining debt is discharged after six years.[11] The interest factor $r(w,x)$ is assumed to be set by the lenders as a function of wealth w, which may serve as security, and x, because with larger x, lenders risk losing more of the amount lent in case of insolvency.

If an entrepreneur does not file for bankruptcy, her wealth in period t+1 will be $\Omega_{s,nb} = w + z - b\,r(x,w)$. If she files for bankruptcy, her wealth will be $\Omega_{s,b} = x$. She will file for bankruptcy if and only if $\Omega_{s,b} > \Omega_{s,nb} \Leftrightarrow z < x - w + b\,r(x,w)$. Thus an entrepreneur's expected wealth in period t+1 is

$$E(\Omega_s) = x\int_{-\infty}^{-w+x+br(x,w)} f(z)\,dz + \int_{-w+x+br(x,w)}^{\infty} f(z)\left(w+z-br(x,w)\right)dz .$$

If instead the agent chooses to be a wage worker in period t, in period t+1 she will have wealth $\Omega_w = w + v$, where v is the salary in period t.

Lenders are willing to lend the amount b if their expected returns are at least as high as the opportunity costs, which are given by $b\,R$. The zero-profit condition is written as

$$\int_{x-w}^{-w+x+br(x,w)} (w-x+z)\,f(z)\,dz + br(x,w)\left(\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz\right) = bR ,$$

where the first term on the left-hand side represents partial repayment by debtors who file for bankruptcy and the second term full repayment by debtors who avoid bankruptcy. Partially differentiating both sides of the equation with respect to x and w and solving for the first derivatives of $r(x,w)$ yields

$$\frac{\partial r(x,w)}{\partial x} = \frac{\int_{x-w}^{-w+x+br(x,w)} f(z)\,dz}{\int_{-w+x+br(x,w)}^{\infty} bf(z)\,dz} \geq 0 ,$$

[10] As mentioned, between January 1999 and December 2001 the time to discharge was seven years, but this rather small change is not considered in the following.

[11] Of course, if debt is repaid completely before the six years have passed, the debtor can keep the full income after repayment. In these cases, the reform did not change x.

$$\frac{\partial r(x,w)}{\partial w} = -\frac{\int_{x-w}^{-w+x+br(x,w)} f(z)\,dz}{\int_{-w+x+br(x,w)}^{\infty} bf(z)\,dz} \leq 0.$$

Thus, lenders charge higher interest rates when x increases and lower interest rates when *w* increases. This reflects that banks risk losing a larger share of repayments in case of bankruptcy when *x* becomes larger, and that *w* can be used as collateral.[12]

Turning back to the decision problem of potential entrepreneurs, the partial derivative of $E(\Omega_s)$ w.r.t. *w* is

$$\frac{\partial E(\Omega_s)}{\partial w} = \left(1 - b\frac{\partial r(x,w)}{\partial w}\right)\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz.$$

which is greater than $\partial E(\Omega_w)/\partial w=1$ at least for large *w*, because the integral approaches 1 when *w* becomes large, and the term in brackets is larger than 1 since $\partial r/\partial w<0$. Thus, entrepreneurship becomes more attractive relative to wage employment when more wealth is available, which is explained by the cheaper credit.

The partial derivative of $E(\Omega_s)$ w.r.t. *x* is

$$\frac{\partial E(\Omega_s)}{\partial x} = \int_{-\infty}^{-w+x+br(x,w)} f(z)\,dz - b\frac{\partial r(x,w)}{\partial x}\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz.$$

For the moment suppose $\partial r/\partial x = 0$. Then $\partial E(\Omega_s)/\partial x \geq \partial E(\Omega_w)/\partial x = 0$, as the first integral is positive, and the inequality is strict as long as there is at least a small probability of bankruptcy. Hence, with fixed interest rates, higher *x* (i.e a more forgiving insolvency law) makes entrepreneurship unambiguously more attractive relative to wage work. If $\partial r/\partial x > 0$ as derived above, it is ambiguous whether higher *x* makes entrepreneurship relatively more or less attractive; this depends on whether the insurance effect or the interest effect dominates.

The cross-derivative of entrepreneurs' expected wealth is derived as

[12] Instead of raising interest rates when *x* increases, lenders could also ration credit supply (cf. Stiglitz and Weiss, 1981).

$$\frac{\partial E(\Omega_s)}{\partial x \partial w} = f\left(-w+x+br(x,w)\right)\left(b\frac{\partial r(x,w)}{\partial w}-1\right)\left(b\frac{\partial r(x,w)}{\partial x}+1\right)- b\frac{\partial r(x,w)}{\partial x \partial w}\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz .$$

If $\partial r/\partial x\partial w > 0$ it follows unambiguously that $\partial E(\Omega_s)/\partial x\partial w < 0$, given the signs of the first derivatives of r derived above. The positive change in $E(\Omega_s)$ when w increases (see above) thus reduces when x increases. Accordingly, the positive effect of w on the attractiveness of entrepreneurship relative to wage work also decreases when x increases, since $\partial E(\Omega_w)/\partial x\partial w = 0$. The intuition is that the more wealth w an entrepreneur disposes of, the less she benefits from the insurance effect implied by an increase in x. If $\partial r/\partial x\partial w < 0$, the sign of $\partial E(\Omega_s)/\partial w\partial x$ is ambiguous, however. In this case, it is possible that the interest effect exceeds the insurance effect. Poorer entrepreneurs suffer more from the increased credit costs triggered by larger x than wealthier entrepreneurs. It remains an empirical question which effect dominates, as the sign of

$$\frac{\partial r(x,w)}{\partial x \partial w} = \frac{f(x-w)\left(\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz\right)^2 - f\left(-w+x+br(x,w)\right)\left(\int_{x-w}^{\infty} f(z)\,dz\right)^2}{b\left(\int_{-w+x+br(x,w)}^{\infty} f(z)\,dz\right)^3}$$

depends on whether the first or the second summand in the nominator is larger, which cannot be determined without further assumptions. Note that while $\partial r(x,w)/\partial x\partial w > 0$ is sufficient to conclude that the insurance effect dominates, $\partial r(x,w)/\partial x\partial w < 0$ is necessary, but not sufficient to conclude that the interest effects dominates.

This leads to two alternative hypotheses for the empirical work:[13]

H1: The positive effect of wealth on the probability of entry into and of being self-employment decreased after the introduction of the insolvency code on January 1, 1999

[13] For both hypotheses, the null hypothesis is that the introduction of the "fresh start" policy did not change the effect of wealth on self-employment at all.

(which increased *x*). The insurance effect dominates and the introduction of the "fresh start" made self-employment more attractive especially for less wealthy potential entrepreneurs.

H2: The positive effect of wealth on the probability of entry into and of being self-employment increases further after the introduction of the insolvency code. The interest effect dominates and the "fresh start" legislation made self-employment less attractive especially for less wealthy potential entrepreneurs.

4 Empirical analysis of the natural experiment

4.1 Identification strategy

To test the hypotheses derived above, I exploit the introduction of the Insolvency Code in Germany on January 1, 1999, as a natural experiment. Specifically, the model predicts that the policy reform, which made a "fresh start" available, changed the effects of wealth on the probabilities of entry into self-employment and on being self-employed. Therefore I estimate models of the probabilities of entry and of self-employment state, where the effect of wealth is allowed to change with the policy shift, controlling for other relevant factors. Then I test if the change in the effect of wealth is significantly negative, which would support hypothesis *H1*, or positive, which would support *H2*.

