

## The Welfare Costs of Addiction

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### Abstract

This paper presents an attempt to calculate the non-financial costs of tobacco addiction. Using data on individual well-being and smoking behaviour, it is shown that tobacco addicts are on average less happy than non-addicts even if the potential endogeneity of smoking is controlled for. This lends support to the notion of “unhappy addicts”. It is estimated how much money income individual smokers must be given in order to be compensated for their reduction in well-being. Projections based on these figures suggest that the aggregate non-financial welfare costs of smoking might easily be higher than the aggregate financial costs.

### Zusammenfassung

In diesem Beitrag wird versucht, die intangiblen Kosten des Tabakkonsums zu schätzen. Mit Individualdaten zur Lebenszufriedenheit und zum Rauchverhalten wird gezeigt, dass Raucher selbst dann im Durchschnitt eine geringere Lebenszufriedenheit aufweisen als Nichtraucher, wenn die potentielle Endogenität des Rauchverhaltens kontrolliert wird. Dieser Befund stützt die These, dass Abhängigkeit unglücklich macht. Die individuellen Wohlfahrtskosten der Sucht werden als der Betrag berechnet, um den das Einkommen eines Rauchers erhöht werden müsste, um die negativen Folgen der Sucht für die Lebenszufriedenheit zu kompensieren. Auf die Gesellschaft hochgerechnet sind diese Kosten noch höher als diejenigen, die schon durch Morbidität und vorzeitige Mortalität verursacht werden.

*JEL-Classification: I12, J17*

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"When I bought the book I was filled with an almost uncontrollable panic. It is this panic which keeps me from picking up another cigarette because I don't panic anymore BECAUSE I no longer smoke. I am no longer reliant on them, I don't need them, I don't want them and I don't crave them because I AM FREEEEEEEE!"

"This is not going to be some long winded tale of how I mastered the dreaded weed and overcame my addiction ... Truth is, I simply read Allen Carr's remarkable book and IT DOES WHAT IT SAYS IT DOES ... After 30 years of killing myself and believing I was a hopeless case, destined to smoke myself into an early grave, here I am a happy NON-smoker. ... The big monster (in the head) has no further hold on me and I have escaped from this prison after thirty years. Anyway, just follow everything Mr Carr advises in the book and you will be FREE, FREEEEEEEEEEEE."

Customer reviews on a popular self-help book on smoking cessation at an internet book shop.

## 1. Introduction

The social costs of tobacco consumption are conventionally calculated as the sum of (1) direct costs from health care expenses attributable to smoking, (2) indirect morbidity costs due to early retirement, and other working days lost, and (3) indirect mortality costs associated with the loss of productivity caused by premature deaths (Chaloupka and Warner, 2000).<sup>1</sup> The latest figures available for Germany are for the year 1993 and range from 17.3 to 43.7 billion €, depending on the valuation of unpaid work (Welte et al., 2000). The appropriateness of such cost accounting is controversial, because it basically ignores the idea that the society might also "benefit" from premature deaths of smokers. Firstly, premature deaths, in particular before retirement, take a considerable financial burden off the pay-as-you-go public pension system. Recent estimates for Germany show that aggregate public pensions would be six to nine per cent (about six to nine billion € per year) lower if no one had ever smoked (Warschburger, 2002). Secondly, even the net effect of smoking cessation on health care costs is unclear, because non-smokers live longer but eventually incur the same or even higher health costs than smokers. For instance, Barendregt et al. (1997) show that health care costs in a non-smoking population would be seven per cent higher among men and four per cent higher among women than in a mixed population of smokers and non-smokers.

In this paper, I explore a complementary approach to measuring the social costs of cigarette addiction. While the aforementioned types of studies define

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<sup>1</sup> Health damages from second-hand smoke are usually not accounted for in cost of smoking calculations, since it is still controversial whether there are any sizeable effects. The long-run economic costs of smoking during pregnancy are another issue that may deserve more attention.

welfare costs solely as income and productivity losses of smokers, I broaden this view by looking at non-monetary welfare costs, such as the loss in quality of life from being addicted to tobacco.<sup>2</sup> The paper is hence very much in the spirit of Schelling (1978). The above quotations provide some sort of idea about how people feel before and after they stopped smoking. Evidence from large-scale surveys also suggests that smoking is to some extent involuntary: the majority of smokers state they would like to become non-smokers if they only could force themselves to quit (Boyle et al., 2000). More than 70 per cent of those who want to stop smoking have already attempted to do so unsuccessfully. Relapse rates are extremely high. Medical evidence clearly indicates that nicotine alters the brain's metabolism and that smoking is an addictive behaviour. It is in the nature of addiction that those affected would like to reduce or give up their bad or unhealthy habit, but are scared off by immediate withdrawal costs, i.e. mental and/or physical discomfort.

Withdrawal costs are taken into account explicitly in recent economic models of cigarette addiction as asymmetric adjustment costs or fixed costs (Yen and Jones, 1996, Suranovic et al., 1999). The asymmetry reflects the idea that increasing cigarette consumption is easier than reducing cigarette consumption, and that to start smoking is easier than to stop. In contrast to the "rational addiction" model now prevailing in the economics literature (Becker and Murphy, 1988), the Suranovic et al. model does not assume that agents sit down when they are young and rationally plan a lifetime tobacco consumption path, but rather that they decide only how many cigarettes to smoke today. In particular, agents are not aware of the fact that they *will* get hooked. Fehr and Zych (1998) provide strong experimental support for bounded rationality of this type and against the Becker-Murphy assumption of consistent forward-looking behaviour. The Suranovic et al. model shows how "boundedly" rational agents get hooked and become "unhappy addicts". Smokers may come to regret their past consumption decisions, state the wish to stop smoking, and still not find themselves able to do so. Alternative economic explanations of addiction stress the importance of weakness of will and the lack of self-control (Schelling, 1978, Akerlof, 1991, O'Donoghue and Rabin 2000). Self-control problems can be modelled formally by giving immediate gratification an extra weight in the individuals' intertemporal utility function (see e.g. O'Donoghue and Rabin 2000). Many addicts know all too well what the dire long-term consequences their behaviour will be, but still postpone quitting until the next week, next month, or next year, without realising that when that time comes, they will again postpone quitting. Most smokers want to stop smoking, but not today. It requires self-control or some commitment device to overcome this

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<sup>2</sup> Analogous to the discussion of monetary costs, a full appraisal of the welfare cost of smoking should include nuisance costs to non-smokers or even other smokers.

kind of self-deception.<sup>3</sup> This explains the existence of anti-markets (Winston, 1980) and why smokers want to be told by their doctors that they should stop smoking (Boyle et al., 2000). Gruber and Mullainathan (2002) argue that excise taxes on tobacco might serve as external commitment devices for smokers, showing that higher taxes (e.g. better commitment devices) are associated with increased smoker happiness. It is hard to see why the Becker-Murphy rational smoker without self-control problems should change his behaviour just because he is told something he already knows or why he should become happier when the price of the addictive good increases.

