



Department of Economics

Credit Card Borrowing, Illiquid Assets and Self-Control Problems

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Für meine Eltern

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Contents

GENERAL INTRODUCTION	1
CHAPTER 1: SURVEY OF SELF-CONTROL PROBLEMS IN ECONOMICS	4
1. Introduction	5
2. Modelling Self-Control Problems	9
2.1. Hyperbolic Discounting	9
3. Literature Review of Applications	13
3.1. Saving and Borrowing	13
The hyperbolic consumption model	13
Empirical Contributions	18
Indirect Empirical Evidence	20
Conclusion	21
3.2. Procrastination	22
3.3. Internal Commitment Devices	27
3.4. Addiction	27
3.5. Contract Choice and Contract Design	33
4. Concluding Remarks	36
CHAPTER 2: MEASURING SELF-CONTROL PROBLEMS	39
1. Introduction	40
2. Empirical Strategies in the Literature	40
2.1. Structural Models	41
2.2. The "time versus money" approach	42
2.3. Delay of Gratification and Intention Reality Gap	43
2.4. Information on everyday behavior	45
3. Smoking as Measure of Self-Control Problems	47
3.1. Gap between intentions and actions	47
3.2. Commitment Devices against Smoking	48
3.3. Rational Addiction vs Self-Control Problems	50
Theory	50
Empirical Evidence	51
3.4. Other empirical studies	53
3.5. Conclusions	54
4. Alternative interpretations of smoking	55
5. Concluding Remarks	57
CHAPTER 3: SELF-CONTROL AND CREDIT CARD BORROWING	59
1. Introduction	60
2. Data	62
2.1. Smoking in the Sample	63
2.2. Outcomes	64
2.3. Explanatory Variables	66
3. Descriptive Results	70
3.1. Means of Smokers and Non-Smokers	70
3.2. Explanatory variables and Smoking	72
3.3. Probit and Tobit analysis	75

	Payoff Probability	75
	Credit Card Debt	77
4.	In search for a self-control interpretation	80
4.1.	Potential confounding factors	80
	Risk Aversion	80
	Health Expenditures	82
	Stressful Events	82
	Peer Effects	84
4.2.	Estimation with Extended Specification	86
4.3.	Potential identification problems	90
4.4.	Plausibility Arguments	91
	Constant-Time Discounting	92
	Learning Ability	92
	Reverse Causality and Tobacco Expenses: The Case of Former Smokers	93
4.5.	Instrumental Variable Estimation	98
	Instrument	98
	Payoff Probability	99
	CARDDEBT	103
4.6.	Discussion	107
5.	Conclusions	108
	Appendix to Chapter 3	110
	A1.1 Additional Tables	110
CHAPTER 4: SELF-CONTROL PROBLEMS AND SAVING IN ILLIQUID ASSETS		119
1.	Introduction	120
2.	Theory Review	123
3.	Retirement Income Provision in Australia	124
3.1.	Old Age Pension	125
3.2.	The Superannuation Guarantee	126
3.3.	Voluntary Saving	127
3.4.	The Liquidity of Superannuation Funds	127
3.5.	Taxation	128
3.6.	Conclusions	129
4.	Data	130
4.1.	Accumulated Savings in Superannuation Funds	132
4.2.	Control Variables	134
5.	Smoking and Superannuation Fund Value	138
5.1.	FUNDVALUE Regressions	141
5.2.	Robustness	146
	Outliers	146
	Tax incentives	146
	Normalized FUNDVALUE	147
	Other measures of smoking	148
6.	A Self-Control Interpretation	149
	Confounding Factors	149
	Unobservable confounding factors	150
	Reverse Causality	151
	Interactions of SMOKER and CONTROLS	152
	Conclusions	152
7.	Smoking and Liquid Assets	153
8.	Conclusions	158

Appendix to Chapter 4	160
A1.2 Additional Tables	160
Bibliography	168

General Introduction

The inclusion of findings from psychology into economics (see e.g. Rabin (1998)) and the increasingly available evidence of deviations from the standard model of behaviour in economics (e.g. DellaVigna (2007)) have given rise to a new sub-discipline of economics, behavioural economics. Behavioural economics studies deviations from the standard economic model in three respects: first, non-standard preferences, second, non-standard beliefs, and third, non-standard decision making. The study of self-control problems can be regarded a subfield of the study of non-standard preferences.

A general definition of self-control problems is the inability to stick to a decision or the inability to carry out a plan. This inability might result from time-inconsistent preferences, i.e. preferences that make people judge objectively equivalent trade-offs differently only due to the fact, that they make these judgements at different points in time. The recent years have seen a surge of theoretical literature establishing a theoretical framework for the analysis of self-control problems and applying this framework to many fields (see Frederick et al. (2002), and Chapter 1). Some contributions have also assessed the effect of self-control problems on different outcomes empirically. My thesis is an attempt to contribute to this empirical literature. I try to assess the effect of self-control problems on different outcomes of interest, namely credit card borrowing and saving. After surveying the relevant literature in Chapter 1, I discuss the measurement of self-control problems in Chapter 2. Chapter 3 is an attempt to assess the effect of self-control problems on credit card borrowing and Chapter 4 is an attempt to assess the effect of self-control problems on saving in illiquid assets. I use data from a recent household survey from Australia.¹

In Chapter 1 I give an overview of the main conceptual issues arising from the concept of self-control problems and introduce the most widely used theoretical approach to deal with this

¹ This thesis uses a confidentialised unit record file from the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA Project was initiated and is funded by the Commonwealth Department of Family and Community Services (FaCS) and is managed by the Melbourne Institute of Applied Economic and Social Research (MIAESR). The findings and views reported in this paper, however, are those of the author and should not be attributed to either FaCS or the MIAESR.

concept: quasi-hyperbolic discounting. Then I survey those fields of the literature that are of relevance to my thesis. Thus I first discuss the main contributions in the field of saving and borrowing. Then I discuss the theory of procrastination and how internal rules can arise as commitment devices against self-control problems. Finally I present the literature in two further fields of application: the theory of addiction and of contract choice or design. The current state of the literature on the application of the theory of self-control problems allows some conclusions: first, self-control problems provide an explanation for a range of stylized facts in a number of industries. Second, the theory of self-control problems provides a theoretical representation of several “problems” that could not be conceptualized as such in the standard framework. Third, these problems may not always be solved by market mechanisms and thus provide a rationale for policy interventions.

In Chapter 2 I discuss how the existing empirical literature has tried to measure self-control problems. Three approaches can be distinguished: structural models that estimate parameters that represent self-control problems, custom-designed experiments or surveys and proxy measures from general surveys. Then I discuss smoking as an indicator of self-control problems. While there are obvious drawbacks from using a behaviour like smoking as a measure of self-control problems that may have numerous causes and correlates, I argue that it also has some distinct advantages and can be supported by a range of arguments and evidence.

Chapter 3 is an attempt to assess the effect of self-control problems on credit card borrowing similar to Bertaut and Haliassos (2002). I use a sample of individual credit card owners that have the sole responsibility for their card use and debt payments. Using a large number of control variables I find that smoking is statistically and economically strongly correlated with the probability to pay off one’s credit card debt entirely and with the amount of debt accumulated on a credit card account. Smokers have a lower pay-off probability and more accumulated credit card debt. This correlation might not be due to self-control problems, however. I argue that reverse causality and unobserved heterogeneity, in particular the cost of tobacco consumption, are the main alternative interpretations of this result. I propose two approaches to solve this identification problem. First, I argue that the pattern of correlations

that is obtained when also distinguishing former smokers from current smokers and people who never smoked is unlikely to arise under any of the alternative interpretations. Second, I propose to use an individual's parent's divorce when this individual was young as an instrument for smoking. The instrumental variable estimates are unusually large, however, calling the validity of the instrument into doubt. Thus I conclude that while the overall pattern of correlations between current smoking, former smoking and credit card debt does not lend itself to any obvious alternative interpretation, I cannot convincingly establish that this pattern is due to self-control problems.

In Chapter 4 I try to assess the effect of self-control problems on saving in illiquid assets. I construct a sample of employees who have access to an illiquid retirement savings account. This account is illiquid in the sense that money in this account can only be withdrawn after a certain age is reached (55 in the current sample). For all employees in the sample, employers make the same contribution as a percentage of gross-wage into these accounts, for which I control. Importantly employees have the possibility to make voluntary contributions to these accounts and a substantial share of overall savings in these accounts is due to voluntary contributions (more than 50% according to Bateman and Piggott (2001)). Then I run simple wealth regressions as in Ameriks et al. (2003, 2007). Interestingly I find that on average smokers have more accumulated funds in such accounts than non-smokers. This is consistent with the hyperbolic consumption model (Laibson et al. (1998, 2000)) and the intuition that people with self-control problems use illiquid assets as commitment devices against their own over-spending. I also argue that reverse causality is unlikely to play a role here. The negative correlation between liquid assets and smoking also supports a self-control interpretation of this result. Nevertheless two caveats are due: first, the result is not very strong in statistical terms as it relies on the tails of the distribution of illiquid wealth in retirement accounts. Second, there may be interactions between smoking and institutional features that I am not aware of. If the result is valid, however, it is the first purely empirical study that is consistent with this prediction of the hyperbolic consumption model.

Chapter 1: Survey of Self-Control Problems in Economics

Many who are capable of the higher pleasures, occasionally, under the influence of temptation, postpone them to the lower. But this is quite compatible with a full appreciation of the intrinsic superiority of the higher. Men often, from infirmity of character, make their election for the nearer good, though they know it to be the less valuable; and this no less when the choice is between two bodily pleasures than when it is between bodily and mental. They pursue sensual indulgences to the injury of health, though perfectly aware that health is the greater good.

John Stuart Mill, 1871

Consumers face two challenges: making good decisions and sticking to them. Economists have adopted optimistic assumptions on both counts.

Laibson et al. 1998

1. Introduction

The most general definition of self-control as suggested by the quote of Laibson et al. (1998) is a basic ability to stick to decisions. Other descriptions of the same concept are self-discipline, self-possession or willpower. While this most basic definition of self-control is agnostic about the sort of decisions that are to be followed, when speaking of self-control people usually have concepts in mind that involve some value judgements as illustrated by the quote of John Stuart Mill.

If people do not have sufficient self-control to follow through with a decision they suffer from self-control problems. Examples of such problems abound in economic and other activities. People want to exercise more regularly, eat more healthily or study more for an exam than they manage to do. Some people never manage to arrive at work on time despite repeated efforts to do so. Others may lag consistently behind their savings target because they do not manage to delay consumption in the way they intend to. A smoker may decide to quit "tomorrow" every day, but when the next day comes around he postpones quitting to the next day again.

These examples illustrate that first, people often seem to deviate from behavior that is judged optimal by their own standards, and second, that this deviation does not seem to occur at random but in the direction of instant gratification. Specifically, when people face actions that involve immediate benefits but delayed costs, like smoking, eating sweets, or sleeping in, they tend to do this action more than they would like to. Conversely when people face actions that involve immediate costs and delayed benefits, like saving or exercising, they tend to follow this action less than they would like to. The opposite situation of smoking too little, eating too healthily, or studying too much is rarely reported and if it is, with a few exceptions (like workaholism) it is usually not regarded a problem.

The examples on studying, saving or smoking further demonstrate that problems of self-control can come at a great cost in many domains, be it health, wealth or human capital accumulation. Nevertheless economics has mostly ignored this phenomenon until about 10

years ago. This is probably due to the fact that the notion of self-control problems violates the idea that only observable actions matter for welfare judgments, or that only such observable actions can be analyzed in a scientific manner. The incorporation of psychological findings into economic theory (see e.g. Rabin (1998)) in the last decade has changed this perception, however. Thus today the study of self-control is a burgeoning field of behavioral economics.

The existence of self-control problems gives rise to many interesting questions in economics and beyond. A helpful concept in thinking about self-control problems is to adopt a multiple “selves” interpretation of individuals. The same person can be regarded as split between a planner and a doer self, a principal and an agent self, or a succession of many temporal selves. One self pursues different goals than another self. A planner self may want to save and study a lot, but the doer self may decide that it prefers to do less onerous tasks instead, and today’s self may have different plans for tomorrow’s self, then tomorrow’s self. This framework of multiple selves will serve to discuss some fundamental issues arising from the concept of self-control problems.

First, if there exist several selves within the same individual that have conflicting interests, which self is to represent the individual? This is an obviously important ethical or legal question, but it is also directly relevant for economic analysis. In judging the welfare impact of certain actions or policies, which self’s welfare is one to maximize?

There is no conclusive answer to this question. A strict welfare criterion would be a Pareto criterion allowing a welfare improvement only when no self is made worse off. This criterion seems to be too hard to meet to be of practical relevance. A less strict criterion would be to favor one self over other selves and adopt this self’s perspective as the welfare standard. It might be considered natural to give priority to long term goals over short term ones, for example, like health over instant enjoyment of smoking. Thus one may also want to give priority to the welfare of the “reasonable” self, the planner or the long-term self. While such a criterion is more easily met it is clearly arbitrary.

Second, if there are several selves within the same person how do these selves interact, and how does this interaction result in action? The multiple selves view lends itself to some standard tools of economics like game theory and principal agent theory. In a game theoretic model actions are those strategies of the multiple selves that prevail in equilibrium. In a principal agent approach a rational self will try to place incentives or restraints on an impulsive self. Other models involving rivaling sub-utility functions have been proposed as well.

Third, if there are several selves within the same individual how can one know which self is actually acting when an action is observed? In other words, how can one tell whether a specific action is due to self-control problems or to "rational" decision making? The breaking of the link between observed actions and assumed preferences is a fundamental deviation from the standard economic paradigm of revealed preferences. Chapter 2 discusses how the economic literature has dealt with inferring on the existence of self-control problems. Economists also make use of methods from neuroscience like brain imaging to find out whether certain actions can be characterized as controlled or affective, or controlled or automated (see Camerer et al. (2005)).

Another important issue that arises from the concept of self-control problems is the degree of awareness individuals have of this condition. Two extreme cases (due to Strotz (1955)) are completely naive agents, who are not aware of their future self-control problems at all, and sophisticated agents, who are completely aware of their future self-control problems. As will be seen later, the results from modelling intrapersonal decision-making usually differ substantially depending on which model of awareness is chosen. It is likely that most people are at least somewhat aware of their self-control problems. The economics literature has also developed models of partial naiveté, where an agent is aware of his self-control problems but underestimates the degree to which he suffers from them.

When people are aware of their self-control problems, they can employ strategies to commit their future selves to certain paths of action. Whether they manage to do so depends on the availability of commitment devices. Commitment devices may be internal or external, and

perfect or imperfect. Internal commitment devices are psychological strategies to overcome temptation. An example is a personal rule where people do not regard a single action separately but as part of a sequence of actions. When realizing that if they do not resist temptation now they most likely will not resist temptation the next time and thereafter, the cost of giving in to temptation appears larger. Naturally such a personal rule is an imperfect commitment device in the sense that it does not guarantee the desired outcome. External commitment devices are more reliable. They consist of either physical force or some mechanism that increases the cost or reduces the benefit of giving in to temptations. Higher prices, enrolling in a drug-rehabilitation centre or asking other people to intervene if certain actions occur are examples. If agents are aware of their self-control problems the existence of commitment devices is an important factor for the prediction and evaluation of observed behavior. When commitment is sought with the help of third persons, ethical or legal dilemmas can arise as the third person has to ignore the will of at least one of the selves of the person they are acting for. Schelling (1984) provides an enlightening discussion.

The existence of self-control problems may justify the provision of commitment devices to consumers by policy means. Many long established policies can be regarded in this view. Obligatory retirement savings systems as they exist in many countries are often justified by the concern that people would not save enough on their own but would regret not having done so when they are old. The same is true for other compulsory social insurance schemes like health and unemployment insurance. Other examples are sin taxes against addictive substances that, other than accounting for externalities, are also meant to deter consumption.

The theory of self-control problems and intra-personal struggle has already found many applications. This chapter is a survey of some of those fields of application. The customary disclaimer of survey articles, that they are not exhaustive, applies here in many ways. First, I only cover topics that are of relevance to my thesis. Thus I will cover some topics on general behaviour, i.e. procrastination and internal commitment devices, and several areas of application that are of relevance to my thesis: saving and borrowing, addiction and contract theory. Where available I complement the theoretical insights with insights from empirical

studies. Second, I focus on intuition and insight, not on methodology. Nevertheless, since almost all theoretical papers I cover are based on the method of hyperbolic discounting, I give a short intuitive introduction into how hyperbolic discounting is used to model self-control problems before I start the literature review.

Frederick et al. (2002) and Rabin (1998) give a very concise summary of the theoretical literature based on hyperbolic discounting. DellaVigna (2007) summarizes the state of the evidence on self-control problems in the literature. This chapter complements these reviews by giving more attention to the intuition and mechanism behind the insights. Brocas and Carillo (2000) is a comprehensive review of the application of hyperbolic discounting to the strategic value of information.

In section 2 I present the intuition underlying hyperbolic discounting. Then I focus on the intuition and main insights of the papers that apply this concept in different fields of economics in section 3. Section 4 concludes.

2. Modelling Self-Control Problems

The theoretical literature has developed several different approaches towards modelling self-control problems. Perhaps the most prominent approach is based on hyperbolic time discounting. All theoretical papers I will use to motivate the empirical analysis of the following chapters are based on hyperbolic discounting. Therefore I give a short intuitive introduction into this technique.

2.1. Hyperbolic Discounting

The dominant paradigm for time discounting in economics is the Discounted Utility (DU) model proposed by Samuelson (1937). It describes a person's intertemporal utility by the following function

$$U^t(u_t, \dots, u_T) = \sum_{k=0}^{T-t} D(k) u_{t+k}$$

$$D(\tau) = \left(\frac{1}{1 + \rho} \right)^\tau$$

Where u_t is the instantaneous utility function, $D(\tau)$ is the discount factor and ρ is the discount rate. The noteworthy feature about the DU model is that the discount rate ρ is constant over time. This implies that shifting two dated outcomes by a common amount in time does not affect the preferences between these outcomes.² In particular a constant discount rate implies that a person's intertemporal preferences are time-consistent, meaning that later preferences confirm earlier ones.³

Along with many other assumptions of the DU model, time-consistency has been shown to be an inadequate description of time discounting (see Frederick et al. (2003)). Psychologists have accumulated substantial evidence that people exhibit preference reversals in many situations (e.g. Ainslie (1992a)).⁴ For example, quoting from Ainslie and Haslam (1992), "a majority of people say they would prefer to have a prize of a \$100 certified check available immediately over a \$200 certified check that could not be cashed for 2 years. The same people do not prefer a \$100 certified check that could be cashed in 6 years to a \$200 certified check that could be cashed in 8 years, although this is the same choice seen at 6 years greater delay."