This estimation strategy adapts the difference-in-difference (DID) estimator (e.g. Blundell and Costa Dias, 2008). The DID estimator contrasts a group identified as being affected by the policy change with an unaffected comparison group. One calculates the change in the outcome before and after the policy reform both for the treatment and comparison groups. The difference in these changes is interpreted as the average treatment effect of the policy reform on the treated. Identification requires the common trend assumption, which states that in the absence of the policy reform, the change in the outcome would have been the same in the two groups. In this application, less wealthy potential

entrepreneurs are the treatment and more wealthy the comparison group, because, as argued above, bankruptcy law is more relevant for less wealthy people. As it would be arbitrary to set a threshold of wealth that sharply separates the treatment from the comparison group, I test if the effect of the continuous wealth variable on entrepreneurial activity changes with the reform. The common trend assumption in this application states that in the absence of the reform, the effect of wealth on entrepreneurship would not have changed at the time of the reform. Several empirical tests in section 5 assess the plausibility of this assumption.

4.2 Discrete time hazard rate model

The probability of entry into self-employment is specified as a discrete time hazard rate model and estimated conditional on the tenure in dependent employment or the duration of non-employment, based on the sample of those in dependent employment and those not in paid work. For additional information, I analogously estimate a hazard rate model of exit from self-employment conditional on the duration of the current spell in self-employment, based on the sample of the self-employed. I use yearly data because the interviews occur once a year, and the covariates are not available for higher frequencies. Applying discrete time hazard rate models allows consistently taking into account state dependence and avoids survivorship bias. Another advantage of the hazard rate model is that all the explanatory variables, especially wealth, are measured *before* potential entries into (or exits from) self-employment occur. Starting from a general notation of a survivor model, Appendix B derives the estimation equation as a logit model of the transition probability conditional on the duration of the current state, estimated on the data in person-year format (cf. Caliendo et al., 2010).

The baseline hazard, which captures duration dependence, is specified flexibly as a third degree polynomial of the duration in the current state. For example, in the model of exit from self-employment, we expect the probability of exit to be high during the initial years of self-employment and to decline over time, once the initial hurdles are passed (Caliendo et al.,

2010). The model of entry into self-employment allows the baseline hazards to differ between those in dependent employment and those not working. This is achieved by an interaction of the variables capturing the spell duration with a dummy variable indicating the current state. For those in dependent employment, for instance, the probability of switching to self-employment may decrease with tenure, e.g. because of habituation, whereas for unemployed people the probability may increase, as self-employment may appear as a means to escape unemployment when no other job is found.

In the long run, entry and exit rates together determine the equilibrium self-employment rate. Instead of relying exclusively on the estimation of the flows, in addition I directly estimate the probability of being self-employed. Specifically, I estimate a logit model of self-employment state, based on the full sample of the self-employed, those in dependent employment, and those not in paid work.

In the models of entry, exit and self-employment state, I include as key explanatory variables a measure of individual wealth; a "post reform" dummy variable which is coded as 1 if the interview occurred after January 1, 1999, when the Insolvency Code came into effect, and zero otherwise; and an interaction term between wealth and the post reform dummy. The interaction term allows the effect of wealth to change with the reform, which allows testing the hypotheses.

Furthermore, I include as control variables determinants of entrepreneurship known from the literature: age, prior working experience and prior unemployment experience, the number of children, and dummy variables indicating gender, educational degrees, disability, German nationality, marital status, geographical region, and whether the father was self-employed when the respondent was 15 years old. I also include year dummies to control for the business

cycle. Weighted means of the variables by employment type appear in Table A 1,[14] and variable descriptions in Table A 2, both in Appendix A.

4.3 Representative household panel data

The analysis is based on the German Socio-Economic Panel (SOEP), a representative yearly panel survey containing detailed information about the socio-economic situation of private households in Germany.[15] The main analysis draws on the waves between 1993 and 2004; 6 years before and after the reform on January 1, 1999. During this time, the SOEP covered about 12 000 persons in 6 000 households.[16] Additional robustness checks assess the sensitivity of the results with respect to alternative time windows.

The concept of entrepreneurship may differ from self-employment, as the former usually implies risk bearing and innovation, whereas the latter goes along with income risk but not necessarily with innovation. This study focuses on self-employment, which can be identified in the data used. The classification of individuals as self-employed is based on a survey question about the respondents' occupational status. If respondents are employed or self-employed in more than one position, they are asked to report their status in their primary activity. The sample is restricted to individuals between 18 and 59 years of age and excludes farmers, civil servants, pensioners, and those currently in education, vocational training, or military service. I also exclude family members working for a self-employed relative from the

[14] The self-employed enjoy considerably more wealth, a higher home ownership rate, and higher gross labor income than both employees and those not working. Note that the self-employed on average also work more hours than employees, and average hourly income from self-employment is similar to average wages in Germany (Fossen, 2009). The table further shows that the mean wealth and home ownership rates are somewhat higher in the sub-sample of those not in paid work than in the sub-sample of employees. This may be explained by the relatively low female work participation rate in Germany; many families with mothers not in the work force live in their own houses.

[15] The central aim of the SOEP is to collect representative micro-data about individuals and households. It is similar to the BHPS (British Household Panel Survey) in the UK and the PSID (Panel Study of Income Dynamics) in the USA. A stable set of core questions appears every year, covering the most essential areas, such as population and demography; education, training, and qualification; labor market and occupational dynamics; earnings, income, and social security; housing; health; household production; and basic orientation. For a more detailed data description, see Wagner, Frick, and Schupp (2007).

[16] The SOEP sample was enlarged several times during the period of this analysis, most notably in 2000 ("Innovation Random Sample"), but I only use the original sub-samples started in 1984 in West Germany (including immigrants) and 1990 in former East Germany to avoid a strongly unbalanced sample.

data set because these individuals are not entrepreneurs in the sense of running their own business. I identify year-to-year transitions into and out of self-employment in the data when a person is observed in different employment states in two consecutive years, *t* and *t*+1.

4.4 Construction of the wealth measure

A key variable in this analysis is the individual wealth stock. Questions about individual wealth stocks and asset portfolios are available in 2002 (as well in 1988 and 2007, but these waves are not used due to the time away from the period of interest). Questions about capital income flows (in the year before the interview) and dwelling characteristics are included in every survey wave. I use the information available to estimate a proxy of individual wealth as the sum of the three most important wealth components of private persons, i.e. financial assets, owner-occupied housing, and other property. I calculate real wealth in prices of 1998, using the Consumer Price Index.

To estimate the stock of financial assets, I use household income from interests and dividends, which is reported yearly, and a time series of yields on Federal securities provided by the German Bundesbank (2010).[17] Some SOEP respondents report the exact amount of their financial income, while others just indicate a range. For the latter respondents, I impute the mean income of those who actually give the exact amount within this range, following Fuchs-Schündeln and Schündeln (2005).

To infer the value of property rented out, I draw on household income from renting out, which again is provided yearly. I estimate a yearly rate of return to renting out by dividing the income from renting out reported in 2002 by the market value of not user-occupied property, which is elicited in the 2002 wealth questionnaire. Using plausible rates of return greater than

[17] Specifically, I use yields on listed Federal securities with annual coupon payments and with a residual maturity of one year, which are derived from the term structure of interest rates. The time series provides yields at the end of each month, of which I calculate the yearly averages.

0 and smaller than 0.25 only, I calculate a weighted average (using population weights) of .0366848, which I then use as the rate of return.

Finally, to estimate the value of user-occupied housing, I use yearly information on housing characteristics. I calculate the net value in 2002 using information from the 2002 wealth questionnaire about the market value of user-occupied property and remaining mortgage debt. Then I run a regression of this net value on the housing characteristics in the cross-section of 2002. The estimated coefficients allow predicting the net value of user-occupied housing in other years, using current characteristics. The characteristics used to explain the value of user-occupied housing include its size in square meters (and square meters squared) and dummy variables indicating the type of the dwelling, the age of the building, features like balcony/terrace and garden, need for renovation, the town size, and region. Furthermore, the SOEP provides a variable indicating the sum of yearly interest and mortgage amortization payments for user-occupied housing, and the number of years the owners have been living in their dwelling. I include both variables and an interaction term between them. This allows that for newly bought property, high interest payments indicate that the net value is low, because little of the mortgage has been paid off yet, whereas for property owned for a long time, high mortgage payments indicate that the net value is high, because yearly mortgage amortization payments are usually constant over a fixed period of time. Table A 3 in Appendix A presents the regression results. As expected, the coefficient of the interaction term is positive and significant, and the estimated coefficients of the other variables are also consistent with expectations. The wealth measure will be subject to sensitivity analysis in section 5.2.