Unhappiness from being an addict arises if smokers' decisions are time inconsistent or boundedly rational, and I believe that this unhappiness is an important part of the welfare costs of addiction. Public stigmatisation of smokers through large-scale anti-smoking movements and smoke-free environment campaigns might add to this unhappiness. The present study is an attempt to measure the welfare costs of smoking by estimating the money value of unhappiness using individual data on overall self-reported life satisfaction, smoking behaviour, and income from a large German panel data set.<sup>4</sup> The welfare costs of addiction to tobacco are calculated as the amount of money a smoker has to be given to report the same level of life satisfaction as a non-smoker with otherwise identical characteristics. Projections based on inverse sampling probabilities eventually yield estimates for the social costs of addiction. Ultimately, this is an educated guess of what Schelling (1978) refers to as the "nonfinancial cost associated with smoking – better health, freedom from a 'habit', cleaner teeth, or cleaner ashtrays". His rule-of-thumb estimate of the present value of the non-financial costs amounts to 150 billion (1978) US dollars.

In Section 2, I will briefly present the method employed in this study to estimate the welfare costs of addiction in Germany. Section 3 contains a description of the data and some bivariate results. Empirical results and a discussion of some potential objections against the validity of these findings follow in Section 4. Section 5 concludes.

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<sup>3</sup> Note, however, that being naive in the sense of being unaware of future self-control problems is not a necessary condition to become addicted to harmful substances. O'Donoghue and Rabin (2000) illustrate that sophisticated people, i.e. people who know they have a self-control problem, might become addicts under much more realistic assumptions (about discount factors) than are needed for time-consistent planners to become addicts.

<sup>4</sup> A thorough discussion of the usefulness of self-reported well-being for economics lies beyond the scope of this paper. Sceptics are referred to Frey and Stutzer (2002), who provide arguments for why subjective well-being is a satisfactory approximation to individual utility or welfare. The following calculations are based on this assumption.

## 2. Conceptual Framework

In what follows, I will assume that each individual has a *reported* well-being or life satisfaction function (Blanchflower and Oswald, 2000):

$$(1) \quad RWB = f[u(addict, y, Z)] + \varepsilon.$$

Self-reported life satisfaction *RWB* is some (integer) number on a life satisfaction index.  $u(\cdot)$  is the respondent's true well-being or utility, which depends on income  $y$ , on being an addict, and on a number of other characteristics  $Z$ , such as age, health status, etc.  $f(\cdot)$  is a function that translates true well-being into discrete numbers on the life satisfaction index, and  $\varepsilon$  is a residual term that captures, among other things, individual idiosyncrasies and errors in the transmission of true into reported well-being. At this stage it is not clear whether eq. (1) represents lifetime utility or some instantaneous utility function. In the empirical part of the paper, however, it will be interpreted as the latter.

In order to calculate the welfare costs of addiction, I estimate the parameters of the above life satisfaction function empirically. By solving

$$(2) \quad u(addict = 0, y, Z) = u(addict = 1, y + \Delta, Z)$$

for  $\Delta$ , it is then possible to calculate from these parameters how much additional income an addict must receive to become as happy as a non-addict.<sup>5</sup>

A plausible assumption is that well-being follows a concave function of income. For convenience, I will use the logarithmic function:

$$(3) \quad (addict, y, Z) = \beta addict + \gamma \ln y + \zeta Z$$

In order to be as well off as a non-addict with the same characteristics  $Z$ , an addict has to have an income that is  $\delta = \exp(-\beta/\gamma) - 1$  per cent higher than the non-addict's income. In this case, the costs of addiction can be calculated as  $\Delta = \delta y$ , i.e. as a fixed proportion of the addict's income. It is unclear whether this trait of the above specification is desirable. Welfare costs are equal for each addict if we assume a well-being function linear in income:

$$(4) \quad u(addict, y, Z) = \beta addict + \gamma y + \zeta Z$$

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<sup>5</sup> An early example of this kind of "happiness calculus" can be found in Clark (1996), who uses satisfaction with pay data to compute the shadow wage rate as the amount of money an employee must be given to be compensated for an additional weekly hour of work. Similar applications can be found in Blanchflower and Oswald (2000), who use life satisfaction data to assess the monetary value of marriage, and in Van Praag and Baartsma (2000), who compute the shadow price of aircraft noise nuisance at Amsterdam airport.

The costs of addiction are then calculated as  $\Delta = -\beta/\gamma$ . Once the individual costs of addiction are determined, it is straightforward to calculate the aggregate costs of addiction, i.e. the society's welfare loss, as the (projected) sum of individual costs.

The main difficulty faced in the present study is to identify  $\beta$ , the effect of smoking on life satisfaction. In order to estimate the costs of addiction, we need to know the individual smoker's level of well-being if he or she were a non-smoker. OLS estimates of  $\beta$  may be biased for at least three reasons: one is reverse causation, i.e. the claim that dissatisfied individuals have a higher propensity to be smokers, or to become addicts in general, than satisfied individuals (Becker and Murphy, 1988). Although it seems unlikely that adults who *never smoked* start smoking in times of psychic pressure or distress, former smokers might suffer a relapse and smokers might be less willing to stop smoking. If such potential endogeneity of smoking is not accounted for, estimates of  $\beta$  may be biased. A second source of bias – somewhat related to reverse causation – is unobserved heterogeneity. The effect of smoking on self-reported life satisfaction measured in the single equation framework above could be due to the fact that both being a smoker and being unhappy is caused by some unobserved background variables, such as personality traits. In fact, psychological studies suggest that neuroticism (emotional instability) is positively related to smoking and at the same time negatively related to subjective well-being (U.S. Department of Health, 1964, Diener et al., 1999). However, a deeper analysis of such psychological arguments clearly lies beyond the scope of the present paper. Still, a debate about the direction of causation between smoking and individual well-being can be found in the psychology literature. Parrott (1999, 2000) claims that smoking causes stress and that smoking cessation reduces stress, and Goodman and Capitman (2000) find evidence that adolescent smoking causes depression rather than that depressed adolescents are more likely to smoke. Others (Kassel, 2000, Piasecki and Baker, 2000, Gilbert and McClernon, 2000) draw attention to the many other ways in which the positive correlation between smoking and stress (or “negative affect”) can be interpreted.

The third source of bias is measurement error. Firstly, not everybody claiming to be a smoker is a tobacco addict, and not everybody claiming not to smoke does so truthfully. Thus, self-reported smoking behaviour measures addiction with a (non-classical) error. In case of a binary regressor, the error depends on the true value of the independent variable and has non-zero mean. However, the direction of the bias is the same as with classical measurement error (Aigner, 1973), i.e. the effect of smoking on life satisfaction might also be biased downwards.

In this paper, I adopt two identification strategies: fixed effects and instrumental variables. With two waves of panel data at hand, it is possible to examine changes in life satisfaction for those who start to smoke, those who quit

smoking and those who do not change their smoking behaviour, while controlling for unobserved heterogeneity.<sup>6</sup>

While fixed effects or first difference models are convenient to sweep out heterogeneity, they unfortunately do not guarantee identification of the causal effect. Even if a positive relation between smoking cessation and improved well-being is found, this does not *necessarily* mean that people feel better because they succeeded in quitting. That people quit smoking because they feel better and no longer “need” tobacco remains a possible explanation, although I think it is a less plausible one. It is also possible that the estimated effect of smoking cessation on well-being is biased upwards, because only individuals who expect the highest gain from abstinence actually try to stop smoking. *The gain in well-being that those who do not stop smoking would have experienced if they they had stopped* is not directly observable even with panel data.