Time consistent preferences as in the standard discounted utility model cannot account for such preference reversals. At any point in time either the earlier or the later reward is judged more favorable but the order of preference never changes as time goes by. In order to allow preferences to reverse, discount functions have to cross, such that before the intersection

² Formally, when in period t a person prefers X at time τ to Y at time $\tau + s$ for some τ then this person prefers X at time τ to Y at time $\tau + s$ at all τ .

³ Formally, a person's intertemporal preferences are time-consistent, if, for any two consumption profiles (c_t, \dots, c_T) and (c'_t, \dots, c'_T) , with $c_t = c'_t$, $U^t(c_t, \dots, c_T) \geq U^t(c'_t, \dots, c'_T)$ if and only if

$$U^{t+1}(c_{t+1}, \dots, c_T) \geq U^{t+1}(c'_{t+1}, \dots, c'_T)$$

⁴ Formally a preference reversal occurs if at time t a person prefers outcome Y at time $\tau + s$ to outcome X at time τ for some τ but then prefers outcome X at time τ to Y at time $\tau + s$ at some larger τ .

point the agent prefers the larger later reward and as the time of action comes closer, the agent reverses his preferences and prefers the smaller earlier reward. Discount functions that are generalized hyperbolas capture this feature (see e.g. Loewenstein and Prelec (1992)). In hyperbolic discounting events that are τ periods away are discounted with factor

$$f(\tau) = (1 + \alpha\tau)^{-\gamma/\alpha}$$

with $\alpha, \gamma > 0$. The instantaneous discount rate for this discount function falls as τ rises.

That is, for discount function $f(\tau)$ the instantaneous discount rate is

$$-\frac{f'(\tau)}{f(\tau)} = \frac{\gamma}{1 + \alpha\tau}$$

The coefficient α determines how strongly the discount function deviates from constant discounting. The limiting case with α approaching zero is exponential discounting. As α increases, the discount function becomes more and more convex. In the extreme, as α approaches infinity, the discount function approaches a step function, which gives unit weight to utility at time 0 and a constant (less than unity) weight to all future utility.

In economics most theoretical work using hyperbolic discounting employs a simplification: quasi hyperbolic discounting (Phelps and Pollak (1968)). Quasi hyperbolic discounting mimics hyperbolic discounting but is analytically more tractable (e.g. Laibson (1997)). With quasi hyperbolic discounting the intertemporal utility function takes the following form:

$$U^t(u_t, \dots, u_T) = \delta^t u_t + \beta \sum_{\tau=t+1}^T \delta^\tau u_\tau$$

Where $0 < \beta, \delta \leq 1$. The parameter β here is similar to the parameter α in hyperbolic discounting as it determines the degree of convexity of the discount function and thereby how strongly the function deviates from constant discounting. Parameters β and α can therefore be regarded as formal measures of time-inconsistency or self-control problems.

Quasi-Hyperbolic Discounting can be easily interpreted. The parameter β introduces a present-bias into utility weighting, whereas parameter δ represents long term discounting. Before a certain period τ arrives, the utility in that period compares to the utility in other (future) periods only via parameter δ (e.g. u_{t+1} is weighted at $1/\delta$ when compared to u_t). As soon as period τ is reached, however, the person gives more relative weight to that present period via parameter β than he did in any previous period (e.g. u_{t+1} is weighted at $1/\beta\delta$ when compared to u_t). This is the mechanism at work in preference reversals.

Thus quasi-hyperbolic discounting provides an intuitive and analytically tractable representation of self-control problems. It allows to grasp many of the issues discussed in the introduction. Multiple selves arise as period t self always judges tradeoffs between utility occurring at t and any utility occurring after t different from the period $t-1$ self. Giving priority to long-term goals over short term goals would mean to use the utility of a period 0 self that is not involved in any consumption as the welfare standard. Not having any self-control problems is grasped by setting $\beta = 1$. Sophisticated agents know that their true β is smaller than 1. Naïve agents think that their $\beta = 1$ but in reality it is smaller than 1. Partial naiveté is modelled by a perceived level of β being larger than the true β , so that agents do expect to have a self-control problem but underestimate its degree.

Given these favourable features of quasi-hyperbolic discounting it is not surprising that it is the most widely used approach. Other theoretical models have been proposed and used, however. Most prominently Gul and Pesendorfer (2001) present a model in which a person's utility does not only depend on the goods consumed but also on the goods that were in his choice set. If any of these goods that were available but not chosen constituted a temptation an agent has a cost of self-control which decreases his utility. Thaler and Shefrin (1981) model the relationship between a far-sighted planner self and a short sighted doer self as a principal-agent relationship. Finally it should be born in mind, that many of the criticisms levelled against exponential discounting can also be levelled against quasi-hyperbolic discounting. While, by incorporating a concept of self-control, the latter probably does constitute a more realistic theory of time preference than exponential discounting, there still

exist many documented features of time- or general preferences that are not grasped by quasi-hyperbolic discounting either (see Frederick et al. (2002)).

3. Literature Review of Applications

As self-control problems can be considered a feature of intertemporal choice they potentially affect almost every economic action. Not surprisingly the theory of self-control problems has found applications in many different fields. This section reviews the literature on saving and borrowing, addiction, contract choice and on procrastination and commitment in general.

3.1. Saving and Borrowing

Saving involves sacrificing immediate gratification for future gratification, borrowing involves the sacrifice of future for current gratification. Thus one would expect self-control problems to play a role. Laibson et al. (1998) report three sets of evidence for this: first, popular and professional financial advice that reminds people to transfer money into savings accounts immediately when their wage arrives or to leave credit cards at home. Second, evidence on preferred and actual consumption paths: people prefer upward sloping consumption paths but implement downward sloping ones, and third, systematic differences between target and actual saving rates. In order to grasp self-control problems the hyperbolic consumption model incorporates quasi-hyperbolic discounting.

The hyperbolic consumption model

In the simplest version of the standard model of intertemporal consumption choice the decision to borrow or save is governed by the interest rate. Agents equate their current marginal utility of consumption to the expected future marginal utility of consumption corrected by the interest factor and the discount factor as demonstrated by the standard Euler equation:

$$u'(c(x_t)) = E_t R \delta u'(c(x_{t+1}))$$

where u is instantaneous utility, c is the consumption function, x is cash on hand, R is the interest factor and δ is the discount factor. Under the assumption that marginal utility is constant over time, agents postpone consumption if the incentive to wait, the interest rate, overcomes impatience, given by the discount rate. Thus with a constant discount rate and a constant marginal utility only the interest rate determines variation in saving or borrowing.

When incorporating quasi-hyperbolic discounting, the implications of self-control problems on saving and borrowing decisions can be elegantly represented by the hyperbolic Euler equation, derived by Harris and Laibson (2001).

$$u'(c(x_t)) = E_t R [c'(x_{t+1})\beta\delta + (1 - c'(x_{t+1}))\delta] u'(c(x_{t+1}))$$

Here the standard discount factor δ is replaced by the term

$$[c'(x_{t+1})\beta\delta + (1 - c'(x_{t+1}))\delta]$$

which is called the effective discount factor. The effective discount factor for hyperbolic consumers is a weighted average of $\beta\delta$ and δ , with respective weights $c'(x_{t+1})$, the marginal propensity to consume out of liquid wealth, and $1 - c'(x_{t+1})$.

The hyperbolic Euler equation allows to compare the behavior of hyperbolic to standard consumers, or those with self-control problems to those without. As shown by Laibson (1997) (and discussed below) hyperbolic consumers may want to limit the amount of liquid assets available to future selves in order to prevent them from over-consuming. This can be done by shifting resources from liquid into illiquid assets. Thereby they will increase the marginal propensity to consume out of liquid assets in every given period. This gives stronger weight to β in the effective discount factor and thus decreases it. If the decrease is strong enough it might overcome the interest factor and induce the agent to consume more in the present, thereby saving less or borrowing funds from the future.

If the factor β can vary across consumers, a lower value of β , corresponding to more severe self control problems, will directly decrease the effective discount factor. At any marginal propensity to consume out of liquid assets agents with low β therefore have a higher effective discount rate, which makes them more willing to borrow at high interest rates.

The effective discount rate is endogenously determined by an agent's decision to limit his liquid assets, i.e. by shifting his resources to illiquid assets. Intuitively the decision to do so must result from strategic intrapersonal interaction. Laibson (1997) explicitly models this strategic interaction in the domain of consumption and saving when consumers have self-control problems and have access to an illiquid asset. He assumes that consumers are fully aware of their self-control problems, that is they are sophisticates, and therefore can make use of commitment devices to constrain the behavior of their future selves. The asset used as a commitment technology is illiquid in the sense that the sale of this asset has to be initiated one period before the proceeds from the sale can be realized.

In each period the consumer receives income and determines the allocation of his resources between liquid and illiquid assets for the following period. In order to determine the optimal allocation the consumer plays a non-cooperative intrapersonal game against all his other selves (one in each period). Laibson characterizes conditions that give a unique subgame perfect equilibrium strategy of this game. On the equilibrium path, early selves prevent later selves from splurging by limiting the amount of liquid assets available to them. Thus each self is endogenously liquidity constrained by the allocation choices of earlier selves and accumulates more capital in illiquid form than it would without commitment device.

Additionally to providing a rationale for reducing the liquidity of future selves, the model can explain several empirical regularities that are difficult to explain in the standard life-cycle/permanent income consumption model. It generates comovement of consumption and income, for example. Earlier selves (say in $t-1$) try to counterbalance predictable income fluctuations by allocating more resources to the illiquid asset when income is high. Self $t-1$ can only deny assets to self t that have been accumulated in the past, however. It cannot

deny self t access to labor income in period t . Thus when labor income is high in period t , self t can also consume more. This generates consumption-income comovement.

The model also predicts asset specific marginal propensities to consume (MPC). Thaler (1990) presents evidence that the MPC out of current income is unity, the MPC out of future income is close to zero and the MPC out of net assets is somewhere in between. As every self in each current period is likely to be liquidity constrained due to the asset allocation decision of earlier selves, they consume all cash that is available to them implying a MPC out of current income of one. The other two predictions are technical in nature and cannot be explained in an intuitive way.

One of the most interesting applications of Laibson's model regards the declining saving rates in the 1980's in the U.S.A. The ability to prevent later selves from overconsuming depends on the availability of illiquid assets. Laibson argues that the expansion of the consumer credit market in the U.S.A. during the 80's has reduced the effectiveness of illiquid assets as commitment devices. One example of consumer credit products are credit cards. These allow access to instantaneous credit and thereby relax the constraint on consumption in each period by the amount of credit lines available. In other words self t can consume out of his illiquid assets by taking credit that matches the value of these illiquid assets. Thus illiquid assets lose their commitment property. Given that the share of households with a credit card has grown rapidly during the 80's, this availability of instantaneous credit may have impeded many households from saving, thereby leading to a decline of the national saving rate.

Laibson's model does not explicitly take into account one important life-cycle event: retirement. If the date of retirement is not given exogenously it is part of a strategic intrapersonal game and possibly affected by self-control problems. An individual who is close to his expected retirement date may be tempted to retire early for example. An individual expecting to give in to the temptation to retire early may have an incentive to save more early in life, or he may have the incentive to save less in order to induce later retirement.

Diamond and Koszegi (2003) analyze this additional strategic interaction by adding endogenous retirement to the model in Laibson (1997). At a certain future period an agent

can decide to either continue to work or retire. In their standard case they assume that agents can neither commit to a decision concerning retirement nor to a certain level of consumption. Their results are ambiguous. One possible outcome is called “strategic undersaving”: in order to induce later selves to continue to work when they have the option to retire, an agent will save less than he would if the early retirement option was not available. This undersaving would add to the undersaving that occurs in Laibson’s original model without retirement. Another possible equilibrium, however, is higher saving even when commitment (to saving) is not available. One reason for higher saving is that agents expect to retire early because the discounted utility cost of continuing to work is too high. In order to accommodate this early retirement, agents save more. Diamond and Köszegi (2003) call this scenario “resigned oversaving”. The other reason for why higher saving can occur is that agents might expect to be eager to work just prior to retirement. In order to make themselves retire they accumulate more savings. In the case of higher saving therefore, including the retirement decision into the intrapersonal game mitigates the undersaving problem of the game without endogenous retirement.

A variation to the standard case is to consider naïve agents. One interesting possibility then is that naïve agents always expect the deciding self to retire late, i.e. choose to continue to work and thus do not save more for the case of early retirement. The deciding self, however, chooses early retirement when the decision period arrives. Thus at retirement the agent realizes he saved less than necessary which leads to a drop in consumption at retirement often observed in the data. Thereby the model with naïve agents can explain an empirical regularity that the standard life-cycle theories fail to explain (see e.g. Bernheim, Skinner and Weinberg (2001) or Banks et al. (1998)).

Several papers enrich the hyperbolic consumption model and try to assess its empirical validity with the help of numerical simulation methods. Laibson, Repetto and Tobacman (1998) analyze the savings behavior of an economy populated by exponential households and compare it to an economy populated by hyperbolic households as representative agents. They simulate demographics, labor income, bequests, assets and taxes in their model and calibrate it to U.S. data. They find that in the presence of a liquid asset only, an economy populated

with hyperbolic agents is almost indistinguishable from an economy with exponential agents, with the exception that hyperbolic agents are more likely to face binding liquidity constraints. When they introduce an illiquid asset modelled after a defined contribution pension plan, however, hyperbolic consumers hold lower levels of liquid assets and higher levels of illiquid assets than exponential consumers. Laibson, Repetto and Tobacman (1998) also consider a hybrid economy with both, hyperbolic and exponential agents. In the hybrid economy as well, hyperbolic agents save more in illiquid than in liquid assets, when compared to exponential agents.

In a similar paper Laibson, Repetto and Tobacman (2000) (and similarly Angeletos et al. (2001)) address the problem of reconciling wealth accumulation in low yielding assets with borrowing on credit cards at high interest rates. The problem is the following: in order to match the magnitude of retirement wealth accumulation in the US the simulation models built for this purpose need to be calibrated to a low exponential discount rate of around .05. In order to match the actual rate of credit card borrowing, however, these models have to be calibrated with a high exponential discount rate of around .18. The authors call this the “Debt Puzzle”: Consumers behave patiently when it comes to retirement accumulation but impatiently in the credit card market. Assuming quasi-hyperbolic rather than exponential discounting offers a solution to this puzzle. In a simulated economy with exponential discounting around 20% of households borrow on their credit cards, while for US data the corresponding figure is around 60%. Simulations where agents have hyperbolic discount functions are able to match the empirical borrowing rate of 60%. When liquidity constrained, hyperbolic agents act like exponential ones with discount rates of around 40%. When investing into illiquid assets, however, as the benefits from this investment accrue in the long term, they act patiently. Thus households borrow aggressively on credit cards and save substantial amounts for retirement primarily in illiquid assets.

Empirical Contributions

While the hyperbolic consumption model is an intuitive way of modelling self-control problems and is able to predict several empirical regularities, it may still be restrictive to think of self-control problems only as a variant of time preferences. The following papers

take an agnostic approach at how self-control problems should be modelled. Instead they use measures that attempt to measure self-control directly and analyze their effect on saving and borrowing.

Ameriks, Caplin, Leahy and Tyler (2004, 2007) use a custom-designed survey to construct a measure of self-control problems. (The details of this measure are discussed in chapter 2). They use this measure to assess the effect of self-control problems on wealth accumulation and obtain several interesting results. First of all, they find that there exist individual differences in self-control problems. Naturally models based on a representative agent assumption of the type described above cannot grasp these individual differences. Moreover these differences are of a quantitative and a qualitative nature. While it is standard to think of self-control problems as urges for immediate gratification they also find that some people suffer from the opposite problem of underconsumption. Therefore their measure of self-control is not one corresponding to immediate gratification. It rather measures the deviation of expected behavior from a self-defined ideal and this deviation may occur in any direction. When regressing this measure of self-control problems on net worth, they find that the average overconsumer accumulates around 20% less than a person without self-control problems, and the average underconsumer accumulates around 25% more. When regressing their measure separately on liquid and on illiquid wealth, they find that self-control problems impede wealth accumulation in liquid form but do not find a statistically significant effect on illiquid wealth. Thus their results are consistent with the intuitive prediction that people with self-control problems have difficulties with saving at least in liquid form.

The authors acknowledge that there may be alternative explanations for their wealth result. People may rationalize their higher wealth by concluding that they must have consumed less than desirable and thus respond in the corresponding way to the survey questions. Alternatively they may have responded in a way they perceived as socially desirable. The authors present evidence against both alternative interpretations.

In an earlier paper Ameriks et al. (2003) use a custom designed survey to measure an individual's propensity to plan. They regress this measure on different measures of wealth

and find that an individual's propensity to plan has a statistically significant positive correlation with wealth accumulation in liquid form. Using instruments that were specifically designed for their question, they find that reverse causality is not the driving force behind this correlation. Similarly they can exclude that several preference parameters that might be grasped by their survey question are confounding factors. Thus they establish people's planning behaviour as a genuine factor in wealth accumulation. One explanation they offer for this result is that planning is used as a means of "effortful self-control". Planning may allow people to detect uncontrolled spending patterns or identify areas of behaviour where spending problems occur and take the necessary steps to prevent or mitigate these.

Bertaut and Haliassos (2002) use certain behaviours as measures of self-control problems to explain another puzzle in saving and borrowing behaviour. With the aim of explaining the observed coexistence of high interest credit card debt and low yielding liquid assets, they build a model with a patient "accountant" self that takes the long run financial decisions of the household, and an impatient "shopper" self that indulges in credit card financed consumption. The accountant self has an interest in limiting the consumption possibilities of the shopper self. Therefore he does not pay off the credit card bill entirely but keeps a positive balance. This constrains the shopping opportunities of the shopper to the remaining credit between the card limit and the maintained balance. The foregone interest savings can be seen as the cost of self-control.

In order to assess their model empirically they use smoking and certain attitude variables as indicators of self-control problems. Using household level data they estimate the effect of these indicators on the decision to have a credit card and whether to revolve debt. They find that smokers are less likely to have a credit card but more likely to revolve debt on them. This is consistent with the predictions from their theory. It is also consistent with the predictions from the hyperbolic consumption model.

Indirect Empirical Evidence

Several papers provide indirect evidence that self-control problems might play a role in saving. Ashraf, Karlan and Yin (2006) offer a bank account with a commitment property to a

randomly chosen group of people with pre-existing bank accounts. Commitment consists of the inability to withdraw money from these bank accounts before a pre-specified amount of savings is reached or before a pre-specified amount of time has elapsed. A randomly chosen control group with pre-existing bank accounts was given only verbal encouragement to save more. Savings in the group of people who took up the account with the commitment property were 6.5% more likely to increase than in the group of people who only received a verbal encouragement. Similarly, the Save More Tomorrow Program, SMarT, described in Benartzi and Thaler (2004) offers employees to automatically invest a share of their future pay rises into their retirement accounts. They found that 78% of those who were offered the plan joined and that after 40 months the average contribution rate to their retirement plan had increased from 3.5% to 13.6%.