5 Empirical results

5.1 Estimation results support hypothesis *H1*

The upper panel of Table 1 presents the logit coefficients from the baseline estimations of the yearly probabilities of entry into and exit from self-employment and of being self-employed with their cluster and heteroscedasticity robust standard errors. Results for all control variables appear in Table A 4 in Appendix A. The coefficients of the polynomial terms of the duration in the current employment spell are jointly significant both in the entry and exit models, indicating that duration dependence matters for the dynamics of self-employment. In the entry model, the three interaction terms of the dummy variable indicating that somebody is not in paid work (*notempl*) with the duration terms are individually insignificant, but jointly significant at the 5% level, which shows that employees have a different hazard rate of entry into self-employment than people not in paid work. The effects of the control variables confirm results from the literature. Women have lower yearly entry and higher yearly exit probabilities and are therefore less likely to be self-employed. Having had a self-employed father at the age of 15 increases the probability of entry, decreases the probability of exit, and consistently increases the likelihood of being self-employed. A university degree increases the probability of entry.

Table 1: Probability of self-employment transitions and state

	A: Entry	A: Exit	A: Self-em. state
postref	-0.0948	0.1909	0.0965
	(0.2197)	(0.2364)	(0.0665)
wealth	0.0483***	-0.0141	0.0682***
	(0.0094)	(0.0178)	(0.0124)
postref * wealth	-0.0450***	-0.1057	-0.0339***
	(0.0146)	(0.0699)	(0.0123)
duration	-0.4500***	-0.4144***	
	(0.0578)	(0.0641)	
dur_sq	0.0241***	0.0261***	
	(0.0055)	(0.0060)	
dur_cu	-0.0004***	-0.0005***	
	(0.0001)	(0.0001)	
notempl	0.3134		
	(0.2418)		
duration_ne	0.1484		
	(0.1630)		
dur_sq_ne	0.0009		
	(0.0240)		
dur_cu_ne	-0.0005		
	(0.0010)		
control variables	yes	yes	yes
Wald χ^2	482.491	222.605	507.860
Log likelihood	-2860.929	-1159.590	-13459.909
Person years	55793	4049	59842
Mean outcome	0.009983	0.098049	0.067662
Effect pre reform	0.000499***	-0.001118	0.003931***
	(0.000174)	(0.001444)	(0.000917)
Effect post reform	0.000030	-0.009818*	0.002071***
	(0.000103)	(0.005907)	(0.000700)
DiD Ai/Norton	-0.000469**	-0.008700	-0.001860**
	(0.000199)	(0.005934)	(0.000795)
DiD Puhani	-0.000403**	-0.008663	-0.002050***
	(0.000175)	(0.005928)	(0.000793)

Notes: The table shows estimation results for logit models of the yearly probabilities of entry into and exit out of self-employment and of being self-employed. The upper panel displays logit coefficients with cluster and heteroscedasticity robust standard errors in parenthesis and additional statistics. The lower panel shows the average marginal effects of wealth before and after the reform of the insolvency code, and the difference following Ai and Norton (2003) and Puhani (2008), with standard errors calculated based on the Delta method. The logit coefficients of all variables included in the models and their marginal effects appear in Table A 4 in Appendix A. Stars (***/**/*) indicate significance of logit coefficients at the 1%/5%/10% levels.
Source: Own calculations based on the SOEP (1993-2004).

To test the hypotheses, special interest is given to the effect of wealth and how it changes with the introduction of the Insolvency Code in 1999. The logit coefficients indicate that before the reform, wealth had a positive and significant effect on the probability of entry, no significant effect on exit, and, consistently, a positive effect on being self-employed. The positive effect of wealth on entry and self-employment state is consistent with the prediction of the

theoretical model introduced in section 3, which suggests that entrepreneurship is more attractive to more wealthy people because their collateral provides them access to cheaper credit, and with the literature on liquidity constraints and entrepreneurship summarized in the introduction. The coefficient of the interaction term with the "post reform" dummy variable is negative and significant in the entry model and the model of self-employment state, which shows that the positive effect of wealth declined after the reform. In the exit model, the interaction term does not indicate a significant change.

In the lower panel of Table 1, I use the estimated coefficients to calculate the average marginal effects of wealth in the three models both before and after the 1999 policy change. The cluster and heteroscedasticity robust standard errors are obtained using the Delta method. The positive wealth effects in the models of entry and self-employment state before the reform are small, but significant. In the entry model, an increase of wealth by 100,000 euro (you may think of comparing a house-owner to a tenant) raises the yearly entry probability by 0.05 percentage points. Given the yearly entry rate in the sample of 1% (see the line "mean outcome" in the table), this corresponds to a relative effect of 5%. Similarly, an increase of wealth by 100,000 euro raises the probability of being self-employed by 0.39 percentage points, which is a relative effect of 5.8%, given the self-employment rate of 6.7%.

Importantly, after the reform, the point estimate of the effect of wealth on entry declines to almost zero, and it is no longer significantly different from zero. The effect on being self-employed is still positive and significant, but also considerably smaller: 0.21 percentage points or 3.1% in relative terms. The results for entry and self-employment state are consistent, because while the effect of wealth on entry may drop to zero instantaneously after the introduction of the Insolvency Code, the stock of the self-employed needs time to adjust.

There is controversy in the literature how to compute a difference-in-difference in nonlinear models, such as the binary logit model used here. While Ai and Norton (2003) argue that the DID should be calculated as the double difference of the predicted probabilities,

Puhani (2008) advocates reporting the marginal effect of the interaction term. The difference arises because in contrast to a linear model, in a nonlinear model the double difference in general is different from zero even when the coefficient of the interaction term is zero, and the discrepancy becomes larger when the probabilities approach 0 or 1. In this application the results are not very different, which increases confidence in the suitability of the model in this context.

The before-after difference in the effect of wealth on entry is -0.047 percentage points following Ai and Norton, and -0.04 percentage points following Punahi. Thus, the policy reform attenuated the positive pre-reform effect of wealth on entry by 94% or 81%, respectively. The change in the effect of wealth on the probability of being self-employed is -0.19 or -0.21 percentage points, respectively, i.e. 47% or 52% of the pre-reform effect (again, consider that the stock of the self-employed needs time to adjust). The effects are significant. In contrast, the Insolvency Code did not significantly change the effect of wealth on the probability of exit from self-employment.

The results clearly support hypothesis *H1*, which states that the introduction of the more forgiving personal bankruptcy law decreased the positive effect of wealth on entry and on self-employment. Having in mind the theoretical model introduced above, this indicates that the insurance effect of the more generous bankruptcy proceedings outweigh the effect of higher interest rates. As the less wealthy benefit more from this than the wealthy, this counteracts the positive effect wealth had on self-employment before.

5.2 Sensitivity analysis indicates robust results

As discussed in section 4.1, identification of the effect of the policy reform requires the assumption that in the absence of the reform, the effect of wealth would not have changed at the time of the reform. While this assumption cannot be tested directly, it is informative to see if this assumption holds before and after the reform. I conduct placebo tests, where I pretend

that the reform had taken place in 1996, and implement the same adjusted DID estimators as before using data before the implementation of the actual reform in 1999, i.e. the period 1993-1998. Analogously, in another placebo test, I act as if the reform had taken place in 2002 and estimate the models on the data after the actual reform, i.e. on the waves 1999-2004.