I will therefore go further and try to identify the causal effect of smoking on life satisfaction by estimating the satisfaction equation in a simultaneous equation framework. The problem here is to find appropriate instrumental variables for smoking behaviour, i.e. one needs variables that are correlated to being a smoker but that do not affect life satisfaction directly (the only influence being indirect, i.e. through the smoker variable). Based on the idea that smokers have a stronger taste for immediate gratification, and that this taste has no *direct* effect on happiness, three different instrumental variables are discussed below: education, the frequency of doing sports, and saving behaviour. The identifying assumption used here – the degree to which people pursue instant gratification has no immediate effect on reported well-being – deserves some discussion. Economic theory makes no clear predictions, but one could for example argue that patient people are happier than impatient ones. However, considering the issue from a slightly different angle leads to an equally plausible yet contradictory argument: short-sighted people are happier because they worry less about the more distant future. Since, to my knowledge, there is no empirical evidence concerning the relationship between individual time preference and happiness, I consider the assumption of no relation as practicable.

One referee pointed out an alternative way to use the GSOEP to identify the direction of causation between well-being and smoking. It is possible to combine the long time-series on individual life satisfaction with retrospective information on smoking spells provided in the 2002 wave. Individuals are asked

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<sup>6</sup> Unobserved heterogeneity can be rooted in personality traits and individual idiosyncrasies in response behaviour. One might dispute the possibility of interpersonal comparisons of well-being based on self-reported satisfaction levels, for example because every respondent may have an unobserved but time-invariant baseline against which he judges current well-being. However, individual panel data is perfectly suited to account for this kind of heterogeneity.

at what age they started and in which year they stopped smoking. However, this retrospective information is probably not accurate enough to be useful, so I refrained from a full-blown analysis. I nevertheless report some preliminary results below.

3. Data Description

The data used in this study are drawn from the 1998 and 1999 waves of the German Socio-Economic Panel (GSOEP); see SOEP Group (2001). These are the first two waves of the GSOEP that contain information on smoking behaviour. Life satisfaction is measured on a zero-to-ten scale, where zero means completely dissatisfied and ten means completely satisfied. Table 1 summarises the self-reported life satisfaction in both waves. About 45 percent of the respondents report levels of life satisfaction equal to or higher than eight, and less than a tenth of the respondents report a satisfaction level below five, which is the scale midpoint. The aggregate response pattern is very much in line with findings from other studies and/or other countries (see e.g. Blanchflower and Oswald, 2000). The majority of people claim to be fairly happy or fairly satisfied with their lives; only very few report complete dissatisfaction.

Table 1  
Life Satisfaction

	N	Percent	Cum. Percent
0 Completely dissatisfied	138	0.48	0.48
1	117	0.41	0.89
2	362	1.26	2.15
3	736	2.57	4.72
4	1,016	3.54	8.26
5	3,476	12.12	20.38
6	3,437	11.98	32.36
7	6,373	22.22	54.58
8	8,716	30.39	84.96
9	2,974	10.37	95.33
10 Completely Satisfied	1,340	4.67	100.00
Total	28,685	100.00	

Note: Frequencies are unweighted.

The information concerning smoking behaviour gathered in 1998 and 1999 is not identical. In 1998, respondents were asked what type of tobacco they consume (cigarettes, pipe, cigars) and how much they consume daily. In 1999, non-smokers were divided into former smokers and persons who had never



smoked, but no information on the consumption of current smokers is available. Table 2 summarises the existing information on smoking behaviour and illustrates the relationship between smoking behaviour and self-reported life satisfaction. About one-third of the respondents are smokers, less than one-half has never smoked. Since more than 99 percent of the current smokers in 1998 are cigarette smokers, I do not further distinguish smokers by their preferred type of consumption. About five-sixths of all smokers claim to smoke up to 20 cigarettes (units) per day, whereas the group of heavy smokers (> 30 units / day) is comparatively small.

Table 2

**Smoking Behaviour and Life Satisfaction**

	<i>N</i>	Percent	Mean Life Satisfaction	Percent Life Satisfaction $\geq 8$
1998				
Non-smokers	9,944	68.0	7.06	47.2
Smokers	4,687	32.0	6.72	39.6
– 1 / 10 units	1,608	34.8	6.91	44.2
– 11 / 20 units	2,265	48.9	6.70	39.0
– 21 / 30 units	542	11.7	6.53	33.3
– 31+ units	213	4.6	5.97	28.6
1999				
Non-smokers	9,367	66.7	7.06	48.0
– never smoked	6,656	71.1	7.10	49.1
– formerly smoked	2,711	28.9	6.95	45.3
Smokers	4,670	33.3	6.79	42.5

Note: Frequencies are unweighted.

How is life satisfaction related to smoking? Table 2 reveals that non-smokers have a higher propensity to report high levels of life satisfaction than smokers. In 1999, 48.0 percent of the non-smokers state a satisfaction level of eight or higher, compared to 42.5 percent of smokers. Overall life satisfaction declines quite sharply with daily consumption. In 1998, 44.2 of those smoking less than 10 units per day reported a high life satisfaction level, whereas only 28.6 percent heavy smokers did so. The following analysis will show that the negative relationship between smoking behaviour and life satisfaction is stable with respect to the inclusion of a number of control variables, i.e. tobacco addicts self-report significantly lower levels of well-being than non-addicts. However, the difference between former smokers and non-smokers that is present in the 1999 data will vanish once other determinants of life satisfaction are accounted for.

Table 3  
Summary Statistics

	Life Satisfaction		Smoking Behaviour		N obs.
	Mean	Percent > 8	Percent Smoking	Mean # Units l Smoker	
<b>Sex</b>					
Male	6.96	0.454	0.391	18.1	13,866
Female	6.96	0.454	0.266	14.4	14,819
<b>Age</b>					
17 – 30	7.24	0.516	0.401	14.8	6,972
31 – 40	7.01	0.456	0.413	17.0	6,485
41 – 50	6.77	0.416	0.378	18.7	5,149
51 – 60	6.72	0.396	0.266	17.4	4,381
61 – 70	6.97	0.460	0.176	15.4	3,398
70+	6.82	0.452	0.076	11.7	2,300
<b>Marital Status</b>					
Married	7.01	0.463	0.294	17.0	17,749
Single	7.11	0.480	0.402	15.1	6,873
Divorced	6.33	0.340	0.491	18.0	2,231
Widowed	6.66	0.410	0.155	15.5	1,832
<b>Per Capita HH Income</b>					
1 <sup>st</sup> Quartile	6.64	0.382	0.384	16.9	6,920
2 <sup>nd</sup> Quartile	6.86	0.421	0.331	16.1	7,925
3 <sup>rd</sup> Quartile	7.07	0.480	0.296	15.7	5,944
4 <sup>th</sup> Quartile	7.29	0.539	0.296	17.5	6,491
<b>Region</b>					
West Germany	7.11	0.498	0.334	17.5	20,982
East Germany	6.54	0.334	0.307	13.8	7,703
<b>Unemployed</b>					
No	7.11	0.498	0.334	17.5	20,982
Yes	6.54	0.334	0.307	13.8	7,703
<b>Health Status</b>					
Very Good	8.00	0.724	0.332	15.2	2,856
Good	7.39	0.552	0.349	16.0	12,093
Satisfactory	6.75	0.369	0.317	17.2	9,072
Fairly Bad	5.97	0.228	0.293	18.4	3,570
Bad	4.38	0.102	0.244	16.9	1,039
<b>First Time Interviewee</b>					
No	6.92	0.444	0.328	16.5	26,413
Yes	7.42	0.574	0.303	16.6	2,272

Note: Frequencies are unweighted.