The literature on default options offers similar conclusions. Madrian and Shea (2001) analyze the effect of a change in default for contribution to retirement plans in the US (401 k plans). Before the change the default was non-contribution and after the change the default was contribution. Employees could easily override the default by making a phone call or filing a form. When making contributions employees also received a 50% employer match irrespective of the default option. Madrian and Shea (2001) find that the participation rate is 37% higher when the default is contribution than when the default is non-contribution. Given the small cost of overriding the default and the high benefits in doing so (e.g. the employer match) it is unlikely that transaction costs can explain this result. Instead, procrastination of an action involving a small but immediate effort is more likely to explain this result. If valid, default effects provide a rationale for why self-control problems can have a particularly large effect in retirement saving.

Conclusion

In summary this literature suggests that self-control problems are an important element in saving and borrowing. First of all, the most prominent and intuitive formal approach towards modelling self-control problems, hyperbolic discounting, can provide explanations to a range of stylized facts that remain unexplained in the standard consumption model. These facts comprise consumption-income co-movement, asset specific marginal propensities to consume

and the simultaneous holding of low-yielding retirement assets and high interest credit card debt. In certain circumstances the assumption of naïve agents with self-control problems can also explain the drop in consumption at retirement. Moreover, the hyperbolic consumption model gives rise to intuitive predictions concerning the behavior of people with self-control problems when compared to people without self-control problems. In particular these predictions are that people with self-control problems save more in illiquid assets in relative terms and are more likely to borrow on credit cards at high interest rates.

Simulation models that implement hyperbolic discounting in rich environments confirm the intuitive predictions from hyperbolic discounting. Hyperbolic discounting provides better approximations to several data moments, e.g. the high proportion of US households that borrow (and pay interest) on credit cards, when compared to models that use standard exponential discounting. Thus hyperbolic discounting has been very successful in providing a theoretical explanation for several stylized facts. Nevertheless hyperbolic discounting may be too rigid a model to grasp a possibly complex behavioural force like self-control problems, which may have many more dimensions than time discounting alone. Therefore, while the hyperbolic consumption model produces largely intuitive results, it may not be ideal to assess these intuitive results solely within a still restrictive theoretical framework. This suggests some intuitive empirical approaches.

Such an empirical literature is still nascent. The use of attempted measures and proxies for self-control problems in regressions on wealth, savings or debt have produced the expected results. Indirect evidence on the importance of commitment devices and default options allow similar conclusions. My thesis is an attempt to add to this literature. As will be seen, the results I obtain point in the same direction.

3.2. Procrastination

Instead of studying the effects of self-control on saving and borrowing directly, another approach is to study the effects of self-control problems on general patterns of behavior and use the insights gained from this in any area of interest. In this section I present and discuss

the literature that identifies self-control problems as the driving force behind procrastination. Procrastination is the action of postponing unpleasant activities, even if this postponement “objectively” involves higher costs than benefits.

As illustrated by some of the introductory examples people tend to postpone unpleasant activities like exercising, dieting or starting a savings plan. Such behavior may constitute instances of self-control problems. The literature on procrastination provides a theoretical basis for this conjecture. It shows how procrastination comes about when people have hyperbolic rather than exponential time discount functions.

The most basic set up for the analysis of procrastination is given in O'Donoghue and Rabin (1999a), which analyzes actions which have to be done exactly once in a given time period. Two distinctions are made. The first one is on the temporal distribution of the utility flows, i.e. does the action involve immediate rewards and delayed costs, or does it involve immediate costs and delayed rewards? The second distinction is the degree of awareness that people have of their self-control problems: either the agent that has to do an action is “naïve”, in the sense that he is not aware of his future self-control problems at all, or he is “sophisticated”, i.e. he is completely aware of them.

For every type of action the behavior that results from hyperbolic time discounting is compared to the behavior that results from standard exponential discounting. Three patterns are possible: first, people procrastinate, that is they wait when they should do an action, second, people “pre-procrastinate”, that is they do an action, when they should wait, and third, they do an action at the “correct” time from the point of view of exponential discounting.

O'Donoghue and Rabin characterize two behavioral effects: the “present-bias effect” and the “sophistication effect”. The present bias effect directly describes the implications of present-biased (hyperbolic) time preferences versus exponential (time-consistent) time preferences. Present-biased people procrastinate, i.e. wait when they should do an action, if actions involve immediate costs. They “preprocrastinate”, do an action when they should wait, in the case of immediate rewards. Naïve agents, i.e. those who are not aware of their future self-control problems, are only influenced by this present bias effect. By contrast, the

sophistication effect directly characterizes the implications of sophistication versus naiveté. Regardless of whether costs or rewards are immediate, sophisticated agents always do an action earlier than a naive agent with the same preferences. An intuition for this result is that a sophisticated agent knows that he will have the same self-control problems in the future that he is experiencing now. Thus in the case of immediate costs, he is correctly pessimistic about his ability to perform the task later and thereby has a reduced incentive to procrastinate. In the case of immediate rewards, the sophisticate knows that he will do the action too soon anyway and thus may decide to do it right away instead of waiting. Thus sophistication mitigates the tendency to procrastinate in the case of immediate costs, but exacerbates the tendency to preproperate in the case of immediate rewards.

The motivation for the study of self-control problems is that they hurt the welfare of people who suffer from them. As discussed in the introduction it is not clear how to measure welfare in the presence of self-control problems though. In order to do a welfare comparison of the two types of agents, sophisticates and naives, O'Donoghue and Rabin adopt the perspective of a fictitious period-zero-self that weighs all future periods equally and does not have to take a decision in period zero. In other words, the period-zero-self is not affected by a present bias in judging different actions. With this perspective, it results that for actions involving immediate costs sophisticates are always better off than naives. This is simply so because naives will procrastinate repeatedly under the incorrect belief that they will not procrastinate tomorrow. In particular, already an arbitrarily low level of present bias (measured as deviation from time-consistent preferences) can induce a severe harm in welfare for naives. By contrast, sophisticates know exactly how costly delay would be and thus procrastinate less. Therefore sophisticates are hurt less by present bias and a small such bias cannot hurt their welfare much. When rewards are immediate, however, a naive agent can be better off than a sophisticated one. Naive agents do an action too early but have optimistic beliefs about the benefits of waiting (believing that they will not do it too early). By contrast sophisticates properly anticipate that they will do the action too early anyway and therefore they have a stronger motivation to do the action right away, i.e. give in to temptation immediately.

This basic model of the effects of self-control problems on the timing of an action can be potentially applied to a broad array of economic situations. Quoting O'Donoghue and Rabin (1999a):

"Since consuming now yields immediate payoffs whereas the increased future payoffs that savings allow are delayed, naives will undersave in essentially any savings model. And since addictive activities involve yielding to some immediate desire today that has future costs, naives will overindulge in essentially any addiction model."

Thus for naives the model gives clear cut predictions. For sophisticates the model is less clear, however. As the sophistication effect reinforces the present-bias effect in the case of immediate rewards, in the above example one may expect overindulgence in addictive substances for sophisticates as well. In the case of immediate costs, however, the sophistication effect might mitigate or even outweigh the present bias effect, and hence the predictions for savings are not clear.

Naiveté and sophistication are the extremes of the range of possibilities of awareness. Most likely people are somewhere in between those extremes. Moreover in most situations people have the choice from a menu of possible actions to take, rather than being limited to only one action. O'Donoghue and Rabin (2001) extend the model described above in these directions.

They introduce the concept of partial naiveté. Contrary to naives, people who are partially naïve know about their self-control problems, but underestimate the degree to which they suffer from them. Formally in the quasi-hyperbolic discounting model, partial naiveté is modelled with a discount factor $\hat{\beta}$, that the partially naïve agent expects to have in the future, which is different from the discount factor β that he will really have. Thus while a completely naïve agent expects to discount events exponentially in the future $\hat{\beta}=1$, the partially naïve agent expects to have a quasi-hyperbolic discount function with $1 > \hat{\beta} > \beta$.

One important insight from studying partial naivete is that already arbitrarily small degrees of naiveté can lead to severe procrastination and hence welfare losses in some situations. In

general, however, there is a lower bound of naiveté that people have to pass before procrastinating severely.

The second extension is that people not only have to decide whether to do an action now or later, but face a menu of possible tasks. In each period they have to complete either one of these tasks or do nothing. Each task involves an immediate cost and generates an infinite stream of benefits. The tasks may differ both regarding their costs and benefits.

The first main result of this analysis is that while people plan to do the task which yields the highest long run benefit they implement the task that is most favorable in the comparison of the immediate costs and the benefits foregone by a short delay. This task may be substantially inferior with respect to the long-run benefit or the features of other available tasks. An interesting implication of this result is that providing people with additional options can induce procrastination. For example, a person may immediately participate in a savings plan when there is only one option. When the person has the choice between different savings plans with different features, however, the person might procrastinate because of his desire to choose the best plan. The immediate cost involved in doing a comparison between savings plans induces him to procrastinate.

The second main finding is that people may procrastinate more in pursuit of important goals than unimportant ones. The intuition behind this result is that a person intends to invest more effort in doing an important task which therefore involves a higher immediate cost and hence induces more procrastination.

The model with partial naiveté and repeated tasks substantially adds in realism to the model. Partial naiveté is probably an adequate description of most people's state of awareness. As the model shows already a small degree of naiveté can lead to severe welfare losses. Thus procrastination is probably an important problem for most people. The finding that procrastination may be particularly severe in pursuit of important goals, may give an explanation not only for why so many people do not save enough for retirement, but also for why so few people give adequate thought to their financial needs in retirement.

3.3. Internal Commitment Devices

Most of the literature on self-control problems either assumes that people are unable to commit to certain actions or assume that people can make use of external commitment devices like illiquid assets or signing binding contracts. Benabou and Tirole (2004) investigate how people may make use of internal commitment mechanisms or personal rules. Examples of such rules are diets, resolutions to smoke only after meals or monthly savings targets. As such rules are entirely self-imposed an obvious question is how they can actually constrain a person. Thus they analyze how genuine self-control comes into existence.

The main ingredient for explaining personal rules is a model of self-reputation (e.g. Ainslie (1992a)). People are assumed to have imperfect knowledge of their own willpower and thus regard their own actions as signals that give information about their type. Thus every action is not considered in isolation but as an indicator of how the person will behave in the future. Actions are hence becoming precedents and the fear of creating negative precedents and losing faith in oneself helps to counter the bias toward instant gratification.

Benabou and Tirole (2004) establish three main results: first, the degree of self-control achieved increases in a person's self-confidence in her own willpower. Second, self-restraint is greater when the action in question is repeated frequently and when lapses are easily brought back into awareness. And third, when initially control is enforced on an individual, she is less likely to develop the confidence in her willpower needed to establish autonomous self-control. Thus this model provides additional conditions for when certain actions that give rise to self-control problems are of particular concern. The third result may also provide a rationale for providing external commitment devices only when a person's own efforts have failed.

3.4. Addiction

As the consumption of noxious substances is an instance of self-destructive behavior, addiction has been regarded as especially puzzling from the viewpoint of a rational agent.

Therefore addiction has received considerable attention in the economics literature in general and recently in the literature on self-control problems in particular.

Addiction presents two paradoxes for any theory that aims to explain human behavior by the concept of general utility maximization. First of all, addiction is regarded as harmful for the person indulging in the addictive behavior. The addict's revealed preferences contradict society's view that severe addictive behaviour is not optimal for anyone. Second, many addicts express the will to change their own behavior without being able to do so. Their stated preferences do not correspond to their revealed preferences. Thus the attempt to explain addiction is maybe the most natural field of application of the theory of self-control problems.

Nevertheless there have been attempts to formulate models of addiction that are based on a rational and in particular a time-consistent decision maker. The rational addiction model by Becker and Murphy (1988) is the cornerstone of this literature. In Becker's and Murphy's rational addiction model, agents are rational in the sense that they maximize utility consistently over time. Addictive goods are characterized by intertemporal complementarities. A person is potentially addicted to a good c if current consumption of c raises future consumption. This occurs if past consumption of c raises the marginal utility of present consumption. The latter property captures two basic features of harmful addiction: reinforcement and tolerance. Reinforcement means that greater current consumption increases future consumption and tolerance means that a given level of consumption is less satisfying if past consumption has been greater. In the rational addiction model consumption of an addictive substance is much like (dis-)investment. Harmful addictive consumption entails an increase in current utility at the expense of future utility. Thus agents engage in harmful consumption only if the trade-off between increased current and decreased future utility warrants such consumption. Therefore the availability of drugs is never bad for an agent as he would only consume it, if it increases his overall utility. For the same reason there is no role for policy in the rational addiction model, just as there is no role for policy interventions in a standard investment model.

This feature of the rational addiction model is unsatisfactory. It does not address the concerns people generally have over drug consumption as according to the rational addiction model whatever level of drug consumption is observed, it must be utility maximizing. Therefore it also does not propose potential cures for the “problem” of the consumption of addictive substances.

As the rational addiction model, the addiction model by O'Donoghue and Rabin (2002) takes account of the standard defining features of addictive products. These are first, habit formation (or reinforcement): the more of the product a person has consumed in the past, the more she desires that product now, and second, negative internalities (or tolerance): the more of the product the person has consumed in the past, the lower is her overall well-being now. Different from Becker and Murphy (1988) agents do not maximize utility consistently over time. Instead O'Donoghue and Rabin (2002) apply the quasi-hyperbolic discounting model to addiction and therefore explicitly allow for self-control problems.

The model adopts a simple setup in which a person can in each period decide to “hit”, i.e. to consume the addictive product, or to “refrain”, i.e. not to consume. First, a stationary environment is assumed. In this context stationarity means that a person's desire to consume depends on past consumption (habit formation), but is otherwise constant. By contrast, in a non-stationary environment, the desire to consume is allowed to vary with exogenous factors. Such factors may be youth or weekdays versus weekends. The usual distinction between naive and sophisticated agents is made.

The conclusions from this model of addiction are very similar to those from the general model of procrastination. First the paper considers the stationary environment with naive agents. It characterizes the implications of self-control problems in comparison to exponential time preferences, which in the general model of procrastination is called the “present-bias” effect. O'Donoghue and Rabin (2002) come to the conclusion that generally people with self-control problems that are naive are more likely to consume an addictive product and will consume more of it than a person without self-control problems. Next they ask what the implications of sophistication versus naiveté for people with self-control problems are. They

identify two effects that arise from sophistication. First, the "pessimism effect" describes the phenomenon that people become pessimistic about their future behavior given their awareness of their future self-control problems. As anyway they will consume in the future they can consume in the present as well. Second there is the "incentive effect", which denotes the realization that people will resist future temptation only if they resist temptation now (and not resisting now makes resisting in the future more difficult due to reinforcement). Thus the pessimism effect tends to exacerbate overconsumption due to self-control problems, while the incentive effect mitigates overconsumption. Whether sophisticates consume more or less than naives depends on the relative strength of these two effects.

In the stationary environment the analysis leads to the counterintuitive result that sophisticates are more likely to start consumption of an addictive substance than naives. The logic for this result is that for the incentive effect to become operative there must be some future periods where the person refrains from consumption. Due to habit formation if a person decides to consume in period 1 when he did not consume before, he will also do so in all future periods (as it is never easier to refrain than when the person has never consumed before). If a person refrains in period 1 when not having consumed before he will also refrain in all future periods. The incentive effect becomes operative only when people want to make refraining easier but as in this case they refrain always or never, it does not matter. Thus the only effect that matters initially is the pessimism effect and this effect makes sophisticates more likely to hit. Hence, in a stationary environment, naiveté helps people to avoid harmful addictions.

In the more realistic non-stationary environment, however, this result is reversed. This is so, because here the incentive effect becomes operative in a wide range of circumstances. For example, people may know that in old age they will have a lower desire to consume. Even when pessimistic about their ability to refrain in the future, they know that refraining now, will make refraining later less painful and that due to lower desire refraining in old age is possible (the incentive effect). Therefore they are also less likely to start consuming an addictive product today.

Hence O'Donoghue and Rabin conclude, that in realistic environments, i.e. in a non-stationary environment in their model, self-control problems help explain severely harmful addictions only in conjunction with some degree of naiveté. The important point of their model is that self-control problems can make people more likely to start consuming an addictive substance and make some consume more. Thus different from the rational addiction model, there is room for welfare improvement in this model.

One point of support for the rational addiction model is that empirical studies have shown that the predictions from Becker and Murphy (1988) as to the effect of future prices on consumption are consistent with the evidence. Gruber and Köszegi (2001) show, however, that similar predictions arise from using a model that incorporates self-control problems. They adapt the rational addiction model to incorporate time-inconsistent preferences in the form of quasi-hyperbolic discounting. While yielding similar predictions as to the effect of future prices on consumption Gruber and Köszegi (2001) find radically different recommendations for government policy. The rational addiction model suggests that taxes on addictive bads should depend only on the externalities their use imposes on society, a model of addiction with time-inconsistent preferences suggests that much higher taxes could be justified on the basis of the "internalities" addictive bads inflict on their users.

In a related paper, Gruber and Köszegi (2004) analyze the incidence of excise taxes on addictive bads like smoking when people have time-inconsistent preferences. Tax incidence on "sin" goods like cigarettes and alcohol are criticized for being highly regressive, as low income groups spend a much higher share of their income on such goods than high income groups. Tax incidence is supposed to measure how much a certain group is "hurt" by a tax policy. The appropriate concept for this is utility. In the standard approach with time-consistent preferences, the utility effect of a price change is equal to the product of the price change, the quantity consumed and the marginal utility of wealth. Thus the utility loss of a person is proportional to the decrease in consumption. When people have self-control problems people do not necessarily reveal their preferences by their consumption actions. Hence a price induced decrease in consumption may actually increase an agent's utility. Gruber and Köszegi (2004) assess this effect of tax increases on utility when people are time-

inconsistent. They conclude that "sin" taxes are much less regressive or even progressive when the benefits of increased self-control from increased taxes are taken into account.

In summary, the theoretical literature that uses hyperbolic discounting in models of addiction successfully addresses the shortcomings of the rational addiction model. First of all they show that addictive behaviours may be due to self-control problems. This allows regarding drug consumption as a "problem" as this behaviour is not utility maximizing and is not in line with people's own preferences. Second, these models can provide policy prescriptions. Gruber and Köszegi (2004) explicitly state tax increases on addictive goods as a welfare enhancing policy intervention.

Given the dramatically different implications of a self-control view of addiction when compared to the rational addiction model, it is important to know which model is more appropriate. As both approaches give similar predictions as to the relationship between future prices and current consumption, novel approaches towards distinguishing these models are necessary.