The results appear in Table 2. In the placebo reform 1996, none of the interaction terms between the "post 1996" dummy and wealth are significantly different from zero in the models of entry, exit, and self-employment state, which confirms that the effect of wealth did not change in this period.[18] Correspondingly, the DID, reported below, are very small and insignificant. As expected, the effects of wealth on entry and on self-employment status, both before and after 1996, are positive and significant and of similar magnitude as estimated in Table 1 for the period before the reform, and the effect on exit is insignificant again. In the 2002 placebo reform, the interaction terms are insignificant in the entry and exit models, indicating that there were no differential time trends for people with different wealth levels after the reform. The model of self-employment state indicates a positive and significant change in the effect of wealth in 2002. The sign is opposite to the estimated effect of the actual reform in 1999. A positive trend in the effect of wealth towards the end of the estimation period, which I do not account for in the baseline estimation, tends to bias the negative impact of the actual bankruptcy law reform on the effect of wealth towards zero. Thus, in absolute terms, the estimated effect of the 1999 reform should be interpreted as a lower bound to the true effect in the model of self-employment state.

[18] The insignificance is not due to the smaller sample size in the placebo reform estimations, because the standard errors of the interaction term coefficients are not much larger than in the baseline estimations. The coefficients are insignificant because their point estimates are substantially closer to zero. The same applies to the estimated DID.

Table 2: Placebo reforms in 1996 and 2002

	Placebo reform in 1996 (data: 1993-98)			Placebo reform in 2002 (data: 1999-04)		
	Entry	Exit	Self-em. state	Entry	Exit	Self-em. state
postref	-0.0930	-0.0926	-0.0109	0.1056	0.1421	-0.1247**
	(0.2052)	(0.2482)	(0.0593)	(0.2262)	(0.2390)	(0.0612)
wealth	0.0491***	0.0023	0.0798***	0.0081	-0.0925	0.0269***
	(0.0138)	(0.0145)	(0.0177)	(0.0087)	(0.0744)	(0.0069)
postref * wealth	-0.0042	-0.0321	-0.0195	-0.0069	-0.1725	0.0356***
	(0.0189)	(0.0359)	(0.0145)	(0.0218)	(0.1405)	(0.0110)
duration	-0.3393***	-0.3398***		-0.6736***	-0.4593***	-0.0012
	(0.0684)	(0.0836)		(0.1250)	(0.0922)	(0.0375)
dur_sq	0.0187***	0.0174**		0.0432***	0.0321***	-0.0100***
	(0.0061)	(0.0075)		(0.0150)	(0.0086)	(0.0032)
dur_cu	-0.0003**	-0.0003		-0.0009*	-0.0006***	0.0002***
	(0.0001)	(0.0002)		(0.0005)	(0.0002)	(0.0001)
notempl	0.8799**			-0.2588		
	(0.3456)			(0.3623)		
duration_ne	-0.1726			0.4057*		
	(0.2782)			(0.2389)		
dur_sq_ne	0.0471			-0.0170		
	(0.0500)			(0.0323)		
dur_cu_ne	-0.0028			-0.0002		
	(0.0024)			(0.0012)		
control variables	yes	yes	yes	yes	yes	yes
Wald χ^2	310.957	107.991	391.375	247.418	140.784	481.908
Log likelihood	-1603.355	-609.568	-6913.819	-1232.227	-537.135	-6240.533
Person years	30055	2067	32122	25738	1982	27720
Mean outcome	0.010414	0.100629	0.064348	0.009480	0.095358	0.071501
Effect pre reform	0.000521**	0.000198	0.004527***	0.000072	-0.007102	0.001692***
	(0.000225)	(0.001283)	(0.001246)	(0.000087)	(0.006035)	(0.000517)
Effect post reform	0.000435**	-0.002374	0.003340***	0.000012	-0.019596**	0.003695***
	(0.000186)	(0.002771)	(0.000829)	(0.000196)	(0.009587)	(0.000970)
DiD Ai/Norton	-0.000087	-0.002573	-0.001187	-0.000059	-0.012494	0.002004***
	(0.000220)	(0.002998)	(0.000884)	(0.000209)	(0.010327)	(0.000768)
DiD Puhani	-0.000040	-0.002553	-0.001083	-0.000066	-0.012758	0.002107***
	(0.000186)	(0.002947)	(0.000818)	(0.000213)	(0.010453)	(0.000755)

Notes: The table shows estimation results for logit models of the yearly probabilities of entry into and exit out of self-employment and of being self-employed. The upper panel displays logit coefficients with cluster and heteroscedasticity robust standard errors in parenthesis and additional statistics. The lower panel shows the average marginal effects of wealth before and after the reform of the insolvency code, and the difference following Ai and Norton (2003) and Puhani (2008), with standard errors calculated based on the Delta method. Stars (***/**/*) indicate significance of logit coefficients at the 1%/5%/10% levels.
Source: Own calculations based on the SOEP (1993-2004).

I conduct further robustness checks to test if the results are sensitive to specification choices. Table 3 shows the results for the model of self-employment state; the results for the entry and exit models appear in Table 4 and Table 5. In the following, I first comment on the results from the models of self-employment state and entry, later returning to the exit model at the end of this section.

Table 3: Probability of being self-employed: Robustness checks

	B: Polynom-ial function	C: Home-ownership	D: Incl. gross labor income	E: Incl. risk attitude	F: Incl. time trend	G: Rare events logit	H: Data 1998-99	I: Data 1989-07	J: Excluding 2000/01
postref	0.0509	0.1677**	0.1014	0.0380	0.4680*	0.0967	0.0811*	0.2650***	-0.0492
	(0.0687)	(0.0746)	(0.0775)	(0.0843)	(0.2579)	(0.0665)	(0.0437)	(0.0857)	(0.0726)
wealth	0.1685***	0.3989***	0.0520***	0.0524***	0.0614***	0.0679***	0.0559***	0.0737***	0.0685***
	(0.0252)	(0.0864)	(0.0115)	(0.0116)	(0.0164)	(0.0124)	(0.0144)	(0.0121)	(0.0124)
postref * wealth	-0.0360	-0.1920**	-0.0214*	-0.0190*	-0.0433***	-0.0340***	-0.0175	-0.0411***	-0.0328***
	(0.0292)	(0.0877)	(0.0117)	(0.0104)	(0.0166)	(0.0123)	(0.0164)	(0.0116)	(0.0126)
wealth_sq	-0.0049***								
	(0.0012)								
postref * wealth_sq	0.0026**								
	(0.0012)								
wealth_cu	0.0000***								
	(0.0000)								
postref * wealth_cu	-0.0000***								
	(0.0000)								
grosslaborinc			0.2915***						
			(0.0380)						
risk tolerance				0.1723***					
				(0.0276)					
time trend					-0.0617				
					(0.0463)				
time trend * wealth					0.0018				
					(0.0023)				
control variables	yes	yes	yes	yes	yes	yes	yes	Yes	yes
Log likelihood	-13378.798	-15621.999	-11156.994	-9693.174	-13459.487		-2399.018	-20342.258	-13072.046
Person years	59842	68453	56850	43717	59842	59842	10218	90486	57614
Mean outcome	0.067662	0.068485	0.057889	0.067983	0.067662	0.067662	0.071247	0.067591	0.068421
Effect pre reform		0.023545***	0.002530***	0.003055***	0.003110***	0.003926***	0.003398***	0.003981***	0.004203***
		(0.006097)	(0.000704)	(0.000867)	(0.001022)	(0.000918)	(0.001060)	(0.000859)	(0.000959)
Effect post reform		0.012876**	0.001584***	0.001977***	0.001274	0.002056***	0.002449***	0.002094***	0.002053***
		(0.005862)	(0.000533)	(0.000672)	(0.001739)	(0.000700)	(0.000927)	(0.000539)	(0.000537)
DiD Ai/Norton		-0.010669*	-0.000945	-0.001078	-0.001836	-0.001870**	-0.000949	-0.001887**	-0.002150**
		(0.005628)	(0.000628)	(0.000669)	(0.001365)	(0.000797)	(0.001041)	(0.000747)	(0.000847)
DiD Puhani		-0.011950**	-0.001107*	-0.001119*	-0.003048**	-0.002060***	-0.001114	-0.002642***	-0.001885**
		(0.005705)	(0.000629)	(0.000642)	(0.001301)	(0.000795)	(0.001058)	(0.000816)	(0.000762)

Notes: The table shows estimation results for logit models of the yearly probabilities being self-employed. The upper panel displays logit coefficients with cluster and heteroscedasticity robust standard errors in parenthesis and additional statistics. The lower panel shows the average marginal effects of wealth before and after the reform of the insolvency code, and the difference following Ai and Norton (2003) and Puhani (2008), with standard errors calculated based on the Delta method. Stars (***/**/*) indicate significance of logit coefficients at the 1%/5%/10% levels. Source: Own calculations based on the SOEP (1993-2004).