In Table 3, I report some statistics on the relationship between smoking behaviour, general life satisfaction, and other characteristics. Females report on average the same level of happiness as males, but they have a smaller propensity to smoke and they smoke less. The age-life satisfaction relationship is U-shaped, with those between 50 and 60 being the least satisfied. The very old (70+) are a bit less happy than the 61 to 70 year olds. Smoking is very much related to age. The proportion of smokers is quite stable up to age 50, but then declines strongly. The daily consumption is highest among the 41 to 50 year olds. Marital status is also strongly related to life satisfaction. The widowed and divorced are less happy than singles and those married. Smokers can most often be found among singles and divorced individuals, and daily consumption is highest among the latter. Per capita net household income is positively related to life satisfaction and negatively related to being a smoker. The former result confirms the idea that higher income breeds happier people (at least in cross-sections), and the latter result shows that smoking is more common among low-income individuals. Even about 10 years after the fall of the iron curtain, East Germans are still much less happy than West Germans. They are also less likely to smoke and daily consumption is lower. Another comparison is between the unemployed and all others. Unemployed individuals are consistently shown to be unhappy or dissatisfied with their lives (Clark and Oswald, 1994, Winkelmann and Winkelmann, 1998). Table 3 also reveals that they are more likely to be smokers than others. Self-reported health status and self-reported life satisfaction are very strongly correlated. More than 70 percent of those with good health report high life satisfaction, compared to only 10 percent of those with poor health. Finally, those being interviewed for the first time in course of the GSOEP report on average substantially higher life satisfaction than those who have already been interviewed repeatedly.<sup>7</sup>

#### 4. Results

The first set of results that I present here, primarily for descriptive purposes, are simple cross-section regressions from the 1998 and 1999 samples. Reported well-being is measured on an ordinal scale, while true well-being is a continuous latent variable. Although it is common practice (at least in cross-section analysis) to account for this fact by estimating the life satisfaction function as an ordered probability model, I will present only least squares estimates of life satisfaction equations (the issue of non-linear estimation being discussed later on). This preserves comparability with later analyses, where I account for individual heterogeneity and the potential endogeneity of smoking behaviour. The econometric specification of the well-being function is:

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<sup>7</sup> Respondents tend to overstate satisfaction levels in the first wave of a panel study for several reasons. See e.g. Landua (1993), Schräpler (2001) or Jürges (2003).

(5) 
$$RWB_{it} = \beta smoke_{it} + \gamma y_{it} + \zeta Z_{it} + \varepsilon_{it}$$

where  $RWB_{it}$  is self-reported well-being of individual  $i$  in year  $t$   $smoke_{it}$  is a dummy variable that measures smoking behaviour (1 for current smokers, 0 else),  $y_{it}$  is per capita household income (also in logarithms), and  $\varepsilon_{it}$  is an error term that is assumed to be uncorrelated with the explanatory variables (smoking behaviour in particular). This assumption will be questioned below. The set of control variables  $Z$  included in the well-being function contains age dummies, sex and marital status of the respondent, a dummy variable for East German households, for first-time interviewees, for unemployed individuals, dummies for self-reported health status, and a year dummy where this is meaningful.

Table 4  
Cross-Section Estimates of Life Satisfaction Equations

	1998 – 1999		1998		1999	
	(1)	(2)	(3)	(4)	(5)	(6)
Smoker	-0.216 (8.98)**	-0.220 (9.13)**				
1 / 10 Units			-0.111 (2.58)**	-0.112 (2.60)**		
11 / 20 Units			-0.265 (6.97)**	-0.269 (7.05)**		
21 / 30 Units			-0.452 (6.36)**	-0.458 (6.43)**		
30+ Units			-0.735 (6.68)**	-0.743 (6.74)**		
Current smoker					-0.186 (5.92)**	-0.190 (6.02)**
Former smoker					-0.009 (0.24)	-0.003 (0.09)
Log Income	0.442 (17.81)**		0.420 (14.14)**		0.463 (15.69)**	
Income (1000 €)		0.371 (14.00)**		0.363 (11.70)**		0.377 (12.62)**
Age: 21 – 30	-0.285 (5.71)**	-0.244 (4.92)**	-0.306 (4.89)**	-0.267 (4.28)**	-0.237 (3.74)**	-0.197 (3.11)**
Age: 31 – 40	-0.403 (7.29)**	-0.358 (6.48)**	-0.438 (6.37)**	-0.397 (5.77)**	-0.335 (4.88)**	-0.287 (4.17)**
Age: 41 – 50	-0.486 (7.96)**	-0.422 (6.93)**	-0.509 (6.85)**	-0.451 (6.09)**	-0.425 (5.71)**	-0.356 (4.78)**
Age: 51 – 60	-0.336 (5.23)**	-0.250 (3.90)**	-0.355 (4.54)**	-0.276 (3.54)**	-0.290 (3.68)**	-0.197 (2.51)*
Age: 61 – 70	-0.076 (1.16)	0.009 (0.14)	-0.128 (1.60)	-0.049 (0.61)	-0.009 (0.11)	0.082 (1.03)

Age: 71+	0.047 (0.63)	0.142 (1.89)	0.004 (0.05)	0.091 (1.03)	0.109 (1.22)	0.210 (2.37)*
Female	0.079 (3.52)**	0.078 (3.50)**	0.060 (2.21)*	0.060 (2.19)*	0.075 (2.72)**	0.075 (2.71)**
Single	-0.332 (9.37)**	-0.299 (8.42)**	-0.353 (8.10)**	-0.322 (7.40)**	-0.310 (7.11)**	-0.275 (6.30)**
Divorced	-0.552 (11.53)**	-0.557 (11.56)**	-0.533 (10.41)**	-0.538 (10.45)**	-0.555 (10.93)**	-0.561 (10.98)**
Widowed	-0.313 (5.57)**	-0.302 (5.36)**	-0.350 (5.59)**	-0.337 (5.39)**	-0.267 (4.26)**	-0.256 (4.08)**
East	-0.410 (16.47)**	-0.412 (16.45)**	-0.444 (14.68)**	-0.445 (14.64)**	-0.394 (13.08)**	-0.397 (13.12)**
Unemployed	-0.713 (15.06)**	-0.767 (16.18)**	-0.742 (14.82)**	-0.790 (15.87)**	-0.677 (12.67)**	-0.735 (13.82)**
First Time Inter.	0.341 (9.31)**	0.345 (9.41)**	0.358 (9.12)**	0.360 (9.15)**	0.220 (1.99)*	0.238 (2.14)*
Health: Good	-0.587 (17.43)**	-0.587 (17.35)**	-0.551 (11.90)**	-0.549 (11.82)**	-0.622 (12.88)**	-0.625 (12.90)**
Health: Satisfactory	-1.273 (33.51)**	-1.275 (33.41)**	-1.215 (24.27)**	-1.214 (24.19)**	-1.323 (25.71)**	-1.329 (25.73)**
Health: Fairly Poor	-2.089 (43.28)**	-2.094 (43.25)**	-2.021 (34.32)**	-2.021 (34.24)**	-2.147 (35.60)**	-2.158 (35.67)**
Health: Poor	-3.710 (41.62)**	-3.722 (41.66)**	-3.553 (42.30)**	-3.559 (42.27)**	-3.860 (45.15)**	-3.880 (45.24)**
1999 Dummy	0.072 (4.79)**	0.076 (5.03)**				
Constant	5.641 (34.15)**	8.192 (131.87)**	5.806 (29.43)**	8.217 (106.18)**	5.543 (27.89)**	8.231 (103.18)**
Delta (implied)	0.629 (6.24)**	0.593 (7.56)**				
Observations	27020	27020	13656	13656	13314	13314
R-squared	0.26	0.25	0.26	0.25	0.26	0.26

Absolute *t*-statistics in parentheses; \* significant at 5 % level; \*\* significant at 1 % level.