Gruber and Mullainathan (2002) propose the following: while the effect of price increases on consumption is negative in both models, such price increases should decrease the utility of rational addicts, but increase the utility of addicts who consume due to self-control problems. They suggest the use of self-reported happiness as a direct measure of utility. They estimate the effect of a rise in cigarette excise taxes on subjectively reported well-being. As the smoking decision might be endogenous to excise taxes they cannot use smokers only for their analysis. Moreover state revenue from excise taxes might have been directly used for welfare increasing measures and any measured effect of excise taxes on well-being in general might also be misleading. Therefore their empirical strategy is to study the impact of excise taxes on predicted smokers versus the impact of excise taxes on people predicted not to smoke. Using data from the US and Canada they find that higher excise taxes make predicted smokers happier. This suggests that addicts are better off after a price increase. Thus the empirical study is consistent with a self-control model of addiction (or at least smoking), but not with the rational addiction model.

3.5. Contract Choice and Contract Design

If people generally suffer from behavioral biases like self-control problems a crucial question is how such biases affect the working of markets. Firms might, for example, provide the necessary products or services for people to overcome their self-control problems. Alternatively they might exploit consumer's self-control problems. The following papers explore how behavioural biases might explain the observed choice of people who can choose from a menu of contracts and how profit maximizing firms would react to self-control problems of consumers.

DellaVigna and Malmendier (2006) analyze how consumers choose from a menu of contracts of gym memberships and how their later actions relate to this choice. In their data consumers have the choice to pay per visit or to buy a monthly or yearly subscription to the gym. In the case of buying a subscription consumers have the right to use the gym as often as they want in the relevant interval. A monthly subscription is renewed automatically unless the member cancels, whereas a yearly subscription ends after a year. They identify several puzzling features of consumer behavior. Consumers choosing a monthly contract, for example, on average pay 70% more per visit than what they would have paid under the pay-per-visit option. Eighty percent of monthly members would have been better off under the pay-per-visit option given the actual number of visits to the gym. Another example is that people with a monthly contract are 18% more likely to stay enrolled for more than one year. This is surprising because the option to cancel monthly comes at a higher fee. They identify several other empirical regularities that are hard to reconcile with the predicted behavior of an agent with standard preferences. Then they explore several possible explanations for these empirical findings. Some of these explanations are extensions of the standard behavioral model like risk aversion or transaction costs. Others are non-standard models like models of limited memory, time variation in preferences or time-inconsistent preferences. Most models can explain some features of behavior. The only model that can explain all the empirical findings, however, is the one with time-inconsistent agents, who are partially naive. These agents overestimate their future gym attendance and procrastinate on the cancelation of their monthly subscriptions as the cancelation act comes at a small effort cost. If self-control

problems and naivete are the correct explanation one should observe a positive correlation between the overestimation of attendance and procrastination of cancelling. The data reveal a significant positive correlation between paying a high price per attendance and displaying a longer gap between last attendance and termination for users with a monthly contract.

Shui and Ausubel (2005) analyze a similar situation. They have a dataset of credit card solicitations and credit card accounts. Thus they observe how people choose a credit card contract from a menu of contracts and how they subsequently make use of their credit cards. Specifically, consumers had the choice between an introductory offer with a lower interest rate and a shorter duration versus a higher interest rate and a longer duration. More consumers chose the lower interest rate with shorter duration than the higher interest rate with longer duration. This is puzzling because, *ex post*, the offer with higher interest rate and longer duration was better given the actual consumption of credit that occurred. Again self-control problems and naiveté seem to be able to explain this puzzle. Time consistent consumers would always choose the offer that minimizes their overall interest-payments. Hyperbolic consumers, however, can exhibit the behavior described above. Sophisticated consumers may choose a shorter introductory period with low rates in order to commit themselves not to borrow too much in the future. Naïve consumers may choose the shorter introductory period with lower rates because they underestimate their own likelihood to borrow in the future.

If consumers systematically exhibit self-control problems, profit maximizing firms should adopt their products to such a behavior. DellaVigna and Malmendier (2004) analyze how profit maximizing firms react to consumers with self-control problems. They derive the optimal contract design that results from this interaction and compare it to the actual contract design in a number of industries. Two types of goods are considered. Investment goods have current costs and future benefits. Examples are health club attendance (current effort costs, future health benefits) or dieting. Leisure goods have current benefits and future costs like for example credit card financed consumption. They also make the standard distinction between sophisticated and (partially) naïve people.

In a two-period model where firms choose a two-part tariff they show that firms always price below marginal cost if consumers have time-inconsistent preferences. This is true for a monopolistic as well as a competitive market structure and holds for sophisticated as well as for naive consumers. The intuition for this result is straightforward. Sophisticated individuals ask for commitment devices in order to increase their consumption of the investment good. The firm supplies such a device in the form of low per-usage prices. Naive consumer overestimate their future self-control and therefore tend to consume too little of the investment good now. Firms offer a discount on per usage prices (and a higher flat fee) and as hyperbolic consumers give special weight to this immediate discount they consume more than they otherwise would.

For leisure goods the opposite result holds. Sophisticated consumers demand commitment devices to limit usage while naives underestimate their future consumption of the leisure good. Thus firms price above marginal cost for both types of consumers and an analogous intuition as in the investment good case can be applied to this result. This contractual design has different welfare implications for sophisticates and naives. By pricing above or below marginal cost firms provide commitment devices to sophisticated consumers. Thereby sophisticates consume the efficient amount and thus self-control problems have no welfare effects on sophisticated consumers. By contrast, naive agents are exploited by the above contractual design. Firms exploit naives misperception of their own future behavior.

In an extension of their model it is also found that in the case of naive consumers firms have an incentive to introduce switching costs (like transaction costs for canceling a subscription) and a back-loaded fee structure.

The paper finds that a range of industries displays contractual designs that are consistent with the theoretical findings. Examples are both the health club industry and the credit card industry described above.

The literature on contract choice indicates that the market mechanism does not provide working solutions to people's self-control problem. To the opposite, in the likely case that people are at least somewhat naive, profit maximizing firms have an incentive to exploit this

weakness. Even if people are offered a choice of contracts many seem to choose those that are ex-post unfavourable to them.

4. Concluding Remarks

Hyperbolic discounting has been successfully employed to model self-control problems in the literature. This literature has produced many novel, interesting and intuitively appealing results. First of all, hyperbolic discounting has been shown to be a useful theoretical basis to explain behaviours like procrastination of unpleasant tasks, which are a defining feature of self-control problems. The models of procrastination emphasise the importance of the level of awareness for the effects that self-control problems can have but they also show that already low levels of self-control problems and low levels of naiveté can cause severe welfare loss, in particular because procrastination is more likely to occur at important tasks. A model of the origination of personal rules or internal commitment devices against self-control problems provides some conditions for when such internal solutions are likely to develop and when external commitment devices are appropriate.

The application of the theory of self-control problems to certain fields has given rise to a number of explanations and results that were not possible when using “standard” theories. In particular it has enabled the conceptualization of certain “problems” that could not be conceived as such in the standard framework. In the savings literature, for example, the self-control literature has provided a scenario of too little saving and too much credit card borrowing and thereby addresses a practical concern of people and policy makers. This literature can also provide explanations for apparent paradoxa in the consumption literature like the reconciliation of long-term low interest savings with short term high-interest credit card debt, or the drop of consumption at retirement. Likewise the self-control literature on addiction provides a concept of the “problem” of addiction. While the rational addiction model regards the consumption of addictive substances as utility maximizing actions, a model of addiction that incorporates self-control gives rise to the possibility that people consume drugs against their better judgement. This “problem” in drug consumption also gives rise to

welfare improving policy interventions and the literature provides a new rationale for the taxation or prohibition of certain substances.

The analysis of firm's reactions to consumer self-control problems shows that while firms might be able to provide commitment devices to sophisticated consumers, they also might have an incentive to exploit naïve consumers. As it is likely that most people are at least partially naïve, it is likely that this incentive is a widespread form of market failure that causes a welfare loss. The range of products and industries for which self-control problems might play a role suggest that this welfare loss can be considerable.

The empirical literature is as of yet scarce but generally supportive of the developed theories and intuition about self-control problems. Simulation models using hyperbolic discounting have shown that the incorporation of self-control problems can provide better approximations to observed wealth data in the US. Using direct measures or proxies for self-control problems there is some evidence that self-control problems do impede savings in liquid form and do lead to higher credit card debt. One paper also supports a theory of addiction incorporating self-control problems over the rational addiction model in the domain of smoking, using self-reported happiness data. Indirect evidence from default behavior and on the demand and effect of products with a commitment property also allow conclusions on the effect of self-control problems. Finally, observed contract choice in gyms and for credit cards are consistent with a self-control model.

My thesis is an attempt to add to the empirical literature. In methodology and substance it is closest to the papers by Ameriks et al. (2003, 2007) and Bertaut and Haliassos (2002). I use a proxy variable as measure for self-control problems and directly assess the correlations of this proxy with the outcomes of interest. Compared to the papers by Ameriks et al. (2003, 2007) the potential benefit of my analysis is to bring evidence from a broader and more representative dataset to the same questions. This also allows me to control for a more comprehensive set of individual characteristics. The data I use are from a different institutional setting and country, thus possibly allowing conclusions on how robust the observed effects in the literature are. While I have to make a stronger effort to justify the

proxy I use, this proxy also has some potential benefits as discussed in chapter 2. Compared to Bertaut and Haliassos (2002) I cannot make use of a theoretical model for identification. Therefore I have to address the potential problems that arise from the use of the proxy variable for the identification of an effect of self-control problems.

Chapter 2: Measuring Self-Control Problems

1. Introduction

The central challenge in an empirical investigation of the effect of self-control problems on different outcomes is to have a valid measure of self-control problems. As self-control problems cannot be observed they have to be inferred on indirectly. This is not unusual in the social sciences but relatively little research has been done into the measurement of self-control problems as of yet. Therefore the concepts used to define self-control problems and the methods used to measure them differ considerably and any measure will be controversial.

The most basic definition of self-control problems is, in my opinion, the inability of a person to align his actions with his intentions. While actions can sometimes be observed, intentions have to be asked about or assumed. The interplay between assumed or inferred intentions and possibly observable actions yields a measure of self-control problems. As will be seen below, any measure can be criticized with regard to the way the intentions were inferred on or even whether theses intentions are meaningful. Certainly this is also true for the measure I use.

The chapter is organized as follows: In section 2 I review how self-control problems have been measured in the existing empirical literature. In Section 3 I motivate the use of smoking as an indicator for self-control problems and present evidence and arguments in favor of this choice. Section 4 concludes.

2. Empirical Strategies in the Literature

There are two broad strategies of measuring self-control problems in the literature. First, in structural models the estimation of the corresponding model parameter can be regarded a way of measuring self-control problems. In models that employ hyperbolic discounting, the relevant parameter would be the short term discount factor β . Naturally such a parameter estimate is of limited use when stepping outside of the specific model used. Below I will describe one such structural model in more detail. The second strategy is to either design experiments that explicitly aim to reveal the level of a person's self-control or to look for

behavior that resembles such experiments in available data. This strategy has the potential to yield measures that are independent of any specific model used. The measures obtained in such a way are subject to other limitations, however.

2.1. Structural Models

Quasi-hyperbolic time discounting has been successfully employed in modeling phenomena that are intuitive examples of self-control problems such as procrastination or under-saving. Data on such phenomena can thus be used to estimate parameters in the model that is employed to explain them. The paper by Laibson et al. (2005) is an example of this approach. It employs the framework of the hyperbolic consumption model to obtain an estimate of the parameter β that governs self-control problems in quasi-hyperbolic discounting. Specifically the authors first calibrate a life-cycle consumption model taking a number of factors into account that affect intertemporal choices like labor income, liquidity constraints, or household size. In a second step, using the Method of Simulated Moments, they estimate the time preference parameters of the quasi-hyperbolic discounting model by minimizing the distance between the simulated moments and empirical moments of credit card borrowing, wealth accumulation and the excess sensitivity of consumption to predictable income. For their main case they find a short run discount rate of around 40% and a long term discount rate of around 4.3% and reject the null-hypothesis of no presence of self-control problems, that is they reject the hypothesis that the short term discount rate is equal to 0, or equivalently that $\beta = 1$.

Naturally - and as the authors acknowledge - such a structural estimation procedure relies on a large set of explicit and implicit assumptions. Moreover, the estimates of the model parameters are sensitive to other parameters set in the model. Thus in one "extreme" case the authors obtain an instantaneous short term discount rate of 101%, while in another "extreme" case the short term discount rate is only 15%.

Other authors, who also use structural estimation of quasi-hyperbolic discounting models, obtain a similarly wide range of estimates. In Paserman (2004) the estimates of the short-

term discount rate range from 11% to 91% and the estimate for the long-term discount rate is only 0.1%. Fang and Silverman (2004) find a short-term discount rate of 108%, and Shui and Ausubel (2005) obtain short-term discount rates of 20% and 24%.

Thus structural parameter estimates clearly have the advantage of having an unambiguous interpretation within the hyperbolic discounting model. Their magnitude seems to be largely dependent on the modelling choices made, however. Moreover, the parameter estimates from the quasi-hyperbolic discounting model are based on a representative agent assumption. This does not permit to investigate if and how individual differences in self-control might affect individual outcomes. Finally it is unclear how such parameter estimates might translate into measures of self-control outside a quasi-hyperbolic discounting model.

2.2. The “time versus money” approach

The “time versus money” approach asks individuals how much money they would have to be paid at various future points in time instead of a certain amount that would be paid to them immediately (Thaler and Shefrin (1981)). It is usually found that the implied discount rate from that experiment is much larger in the short term than in the long term. This is taken as evidence of the existence of self-control problems in the form of overweighting of the present. The extent of overweighting can then be regarded a measure of the extent of self-control problems of a particular individual.

Frederick et al. (2002) provide a detailed critique of this approach. One critique is that such an experiment has no allocative significance, as receiving a reward immediately does not mean that the individual also spends the same amount immediately. When expressing the preference for the lower but immediate reward, people may also take account of the uncertainty and inconvenience of any future reward. Individuals may also anticipate a higher baseline income or wealth in the future and thus attach a higher utility to money now than in the future. All these problems potentially lead to an exaggeration of the overweighting of the present in this measure.

2.3. Delay of Gratification and Intention Reality Gap

Mischel et al. (1992) measure the degree of self-control by the ability to delay consumption or gratification. Four year old children were asked whether they preferred one cookie or two cookies. All of them stated a preference for two cookies. Then these children were given the choice of having one cookie immediately or to wait for 20 minutes until the experimenter's return and obtain two cookies. The children also had the option to call the experimenter prematurely to obtain their 2 cookies. Whether or not a child waited until the return of the experimenter, and, if it did not wait the whole 20 minutes, how long a child managed to wait until it called the experimenter into the room, is used as measure of self-control.

The first finding of this experiment was that there is considerable variation in the ability to delay gratification in children. Moreover these variations also seem to have important consequences: in a follow up study, the authors asked the parents of these children to characterize the level of self-control of their children according to the following two questions:

1. *How likely is your child to exhibit self-control in frustrating situations?*
2. *How likely is your child to yield to temptation?*

The parents were also asked to provide their children's SAT scores. The ability to delay gratification at age 4 was statistically significantly correlated to both the parent's later assessment of their children's self-control and SAT scores.

The authors also found, however, that the ability to delay gratification was strongly influenced by the experimental environment, specifically the exposure to the rewards, the direction of attention to the rewards and the availability of distractions during the waiting time. The direction of attention and the exposure to the rewards reduced the average waiting time and available distractions increased the average waiting time. Hence while such an experiment allows isolating a specific behavior that is supposed to measure self-control, the results seem to be quite sensitive to the experimental set-up. Moreover, the experiment might not reflect realistic real-life scenarios. Whether a child obtains two cookies or one may

not be comparable to situations where the stakes are high as, for example, in the decision whether to accept a lower wage immediately or whether to invest additional years in education for a higher wage later. Where self-control is particularly important, an individual can be expected to make a bigger effort at self-control, however. Specifically, measuring the delay of gratification at age 4 may not give adequate weight to the factor of awareness of one's self-control problems, which can be expected to develop as a person grows up. Therefore, even a measure resulting from a purpose-built experiment has to be regarded with caution.

Another experimental approach is employed by Ameriks et al. (2004, 2007). They make use of the idea that self-control problems should induce a gap between how people intend to behave and how they really behave. To this end they collected data from a *thought* experiment administered to participants in a custom designed survey. The participants were asked how they would ideally allocate a number of free restaurant visits over a period of 2 years. Then, after making their ideal allocation, the participants were asked which allocation they expect to follow in reality. Specifically they were asked whether they would be "tempted" to use up their restaurant visits sooner or later than intended. The deviation of the imagined *realized* allocation from the imagined *ideal* allocation is then used to construct a measure of self-control problems.

Specifically the measure is an intention-reality gap computed as the difference between the expected realized number of restaurant visits in the first year (expectation E) and the ideal number of restaurant visits in the first year (ideal I), or $E-I$ gap. When the expected allocation is the same as the ideal allocation, the $E-I$ gap is 0. If the expected allocation of restaurant visits in the first year is higher than the ideal allocation, people are impatient and consume more in the first year than ideal and the $E-I$ gap is positive. If people consume less in the first year than according to their ideal allocation the $E-I$ gap is negative.

Around 70% of their sample reported an $E-I$ gap of 0. Surprisingly, a larger proportion of people reported a negative $E-I$ gap than a positive one. This might suggest that under-consumption is a more prevalent problem than over-consumption in their sample.

Interestingly, the authors regard any deviation from the ideal, positive or negative, as an incident of self-control problems.

The flexibility of this measure can be regarded an advantage. The measure does not impose in which direction the deviation of actions from intentions occurs. That is, people can "err" in both directions: using up their free restaurant visits earlier or later than intended. An obvious critique of this method is that it relies on a thought experiment instead of real behavior. Thus it is not only subject to the criticism that the experimental set-up may influence people's (imagined) behavior and that it is not representative of important real-life situations, but additionally that it relies entirely on a person's self-assessment. People may have different degrees of awareness of their self-control problems, however, or they may simply differ in their honesty towards themselves or the survey administrator. This may be reflected in the way they describe their deviation from the intended allocation.

2.4. Information on everyday behavior

An alternative to experiments is to look at behavioral patterns from people's everyday lives that might indirectly reveal a low level of self-control. DellaVigna and Paserman (2005) use behavior that reveals a preference for early gratification, noting that "relatively impatient individuals frequently engage in activities characterized by immediate rewards and delayed costs. Conversely, patient individuals are likely to take on activities with immediate costs and delayed benefits." They identify the following behavior in their data that can be characterized in such a way:

- cooperation in the interview: hostile or uncooperative respondents reveal a dislike for the immediate burden of the interview.
- Having a bankaccount: patient individuals are more inclined to save and thus are more likely to have a bankaccount.
- Use of contraceptives: the more patient an individual is, the higher the value of avoiding a sexually transmitted disease or undesired pregnancy.
- Having a life insurance: indicates a taste for the long run.