Table 4: Probability of entry into self-employment: Robustness checks

	B: Polynom-ial function	C: Home-ownership	D: Incl. gross labor income	E: Incl. risk attitude	F: Incl. time trend	G: Rare events logit	H: Data 1998-99	I: Data 1989-07	J: Excluding 2000/01
postref	-0.0983	-0.0108	-0.1443	0.0274	-0.7935	-0.0985	-0.1092	-0.0022	-0.2316
	(0.2220)	(0.2099)	(0.2224)	(0.2713)	(1.0775)	(0.2196)	(0.2160)	(0.2382)	(0.2311)
wealth	0.1387***	0.1877	0.0480***	0.0467***	0.0497**	0.0491***	0.0564***	0.0492***	0.0473***
	(0.0400)	(0.1143)	(0.0096)	(0.0124)	(0.0194)	(0.0094)	(0.0201)	(0.0085)	(0.0097)
postref * wealth	-0.0993	-0.1167	-0.0443***	-0.0410**	-0.0433	-0.0346**	-0.0292	-0.0414***	-0.0612***
	(0.0707)	(0.1598)	(0.0144)	(0.0163)	(0.0290)	(0.0146)	(0.0255)	(0.0128)	(0.0179)
wealth_sq	-0.0052*								
	(0.0027)								
postref * wealth_sq	0.0041								
	(0.0042)								
wealth_cu	0.0001*								
	(0.0000)								
postref * wealth_cu	-0.0000								
	(0.0000)								
grosslaborinc			-0.0156						
			(0.0607)						
risk tolerance				0.1571***					
				(0.0285)					
time trend					0.1165				
					(0.1960)				
time trend * wealth					-0.0003				
					(0.0045)				
control variables	yes	yes	yes	yes	yes	yes	yes	Yes	yes
Log likelihood	-2857.206	-3324.885	-2742.717	-2128.460	-2860.927		-455.755	-4367.834	-2794.698
Person years	55793	63765	53559	40745	55793	55793	9490	84370	53672
Mean outcome	0.009983	0.010147	0.010008	0.010480	0.009983	0.009983	0.009905	0.010158	0.010192
Effect pre reform		0.001914	0.000507***	0.000478**	0.000733	0.000524***	0.000569	0.000496***	0.000531***
		(0.001289)	(0.000181)	(0.000210)	(0.000626)	(0.000182)	(0.000353)	(0.000160)	(0.000190)
Effect post reform		0.000683	0.000032	0.000056	0.000042	0.000135	0.000238	0.000075	-0.000117
		(0.001265)	(0.000096)	(0.000106)	(0.000293)	(0.000114)	(0.000225)	(0.000098)	(0.000132)
DiD Ai/Norton		-0.001232	-0.000476**	-0.000421*	-0.000691	-0.000389**	-0.000332	-0.000421**	-0.000648***
		(0.001645)	(0.000202)	(0.000229)	(0.000562)	(0.000195)	(0.000303)	(0.000178)	(0.000250)
DiD Puhani		-0.001121	-0.000388**	-0.000410*	-0.000287	-0.000323*	-0.000255	-0.000396**	-0.000515**
		(0.001563)	(0.000171)	(0.000215)	(0.000264)	(0.000165)	(0.000261)	(0.000165)	(0.000214)

Notes: The table shows estimation results for logit models of the yearly entry probabilities into self-employment. The upper panel displays logit coefficients with cluster and heteroscedasticity robust standard errors in parenthesis and additional statistics. The lower panel shows the average marginal effects of wealth before and after the reform of the insolvency code, and the difference following Ai and Norton (2003) and Puhani (2008), with standard errors calculated based on the Delta method. Stars (***/**/*) indicate significance of logit coefficients at the 1%/5%/10% levels. *Source*: Own calculations based on the SOEP (1993-2004).

Table 5: Probability of exit from self-employment: Robustness checks

	B: Polynom-ial function	C: Home-ownership	D: Incl. gross labor income	E: Incl. risk attitude	F: Incl. time trend	G: Rare events logit	H: Data 1998-99	I: Data 1989-07	J: Excluding 2000/01
postref	0.2227	0.0623	0.0960	-0.0024	1.1499	0.1903	0.6088**	-0.0161	-0.5276*
	(0.2407)	(0.2378)	(0.2639)	(0.2789)	(1.3593)	(0.2343)	(0.2864)	(0.2723)	(0.2901)
wealth	-0.1296*	-0.3696**	-0.0044	0.0031	0.0215	-0.0060	0.0010	-0.0032	-0.0124
	(0.0672)	(0.1559)	(0.0150)	(0.0219)	(0.0385)	(0.0177)	(0.0530)	(0.0118)	(0.0179)
postref * wealth	-0.1909	0.0666	-0.0931	-0.1320*	-0.0398	-0.1027	-0.0323	-0.0344	-0.0541
	(0.1484)	(0.2049)	(0.0652)	(0.0782)	(0.1189)	(0.0693)	(0.0629)	(0.0262)	(0.0368)
wealth_sq	0.0150*								
	(0.0078)								
postref * wealth_sq	0.0113								
	(0.0188)								
wealth_cu	-0.0003*								
	(0.0002)								
postref * wealth_cu	-0.0003								
	(0.0005)								
grosslaborinc			-0.1233***						
			(0.0459)						
risk tolerance				-0.3275***					
				(0.1081)					
risk tolerance square				0.0293***					
				(0.0101)					
time trend					-0.1587				
					(0.2426)				
time trend * wealth					-0.0114				
					(0.0130)				
control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
Log likelihood	-1155.608	-1387.028	-944.187	-880.749	-1159.104		-204.203	-1757.877	-1118.814
Person years	4049	4688	3291	2972	4049	4049	728	6116	3942
Mean outcome	0.098049	0.101536	0.097539	0.106662	0.098049	0.098049	0.104396	0.098757	0.096398
Effect pre reform		-0.030293**	-0.000360	0.000278	0.001276	-0.000488	0.000066	-0.000269	-0.001205
		(0.014566)	(0.001229)	(0.001979)	(0.002443)	(0.001452)	(0.003542)	(0.000991)	(0.001755)
Effect post reform		-0.026517*	-0.007766	-0.010310	-0.002156	-0.009168	-0.002971	-0.002995	-0.004241
		(0.015182)	(0.005389)	(0.006567)	(0.017487)	(0.005934)	(0.004006)	(0.002069)	(0.002601)
DiD Ai/Norton		0.003776	-0.007406	-0.010589	-0.003432	-0.008680	-0.003037	-0.002726	-0.003036
		(0.017791)	(0.005460)	(0.006818)	(0.015700)	(0.006030)	(0.005047)	(0.002197)	(0.002728)
DiD Puhani		0.005825	-0.007416	-0.010557	-0.004697	-0.008666	-0.003065	-0.002739	-0.003449
		(0.018011)	(0.005441)	(0.006718)	(0.014131)	(0.006022)	(0.006025)	(0.002171)	(0.002510)

Notes: The table shows estimation results for logit models of the yearly exit probabilities out of self-employment. Stars (***/**/*) indicate significance of logit coefficients at the 1%/5%/10% levels. See notes under Table A 3 for further explanations. *Source*: Own calculations based on the SOEP (1993-2004).