Table 4 contains the results of the cross-section regressions. The most important coefficients in the context of the present paper are those relating to income and to being a smoker. Per capita household income has a highly significant positive effect on self-reported happiness, but the size of the effect appears to be rather small. The coefficients of log income tell us that a 10 percent increase in income increases average life satisfaction by approximately 0.044 points. The linear specification implies that a 100 € increase in income is accompanied by a 0.037-point increase in average life satisfaction. As already mentioned, the negative effect of being a smoker on well-being remains present even after various other characteristics are controlled for. In particular, the average smoker reports significantly lower levels of life satis-

faction than the average non-smoker even when the potential loss of quality of life from smoking-related health problems is accounted for. Bad health is thus not the only reason why smokers are less happy than non-smokers. The assertion advocated in this paper is that smokers are less happy also because they are addicts, and the calculation of the welfare costs of addiction is based on this assertion. The smoker coefficient is not very large compared to, say, that of being unemployed or divorced, but it represents – almost by definition – a lasting effect. In contrast to current smokers, former smokers are indistinguishable with respect to life satisfaction from those who never smoked. Note also that the current level of tobacco consumption remains strongly linked to well-being when other variables are controlled for.

Let us briefly look at the control variables' coefficients. As in many other satisfaction studies (e.g. Clark et al., 1996, Blanchflower and Oswald, 2000), the age profile of satisfaction is U-shaped. Allowing for the effect of other variables (health status in particular) shifts the minimum from those in the 51-to-60 bracket forward to the 41-to-50 year olds. Another familiar finding is that females report on average higher satisfaction levels than men. Married respondents report higher satisfaction levels than others. The divorced appear to be particularly unhappy with their lives. The difference between married and divorced respondents is two to three times larger than the difference between smokers and non-smokers. East Germans are found to be much less satisfied than West Germans. Ten years after unification, this is a disturbing finding. One might be tempted to argue that this is because of the still inferior economic situation in East Germany. However, if one looks at other satisfaction data in the GSOEP, e.g. health satisfaction, job satisfaction, etc., one finds that East Germans are always less satisfied than West Germans (with one interesting exception: child care facilities). Perhaps East Germans simply answer satisfaction questions in another way than West Germans. At any rate, East-West differences in unemployment cannot be the reason for the observed pattern, since this variable is effectively controlled for. In fact, its effect on self-reported life satisfaction proves to be quite serious. First-time interviewees report higher satisfaction levels than others, which indicates the presence of some measurement effect. Finally, an individual's health status is one of the most important determinants of happiness (see Diener et al., 1999).

The key issue dealt with in the present paper is to find point estimates for the monetary value of the welfare loss due to addiction. Table 5 contains the estimated welfare loss derived from the parameters of the above life satisfaction regressions. Note that these values simply describe the average well-being difference between smokers and non-smokers in per capita household income terms. It is yet unclear if this difference must be causally attributed to tobacco addiction. Median and mean loss are calculated per smoker. If income enters the satisfaction function linearly, both values are of course equal be-

cause every smoker is assigned the same amount. If income enters in logarithms, one obtains a loss distribution that mirrors the shape of the income distribution, and that is thus highly skewed. I therefore report both mean and median. The aggregate loss, i.e. the loss to the German society is calculated by means of projection.<sup>8</sup>

Both individual and aggregate estimates depend to some degree on how income enters the satisfaction function. The aggregate amounts derived from the linear specifications are about 10 per cent higher than the aggregate amounts derived from the log specification. The difference between the individual welfare losses is somewhat smaller. The results are thus sensitive to the assumptions about the shape of the income-satisfaction relationship. I will concentrate on the results obtained from the log specification, since using logged income is not only more plausible a priori, it also provides a slightly better statistical fit. Given these estimates, the median smoker suffers a welfare loss worth 482.6 € per month. This is 63 per cent of the median per capita household income. The mean loss is higher and amounts to 573 €. By aggregation over roughly 20 million smokers, one obtains an estimated monthly welfare loss of 11.86 billion €. Note that these figures are net of health costs, i.e. the loss in well-being from bad health. The social costs of tobacco addiction caused by a reduction in well-being thus grossly exceed the direct and indirect costs attributable to smoking reported in Welte et al. (2000). A full appraisal of the welfare costs should of course include all kinds of costs.

Table 5  
Individual and Aggregate Welfare Costs of Addiction

	Log Specification (based on Table 4, Column 1)	Linear (based on Table 4, Column 2)
Mean Individual Monthly Loss in 1999 (€ per smoker)	573.0	593.1
Median Individual Monthly Loss in 1999 (€ per smoker)	482.6	
Aggregate Monthly Loss in 1999 (billion €)	11.86	13.09

The results presented so far do allow for the possibility that smoking behaviour is endogenous or that the negative correlation between smoking and life

<sup>8</sup> Note that the figures in Table 5 are subject to two sources of error: a projection error and an estimation error. The estimation error is the larger of the two. For example, the 95 percent confidence interval for the proportional income loss from smoking (log specification) is [.432; .827]. The estimates are thus too imprecise to be taken literally and only serve to illustrate the order of magnitude.

satisfaction must be explained by some unobserved background variable. Both problems can be overcome by estimating the satisfaction equation in a simultaneous equation framework. Apart from the practical problem of identifying the structural equations by means of valid instruments, additional difficulties arise in the present application. Strictly speaking, both endogenous variables are non-continuous: being a smoker is a dichotomous variable and life satisfaction is an ordinal variable. I will nevertheless estimate linear equations. As mentioned before, the difference between cross-section linear and ordered probability models proved to be small.

Of at least equal importance as the choice of a consistent estimation method is to find appropriate instruments, i.e. variables that are correlated to being a smoker but that do not affect life satisfaction directly (the only influence being indirect, i.e. through the smoker variable). One such instrument variable might be education. The fairly strong negative association between smoking and education has been exploited in some recent studies, using smoking as an instrument for education in wage regressions (Evans and Montgomery, 1994, Fersterer and Winter-Ebmer, 2000). Education and smoking are correlated for at least two possible reasons. One is a knowledge effect. Better educated individuals might be better informed about the health hazards of smoking and are thus less likely to smoke. However, the last two decades have witnessed a vast increase in public information on these hazards, so that this explanation appears to be rather unlikely. Quite unsurprisingly, education remains an important determinant of smoking behaviour even if an individual's knowledge about smoking risks is controlled for (Kenkel, 1991, Clark and Etilé, 2002). This observation gives credit to another explanation, namely unobserved differences in time preference and/or the ability to exert self-control. Human capital and health investments are similar in the sense that both yield returns in the more distant future. Less patient individuals will therefore acquire less education and care less about the health risks of smoking. In the following, education will be measured with respect to high school education: "no degree", "less than high school", "high school" and "more than high school". To check the robustness of the results, two other instrumental variables (that are supposed to depend on the respondents' time preference or taste for immediate gratification) are proposed: the individual frequency of doing sports and whether a household saves and/or repays a loan. Doing sports regularly can in part be viewed as a long-term investment in health capital and also as an indication of the individuals willpower. Its frequency is measured by the answer to the question how often an individual does sports actively: "every week", "every month", "less often", and "never".