- Smoking and heavy drinking: both activities are pleasurable at the time of consumption but detrimental to health afterward.
- Vocational clubs in high school: pursuing such activities shows forward-looking behavior and thus indicates patience.

The authors use these measures to test predictions from a job search model. The predictions on the effect of impatience on the exit rate from unemployment differ for the model with standard exponential discounting and the model with hyperbolic discounting. The pattern of correlations they find in their data is consistent with hyperbolic but not with standard discounting. Thus they conclude that their measures most likely grasp short term impatience (self-control problems) rather than standard long-term discounting.

Similarly, Bertaut and Haliassos (2002) use smoking as an indicator of self-control problems in an analysis of credit card use. The pattern of correlations they observe in their data is consistent with their model of self-control problems in credit card use.

I follow this approach and use smoking as a measure of self-control problems. An initial justification for the use of smoking is the one of DellaVigna and Paserman (2005) noted above, that smoking involves immediate pleasures but future costs. Compared to the experimental measures discussed above the use of smoking as an indicator of self-control problems has some advantages: first, it utilizes information on people's real life (or the recollection thereof) and thus is not subject to potential influences from the experimental setup. It also does not rely on pure imagination as is the case of the measure of Ameriks et al. (2004). Second, it can be plausibly assumed that people know that they potentially do severe damage to their health when smoking. Therefore the stakes in the smoking decision are high. Third, smoking involves a gain in utility now and a potential loss in utility in the future. Thus it avoids the problem of allocative significance as is the case of the "time versus money" approach. Compared to the parameter estimates from structural models, using a simple smoking indicator has the advantage of not relying on one theory of self-control (e.g. hyperbolic discounting) and it does not rely on a large set of model assumptions.

Nevertheless, using smoking as an indicator for self-control problems is far from ideal. Without guidance from a specific theory it has to be argued that smoking really does grasp

self-control problems. Even if it can be established that it does, most likely, smoking has causes and correlates other than self-control problems. Thus it is difficult to distinguish whether self-control problems or other factors drive a correlation between smoking and an outcome of interest. The following section discusses these and other issues.

3. Smoking as Measure of Self-Control Problems

For smoking to be a suitable measure, it has to be shown that, when smoking, people exhibit many of those characteristics that define self-control problems. These are preference reversals, the deviation of actions from intentions and the use of commitment devices. It is the ability to explain such phenomena that lends credibility to existing theories of self-control like hyperbolic discounting. Likewise the ability to represent such phenomena would lend credibility to an indicator of self-control problems. In this section I present and discuss evidence on the link between smoking and self-control problems.

3.1. Gap between intentions and actions

The struggle to quit smoking is a well documented case of a gap between intentions and actions. Many smokers express a strong and, given the health benefits to be expected, credible desire to quit but are unable or have great difficulties to enact this desire. Schelling (1984) provides an impressive description of the dimension of this struggle:

There are thirty-five million Americans who have quit smoking. Most of them had to make at least three serious tries in order to quit. Of those thirty-five million, about five million are in danger of relapse, and two million will resume smoking and regret it. Most of those will try again, and three quarter will fail on the next try. There are fifty-five million cigarette smokers, among whom some forty or forty-five million have tried to quit; nearly half have already tried three times or more, and some twenty million of those cigarette smokers made a serious try, and failed, within the past year. More than half of all young smokers, of both sexes, tried to quit within the past year and failed. A third of all young smokers have unsuccessfully tried three times or more. They know that smoking is dangerous, and we know that it is worth some years of their life expectancy. ...

Burns (1992) reports that eight of ten smokers in the USA report a desire to quit their habit. Khwaja et al. (2006) report evidence from a recent survey on smoking administered in 2004 and 2005 to people aged 50 to 70 in 3 US cities. In that survey 85% of current smokers had tried to quit smoking in the past, and 76% of current smokers expressed the desire to quit at the time of the interview. Those who had tried to quit did so on average on 1.7 occasions for more than one month. Out of former smokers the average number of quit attempts for more than a month was 2. They also report that current smokers most likely systematically underestimate their likelihood to quit. The mean subjective probability to have quit smoking within 2 years was 41%. The objective quit rate, which Khwaja et al. (2006) computed from the Household Retirement Study, is 16%. Gruber and Köszegi (2004) provide another example of this inability to enact the stated desire or expectation to quit. They cite evidence from the U.S. Department of Health and Human Services that shows that young smokers systematically underestimate their future likelihood of smoking. Among high school seniors who smoked, 56% said that they would not be smoking 5 years later. However, only 31% of them had in fact quit 5 years later.

This evidence suggests that a majority of current smokers have the desire to quit but are unable to do so. It also shows that those who did quit needed several attempts and those who intend to quit will with large probability not carry out their intention as quickly as desired or not at all. Thus it appears that the majority of smokers have severe difficulties aligning their actions with their intentions in a domain that should be of considerable importance to them, namely their health.

3.2. Commitment Devices against Smoking

Another set of evidence pertains to the existence of commitment devices. Examples abound of commitment devices that are offered to and invented by smokers to help them quit or limit smoking. The range of available commitment devices reaches from simple books of advice on how to quit smoking, to pharmacological products like nicotine plasters, to self-help groups, paid assistance or even rehabilitation centers. If smokers did not have problems to enact their

desire to quit, there is no explanation for the existence of such commitment devices. Smokers also employ a large range of individual commitment devices to limit or avoid smoking, for example buying individual packs rather than cartons of cigarettes. Khwaja et al. (2006) report that 81% of current smokers have used some sort of self-control device to limit smoking. Hersch (2005) finds that smokers who try to quit are more supportive of smoking restrictions through regulations than other smokers and that smokers who have tried to quit before are more supportive of restrictions than smokers who try to quit the first time. This indicates that many smokers support restrictions in order to use these as a self-control device.

Gruber and Köszegi (2004) make a more subtle distinction between commitment devices and quitting aids. Quitting aids, like nicotine plasters, reduce the disutility from smoking cessation and make sense even for people who do not have difficulties to align their actions with their intentions. Commitment devices instead decrease the utility of an undesired alternative, here smoking. For people who do not suffer from self-control problems to decrease the utility of an undesired alternative (here smoking) is irrelevant for decision making as this alternative would never be enacted. For people with self-control problems, however, who are aware of them and who want to force themselves to quit smoking such commitment devices are valuable. One example of such a commitment device is side-betting. People bet with others that they will not smoke after a certain point in time, for example. When they are still found smoking after that point in time their utility is diminished by the embarrassment or the money value of their lost bet thereby reducing the utility from smoking.

Altogether this evidence suggests that smoking is a strong example of an action against one's own better judgment or, at least, expressed will. Thus at least for a large part of smokers it can be said that they suffer from self-control problems defined as the inability to align actions and intentions.

However, smoking is widely regarded to be an addictive behavior. Rational addiction theory raises the possibility that people engage in smoking fully rationally and thus there may not be room for self-control problems in the explanation of smoking.

3.3. Rational Addiction vs Self-Control Problems

Theory

Smoking and other addictive habits are generally regarded as self-destructive. Therefore they are puzzling from the viewpoint of utility maximizing behavior. One solution to this puzzle is that self-control problems cause people to smoke. People might engage in addictive behavior fully rationally, however, and thus there might be no role for self-control problems. As discussed in the literature review the cornerstone of the rational addiction literature is Becker's and Murphy's model (Becker and Murphy (1988)). In Becker's and Murphy's model agents consume addictive goods only if the perceived trade-off between current and future utility is favorable and thus they always follow the utility maximizing path. Given that addicts are always on their utility maximizing path this model does not leave any room for policy interventions. There has been considerable research in psychology and economics that calls the validity of the rational addiction model into doubt, however. This literature has developed models of addiction based on hyperbolic discounting and other approaches towards modeling self-control problems. These models depart from full rationality in the sense of allowing for time inconsistent decisions by agents and they avoid some of the problems that are associated with the rational addiction model. For a confrontation of the rational addiction model of Becker and Murphy with the one based on hyperbolic discounting by George Ainslie (1992a) see Skog (1999).

According to Skog, there are two important phenomena rational addiction theory cannot explain: the struggle to quit an addiction and the relapse into addiction after a period of non-consumption. In a Becker-Murphy world one should never observe people who have doubts about their addictive habits. A Becker-Murphy addict always follows his utility maximizing path and is aware of that. Such an agent also either continues to consume or quits consumption, thus one should never observe a former addict who for some reason managed to quit but later relapses into consumption. Both of these predictions, the absence of struggle and relapse, do not match the perceived evidence. Maybe the most fundamental criticism of the rational addiction model is that it simply assumes "the problem" of addiction away. If addicts always behave in a way as to maximize their own discounted lifetime utility, society

should not be concerned about their well-being. Thereby rational addiction theory is clearly at odds with health care professionals, health policy makers and probably with anybody else who has ever been a witness or a victim of addiction as well.

Economists increasingly recognize these shortcomings of rational addiction theory and have proposed alternative theories that allow for time-inconsistent decision making or self-control problems. As reviewed in chapter 1, one strand of the literature builds on hyperbolic discounting to model interpersonal struggle, relapse and harmfulness of addiction (O'Donoghue and Rabin (1999b, 2002), Gruber and Köszegi (2001, 2004)). Bernheim and Rangel (2004) model interpersonal struggle with two different states of the brain. Gul and Pesendorfer (2004) build a theory of addiction with time-consistent preferences that include the presence of temptations which have to be overcome with self-control.

Clearly there exists a lively debate on how to model addiction and which conclusions can be drawn from these models. It seems uncontroversial, however, that self-control problems in the widest sense do play a role in addiction. O'Donoghue and Rabin (2002) conclude:

Whether it be the unpleasantness of failed attempts to quit or the more fundamental problem of over-consumption, we share many non-economists conjecture that self-control problems are a major facet of cigarette, alcohol, and other forms of addiction.

Empirical Evidence

In addition to these qualitative arguments there exists some quantitative evidence. Gruber and Mullainathan (2002) present empirical evidence that supports a self-control theory over a rational addiction theory specifically in the domain of smoking. As shown by Gruber and Köszegi (2001) the discounted utility of a sophisticated hyperbolic discounter can rise with an increase in prices for cigarettes. This is not possible in the rational addiction model where a price rise always leads to lower utility. Gruber and Mullainathan (2002) use this difference of predictions to distinguish between the competing theories of addiction.

Specifically, they use people's self-reported happiness as a measure of utility and test the above mentioned descriptions by analyzing how changes in cigarette excise taxes affect self-reported happiness. This approach faces some problems. Tax revenue from excise taxes might be used for generally welfare improving policies, for example, thus making it difficult to identify the cause of a potential increase in welfare. Moreover, as only around a third of their sample smokes, an effect on smokers could be hidden in the whole sample.

In order to address these problems Gruber and Mullainathan exploit the fact that changes in excise taxes should only affect smokers and former smokers. Thus they study the differential impact that changes in excise taxes should have on smokers compared to non-smokers. Still they cannot use data on smokers directly as the smoking decision is endogenous to tax rates and the happiness effect should operate through current and former smokers. Therefore they compare the impact of changes in excise taxation on predicted smokers, using a large set of variables to predict smoking.

For two data sets, one from the U.S. and one from Canada, they find that higher excise taxes make predicted smokers happier. More precisely they find that higher excise taxes decrease the probability that predicted smokers report to be "unhappy". This finding is consistent with the model of addiction that features agents with self-control problems but it is not consistent with the rational addiction model. Thus it lends empirical support to self-control theories of addiction and specifically to the notion that self-control problems play an important role in smoking.

The findings of Hersch (2005) allow a similar conclusion. In the rational addiction model any restrictions that limit the freedom of smokers should reduce their welfare if smokers are fully rational. If smokers suffer from self-control problems, however, smoking restrictions might constitute a welcome commitment device. Hersch (2005) finds that support for smoking restrictions has increased not only among non-smokers but also among smokers in the period of 1992 to 2002. Moreover, she finds that smokers who try to quit are more supportive of smoking restrictions than other smokers and that smokers who have tried to quit before and try again are more supportive of restrictions than smokers who try to quit the first time.

These results indicate that smokers, or at least a subset of smokers, welcome smoking restrictions, which is at odds with the rational addiction model.

3.4. Other empirical studies

Two other empirical studies lend support to smoking as a measure of self-control problems: Heckman et al (2006) find that non-cognitive skills affect the likelihood of adolescent smoking, which is defined as smoking daily by age 18. Among other traits, the measure of non-cognitive skills they use is meant to grasp the "degree of control" people feel in their lives. The "degree of control" is described as comprising factors like "self-control, time preference or sociability".

Psychologists Malouff et al. (2006) find that smokers on average have lower levels of a character trait called "conscientiousness". The meta analysis is based on 9 studies and a total of 4730 participants. Conscientiousness is regarded as one of the 5 broad personality traits in a taxonomy that the psychology field seems to agree on. The other traits are extraversion, agreeableness, neuroticism and openness. The Handbook of Personality gives a more detailed description of conscientiousness (John (1999)).

Conscientiousness describes socially prescribed impulse control that facilitates task- and goal-directed behaviors, such as thinking before acting, delaying gratification, following norms and rules, and planning, organizing, and prioritizing tasks.

Clearly self-control, if anything, is a character trait that belongs to conscientiousness. "Thinking before acting" and "delaying gratification" can even be regarded a definition of self-control. Moreover Ameriks et al. (2004) explicitly investigated whether their measures of self-control problems were related to conscientiousness. People were given two questions intended to measure conscientiousness: 1. "Sometimes I am not as dependable or reliable as I should be". 2. "I never seem able to get organized". Those who agreed with these statements had higher levels of self-control problems according to their measure than those who disagreed. The finding that smokers have low levels of conscientiousness thus also suggests that smokers have higher levels of self-control problems.

3.5. Conclusions

Three sets of arguments support a relationship between smoking and self-control problems. First, when people smoke they exhibit the characteristics that define self-control problems: they seem to be unable or have great difficulty to align their actions with their intentions and take recourse to commitment devices. Second, testing predictions from the rational addiction model against those from a self-control model of addiction on the basis of smoking data gives support to the self-control model. Both sets of evidence allow the conclusion that at least a substantial part of people who smoke suffer from self-control problems.

This evidence does not allow the conclusion that people who have never smoked, suffer less from self-control problems. It may be that never-smokers have just as much self-control problems as smokers, but were lucky enough not to start smoking in the first place. For smoking to indicate a higher level of self-control problems relative to persons who have never smoked one would have to assume that on average people with higher self-control problems are more likely to take up smoking when tempted to do so. The theoretical findings of O'Donoghue and Rabin (1999, 2002) seem to support this notion and the two empirical studies by Heckman et al. (2006) and Malouff et al. (2006) support the idea that smoking indicates a higher level of self-control problems relative to non-smokers in general.

Altogether the above points indicate that smokers on average have higher levels of self-control problems when compared to non-smokers. The only argument in favor of fully rational, time-consistent smoking is theoretical in nature. While there are many casual observations, behavioral patterns and experiences and even some pieces of empirical evidence that support a role of self-control problems in smoking, there is no evidence at all that supports the rational addiction model while contradicting a model of smoking based on self-control problems⁵. This seems to be more generally true. Referring to time-inconsistent preferences that result from quasi-hyperbolic discounting, Gruber and Köszegi (2004) write: *"there is no evidence, psychological or other, that supports time-consistent preferences over these time-inconsistent ones in any domain."*

⁵ Both models, the rational addiction model and an addiction model based on hyperbolic discounting predict that current smokers react to future price changes, a prediction that is consistent with the evidence. (Becker, Grossman, Murphy (1991)).

4. Alternative interpretations of smoking

Smoking will be used as a proxy for self-control problems in the following chapters. While the above discussed evidence supports the idea that smoking does grasp self-control problems, smoking is also correlated with other characteristics and it might have other causal influences that are important for the analysis to follow. Important characteristics like education and wages can be controlled for. Other, potentially causal influences on smoking are inherently unobservable, however. Here I discuss two potential rival interpretations of smoking that are discussed in the literature: learning ability and (pure) time-discounting. The first paper I discuss asks whether smoking grasps learning ability or time-preference and concludes that it is likely to grasp time-preference. The second paper asks whether smoking rather grasps time-preference of the exponential discounting type or time preference of the hyperbolic discounting type. In other words, it asks whether smoking rather grasps time-consistent discounting or rather grasps time-preference allowing for self-control problems. The third paper asks whether the time-preference exhibited in smoking can be explained by the concept of time-discounting at all, or whether more general measures of time-preference including self-control are more appropriate.

Munasinghe and Sicherman (2005) observe the strong correlation between wages and smoking status. They note that smoking status can be a proxy for two sources of unobserved heterogeneity that might explain this correlation, learning ability and time-preference. People with higher learning ability will be more likely to know and appreciate the detrimental effects of smoking and thus will be less likely to smoke. They will also invest more in their education and job skills and thus will have higher wages and a higher wage growth rate. People with a low discount rate will also be less likely to smoke (as they weigh their future health strongly) and will also be willing to invest more in education and job skills now in return for higher wages in the future and thus higher wage growth rates.

In order to discriminate between both potential explanations they derive a theoretical result with the following intuitive interpretation. They first show that the correlation between the level of the first wage and the wage growth rate is generally negative. If smoking is a proxy

for low learning ability then for smokers this correlation should be less negative, as low learning ability leads to lower first wages and to lower growth rates. If smoking is a proxy for high discount rates, however, then for smokers this correlation should be more negative, as high discount rates lead to relatively higher first wages and lower growth rates. Thus by looking at the sign of the interaction between smoking and first wage in a regression on wage growth rates they can discriminate between both concepts. They find that for smokers the correlation between first wage and wage growth rate is more negative, thus supporting the idea that smoking status measures differences in time-preference rather than differences in learning ability.

If smoking status is a measure of time-preference, it may still grasp different unobservable features of time-preference. Time-discounting is the dominant analytical paradigm for time-preference in economics, even though there is little evidence that it is empirically relevant (Frederick et al. (2002)). DellaVigna and Paserman (2004) indirectly test for whether smoking status measures time-consistent discounting or rather self-control problems as modelled by quasi-hyperbolic discounting. Their theoretical model shows that if impatience (time-preference) is of the time-consistent discounting type one should observe a positive correlation between impatience and the exit rate from unemployment. If impatience is better modelled with quasi-hyperbolic discounting, however, one should observe a negative correlation between impatience and the exit rate. One of their measures of impatience is smoking. In their empirical test they find that smokers are less likely to exit unemployment. This result supports the notion that smoking is a measure of the variant of time-discounting used to model self-control problems, rather than time-consistent discounting.