In Specification B I allow for a non-linear effect of wealth. I specify a third degree polynomial of wealth and interact the wealth terms with the post reform dummy. Again the effects of wealth on being self-employed and entry are significant and positive within a relevant range of wealth. The interaction terms with the post reform dummy are jointly significant at the 1% level in both models (although not individually significant in the entry model). The coefficients of the interaction terms are always of opposite sign to the wealth terms, which again shows that the policy reform attenuated the effect of wealth towards zero.[19]

In Spec. C, instead of the estimated continuous wealth variable, I use a very simple wealth indicator which is available every survey year: A dummy variable indicating if somebody owns the dwelling he or she lives in. Because the wealth indicator is a dummy variable, Spec. C represents the standard DID estimator, just with the coding opposite to the usual conduct: Wealth=0 indicates treatment and wealth=1 indicates the control group (keep in mind that the less wealthy are considered to be affected by the reform of bankruptcy law). In the model of self-employment state, the coefficient of the interaction term and the DID are negative and significant. In fact, the DID indicates that the reform reduced the positive pre-reform effect of homeownership by 45% (Ai and Norton's method) or 51% (Puhani's method) in relative terms, which is very similar to the results from the baseline estimation (47% or 52%). In the entry model, the interaction term's coefficient is also negative, but statistically insignificant. Presumably, the home ownership dummy as a wealth measure is too imprecise and therefore inflates the standard error too much. Note that because transitions are rare and because of the smaller sample size in the transition models, significant results are generally less frequent in the models of entry and exit than in the model of self-employment state.

In Spec. D I include gross labor income in the month before the interview as an additional control variable (I do not include it in the baseline model because of potential

[19] As the nonlinearity is not very pronounced in the relevant range of wealth, I use the linear approximation in the baseline estimation for ease of interpretation.

endogeneity). The coefficient of the interaction term remains negative and significant in both the models of entry and self-employment state.[20] The coefficient of gross income itself is insignificant in the entry model.

Spec. E controls for the self-reported risk attitude, as Caliendo et al. (2009) report a significant and positive effect of risk tolerance on entry. This finding is confirmed here on a different estimation period. The risk attitude was first elicited in the SOEP questionnaire of 2004, which asked respondents to state their general willingness to take risks on an 11-point scale ranging from 0 to 10.[21] As I have to impute the answers given in 2004 into the estimation period, I lose people not observed in 2004, which is why I do not include the risk attitude in the baseline estimations. The negative and significant change in the effect of wealth due to the bankruptcy law reform remains stable in both the models of entry and self-employment state.

Spec. F includes a time trend and its interaction with wealth, which allows for differential time trends by wealth. The time trend and its interaction are jointly insignificant at the 10% level in both the models of entry and state, which indicates that there were no reform-independent differential time trends for people with different wealth levels. This confirms the results from the placebo tests and further supports the plausibility of the identifying assumption. As the time trend and the interaction are jointly insignificant, they can be excluded from the final specification. It is also reassuring that the change in the wealth effect triggered by the 1999 reform remains negative in both models, although statistically significant only in the model of self-employment state. The insignificance in the entry model may be explained by multicollinearity, which may increase the standard error too much.

[20] In Spec. D of the model of self-employment state, the estimated DID is significant if calculated following Puhani (2008), but insignificant following Ai and Norton (2003). The same is observed in Spec's E and F of the state model. The fact that the coefficient of the interaction term is significant in the three specifications suggests that Puhani's method is more adequate here.

[21] Dohmen et al. (2005) conduct a field experiment with real money at stake and find that this survey measure of risk attitude reliably predicts actual risk taking behavior.

Entry into self-employment is a rare event, as only 1% of the population switch to self-employment in any given year. King and Zeng (2001) suggest an adjusted logit estimator for rare events data that corrects otherwise potentially severe finite sample bias. In this application, the results in Spec. G using this estimator are similar, however, which indicates that the standard logit estimator is appropriate here.

Last, but not least, we test the sensitivity of the results with respect to different estimation periods. In Spec. H I choose the narrowest time window possible, only one year each before and after the reform. The point estimates for the coefficients of the interaction terms are negative again in the models of entry and self-employment state, but they are statistically insignificant, presumably because the small sample size inflates the standard errors. Spec. I uses a long period of 9 years both before and after the reform, which replicates the negative and significant results of the baseline model and yields similar magnitudes of the effects. This indicates that the effects of the bankruptcy law reform are not limited to the short term. Finally, one may wonder if the internet bubble, which saw a large number of start-ups in the IT sector, may influence the results in some way. Thus in Spec. J I exclude the years 2000 and 2001, but otherwise stick to the estimation period of the baseline estimations. The change in the effect of wealth remains negative and significant in both models.

In the model of exit (Table 5), almost all the robustness checks confirm the result from the baseline estimation that the bankruptcy law reform did not significantly change the effect of wealth on the yearly probability of exit from self-employment. This finding includes the nonlinear Spec. B, where the three interaction terms with the post reform dummy are jointly not even significant at the 10% level. Only in Spec. E including risk attitude, we observe a negative interaction term which is significant at the 10% level, but the estimated DID remain insignificant.[22] Note that I also include the square of risk tolerance in this specification, as

[22] The significance of the interaction term could easily be due to sampling error, given that actually 10 specifications are estimated.

Caliendo et al. (2010) report that risk tolerance has a U-shaped effect on exit from self-employment. This result is confirmed here using a different time period: The minimal risk of exit is found at a medium level of risk tolerance of about 5-6 on the 11-point scale.

6 Conclusion

The model developed in this paper illustrates that a more forgiving personal bankruptcy law, which allows a "fresh start" for insolvent entrepreneurs, may have two opposing effects on the attractiveness of entrepreneurial activity in comparison to wage work. On the one hand, forgiving personal bankruptcy proceedings provide insurance, as entrepreneurs enjoy a partial discharge from debt in case of misfortune. On the other hand, they also increase interest rates, because banks demand a risk premium as compensation for the lower expected recovery in case of debtor bankruptcy. The model further shows that both effects are more pronounced for less wealthy potential entrepreneurs, because the wealthy bring in their wealth as collateral and thus neither benefit as much from the insurance, nor suffer as much from the increased interest rates.

The introduction of the German Insolvency Code in 1999, which newly provides a "fresh start" policy, serves as a natural experiment to test the model and to assess which effect dominates. The results indicate that the insurance effect outweighs the interest effect. Thus, the "fresh start" makes entrepreneurship more attractive, especially for the less wealthy. Sensitivity analysis shows that the results are robust.

The findings contribute to the literature highlighting the value of a more forgiving personal bankruptcy law for entrepreneurship. In the light of these results, the current plan of the German government to reduce the time to discharge from personal debt from 6 to only 3 years can be expected to further increase entrepreneurial activity. Countries without a "fresh start" policy may want to consider introducing it if the promotion of entrepreneurship is a policy objective. Precise *ex-ante* quantification of the effect of future reforms of personal

bankruptcy law on entrepreneurship requires a more structural estimation approach, which is a possible avenue for future research.