If age and income are controlled for, households with less patient individuals will be less likely to save and more likely to take out loans and repay them later. Below, the first and last of the four possible combinations "neither saves nor repays (a loan)", "only saves", "only repays", and "saves and re-



pays” will be collapsed into a single category. The choice of instruments in the present application is largely guided by theoretical considerations. However, it remains unclear whether the identifying assumption (that these variables do not affect happiness) really holds. This merely reflects the difficulties of finding appropriate instruments in this context. Gruber and Mullainathan (2002), who also use IV estimates to measure the effect of tobacco taxes on smoker’s well-being and face the same difficulty refrain from excluding any potential instruments from the well-being equation.

The results of the panel and IV regressions are reported in Table 6. Columns (1) to (4) contain the estimates under the assumption of exogenous smoking behaviour. OLS and random effects parameters are very similar. However, the Hausman test statistic strongly speaks in favour of the fixed effects (first differenced) model. Fixed and random effects parameters are indeed very different, which must in part be explained by the fact that the fixed effects model does not contain any cross-section variation. Moreover, the within-individual variation of many variables is small since we only have two waves of data. Nearly all fixed effects parameters are smaller than the corresponding random effects parameters. Still, the results are plausible and meet our expectations: changes in income, becoming unemployed or leaving unemployment, changes in health and marital status (in particular becoming a widow or widower) are important determinants of changes in self-reported life satisfaction. The effect of being a smoker remains negative, but becomes insignificant. To be more precise, the measured effect is the one of starting or quitting smoking. The implied individual welfare costs of smoking drop to 28 percent of the net per capita household income or on average 250 € per month. But the first difference estimate for the effect of smoking in column (3) must be treated with some caution. Firstly, the problem of attenuation bias will be more serious than before if smoking behaviour is measured with error. Secondly, the estimates are based on the assumption that the size of the welfare change is the same for people who become a smoker than for those who become a non-smoker. Given the addictive nature of smoking, this is most probably an unrealistic assumption. I therefore differentiated between quitters and starters (see column (4)):<sup>9</sup> those who become non-smokers experience an increase in well-being worth 71 percent of net per capita household income (which is in the vicinity of the pooled OLS result), while the well-being of those who become smokers remains virtually unchanged (although individuals who relapse should suffer from their weakness. Without retrospective information on smoking behaviour in the 1998 data, it is not possible to ascertain whether someone starts smoking for the first time).

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<sup>9</sup> Among the sample of 12157 used in Table 6, column (4) there are 526 starters (or 6.4 percent of the non-smokers in 1998) and 439 quitters (or 11.2 percent of the smokers in 1998).

Table 6: OLS, Instrumental Variables (IV), Random Effects and Fixed Effects Estimates of Life Satisfaction Equations

	Pooled OLS	Random Effects	FD 1	FD 2	Pooled IV	G2SLS	FD 1-IV (W2SLS)	FD 2-IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Smoker	-0.216 (8.98)**	-0.211 (9.14)**	-0.066 (1.30)		-1.224 (6.44)**	-0.975 (5.03)**	-3.846 (3.06)**	
Quit				0.144 (1.87)				3.071 (1.25)
Start				-0.000 (0.00)				-4.247 (2.55)*
Log Income	0.442 (17.81)**	0.428 (18.44)**	0.268 (5.08)**	0.269 (5.10)**	0.412 (18.16)**	0.433 (17.21)**	0.293 (4.50)**	0.286 (4.25)**
Age: 21 – 30	-0.285 (5.71)**	-0.269 (5.52)**	-0.062 (0.53)	-0.070 (0.59)	-0.205 (4.24)**	-0.215 (3.85)**	0.413 (1.96)	0.460 (1.88)
Age: 31 – 40	-0.403 (7.29)**	-0.389 (7.19)**	0.101 (0.66)	0.093 (0.61)	-0.331 (6.36)**	-0.333 (5.53)**	0.609 (2.46)*	0.658 (2.35)*
Age: 41 – 50	-0.486 (7.96)**	-0.480 (8.20)**	0.183 (0.98)	0.176 (0.94)	-0.448 (8.18)**	-0.440 (6.92)**	0.666 (2.40)*	0.701 (2.41)*
Age: 51 – 60	-0.336 (5.23)**	-0.356 (5.78)**	0.109 (0.49)	0.106 (0.48)	-0.420 (7.02)**	-0.421 (6.15)**	0.612 (1.91)	0.620 (1.95)
Age: 61 – 70	-0.076 (1.16)	-0.120 (1.89)	0.124 (0.49)	0.123 (0.49)	-0.236 (3.54)**	-0.212 (2.81)**	0.542 (1.58)	0.536 (1.58)
Age: 71+	0.047 (0.63)	-0.017 (0.24)	0.113 (0.38)	0.113 (0.38)	-0.224 (2.77)**	-0.182 (2.05)*	0.301 (0.76)	0.275 (0.69)
Female	0.079 (3.52)**	0.073 (3.22)**			-0.048 (1.55)	-0.017 (0.49)		
Single	-0.332 (9.37)**	-0.298 (8.42)**	-0.066 (0.48)	-0.063 (0.45)	-0.277 (8.38)**	-0.281 (7.51)**	0.043 (0.25)	0.026 (0.15)
Divorced	-0.552 (11.53)**	-0.533 (12.77)**	-0.121 (0.87)	-0.119 (0.86)	-0.369 (6.99)**	-0.421 (7.51)**	-0.089 (0.52)	-0.099 (0.58)
Widowed	-0.313 (5.57)**	-0.330 (6.38)**	-0.944 (3.99)**	-0.943 (3.99)**	-0.278 (5.73)**	-0.346 (6.22)**	-0.648 (2.58)**	-0.665 (2.62)**