Khwaja et al. (2006) call into doubt whether time-discounting is a model that can grasp the time-preference dimension in smoking at all. They elicit discount rates from committed choice experiments in the financial and health domains. They do so both for standard exponential discounting as well as for quasi-hyperbolic discounting. In the financial domain, for example, they were asking questions like: "Would you rather win \$x now, or \$y in a year?" Questions like these possibly allow them to distinguish between people with high and low discount rates. Surprisingly they found that time-discount rates are not related to smoking

status at all. Instead, more general measures of time-preference, like impulsivity and financial planning horizon were related to smoking status, where they think that financial planning horizon *“should capture longevity expectations, but also other factors such as planning ability and more general problems of self-control”*. They construct an index of impulsivity from the degree of agreement to a number of statements like: “I act on impulse” or “I make hasty decisions”. For financial planning horizon participants were asked: *“In planning your saving and spending, which of the following time periods is most important to you and your household?”* Possible answers ranged from “the next few months” to “more than 10 years”. They find that current smokers have statistically significantly higher levels of impulsivity and shorter planning horizons. Thus the authors conclude that *“rather than identifying smoking simply with higher rates of time discount or more present-biased time discounting, our results indicate that smoking may be a marker for greater problems of self-control that emerge through other channels.”*

In summary, this literature suggests that first, smoking is more likely to grasp time-preference than learning ability. Second, if time-preference is to be modelled with time-discounting, it appears to be time-discounting of the quasi-hyperbolic form, which is used to model self-control problems. And third, other features of time-preference that are more directly related to self-control like impulsivity and the ability or willingness to plan, are significantly correlated with smoking, while time-discounting of any kind does not seem to be correlated with smoking. Thus the literature supports smoking as a measure of self-control even in competition with the equally unobservable characteristics learning ability and standard time-discounting.

5. Concluding Remarks

This section has reviewed the literature on the measurement of self-control problems in economics and has presented arguments and evidence for the use of smoking as an indicator of self-control problems. It has presented evidence that smokers exhibit two defining characteristics of people who suffer from self-control problems: the difficulty or inability to enact a credible desire to quit and the use of commitment devices to limit or avoid smoking.

The current theoretical literature on addictive behavior like smoking also lends support to a role of self-control problems in such behavior. Moreover, one empirical study finds evidence that is consistent with a model of addiction allowing for self-control problems but inconsistent with a model of rational addiction. Finally there are empirical studies that show a correlation between smoking and non-cognitive skills, the definition of which include self-control problems, and between smoking and measures of impulsivity and planning activity.

Smoking might also grasp unobservable characteristics other than self-control problems, however. Two such unobservable characteristics that played a role in the literature are learning ability and time-discounting, in particular standard exponential time-discounting. These will also be important in the chapters to follow. Three empirical studies seem to support a self-control interpretation of smoking over these two alternative interpretations. This lends further support to the use of smoking as an indicator of self-control problems.

Thus the evidence and literature that is reviewed in this chapter indicate that smoking does grasp self-control problems. It certainly does not prove this, however. In particular it is clear that a large number of other factors may potentially be correlates of smoking and possibly cannot be controlled for in an empirical study. The problems arising from the potential presence of other correlates of smoking when using smoking as an indicator of self-control problems are discussed in the specific context of the following two chapters. The goal of this chapter was to establish, that self-control problems are a serious candidate interpretation of any observed correlations with smoking.

Chapter 3: Self-Control and Credit Card Borrowing

1. Introduction

Ausubel (1991) conjectured that *"some people systematically underestimate the likelihood that they will borrow on credit card in the future"*. That is they *"do not intend to borrow but find themselves doing so anyway"*. The recent theoretical literature in behavioral economics suggests that one source of this behavior may be self-control problems (DellaVigna and Malmendier (2004), Laibson, Repetto, and Tobacman (2000), O'Donoghue and Rabin (March 1999), O'Donoghue and Rabin (2001)). People who suffer from self-control problems may be induced to incur more credit card debt in two ways. First, credit card financed consumption allows immediate benefits from consumption but only later payments. As people with self-control problems give relatively more weight to instantaneous gratification they may be induced to consume relatively more on credit card than people without self-control problems. Second, when people face the decision to pay off their card balance, they have the choice between an immediate cost (in the form of the payment) and later benefits (in the form of no interest payments) or immediate benefits (in the form of no immediate payment) and later costs (in the form of interest payments). Again people with self-control problems should be more likely to make the payment relatively later.

This paper is an attempt to assess empirically whether self-control problems play a role in credit card borrowing. Specifically I look at two aspects of credit card use: the propensity to pay off the credit card bill entirely and the amount of accumulated debt on the credit card account. If self-control problems are important, both, the pay-off probability and the accumulated debt should differ for people with a relatively higher level of self-control problems when compared to people with a lower level. In chapter 2 I have presented arguments and evidence for why smoking can be regarded as an indicator of a high level of self-control problems. As a first step, I analyze how this smoking indicator is associated with credit card borrowing before and after controlling for standard explanatory variables for credit card borrowing.

In a second step I discuss and try to address the problems that arise if one wants to interpret the observed correlations in terms of self-control problems. One problem is that smoking may

also measure other characteristics that might affect credit card borrowing. Examples are risk attitudes or health status. Unless risk attitudes, for example, are controlled for one cannot distinguish whether a certain correlation between smoking and an outcome of interest is due to self-control problems or risk attitudes. Even after controlling for additional observable characteristics many problems remain, however. Unobservable heterogeneity and reverse causality may still not allow isolating an effect of self-control problems. An instrumental variable regression and some plausibility checks are presented to address these issues.

Bertaut and Haliassos (2002) have investigated the link between self-control problems and credit card borrowing empirically. They estimate the effect of smoking on the probability to have a credit card and on the probability to pay off one's credit card bill. They find that smokers are more likely to have a card and less likely to pay off their bill. As I do they interpret smoking as an indicator of a higher level of self-control problems.

Using a recent data set from Australia, my results confirm the result of Bertaut and Haliassos (2002) with respect to the probability to pay off the bill entirely. When using a specification that is standard in the literature, smokers are around 15% less likely to pay off their card bill than non-smokers. I also find that smokers have around 550 dollars more in expected credit card debt than non-smokers.

When I turn to the question whether these correlations can be interpreted as reflecting self-control problems, I find that the above correlations persist and are only slightly diminished in magnitude when I control for additional observable and potentially confounding factors. These potentially confounding factors are risk attitudes, health status, some measures for peer groups, and an index of potentially stressful events that have happened to a person in the recent past. Smoking is still associated with a 12% lower payoff probability and around 440 dollars more in expected credit card debt.

Although the inclusion of these additional variables in the estimation makes several channels of bias unlikely, other identification problems remain. One problem is potential reverse causality. The observed correlations may not be due to self-control, measured by smoking, causing credit card debt, but rather due to high credit card debt making people more likely to

smoke. Another problem is unobserved expenditures. High debt may be due to the additional expenses for tobacco products that smokers incur. I suggest two approaches to address these identification problems. First, I argue that several observed correlations are implausible, under these alternative interpretations. Second, I suggest an instrument which might allow solving the reverse causality problem. Using this instrument I find that the effect associated with smoking increases dramatically for both outcome variables. If this result is valid, the effect of self-control problems eclipses all other influences on credit card debt. The dramatic increase itself calls the validity of the used instrument into doubt, however.

The chapter proceeds as follows. Section 2 presents the data used. Section 3 shows the descriptive results. In section 4 I discuss the identification problems and suggest ways to solve them. Section 5 concludes.

2. Data

I use a sample of 3922 credit card holders from the 2002 wave of the HILDA survey⁶. From the original sample of 13041 observations I exclude all those who do not have a credit card in their own name. In contrast to joint credit card accounts, a credit card in one's own name gives the exclusive right to use the card and the exclusive responsibility to meet payment obligations to the holder of the card. While a card owner can certainly use his credit card to fund the consumption of somebody else, nobody else but the card owner can decide on incurring debt and making payments. This allows focusing on individuals instead of households. It is appropriate as self-control is an individual trait and because any potentially complex interactions between the joint owners of an account can be ignored. Furthermore I delete all observations which have missing values for the outcomes or one of the variables of the standard specification described later. This gives the 3922 observations used as the main sample. The actual number of observations may be further reduced when additional variables are used as controls. Thus the sample used may not be representative of the overall

⁶ This chapter uses a confidentialised unit record file from the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA Project was initiated and is funded by the Commonwealth Department of Family and Community Services (FaCS) and is managed by the Melbourne Institute of Applied Economic and Social Research (MIAESR). The findings and views reported in this paper, however, are those of the author and should not be attributed to either FaCS or the MIAESR.

population. However, the sample can be expected to be representative of the population of interest, namely credit card owners.

2.1. Smoking in the Sample

The survey asked the following questions about smoking:

1. *Do you smoke cigarettes or any other tobacco products?*
2. *How many cigarettes do you usually smoke each week?*

The first question is a multiple choice question. The choice categories and the distribution of responses in the sample is given in Table 1.

Table 1: Do you smoke cigarettes or any other tobacco products?

Category	Frequency	%
No, I have never smoked	1882	48
No, I no longer smoke	1217	31
Yes, I smoke less often than weekly	77	2
Yes, I smoke at least weekly but not daily	95	2
Yes, I smoke daily	651	17

About 48% of the sample has never smoked. For this group I construct a dummy variable NEVERSMOKERS. Around 31% of the sample smokes no longer and is represented by the dummy variable FORMERSMOKERS. Around 4.5% of the sample can be said to be moderate smokers smoking less than daily, while 16.5% are daily smokers. I combine moderate and daily smokers into the dummy variable CURRENTSMOKERS. All groups enter the variable SMOKINGSTATUS, which takes on value 1 for NEVER-, 2 for FORMER- and 3 for CURRENTSMOKERS.

Table 2: SMOKINGSTATUS

Category	Frequency	%
NEVERSMOKERS	1,882	48

FORMERSMOKERS	1,217	31
CURRENTSMOKERS	823	21

The information from the second question about the number of cigarettes smoked per week is denoted CIGARETTES and reveals that there is considerable variation in smoking intensity. The mean number of cigarettes for smokers is 18 with a standard deviation of 48. Among current smokers the minimum number of cigarettes is 1, the maximum 600 per week. 99% of smokers smoke less than 300 cigarettes per week, however.

All variables are used as a proxy for self-control problems in the following sections. As discussed in chapter 2, the use of CURRENTSMOKER rests on the assumption that smoking versus non smoking in general is a sign of self-control problems. Thus, on the basis of this indicator, 21% of the sample would be characterized as having relatively high self-control problems when compared to the other 79%. It is not clear, how to treat FORMERSMOKERS. Arguably former smokers have demonstrated strong self-control as they managed to quit smoking. On the other hand, some of the studies discussed in chapter 2 ascribe low levels of self-control to people who smoke in general. Therefore also former smokers may have on average lower levels of self-control than never-smokers. Thus one possibility is that former smokers' level of self-control is in between that of never smokers and current smokers. It may also be the case that former smokers are indistinguishable from never-smokers though. The role of former-smokers will assume importance for identification later. The pattern of correlations that is obtained will also shed light on where to position former smokers relative to never and current smokers. The use of CIGARETTES as a measure of self-control problems requires the additional assumption that the intensity of smoking is also an indicator of self-control problems.

2.2. Outcomes

The binary indicator for the pay-off probability is based on the following survey questions.

Now think about the last bills that you paid for the cards that are in your name only. Did you pay off the entire balance owing on these bills? Possible answers: Yes, No

*How often do you pay off the entire balance on all of your credit card accounts each month?
Possible answers: Hardly ever or never, Not very often, About half of the time, Most months,
Always or almost always.*

The first question refers to credit cards in one's own name only. Around 61% of the sample report having paid off their debt entirely. The binary indicator that I denote PAYOFF follows immediately from that question. PAYOFF assumes value 1 if the person paid off the bill entirely and 0 otherwise. Table 3 shows the answers to the second question.

Table 3: PAYHABIT

Category	Frequency	%
hardly ever or never	725	18
not very often	456	12
about half the time	254	6
most months	389	10
always or almost always	2,096	53

From the answers to the second question I construct a dummy variable called PAYHABIT that assumes value 1 if participants responded that they pay off the entire balance "always or almost always" or "most months". It assumes value 0 when people responded to pay off "hardly ever or never", "not very often" or "about half the time".

The variable that measures the accumulated debt on the credit card account (again only in one's own name), denoted CARDDEBT, is based on the following survey question:

After you had made your payments, how much was still owed? Response in whole dollars.

Table 4: Outcome Variables

Variable Name	Definition	Mean	Min	Max
PAYOFF	(1) paid off entirely, (0) not	0.61	0	1
PAYHABIT	usual payment behavior	0.63	0	1

CARDDEBT	Credit Card Balance	1,056	0	25,000
POSITIVEDEBT	Credit Card Balance if larger 0	2,756	1	25,000

Table 4 gives some descriptive statistics for these variables. Around 61% of the sample paid off their balance entirely the last time they received the bill. This corresponds closely to the dummy constructed from the usual payment behavior, where 63% of people say they pay off most months, almost always or always, and 37% report to pay off at a lower frequency than "most months". For all cardholders in the sample taken together the average amount of credit card debt is 1056 dollars.

The average amount of debt across the whole sample corresponds to 3.7% of average yearly gross wages and 9.5% of average assets held in bank accounts in the sample. For the 1503 subjects that report a positive debt, the average amount of debt is 2756 dollars. This amount corresponds to 10% of the average yearly gross wage of these 1503 subjects and to 72% of average assets held in bank accounts by this group. For 1067 subjects credit card debt exceeds their assets held in bank accounts. Thus at least for those who actually hold debt, the nominal amount of credit card debt has reached a non-negligible magnitude. In particular the 1067 individuals who have less assets in bank accounts than debt on credit cards most likely would have difficulties to pay back their whole credit card debt at once. On the other hand the burden from revolving this credit is still relatively low. Assuming an average interest rate of 16%⁷ gives average yearly interest costs of 167 dollars for the whole sample and 441 dollars for those who actually borrow. This corresponds to 0.6% and 1.6% of the average yearly gross wage of the whole sample and the subsample of people with positive debt respectively.

2.3. Explanatory Variables

Many characteristics of people other than self-control problems can be expected to affect the pay-off behavior and the accumulation of credit card debt. As a starting specification I use variables that have been found important in explaining credit card borrowing in the previous

⁷ Reserve Bank of Australia, Indicator Lending Rates, Statistical Bulletins: <http://www.rba.gov.au/Statistics/Bulletin>

literature. Specifically I try to match the specification used by Calem and Mester (1995) which I call the standard specification. In order to address the problems that arise when using smoking as a proxy for self-control problems I will introduce additional control variables.

Table 5: Explanatory Variables

Variable Name	Definition	Mean	St. Dev
WAGE	Wage before tax (in thousands of \$ Australian)	28	33
HOMEOWNER	Person is a homeowner: (1) yes, (2) no	0.68	0.47
RENT	Housing expenses: rent or mortgage payments	0.52	0.67
EMPTENURE	Tenure with current employer in years	5.68	8.26
UNEMPLOYED	(1) unemployed, (0) employed or out of the labor force	0.02	0.13
AGE	Age in years	45.6	14.76
MALE	(1) male, (0) female	0.48	0.5
MARRIED	(1) if married or widowed, (0) if other status	0.59	0.49
CHILDREN	Number of children	1.71	1.49
HOMES	Number of homes the person has lived in during the last 10 years	2.71	1.66

Table 5 gives definitions and descriptive statistics for all variables of the standard specification but EDUCATION and FATHERORIGIN. The variables WAGE and RENTMORTGAGE are measured in 1000s of dollars.

WAGE is gross salary in the last financial year. As people with higher wages are more capable to pay off their bill one can expect a positive relationship between pay off probability and wage. It is not so clear what to expect for credit card balance. On the one hand people with higher wages have access to more credit card debt which may induce a positive correlation with CARDDEBT. On the other hand they have less need for it.

HOMEOWNER indicates whether the individual is a homeowner. Again, in as far as being a homeowner indicates a certain level of wealth one would expect a positive relationship with PAYOFF and PAYHABIT and a negative one with CARDDEBT. People who became homeowners

recently may also have a higher need for credit, however, which would make it more likely that they hold credit card debt.

RENTMORTGAGE measures the monthly expenses of the corresponding household for rent or mortgage payments. Such payment obligations limit the available resources and might increase the need for credit card debt.

AGE and MALE are self-explanatory. MARRIED takes on value 1 if the person is legally married and 0 otherwise. CHILDREN measures the number of children of a person. As people grow older they establish a credit history and might therefore be granted a higher credit line. Thus one may expect a positive association between age and credit card debt. As people grow older, they also might have less need for credit card debt though. There is no obvious expectation for the effect of being male or being married. As to the number of children, everything else equal, a person with a higher number of children can be expected to have a higher need for funds and therefore possibly a larger need for credit. That should result in a positive correlation between CHILDREN and CARDDEBT, and a negative one between CHILDREN and PAYOFF or PAYHABIT.

EMPTENURE is the number of years a person has worked with her current employer, and HOMES is the number of homes a person has lived in during the last 10 years. HOMES is set to 1 if the person has lived in the same home for more than 10 years. Persons who change their employer or their homes frequently might be regarded a greater credit risk and therefore granted a lower credit limit.⁸ This should induce a positive correlation between CARDDEBT and EMPTENURE and a negative one with HOMES. People who change homes frequently might also be in greater need for funds and therefore credit.

The unemployed can be expected to have less funds and a higher need for credit, and thus I expect a negative correlation between UNEMPLOYED and PAYOFF or PAYHABIT. As the unemployed may also be granted lower credit limits it is not clear what to expect for the correlation with CARDDEBT.

⁸ Calem and Mester use "time at the current job" and "time at the current address". These are cited as reasons for why people applying for credit were turned down by financial institutions in the 1983 Survey of Consumer Finances as reported in Jappelli (1990) page 222, Table 1)

Table 6: EDUCATION AND FATHERORIGIN

Variable Name	Description	Mean
EDUCATION	Highest level of education reached	
1	Masters or Ph.D.	0.04
2	Graduate Diploma or certificate	0.06
3	Bachelor	0.18
4	Advanced Diploma	0.11
5	Certificates iii or iv	0.18
6	Certificates i or ii	0.05
7	Undefined certificate	0.05
8	12 years of schooling	0.11
9	11 years of schooling or less	0.22
FATHERORIGIN	Father's country of birth	
1	Oceania and Antarctica	0.67
2	North/West Europe	0.19
3	South/East Europe	0.06
4	North Africa and Middle East	0.01
5	South East Asia	0.02
6	North East Asia	0.01
7	Southern and Central Asia	0.01
8	Americas	0.01
9	Sub-Saharan Africa	0.01

Table 6 shows the categories for the variables EDUCATION and FATHERORIGIN. The education variable used is the “highest level of education achieved” in the HILDA survey. EDUCATION has 9 categories, ranging from 1, which denotes a master's degree or Ph.D. to 9, which denotes less than 11 years of schooling. One interpretation of education can be as an indicator of long-term earning power. On the basis of this one could expect people with higher levels of education to have lower levels of CARDDEBT even after controlling for wage. The level of education might also indicate a certain level of diligence when pursuing tasks. Thus one might expect people with higher education levels to pay off more likely and incur less debt.