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Appendix A: Supplementary Tables

Table A 1: Weighted mean characteristics by employment type

	Self-employed	Employees	Not working
highschool	0.382	0.219	0.144
apprenticeship	0.428	0.554	0.530
highertechncol	0.294	0.210	0.189
university	0.299	0.169	0.100
female	0.301	0.448	0.773
east	0.194	0.229	0.239
south	0.264	0.259	0.255
north	0.133	0.124	0.128
age	41.5	39.1	40.7
prworkexp10	1.567	1.473	1.148
prunempexp	0.415	0.401	0.804
disabled	0.029	0.059	0.084
german	0.967	0.958	0.945
nchild	0.762	0.659	0.924
married	0.654	0.622	0.757
fatherse	0.188	0.081	0.078
wealth	2.526	0.994	1.173
homeowner	0.558	0.461	0.518
grosslaborinc	2952	2095	0
duration	6.669	9.187	4.396
risk tolerance	5.316	4.732	4.138
Person years	4049	44196	11597

Notes: The table shows means of the variables used in this analysis by employment state, weighted using population weights. For risk tolerance, the number of person years is lower than for the other variables (2972, 32698, and 8047 for the self-employed, employees, and not working people, respectively).
Source: Own calculations based on the SOEP (1993-2004).

Table A 2: Description of variables

Variable	Definition
highschool	Dummy for individuals who finished higher secondary school with a university entrance qualification ("*Fachhochschulreife*" or "*Abitur*")
apprenticeship	Dummy for individuals who finished an apprenticeship ("*Lehre*")
highertechncol	Dummy for individuals who finished a higher technical college, a health care school, or civil service training ("*Berufsschule*", "*Schule Gesundheitswesen*", "*Fachschule*", "*Meister*", "*Beamtenausbildung*", or "*Sonstige Ausbildung*")
university	Dummy for individuals who have a university degree
female	Dummy for females
east	Dummy for individuals living in the area of former East Germany or Berlin.
south	Dummy for individuals living in Baden Wuerttemberg or Bavaria.
north	Dummy for individuals living in Schleswig Holstein or Lower Saxony.
age	Age of individual
prworkexp10[a]	Years of full time work experience prior to the year of observation, divided by 10
prunemexp[a]	Years of unemployment experience prior to the year of observation
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"
fatherse	Dummy for individuals whose father was self-employed when the respondents were 15 years old
wealth	Estimated sum of financial assets, owner occupied property and other property in 100,000 euro, deflated to 1998 prices using the Consumer Price Index
homeowner	Dummy for individuals who own their dwelling
grosslaborinc	Real gross monthly income from paid work (self-employment or regular employment) in 1000 euro, deflated to 1998 prices using the Consumer Price Index
duration[a]	Tenure of current spell (self-employment, regular employment or unemployment/inactivity). For left-censored spells, the duration since the last job change is used, which may be shorter than the overall spell if somebody switched jobs
notempl	Dummy for individuals not in paid work
prostref	Dummy for observations in and after 1999
*x*_sq	Square of variable *x*
*x*_cu	Cube of variable *x*
*x*_ne	Interaction term of variable *x* with the dummy variable notempl

Notes: Dummy variables equal 1 if condition holds and 0 otherwise.
[a] Uses information from the lifetime employment history in the SOEP.

Table A 3: Estimation of the net value of owner occupied housing

needsSomeRenovation	-1.62e+04***
	(4975.3104)
needsFullRenovation	-5.25e+04***
	(1.12e+04)
Size	919.2060***
	(245.6902)
size_sq	-0.8789
	(0.8412)
interestMortgage	-41.2967***
	(7.6973)
yearsInDwelling	-545.1070**
	(240.1739)
interestMortgage * yearsInDwelling	1.2690**
	(0.6228)
city2to20th	3556.1265
	(6528.6200)
city20to100th	2124.6516
	(7427.4328)
city100thTo500th	1.62e+04*
	(8455.6738)
cityGe500th	2.58e+04*
	(1.32e+04)
centralDistrict	-509.6278
	(6141.3238)
cityMissing	1144.6627
	(6650.4868)
Rowhouse	-1.09e+04
	(1.78e+04)
apt3to8units	-950.9687
	(2.73e+04)
apt9plusUnits	-3.06e+04
	(1.97e+04)
otherBuilding	6475.4284
	(1.33e+04)
balconyTerrace	2.09e+04***
	(6053.7877)
Garden	1.34e+04
	(9193.2381)
7 dummies indicating building age	yes
15 federal state dummies	yes
constant	-3.85e+04
	(2.95e+04)
R2	0.151
Person years	2596
Mean outcome	1.05973e+05

Notes: The table shows estimated coefficients of an OLS regression explaining the net value of owner occupied houses and apartments. Heteroscedasticity robust standard errors in parenthesis. Stars (***/**/*) indicate significance at the 1%/5%/10% levels.
Source: Own calculations based on the SOEP (2002).

Table A 4: Probability of self-employment transitions and state: Full results

	A: Entry	A: Exit	A: Self-em. state
postref	-0.0948	0.1909	0.0965
	(0.2197)	(0.2364)	(0.0665)
wealth	0.0483***	-0.0141	0.0682***
	(0.0094)	(0.0178)	(0.0124)
postref * wealth	-0.0450***	-0.1057	-0.0339***
	(0.0146)	(0.0699)	(0.0123)
duration	-0.4500***	-0.4144***	
	(0.0578)	(0.0641)	
dur_sq	0.0241***	0.0261***	
	(0.0055)	(0.0060)	
dur_cu	-0.0004***	-0.0005***	
	(0.0001)	(0.0001)	
notempl	0.3134		
	(0.2418)		
duration_ne	0.1484		
	(0.1630)		
dur_sq_ne	0.0009		
	(0.0240)		
dur_cu_ne	-0.0005		
	(0.0010)		
highschool	0.1302	-0.0379	0.4469***
	(0.1443)	(0.1784)	(0.1160)
apprenticeship	-0.0576	0.1452	-0.1972**
	(0.1207)	(0.1662)	(0.1004)
highertechncol	0.1787	-0.1711	0.3625***
	(0.1362)	(0.1833)	(0.1085)
university	0.5621***	0.0040	0.1649
	(0.1603)	(0.1829)	(0.1297)
female	-0.7520***	0.6040***	-0.8895***
	(0.1095)	(0.1247)	(0.0969)
east	-0.5089***	-0.2787*	-0.1006
	(0.1328)	(0.1596)	(0.1120)
south	-0.1585	-0.0664	-0.0359
	(0.1230)	(0.1541)	(0.1120)
north	-0.1456	-0.3530*	0.0868
	(0.1618)	(0.2114)	(0.1505)
age	0.2164***	-0.0339	0.2265***
	(0.0606)	(0.0707)	(0.0495)
agesq	-0.0026***	0.0005	-0.0024***
	(0.0008)	(0.0009)	(0.0006)
prworkexp10	0.6544**	-0.5462*	0.2704
	(0.2753)	(0.3046)	(0.2158)
prworkexp10_sq	-0.2280***	0.1091	-0.0783
	(0.0802)	(0.0778)	(0.0587)
prunempexp	-0.0682	0.0046	0.0359
	(0.0660)	(0.0998)	(0.0911)
prunempexp_sq	0.0047	0.0170	-0.0179
	(0.0071)	(0.0110)	(0.0186)
disabled	-0.1026	0.4506	-0.6853***
	(0.2204)	(0.2836)	(0.1936)
german	0.0706	0.0894	0.0127
	(0.1869)	(0.2432)	(0.1851)