East	-0.410 (16.47)**	-0.422 (16.69)**	0.179 (0.67)	0.182 (0.68)	-0.449 (19.28)**	-0.431 (16.11)**	-0.029 (0.09)	-0.048 (0.15)
Unemployed	-0.713 (15.06)**	-0.674 (18.52)**	-0.543 (10.18)**	-0.543 (10.19)**	-0.599 (13.98)**	-0.613 (14.54)**	-0.554 (8.36)**	-0.549 (8.20)**
First Time Inter.	0.341 (9.31)**	0.248 (7.35)**	0.096 (2.14)*	0.097 (2.16)*	0.333 (8.69)**	0.274 (6.77)**	0.149 (2.54)*	0.141 (2.28)*
Health: – Good	-0.587 (17.43)**	-0.512 (15.80)**	-0.304 (6.79)**	-0.303 (6.78)**	-0.543 (15.15)**	-0.500 (13.84)**	-0.230 (3.85)**	-0.234 (3.88)**
– Satisfactory	-1.273 (33.51)**	-1.133 (31.85)**	-0.691 (13.30)**	-0.690 (13.29)**	-1.186 (29.15)**	-1.106 (27.09)**	-0.656 (10.08)**	-0.660 (10.05)**
– Fairly Poor	-2.089 (43.28)**	-1.876 (44.79)**	-1.149 (18.39)**	-1.148 (18.38)**	-1.998 (42.08)**	-1.853 (38.73)**	-1.119 (14.49)**	-1.123 (14.51)**
– Poor	-3.710 (41.62)**	-3.292 (54.42)**	-1.894 (20.12)**	-1.895 (20.12)**	-3.612 (55.98)**	-3.290 (48.87)**	-2.077 (16.78)**	-2.071 (16.73)**
1999 Dummy	0.072 (4.79)**	0.055 (3.80)**	0.021 (1.28)	0.015 (0.90)	0.087 (4.31)**	0.059 (3.56)**		
Constant	5.641 (34.15)**	5.628 (36.16)**	0.022 (1.36)	0.016 (0.98)	6.155 (34.78)**	4.035 (30.23)**	0.049 (2.23)*	0.094 (0.75)
Delta (implied)	0.629 (6.24)**	0.636 (6.39)**	0.280 (1.12)	0.708 (1.37)				
Observations	27059	27059	12157	12157	26833	23970	11628	11628
R-squared	0.26	0.26	0.06	0.06	0.19	0.18		
Instruments <sup>a)</sup>					S	ES	ESD	ESD
F-Test instr.					118.3**	63.1**	3.61**	2.20*
$\Delta R$ -sq 1 <sup>st</sup> stage					0.011	0.014	0.003	0.001
F-Test instr.								4.04**
$\Delta R$ -sq 1 <sup>st</sup> stage								0.004
Endogeneity $t/F$					5.60**	4.08**	2.31*	6.59**
Overid. $\chi^2$ (df)					0.60 (2)	7.76 (5)	8.00 (7)	7.99 (6)
FE v RE $\chi^2$ (df)			532.2 (19)**			463.0 (19)** <sup>b)</sup>		

Absolute value of  $t$ -statistics in parentheses; † significant at 10 % level; \* significant at 5 % level; \*\* significant at 1 % level; a) S = sports dummies; E = education dummies ; D = savings and debt dummies; b) Hausman FE v RE – Test using the same set of instruments (ES).

The results of the instrumental variables regressions are reported in columns (5) to (8) of Table 6. Each equation was estimated with seven different sets of instruments: education, sports activities, and saving behaviour alone and any combination of these three variables. I report only results that are internally consistent in the sense that (1) the validity of overidentifying restrictions is not rejected by the Sargan  $\chi^2$ , (2) the instruments have explanatory power in the first stage regression and (3) where the null hypothesis of exogeneity is rejected.<sup>10</sup> The corresponding test statistics are reported together with the parameter estimates. Both, endogeneity and validity (overidentification) tests are carried out by means of appropriate auxiliary regressions (see Davidson and MacKinnon, 1993, ch. 7).

Let us first look at the pooled IV regression (column 5), where the frequency of doing sports is used to identify the causal effect of smoking on life satisfaction. Even when the potential endogeneity of smoking behaviour is taken care of, smoking remains to have a significant negative effect on life satisfaction. These results are in accordance with the notion that smoking does decrease well-being. The point estimate of  $-1.224$  suggests that a 10 percentage point increase in the probability of being a smoker lowers reported well-being by 0.12 points, which translates into a welfare loss in the range of about 25 percent of net per capita household income. Still, the size of the estimates raises some concerns about the appropriateness of the estimation procedure and its interpretation. Compared to the pooled regression with exogenous smoking, the estimate of the smoker parameter is now nearly six times higher, so that the well-being loss from smoking is estimated to be up to two times as large as that of being unemployed. If unobserved heterogeneity is controlled for by estimation of panel IV models, the calculated decline in well-being becomes even stronger. The practical use of the IV-estimates for the welfare cost calculations in the present paper is at least questionable. Implausibly large IV estimates are also found in other studies related to the present one (e.g. Van Ours, 2004, reports similar problems for regressions of wages on alcohol consumption and smoking).

Although the IV-estimates might eventually yield no sensible results as far as a monetary evaluation of the welfare costs of addiction is concerned, they do at least not contradict the qualitative nature of the relationship assumed in this paper, namely that tobacco addiction causes unhappiness and not vice versa. For some other reasons – which will be discussed in the next paragraph – it is questionable if the actual values derived here can be taken at face value. Still, the cost estimates based on the single equation parameters appear to represent some lower bound of the welfare costs of addiction. These costs should thus be taken serious in the sense that even this lower

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<sup>10</sup> When more than one set of instruments lead to internally consistent results, I chose the one with the largest number of instruments.

bound is already way above of what conventional cost of smoking studies measure.

I will now briefly discuss some other objections that could be raised against the calculations performed in this paper. First, one might argue that the ordinal nature of the dependent variable invalidates any results from linear regression. Estimation of an ordered probability model might thus appear as a more sensible way to proceed. In repeated cross-sections this would indeed be the case. However, with panel data, it seems natural to take advantage of the possibility to account for unobserved individual heterogeneity, such as individual reference levels for life satisfaction. Estimation of ordered probability models with random effects is straightforward (for example using LIMDEP). However, the random effects model is very restrictive as it assumes zero correlation between the individual effect and observed characteristics. I have good reason to suspect that this assumption is violated in the present application, because the Hausman test applied to the linear random and fixed effects models rejects the random effects specification at a very high significance level. A fixed effects model should therefore deserve more trust than a random effects model. Greene (2001) recently showed how to avoid the computational difficulties associated with non-linear fixed effects models, so that estimation of a fixed effects ordered probit model would be feasible. However, with two observations for each individual, the inconsistency of the individual effects (the incidental parameter problem) carries over to the slope parameters. Note that this does not hold for the linear fixed effects regression.

Still, I have tried to account for the ordinal nature of the dependent variable in various ways. For example, I ran the regressions above after having applied to the life satisfaction index the “empirical normal transformation” proposed in Van Praag and Baarsma (2001). This transformation replaces the values RWB on the life satisfaction index from 0 to 10 by numbers

$$(6) \quad RWB^* = N^{-1} [cum.p(RWB - 1) + 0.5 p(RWB); 0, 1] ,$$

where  $N$  denotes the normal distribution,  $cum.p(RWB - 1)$  is the proportion of respondents with life satisfaction less than RWB, and  $p(RWB)$  is the proportion of respondents with life satisfaction equal to RWB. The obtained results were nearly equal to those above (except of course for the different scaling), and the statistical fit was even slightly worse.

I also estimated conditional logit models (not accounting for endogeneity) after dichotomising the dependent variable (as in Winkelmann and Winkelmann 1998). Here the results depended to some extent on the value at which life satisfaction was dichotomised. Still, they were in most cases similar to those of the FD 1 model. i.e. the effect of smoking was negative but insignificant while the effects of income and health remained highly significant.

Further, I tried to account for possible endogeneity (this time ignoring the panel structure of the data) by estimating an ordered probit model with an endogenous dummy regressor. Computation times in LIMDEP proved to be prohibitively high for an estimation of the full model. However, preliminary estimates with small subsamples (about 500 observations) and the dependent variable recoded to four categories suggested that this estimation method yields again somewhat smaller estimates for the welfare costs of smoking than the corresponding IV regression (but much higher than the ordered probit without assuming endogeneity). The qualitative nature of the results hence thus remains largely unchanged when non-linear models are estimated.