There is some evidence that culture affects savings (see e.g. Guiso, Sapienza and Zingales (2006)). Thus cultural factors might also affect the propensity to borrow on credit cards. Lacking direct measures I use an individual's father's country of birth, denoted FATHERORIGIN, as proxy for cultural backgrounds. FATHERORIGIN uses the Standard Australian Classification of Countries (SACC). FATHERORIGIN thus could control for different cultural, racial and religious backgrounds and the resulting attitudes towards borrowing.

Calem and Mester (1995) also include three other financial variables in estimation: the amount of liquid assets, any debt other than bank card debt and whether the household keeps stocks or bonds. These variables are likely to be endogenous to credit card debt, however. Thus I do not include them in the specification. Bertaut and Haliassos (2002) do not use these variables either. Furthermore Calem and Mester (1995), and Bertaut and Haliassos (2002) use explanatory variables that represent a person's attitude towards borrowing. An example of such a variable is an indicator for whether a person thinks it is ok to borrow for a holiday, or in order to buy jewelry. These variables could be indicators for a person's demand for card credit as argued by Duca and Rosenthal (1993). They might also be endogenous, however. A person with high credit card debt might rationalize or justify his borrowing behavior by adopting corresponding attitudes. Therefore I also do not include these variables in the standard specification.

3. Descriptive Results

3.1. Means of Smokers and Non-Smokers

As a first step of the analysis I look at the means of the outcome variables for current smokers and non-smokers. Table 7 displays these for PAYOFF, PAYHABIT and CARDDEBT.

Table 7: Means by Smoking Dummy

Means by Smoking Status	Non-Smokers	Smokers
PAYOFF	0.66	0.43
PAYHABIT	0.68	0.45

Means by Smoking Status	Non-Smokers	Smokers
CARDDEBT	875	1,738
CARDDEBT > 0	2,614	3,071

Smokers have more debt and a lower pay-off probability than non-smokers across all outcome variables used. On average 66% of non-smokers and 43% of smokers have paid off their bill entirely the last time they received it. This corresponds closely to the usual payment behavior of these groups as measured by PAYHABIT. With \$875 versus \$1738, non-smokers on average also have \$864 less credit card debt than current smokers. Even when looking at people with positive debt only, smokers still have \$457 more card debt than non-smokers. All these differences are statistically significant at least at the 5% level.

In order to see whether this difference in debt and pay-off levels is driven by a particular group of people in the sample, I look at the same pattern across different sub-groups of the sample. Table 8 shows the means of PAYOFF, DEBT and positive DEBT for men and women, married and unmarried people, and the groups above and below the median for age (44), education (5) and wage (23000).

Table 8: Means of Smokers and Non-Smokers by Group

Group	PAYOFF		CARDDEBT		CARDDEBT >0	
	Non-Smokers	Smokers	Non-Smokers	Smokers	Non-Smokers	Smokers
Men	0.7	0.49	972	1,780	2,151	2,721
Women	0.63	0.37	787	1,699	3,242	3,516
Age<44	0.58	0.39	1,021	1,849	2,427	3,024
Age>44	0.74	0.52	723	1,475	2,868	3,167
Low education	0.61	0.4	935	1,527	2,439	2,576
High education	0.73	0.5	793	2,280	2,954	4,581
Low wage	0.68	0.44	771	1,415	2,422	2,562
High wage	0.65	0.42	984	2,013	2,811	3,486
Married	0.7	0.45	752	1,647	2,531	2,990

Group	PAYOFF		CARDDEBT		CARDDEBT >0	
	Non-Smokers	Smokers	Non-Smokers	Smokers	Non-Smokers	Smokers
Not married	0.6	0.42	1,083	1,804	2,719	3,126

In all the groups shown in Table 8 smokers always have a lower payoff probability and higher average debt than non-smokers. As the pattern persists within these groups it is unlikely that the difference between smokers and non-smokers is driven by gender, marital status, age, education or wage. Interestingly the difference in CARDDEBT is considerably larger among people with high education and high wage. This may be so because this group simply can afford or has access to more credit card debt. Hence the driving force behind these differences in credit card debt and pay-off probability between smokers and non-smokers affect people with many different observable characteristics in a similar way. Smokers are likely to differ in an important way from non-smokers that must play a role in credit card borrowing.

3.2. Explanatory variables and Smoking

The partial correlations between smoking and the variables that the literature has considered important in explaining credit card borrowing might give some insight into what drives the above pattern. Table 9 reports the coefficients from a linear regression of the smoking dummy, CURRENTSMOKER, on the explanatory variables in the standard specification.

Table 9: Partial Correlations with CURRENTSMOKER

Variable Name	Coefficient	t-value
WAGE	-0.0001	-0.26
RENTMORTGAGE	0.0108	1.02
HOMEOWNER	-0.0243	-1.53
AGE	0.0072	2.55
AGESQ	-0.0001	-3.67
MALE	0.0237	1.77
MARRIED	-0.0986	-6.62

Variable Name	Coefficient	t-value
CHILDREN	-0.0041	-0.79
UNEMPLOYED	0.0850	1.82
EMPTENURE	-0.0014	-1.68
HOMES	0.0206	4.55
ED1: MA/PHD omitted		
ED2: graduate diploma	0.0170	0.43
ED3: bachelor	0.0363	1.04
ED4: advanced diploma	0.0774	2.12
ED5: certificate iii or iv	0.1469	4.19
ED6: certificate ii or iii	0.1383	3.19
ED7: undefined cert.	0.1347	3.12
ED8: year 12	0.1306	3.49
ED9: year 11 or less	0.1987	5.69
FO1: Oceania omitted		
FO2: N/W Europe	-0.0252	-1.54
FO3: S/E Europe	0.0357	1.37
FO4: N Africa	0.0579	0.9
FO5: S/E Asia	-0.0584	-1.27
FO6: N/E Asia	-0.1373	-2.42
FO7: S/C Asia	-0.0161	-0.28
FO8: Americas	0.0108	0.18
FO9: SubSaharan A.	-0.1072	-1.56
Constant	0.0221	0.29
Adjusted R ²	0.08	
No of observations	3,922	

A first reaction to observing the differences in PAYOFF, PAYHABIT, and CARDDEBT for smokers and non-smokers might be that smokers on average have less income and less wealth and therefore are less able to pay off the bill and incur more debt. It is remarkable then to see that smoking is not correlated with WAGE. When including the variables that I regard as

endogenous liquid assets, other forms of debt and holdings of stocks and bonds it can be seen that smoking is also not significantly correlated with liquid assets and other forms of debt. The only statistically significant correlation is with holdings of stocks and bonds, which is negative.

Variables that exhibit statistically significant correlations with the smoking dummy are AGE, MARRIED, most education dummies, HOMES, and the indicator for whether a person's father was born in North-East Asia. The positive correlation between HOMES and smoking does not lend itself to any obvious interpretation. One conjecture might be that people change homes often because they have financial problems and therefore have to change homes involuntarily because they are not able to pay the rent for example. The positive correlation between HOMES and WAGE of .16 speaks against such an interpretation though.

AGE is positively correlated with the smoking dummy. The effect is small, however, and declining turning negative at age 70. MARRIED is negatively correlated with CURRENTSMOKER. Marriage may serve as an external commitment device against smoking or it may be the case that smokers are less willing to commit to a partner or less able to find one. People whose father's were born in North-East Asia are significantly less likely to smoke than people whose father was born in Australia. Cultural, genetic or personality reasons may play a role here.

The strongest single factor that is correlated with smoking is education. All education dummies indicate that people with lower education are more likely to smoke. This may be so because people with lower education are less aware of the negative consequences of smoking or, again, because some factor like impatience that makes people smoke also makes them invest less in education.

The main conclusion from the analysis of the correlates of smoking is that it is unlikely that smoking measures financial or economic characteristics of people. This follows from the statistically insignificant correlations between smoking and wage, liquid assets, other forms of debt. Instead, in looking for the driving force behind the correlation between smoking and credit card borrowing the observable correlations suggest that factors pertaining to the personality of people play an important role. This view is supported by the significant

correlations of smoking and gender status, education, marital status and father's country of birth.

3.3. Probit and Tobit analysis

In order to see how smoking is related to the outcomes after controlling for the explanatory variables in the standard specification I estimate probit and tobit models.

Payoff Probability

For PAYOFF and PAYHABIT, I estimate models of the following type:

$$payoff_i^* = \beta_0 + \sum_{k=1}^K \beta_k x_{ik} + \gamma * SMOKING_i + \varepsilon_i$$

$$payoff_i = 1[payoff_i^* > 0]$$

,where payoff* is a latent variable and payoff is the binary indicator for whether a person has paid off the entire bill. Smoker denotes the smoking dummy and X is a vector of control variables. The standard specification contains the following variables in X: WAGE, RENTMORTGAGE, AGE, AGE², MALE, MARRIED, CHILDREN, EDUCATION, FATHERORIGIN, UNEMPLOYED. Table 10 shows the coefficients and marginal effects at the sample means from probit estimation on the propensity to pay off the entire bill, PAYOFF.

Table 10: Probit estimation on PAYOFF

Variable Name	Coefficient	t	ME	t
SMOKINGDUMMY	-0.37	-6.92	-0.14	-6.83
WAGE	0.001	1.59	0.0005	1.59
RENTMORTGAGE	-0.17	-4.79	-0.06	-4.79
HOMEOWNER	0.31	5.77	0.12	5.73
AGE	-0.05	-4.89	-0.02	-4.9
AGESQ	0.001	6.54	0.0003	6.56
MALE	0.17	3.79	0.07	3.8
MARRIED	0.10	1.99	0.04	1.99

Variable Name	Coefficient	t	ME	t
CHILDREN	-0.06	-3.35	-0.02	-3.35
UNEMPLOYED	-0.26	-1.68	-0.10	-1.64
EMPTENURE	0.003	0.93	0.001	0.93
HOMES	-0.05	-3.44	-0.02	-3.44
ED1: MA/PHD omitted				
ED2: graduate diploma	-0.31	-2.1	-0.12	-2.06
ED3: bachelor	-0.32	-2.39	-0.12	-2.36
ED4: advanced diploma	-0.47	-3.4	-0.18	-3.37
ED5: certificate iii or iv	-0.69	-5.18	-0.27	-5.26
ED6: certificate ii or iii	-0.76	-4.81	-0.30	-5.06
ED7: undefined cert.	-0.73	-4.61	-0.29	-4.82
ED8: year 12	-0.57	-4.07	-0.22	-4.08
ED9: year 11	-0.86	-6.42	-0.33	-6.68
FO1: Oceania omitted				
FO2: N/W Europe	0.03	0.47	0.01	0.48
FO3: S/E Europe	0.14	1.56	0.05	1.6
FO4: N Africa	-0.08	-0.39	-0.03	-0.38
FO5: S/E Asia	0.23	1.48	0.08	1.56
FO6: N/E Asia	0.79	3.55	0.24	4.99
FO7: S/C Asia	0.65	3.03	0.21	3.9
FO8: Americas	-0.32	-1.62	-0.13	-1.59
FO9: SubSaharan A.	0.35	1.38	0.12	1.52
Constant	1.61	6.04		
Pseudo R ²	0.11			
No. of Observations ^a	3922			
log-likelihood	-2319			

On average current smokers are around 14% less likely to pay off their bill entirely than current non-smokers. The effect is highly statistically significant. Thus smoking is highly negatively correlated to payoff probability even after controlling for the factors that are

correlated with smoking like AGE, MARRIED, EDUCATION and father's country of birth. This suggests that smoking grasps some effect beyond these factors. The marginal effect of age is negative at age 18 with an effect of around -1% and turns positive at around 37 years of age. It reaches 1% at age 55.

Many of the other marginal effects display the expected sign. Homeowners are more likely to pay off their bill entirely. People who face higher rent or mortgage payments and those who have more children are less likely to do so. The negative and statistically significant marginal effect of HOMES may imply that people who change homes a lot are either in more need for credit or indeed use the fact that they are harder to track down after moving to leave their credit unpaid.

The negative association of smoking with the payoff probability confirms the finding of Bertaut and Haliassos (2002) which is based on data from the U.S. Survey of Consumer Finances. With the exception of UNEMPLOYED, the coefficients on all other variables which are significant in both studies and comparable display the same sign. These are CHILDREN, AGE, EDUCATION, HOMEOWNER, and the proxies used for cultural background. Thus the observed correlations are not only intuitively reasonable but also consistent with evidence from a different data set.

Credit Card Debt

Credit card debt takes on value 0 or positive values. Hence I estimate a tobit model:

$$CARDDEBT_i = \max(0, \beta_0 + \sum_{k=1}^K \beta_k x_{ik} + \gamma * SMOKER_i + \varepsilon_i)$$

The explanatory variables are the same as above. Table 11 shows coefficients and marginal effects from tobit estimation on CARDDEBT measured in thousands of dollars. Smokers have around 450 dollars more in expected debt. The amount of credit card debt associated with smoking is therefore also quantitatively important. It is around 40% larger than the effect associated with HOMEOWNER and almost twice as large as the effect associated with a 1000 dollar increase in rent and mortgage expenses. The only larger effects are those associated

with the indicators for lower education levels than the Masters/Ph.D. level and some indicators of father's country of birth.

Table 11: Tobit Estimation of CARDDEBT

Variable Name	Coefficient	t	ME on E(y X)	t
CURRENTSMOKER	1.53	7.1	0.45	6.71
WAGE	0.004	1.29	0.001	1.29
RENTMORTGAGE	0.97	6.43	0.27	6.44
HOMEOWNER	-1.44	-6.55	-0.42	-6.34
AGE	0.27	6.32	0.08	6.36
AGESQ	-0.003	-7.31	-0.001	-7.37
MALE	-0.22	-1.16	-0.06	-1.16
MARRIED	-0.49	-2.29	-0.14	-2.28
CHILDREN	0.20	2.7	0.06	2.7
UNEMPLOYED	0.72	1.17	0.21	1.12
EMPTENURE	-0.0001	0	-0.00002	0
HOMES	0.18	2.78	0.05	2.78
ED1: MA/PHD				
ED2: graduate diploma	1.72	2.63	0.53	2.4
ED3: bachelor	1.95	3.35	0.59	3.08
ED4: advanced diploma	2.68	4.42	0.86	3.87
ED5: certificate iii or iv	3.00	5.11	0.96	4.52
ED6: certificate ii or iii	3.11	4.57	1.05	3.83
ED7: undefined cert.	3.85	5.67	1.37	4.58
ED8: year 12	2.60	4.25	0.84	3.73
ED9: year 11 or less omitted	3.37	5.75	1.07	5.09
FO1: Oceania omitted				
FO2: N/W Europe	-0.18	-0.76	-0.05	-0.77
FO3: S/E Europe	-0.42	-1.11	-0.11	-1.13
FO4: N Africa	0.57	0.66	0.17	0.64
FO5: S/E Asia	-0.61	-0.92	-0.17	-0.95
FO6: N/E Asia	-3.62	-3.56	-0.82	-4.49

Variable Name	Coefficient	t	ME on E(y X)	t
FO7: S/C Asia	-2.97	-3.09	-0.69	-3.74
FO8: Americas	1.04	1.33	0.31	1.25
FO9: SubSaharan A.	-1.34	-1.25	-0.34	-1.36
Constant	-9.95	-8.65		
Pseudo R ²	0.04			
No. of Observationsa	3,922.00			
log-likelihood	-5,611.00			

Being a home owner is negatively associated with CARDDEBT. This may be so because homeowners are on average wealthier. Having higher expenses for rent or mortgage is positively associated with CARDDEBT as expected. AGE is positively associated with CARDDEBT but at a decreasing rate. This may be so because people get granted higher credit lines as they grow older and establish a credit history but also need less credit after some age. CARDDEBT increases in the number of children. Children are a cost factor that increases a person's need for credit. Any education level that is lower than a Masters degree or a Ph.D. is positively associated with CARDDEBT. Education may signal long term earning power and thus people with higher education might have a lower need for credit card debt. Where statistically significant and comparable all the coefficients in my estimation display the same sign as in Calem and Mester (1995). These are AGE (when using a linear term), CHILDREN, HOMEOWNER, RENTMORTGAGE, and the indicators for culture or race.

The coefficients on the smoking dummy are only slightly reduced in magnitude and still highly statistically significant if the variables that are deemed endogenous here but included in Calem and Mester (1995) are included in the regression (see Table 26 in the Appendix).

Thus there is a strong and statistically highly significant correlation between credit card borrowing and smoking. It is unclear however, how such a correlation can be interpreted. The following section discusses whether this correlation can be considered an effect of self-control problems.

4. In search for a self-control interpretation

Even if one follows the arguments in chapter 2 and smoking is accepted as a valid indicator of self-control problems, from observing a correlation between smoking and credit card borrowing one cannot conclude that self-control problems are driving this correlation.

One problem is that there may be reasons other than self-control problems for why smoking should be included as an explanatory variable for credit card borrowing. For example, smoking might grasp other important characteristics like risk aversion and health status. If these are not controlled for directly it is unclear whether a correlation is due to self-control problems or due to these other characteristics. A more serious problem could be that the observed correlations come about because people with high debt tend to smoke more likely or because people who smoke incur higher expenses due to the cost of tobacco products.

Next I discuss potentially confounding factors that are observable in the HILDA data and present the results when including them as additional controls. Then I discuss the different possible sources of endogeneity that remain.

4.1. Potential confounding factors

Risk Aversion

There may be uncertainty about the ability to pay off a credit card bill in the future. This uncertainty may arise from uncertainty with respect to future income or with respect to future financial needs. Incurring credit card debt in the present carries the risk of substantial future interest payments or even the risk of personal bankruptcy. Then risk averse individuals can be expected to incur less credit card debt and pay off more likely than risk loving individuals. Similarly the decision whether or not to consume (or start consuming) noxious substances like cigarettes involves the uncertainty about the realization of negative consequences of consumption like major diseases. Thus a higher level of smoking may simply reflect a lower level of risk aversion. Several studies have shown a link between risk taking and smoking (see e.g. Hersch and Viscusi (2001)).

As people in the HILDA survey are directly asked about their level of risk aversion in financial matters I control for this alternative interpretation by including a variable on risk aversion. Specifically participants were asked the following question:

Which of the following statements comes closest to the amount of financial risk that you are willing to take with your spare cash, that is cash used for savings and investments? "1 not any risk, 2 average, 3 above average, 4 substantial risk, 5 do not have any spare cash".