Continued on the following page

Table A 4 continued

	A: Entry	A: Exit	A: Self-em. state
nchild	-0.0397	0.0151	0.0051
	(0.0536)	(0.0683)	(0.0428)
married	0.0037	0.2277	-0.2533***
	(0.1137)	(0.1460)	(0.0952)
fatherse	0.4122***	-0.3465*	0.9172***
	(0.1568)	(0.1944)	(0.1240)
d1994	0.1163	-0.1669	-0.0612
	(0.1959)	(0.2424)	(0.0464)
d1995	0.0074	-0.4291*	-0.0742
	(0.2019)	(0.2569)	(0.0541)
d1996	-0.0724	-0.1002	-0.0260
	(0.2052)	(0.2421)	(0.0590)
d1997	-0.0146	-0.4365*	-0.0190
	(0.2034)	(0.2596)	(0.0617)
d1998	0.0450	-0.4589*	-0.0057
	(0.2018)	(0.2604)	(0.0643)
d2000	0.0211	-0.3389	-0.1409***
	(0.2225)	(0.2464)	(0.0435)
d2001	-0.1164	-0.6185**	-0.1355***
	(0.2368)	(0.2723)	(0.0506)
d2002	0.0457	0.0461	-0.1835***
	(0.2233)	(0.2430)	(0.0574)
d2003	0.1912	-0.7290**	-0.1889***
	(0.2191)	(0.2943)	(0.0593)
d2004	0.2852	-0.2140	-0.1020
	(0.2174)	(0.2531)	(0.0632)
_cons	-7.5070***	-0.2019	-7.4744***
	(1.0755)	(1.2598)	(0.8776)
chi2	482.491	222.605	507.860
Log likelihood	-2860.929	-1159.590	-13459.909
Person years	55793	4049	59842
Mean outcome	0.009983	0.098049	0.067662

Notes: The table shows estimated logit coefficients of a model of the yearly probabilities of entry into and exit out of self-employment and of being self-employed. Cluster and heteroscedasticity robust standard errors in parenthesis. Stars (***/**/*) indicate significance at the 1%/5%/10% levels.
Source: Own calculations based on the SOEP (1993-2004).

Appendix B – Hazard Rate Model

This appendix describes the discrete time hazard rate model used to estimate probabilities of entry into and exit from self-employment, conditional on the duration of the current state. Exit from self-employment and entry into self-employment are modeled 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. Respondents may experience multiple spells during the observation period. I use the discrete non-negative random variable T_{ik} to describe 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 a value of *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) conditional on survival until the beginning of *t*:

$$\lambda_{ik}\left(t\middle| X_{ik}(t)\right) = P\left(T_{ik} = t \middle| T_{ik} \geq t, X_{ik}(t)\right). \tag{B1}$$

where $X_{ik}(t)$ is a vector of the characteristics and covariates of individual *i* in interval *t* of spell *k* including the personality characteristics. The probability of remaining in the current state in period *t* ("survival"), conditional on having survived until the beginning of *t*, is the complementary probability

$$P\left(T_{ik} > t \middle| T_{ik} \geq t, X_{ik}(t)\right) = 1 - \lambda_{ik}\left(t\middle| X_{ik}(t)\right). \tag{B2}$$

The survivor function, which represents 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*:

$$S\left(t\middle| X_{ik}\right) = P\left(T_{ik} > t \middle| X_{ik}\right) = \prod_{\tau=1}^{t}\left(1 - \lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)\right). \tag{B3}$$

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*:

$$P\left(T_{ik}=t\middle|X_{ik}\right)=\lambda_{ik}\left(t\middle|X_{ik}(t)\right)\prod_{\tau=1}^{t-1}\left(1-\lambda_{ik}\left(\tau\middle|X_{ik}(\tau)\right)\right). \tag{B4}$$

The model is estimated using the maximum likelihood method, which takes into account completed spells as well as both left-censored and right-censored spells. For a fully observed spell completed with an exit from the current employment state, the contribution to the likelihood function is given by equation (B4). For a right-censored spell the likelihood contribution is given by the survivor function (B3), because it is only known that a person "survived" until the end of the observation period, but not when the spell will end. Combining these two cases, the likelihood contribution of a spell *k* of an individual *i* can be written as

$$L_{ik}^{\,not\,left-censored}\left(parameters\middle|c_i,X_{ik}\right)=\left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}\right]^{c_{ik}}\prod_{\tau=1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_{ik}(\tau)\right)\right) \tag{B5}$$

where c_{ik} is a censoring indicator defined such that c_{ik} = 1 if a spell is completed and 0 if a spell is right-censored.

If a spell is left-censored in the SOEP, because person *i* enters the panel after spell *k* has already lasted u_{ik} years, conditioning on survival up to the end of period u_{ik} means dividing expression (B5) by $S(u_{ik})$. Then the likelihood contribution of the spell is

$$\begin{aligned} L_{ik}\left(parameters\middle|c_i,X_{ik}\right) &= \left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}\right]^{c_{ik}}\frac{\prod_{\tau=1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_{ik}(\tau)\right)\right)}{\prod_{\tau=1}^{u_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_{ik}(\tau)\right)\right)} \\ &= \left[\frac{\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}{1-\lambda_{ik}\left(t_{ik}\middle|X_{ik}(t_{ik})\right)}\right]^{c_{ik}}\prod_{\tau=u_{ik}+1}^{t_{ik}}\left(1-\lambda_{ik}\left(\tau\middle|X_{ik}(\tau)\right)\right) \end{aligned} \tag{B6}$$

Note that this more general notation includes equation (B5) for spells that are not left-censored (u_{ik} = 0). In the SOEP, retrospective employment history questions enable me to recover the spell durations u_{ik} and thereby deal with left-censoring.

The overall likelihood contribution of an individual *i* equals the product of the likelihood contributions of the K_i spells the person experienced in the observation period. The sample likelihood function is the product of the individual likelihood contributions:

$$L\left(\textit{parameters}\middle| c, X\right) = \prod_{i=1}^{N}\prod_{k=1}^{K_i} L_{ik} \tag{B7}$$

The log-likelihood function is

$$\begin{aligned}&\log L\left(\textit{parameters}\middle| c, X\right) = \sum_{i=1}^{N}\sum_{k=1}^{K_i}\log L_{ik} \\ &= \sum_{i=1}^{N}\sum_{k=1}^{K_i} c_{ik}\log\left[\frac{\lambda_{ik}\left(t_{ik}\middle| X_{ik}(t_{ik})\right)}{1-\lambda_{ik}\left(t_{ik}\middle| X_{ik}(t_{ik})\right)}\right] + \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\log\left[1-\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)\right]\end{aligned} \tag{B8}$$

Define a new binary transition indicator variable $y_{ik\tau} = 1$ if person *i* completes spell *k* in period τ, and 0 otherwise. The $y_{ik\tau}$ correspond to dummy variables that equal 1 if a transition is observed between τ and $\tau + 1$, and 0 otherwise. Effectively adding some zeros to the sum, it can be written

$$\begin{aligned}&\log L\left(\textit{parameters}\middle| y, X\right) \\ &= \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}} y_{ik\tau}\log\left[\frac{\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)}{1-\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)}\right] + \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\log\left[1-\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)\right] \\ &= \sum_{i=1}^{N}\sum_{k=1}^{K_i}\sum_{\tau=u_{ik}+1}^{t_{ik}}\left(y_{ik\tau}\log\left[\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)\right] + (1-y_{ik\tau})\log\left[1-\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right)\right]\right)\end{aligned} \tag{B9}$$

The last expression has exactly the same form as the standard log-likelihood function for a binary regression model in which $y_{ik\tau}$ is the dependent variable and the data are organized in person-period format, where τ is measured from the beginning of the current spell and thus measures its duration (cf. Jenkins, 1995).

The functional form of the hazard rate is specified as a logistic hazard model:

$$\lambda_{ik}\left(\tau\middle| X_{ik}(\tau)\right) = \frac{\exp\left(f(\tau) + X_{ik}(\tau)\beta\right)}{1+\exp\left(f(\tau) + X_{ik}(\tau)\beta\right)}, \tag{B10}$$

where the function $f(\tau)$ represents the dependence of the hazard rate on the spell duration τ (baseline hazard), specified as a polynomial function of the third degree.