A common criticism is that self-reports of life satisfaction follow a purely random pattern and thus do not measure anything that exists in real life. However, the growing literature on subjective well-being shows impressively that self-reported satisfaction levels have considerable explanatory power for individual behaviour. One example is the frequent observation that dissatisfied workers have a higher propensity to quit or to shirk. Further, exogenous events have considerable impact on self-reported well-being. The first differenced regressions above impressively show that things that happen between two panel waves to the respondents (such as becoming a widow or widower, i.e. when the spouse dies) have a measurable impact on their self-reported happiness (also see Clark et al., 2003).

A more serious concern relates to the effect of money income on satisfaction. The income coefficients enter the welfare cost estimates' denominator. Everything else constant, the smaller the estimated impact of income on well-being, the larger the estimated welfare costs of addiction. At the extreme, if money did not matter at all, the welfare costs of addiction would become infinite. The correct specification of the relation between income and life satisfaction is thus important to obtain useful results.<sup>11</sup> It seems as if the sensitivity of the results with respect to assumptions about the functional form of the income-happiness relation is a direct measure of our ignorance about this issue. It is perhaps more useful to compare the size of the addiction effect to the effect of other, preferably exogenous variables. The death of a partner is an exogenous event that makes people unhappy. When smoking is also treated as exogenous, the absolute effect of being a smoker is much smaller than the effect of such an event. In comparison, tobacco addiction may thus be considered a mild – but lasting – impediment to happiness. When smoking is treated

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<sup>11</sup> In a previous version of the present paper, I let income enter in absolute and in relative terms, i.e. in relation to some reference or comparison income (Clark and Oswald, 1996). The calculated welfare costs of smoking did not differ substantially from those reported here. However, the effect of relative income was stronger than the effect of absolute income. Welfare costs were thus for the most part calculated in terms of relative income, which invalidates the conclusion that compensating each addict would make the mixed population as happy as a non-smoker population.

as endogenous, its effect is two times as large as that of becoming a widow or widower, independent of the set of instruments. Again, this raises concerns about the appropriateness of the IV procedure.

As already mentioned, an alternative to IV estimation is to combine the long time-series on individual well-being with smoking spell data, generated on the basis of wave 2002 information on the age at which individuals started and the year in which individuals stopped smoking. Unfortunately, respondents have a tendency to round off this kind of information to focal numbers such as multiples of five, so that the accuracy of the retrospective information is at best questionable. I nevertheless tried to find effects between retrospective smoking data and life satisfaction. The results do not contradict the main idea underlying the present paper, but they must be interpreted with caution (due to space constraints I give only a short summary; detailed results are available on request). I find that both people who have started smoking and people who have stopped smoking are happier the following year. But for starters, the effect is short: after one year, happiness reverts to the initial level. For quitters, the effect lasts longer. Happiness does not revert to its initial level. I also find that happier people have a higher probability of starting to smoke, and that a decrease in life satisfaction has only insignificant effects on the probability of starting to smoke. Finally, happier smokers are also more likely to quit.

Finally, to illustrate the potentials of the happiness-calculus performed in this paper, let us make a few further calculations. With the aid of the above estimates, it is also possible to establish the aggregate willingness to pay for being *forever* relieved of tobacco addiction (remember that up until now, we have only referred to monthly costs). I determine this figure as the present value of the future non-financial costs incurred by being addicted to tobacco, aggregated for the current German population. The present value of the loss in well-being of an individual who is  $a$  years old is calculated as:

$$(7) \quad NPV_a = \delta \sum_{t=0}^{T_a} \hat{y}_{a+t} \rho^t,$$

where  $T_a$  denotes the expected number of years an individual of age  $a$  will continue to smoke,  $\hat{y}_{a+t}$  denotes the expected annual income of that individual at age  $a + t$  (estimated by a regression of per capita household income on a third-order polynomial of age),  $\rho$  is a discount factor (assumed to be 10 percent) and  $\delta$  is the well-being loss as a percentage of net per capita household income. To derive  $T_a$ , I assume that all smokers start at age 17, and that smoking behaviour is stationary. I neglect differential mortality and morbidity of smokers and former smokers (everybody dies at age 80). Based on the cross-section of current and former smokers in 1999, I calculate the probability of a 17 year old to have stopped smoking by age  $17 + t$  as the proportion of former

smokers among all smokers (current and former) at age  $17 + t$ .  $T_{17}$  is then the expected duration of the smoking spell based on these probabilities.  $T_{18}$  is the expected duration of the smoking spell based on probabilities conditional on still being a smoker at age 18, and so on. The results of this procedure are displayed in Figure 1, together with the estimated present value of income accruing during the smoking spell (NPV). The average 20 year old smoker will smoke for 26.1 years. The net present value of his or her income during this time span is 80,145 €. The average 60 year old smoker will still smoke for another 9.8 years and the present value of income while he smokes amounts to 67,375 €. If e.g.  $\delta = 0.62$ , the aggregate willingness to pay to get rid of the “evil weed” forever amounts to 2,544 billion €.

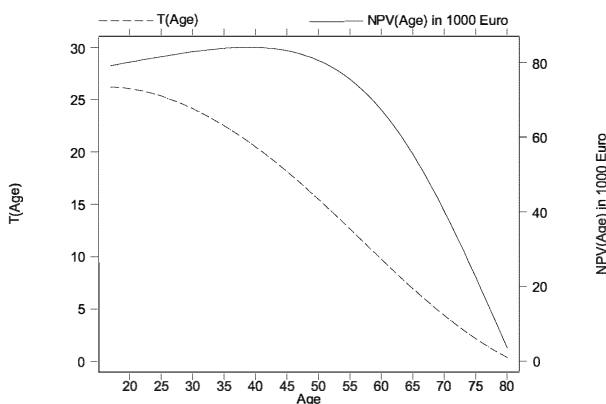


Figure 1: Expected smoking spell duration and present value of income during smoking spell costs (by age)

## 5. Summary

Conventional empirical studies estimate the costs to society caused by tobacco consumption as the sum of direct health expenses for smoking-related illness and indirect costs from productivity losses due to increased morbidity and mortality. In this paper I follow a different, complementary approach. I assume that most smokers are aware of the dangers to health, and that most smokers would prefer to be non-smokers but that they cannot will themselves to quit because they are addicts. Adjustment costs, lack of self-control, or weakness of will prevent smokers from stopping, and the knowledge about future consequences and one's own weakness makes smokers less happy than non-smokers. This is the welfare loss from addiction. In order to put a price tag on this loss, I use a large-scale German survey and calculate the costs of tobacco addiction as the amount of money a smoker must receive to self-re-



port the same level of life satisfaction as a non-smoker with otherwise identical characteristics. Although this figure is quite sensitive to estimation method and functional form assumptions, an average amount of 500 € per smoker per month emerges as the most plausible value. The German society then suffers an aggregate loss of 125 billion € per year. In order to calculate the social costs of tobacco consumption, these figures must of course be added to those obtained from the usual estimates of the costs of smoking. Conventional studies thus grossly understate the total welfare costs of tobacco consumption.

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