Table 12: Risk Aversion, Smoking and Card Debt

Response Category	Frequency	Share of Sample	Smoking Prevalence	Mean of CARDDEBT
Not any risk	1,264	0.32	0.22	893
Average risk	1,642	0.42	0.17	775
Above Average Risk	323	0.08	0.19	1248
Substantial Risk	71	0.02	0.28	1428
Never have spare cash	622	0.16	0.29	1986

Table 12 displays the response frequency and smoking prevalence in each category. Smoking prevalence is highest among those who said to be willing to take on substantial risk and those who said never to have any spare cash. It is lowest among those who responded with option 2 and 3, i.e. average and above average risk. Thus smoking prevalence does not strictly decrease with risk aversion in financial matters. The partial correlation between smoking and dummies for risk taking categories after controlling for the standard specification also shows that there does not seem to be a clear relationship between risk attitudes and smoking in this sample. Being willing to take on average or above average risk as compared to not wanting to take on any risk is statistically significantly negatively correlated to smoking. Being willing to take on substantial risk is not correlated to smoking, however.

The last response category, not having any spare cash, is most likely endogenous to credit card debt. People who do not have any spare cash will also be more likely to have credit card debt.

Health Expenditures

People who smoke are likely to be in worse health. Worse health might increase the need for health services and medical products, which in turn might translate into higher credit card debt and a lower ability to pay off the balance. To account for this possibility I include an indicator of self-reported health status into the model. The variable HEALTH is based on the question:

In general, would you say your health is: (1) excellent, (2) very good, (3) good, (4) fair, (5) poor ?

Table 13: Health Category, Smoking and Card Debt

Response Category	Frequency	Share of Sample	Smoking Prevalence	Mean of CARDDEBT
Excellent	456	0.12	0.14	963
Very good	1523	0.40	0.19	1016
Good	1320	0.34	0.24	1081
Fair	430	0.11	0.28	1124
Poor	99	0.03	0.23	1185

Not surprisingly worse health status is positively correlated with smoking prevalence. The simple correlations of HEALTH with CURRENTSMOKING, SMOKINGSTATUS, and CIGARETTES are 0.9, 0.11, and 0.14 respectively. The partial correlations with smoking of dummies for any other health status but “excellent” are also positive and highly statistically significant. Given that also credit card debt is higher for people reporting worse health, this seems to be an important confounding factor to control for.

Stressful Events

Some people may have been subject to stressful experiences that increase their short term demand for credit card debt or decrease their short term availability of financial resources to pay off their bill. Some of these experiences may also make people more likely to smoke. Khwaja et al. (2006) report that stress was the most mentioned reason for relapsing into smoking after having quit among participants in the Survey of Smoking administered in 3 US cities in 2004 and 2005. Therefore I construct an index of stressful and possibly expensive

events from indicators for the following events if they happened in the 12 months prior to the interview date: separation from a partner, serious personal injury or injury of a family member, death of a family member, close relative or close friend, having been a victim of crime, job loss, and having been in jail. The stress index is the sum of the number of stressful events that have happened to an individual in the past 12 months.

Table 14: Stressful Events

Event	Mean	Event	Mean
Separation from partner	0.05	Death of a friend	0.11
Serious personal injury	0.08	Victim of violence	0.01
Serious injury of a family member	0.19	Victim of crime	0.07
Death of a family member	0.01	Having been in jail	0.01
Death of a close relative	0.10	Having been fired	0.03

Table 15: Stress Index, Smoking and Card Debt

Index Level	Frequency in Sample	Share of Sample	Smoking Prevalence	Mean of CARDDEBT
0	2,071	0.54	0.19	931
1	1,176	0.31	0.21	1200
2	436	0.11	0.27	1133
3	124	0.03	0.31	1427
4	27	0.01	0.22	1697
5	5	0.001	0.60	2570

Table 14 shows that a substantial part of the sample has experienced a stressful event in the last 12 months, with 19% having experienced a serious injury, and 10% a death of a relative and a death of a close friend. Table 15 shows the distribution of the stress index. About 31% of the sample has experienced at least one stressful event. Another 11% have experienced 2 stressful events. Smoking prevalence is also higher the higher the stress index and so is average debt level. Thus stress according to this measure is a potentially important confounding factor.

Peer Effects

There may be environments which are both more conducive to smoking and more accommodating towards credit card debt. In other words there may be peer effects, which make it more acceptable to smoke and more acceptable to have credit card debt. Smoking might be more prevalent among blue collar workers, for example, and these workers might also find it more acceptable to keep debt on their credit card account. Table 16 shows occupation groups, smoking prevalence and the mean of card debt. In the group of people in my sample who are classified as "Professionals" according to the International Standard Classification of Occupations (ISCO), for example, the share of current smokers is 15% and the average card debt level is \$1089. The group of persons that is classified as "Plant and Machine Operators and Assemblers" exhibits a smoking rate of 34% and an average debt level of \$1607. Thus any blue collar worker might find it more acceptable to engage in both activities because others he knows do so as well. In order to account for this possibility I include indicators for a person's occupation group according to ISCO at the one-digit level.

Table 16: Occupation Groups, Smoking and Card Debt

One-Digit ISCO Occupation Group	Frequency	Share of Sample	Smoking Prevalence	Mean of CARDDEBT
Legislators, Senior Officials and Managers	362	0.09	0.23	1,427
Professionals	748	0.19	0.15	1,089
Technicians and Associate Professionals	515	0.13	0.21	1,024
Office clerks	357	0.09	0.23	1,160
Personal and Protective Services Workers	275	0.07	0.35	1,238
Skilled Agricultural and fishery Workers	110	0.03	0.11	904
Craft and Related Trades Workers	231	0.06	0.26	1,521
Plant and Machine Operators and Assemblers	127	0.03	0.34	1,607
Elementary occupations	151	0.04	0.29	1,125
Unemployed	73	0.02	0.36	1,395

One-Digit ISCO Occupation Group	Frequency	Share of Sample	Smoking Prevalence	Mean of CARDDEBT
Not in Labor Force	949	0.24	0.16	613

Likewise, people may be affected by the habits of the people who live around them. People living in a "worse" area in the sense that people are less educated and have lower income and wealth may see more smoking and credit card borrowing around them and therefore be more inclined to do the same. To account for this, I include a variable denoted AREA that is based on an index of socio-economic advantage/disadvantage for areas (SEIFA). This index was constructed by the Australian Bureau of Statistics on the basis of the 2001 Census of Population and Housing. It focuses on such characteristics as low income, low educational attainment or high unemployment. The variable AREA allocates each household the individual is part of to a decile of this index. Thus AREA assumes values from 1 to 10, with 1 denoting the most disadvantaged areas and 10 denoting the most advantaged. Table 17 shows the distribution of the AREA Index in the sample and the levels of smoking and card debt in the different categories. There is again a clear negative relationship between the AREA Index and smoking prevalence. The "better" is the area, the lower the smoking rate. The simple correlation between AREA and the smoking dummy is -0.9. The relationship between AREA Index and CARDDEBT is less strong, with a correlation of -.04 only.

Table 17: AREA Index, Smoking and Card Debt

Decile of AREA Index	Frequency	Share of Sample	Mean of CURRENTSMOKER	Mean of CARDDEBT
lowest	294	0.07	0.29	1,330
2nd	269	0.07	0.27	1,104
3rd	369	0.09	0.24	1,244
4th	456	0.12	0.25	986
5th	371	0.09	0.17	1,079
6th	425	0.11	0.20	

Decile of AREA Index	Frequency	Share of Sample	Mean of CURRENTSMOKER	Mean of CARDDEBT
				1,029
7th	419	0.11	0.22	943
8th	290	0.07	0.25	1,210
9th	523	0.13	0.15	1,114
highest	506	0.13	0.15	748

4.2. Estimation with Extended Specification

Table 18 shows the marginal effects from Probit estimation using the extended specification. The marginal effect on CURRENTSMOKER is reduced from $-.14$ to $-.11$ but still highly statistically significant.

The willingness to take on financial risk rather than not being willing to take any risk is positively associated with the payoff probability. Thus the willingness to take on financial risk does not seem to affect credit card borrowing in the conjectured way, i.e. risk aversion does not seem to play a role in credit card borrowing. Therefore it also seems unlikely that the willingness to take on financial risk is an important confounding factor when interpreting the effect of smoking. The positive association might be explained if these risk attitudes also grasp financial sophistication.

Using the variable RISKAVERSION introduces a potentially endogenous variable in estimation, as the 5th response category is not to have any spare cash. This indicator has the expected sign and is highly statistically significant. In order to avoid this problem and given that it is unlikely that RISKAVERSION is an important confounding factor, I will not use RISKAVERSION as an explanatory variable later on.

Table 18: Probit Estimation on PAYOFF with extended specification

Variable Name	ME	t	Vairable Name	ME	t
CURRENTSMOKER	-0.11	-5.28	North East Asia	0.22	3.13
WAGE	0.0002	0.66	Southern and Central Asia	0.23	3.33
RENTMORTGAGE	-0.07	-5.26	Americas	-0.13	-1.58
HOMEOWNER	0.11	4.95	Sub-Saharan Africa	0.09	0.99
AGE	-0.02	-4.04	Not any risk omitted		
AGESQ	0.0002	5.46	Average risk	0.08	3.99
MALE	0.03	1.76	Above Average Risk	0.07	2.14
MARRIED	0.002	0.1	Substantial Risk	0.10	1.64
CHILDREN	-0.01	-1.2	Never have spare cash	-0.22	-8.06
UNEMPLOYED	-0.09	-1.29	Excellent Health omitted		
EMPTENURE	0.001	0.5	Very good Health	-0.07	-2.35
HOMES	-0.02	-3.14	Good Health		
Masters or Ph.D. omitted			Fair Health	-0.15	-3.92
Graduate Diploma or certificate	-0.15	-2.35	Poor Health	-0.10	-1.64
Bachelor	-0.14	-2.56	Legislators, Senior Officials and Managers omitted		
Advanced Diploma	-0.19	-3.21	Professionals	-0.07	-1.84
Certificates iii or iv	-0.25	-4.23	Technicians and Associate Professionals	0.01	0.16
Certificates i or ii	-0.29	-4.28	Office clerks	-0.04	-0.86
Undefined certificate	-0.27	-4	Personal and Protective Services Workers	-0.11	-2.39
12 years of schooling	-0.22	-3.61	Skilled Agricultural and Fishery Workers	0.06	1.07
11 years of schooling or less	-0.30	-5.12	Craft and Related Trades Workers	-0.01	-0.28
Oceania and Antarctica omitted			Plant and Machine Operators and Assemblers	-0.08	-1.41
North/West Europe	-0.01	-0.45	Elementary occupations	-0.07	-1.23
South/East Europe	0.05	1.37	Not in Labor Force	0.01	0.31
North Africa and Middle East	-0.005	-0.06	AREA	0.02	5.07
South East Asia	0.11	1.91	STRESS	-0.02	-2.01
Pseudo R ²	0.16				

No of Observations	3726	
log-likelihood	2079	

The marginal effects and coefficients on the HEALTH dummies are highly statistically significant and indicate that worse health is always associated with lower payoff probability and higher debt. As worse health is also correlated with smoking it is likely that these HEALTH dummies account for some of the reduction in the effect of CURRENTSMOKER. Including HEALTH in estimation is therefore important.

Only one of the indicator variables for occupation groups is statistically significant, the indicator for belonging to the group of "Personal or Protective Services Workers" rather than to the left out category of "Legislators, Senior Officials and Managers". This indicator is negatively associated with the payoff probability. This is also the occupation group with the highest smoking rate of 34.5% and the lowest payoff rate of 41.1%. Thus including this occupation group may be important to control for potential peer or class effects.

The socio-economic index of areas, denoted AREA, is highly statistically significant. People living in "better" areas are more likely to pay off their bill. Thus AREA probably accounts for some of the reduction in the magnitude of the effects of CURRENTSMOKER. AREA might capture peer effects as conjectured above and therefore it is also important to include this variable in estimation.

The index of stressful events, STRESS, displays the expected sign and is also statistically significant and thus probably contributes to the reduction in magnitude of the smoking dummy as well.

In summary the observed pattern of correlations indicates that health status, living areas, occupation groups and stressful experiences are potentially important confounding factors when using smoking as a proxy for a deeper character trait. Risk attitudes do not seem to play the expected role.

Importantly the effects of all smoking measures remain large in magnitude and highly statistically significant across all different specifications. Table 19 shows the marginal effect and coefficients on all smoking measures for both probit estimation on PAYOFF and tobit estimation on CARDDEBT. I use the standard specification and 3 different extensions: first, all the potential confounding factors excluding the variable RISKAVERSION, as this indicator can be expected to be endogenous. Second, all variables are included as before and the variable RISKAVERSION. Finally, I also include all those variables that the previous literature has used in the context of studying credit card borrowing but which are deemed endogenous here.

Table 19: Coefficients on Smoking Measures for different specifications for probit estimation on PAYOFF and tobit estimation on CARDDEBT

PAYOFF	CURRENTSMOKER	SMOKINGSTATUS		CIGARETTES
		former smoker	current smoker	
Standard	-0.14	-0.06	-0.17	-0.001
t	-6.92	-3.15	-7.58	-6.03
Standard + All excluding RISKAVERSION	-0.12	-0.06	-0.14	-0.001
t	-5.46	-2.94	-6.14	-4.73
Standard + All including RISKAVERSION	-0.11	-0.06	-0.14	-0.001
t	-5.28	-2.92	-5.95	-4.67
Standard + All + endogenous	-0.1	-0.05	-0.12	-0.001
t	-4.74	-2.36	-5.26	-4.07
CARDDEBT	CURRENTSMOKER	SMOKINGSTATUS		CIGARETTES
		former smoker	current smoker	
Standard	1.526	0.738	1.816	0.01
t	7.1	3.42	7.84	6.2
Standard + All excluding RISKAVERSION	1.329	0.683	1.601	0.01
t	5.96	3.07	6.66	5.13
Standard + All including RISKAVERSION	1.263	0.699	1.541	0.01
t	5.73	3.17	6.49	5.05

Standard + All + endogenous	1.16	0.582	1.394	0.01
t	5.31	2.66	5.91	4.59

All smoking measures are highly statistically significant across all different specifications. Interestingly also former smokers are statistically significantly less likely to pay off their bill entirely and have more debt than people who have never smoked. When also controlling for these former smokers, the effect on CURRENTSMOKER increases in magnitude and statistical significance.

If the remaining effect of smoking was to be attributed to self-control problems, self-control problems do play an important role in credit card borrowing. The effect of currently smoking versus not currently smoking is slightly larger in size than the effects associated with home ownership or a thousand dollar increase in rent and mortgage payments and about half the size of the effect associated with lower education levels or cultural backgrounds where these are statistically significant. An increase of 10 in weekly cigarette consumption is associated with a 1% decrease in the payoff probability and with an increase of around \$100 in credit card debt.

Controlling for observable potential confounding factors makes it less likely that the observed correlations are due to one of these factors. Nevertheless important reasons for why it is problematic to interpret the effect associated with smoking in terms of self-control problems remain.

4.3. Potential identification problems

Just as ability or intelligence, one would regard a person's level of self-control problems as a long-term character trait that is not subject to influences from current events. Hence it is unlikely that a person's level of self-control problems is affected by credit card borrowing, and thus true (unobservable) self-control problems can be regarded as exogenous to credit card borrowing. As self-control problems cannot be directly observed, however, one has to rely on indirect and imperfect measures. At the same level of unobservable true self-control the manifestation of such measures may vary, however, due to factors that also vary

systematically with the outcomes that are to be explained. Thus endogeneity may arise from the imperfect measurement. In the case of using smoking as a proxy for self-control problems there are three main problems.

First, reverse causality may exist if smoking is a way to cope with stressful situations. This is why an index of stressful events was included in the extended specification above. High credit card debt itself might be a stressful event, however, and thus induce some people to smoke more or to postpone quitting. Then a positive correlation between smoking and credit card borrowing would be observed not because smoking measures self-control problems but because high debt causes people to smoke more likely or to have higher cigarette consumption.

Second, smokers might have more credit card debt simply due to the fact that cigarettes and other tobacco products cost money. This additional expense of smokers in comparison to non-smokers might be the driving force behind the difference in credit card debt.

Third, smoking might be a measure of unobservable characteristics other than self-control problems which also affect credit card borrowing. In the literature smoking has been considered a potential proxy for time preference, in particular in the form of constant time-discounting, and learning ability (Munasinghe and Sicherman (2005)). Thus rather than self-control problems, the observed correlations might be due to these latter characteristics.

4.4. Plausibility Arguments

In this section I suggest to address the potential alternative interpretations of smoking, the potential reverse causality and the problem that higher debt might simply be due to expenses for tobacco products with some plausibility arguments. In particular I argue that several observed correlations in the data are not plausible under alternative interpretations of smoking or under a reverse causality or tobacco cost argument. In the next section I propose an instrumental variable to address the reverse causality problem.

Constant-Time Discounting

While self-control problems can be considered a feature of more general time-preference, the specific form of time-preference that is considered in the literature in a different context is constant time-discounting. I cannot distinguish between the constant time discounting type of time-preference and the self-control problems type of time-preference here. Results from the literature speak against a constant time-discounting paradigm, however. Indeed the motivation for this paper and for theoretical studies that study the link between credit card borrowing and self-control problems is precisely, that constant time-discounting was found inadequate to explain the observed behaviour (see e.g. Ausubel (1991), Laibson, Repetto and Tobacman (1998)). Moreover, there is little evidence for the empirical relevance of constant time-discounting in general (see e.g. Frederick et al. (2002)). In particular, as discussed in chapter 2, there does not seem to be a link between smoking and time-discounting of any kind (see Khwaja et al. (2006)). Thus I will discard constant time-discounting as a potential confounding factor here.

Learning Ability

Even though Munasinghe and Sicherman (2005) find that in their context (wage growth rates) smoking likely grasps time-preference rather than learning ability, smoking might still pick up some learning ability. I am not aware of any theory or any evidence that links learning or cognitive ability to credit card borrowing, however. The only indication for such a relationship would be higher credit card debt levels for people with lower education in general. However, the highest level of education achieved should be a much better indicator of learning ability than smoking. In particular, one should expect that if a high level of learning ability has been demonstrated (by a high level of education achieved) that any additional signal of learning ability, especially if it is a noisy one like smoking, should contain only little additional information. On the other hand, if no signal or only a weak signal of learning ability is available, as is the case for high-school drop outs, one should expect any additional signal of learning ability to contain relatively more additional information.

If these conjectures are correct and smoking captures learning ability, one should observe that individuals with a high level of education should only exhibit a weak additional effect for

smoking, while this effect should be relatively stronger for individuals with a low level of education. The data point in the opposite direction, however. When including an interaction dummy for smokers with the highest level of education (Master/Ph.D.) along with the smoking dummy in tobit estimation, a large, positive and statistically significant coefficient on the interaction dummy results (4.07 with a t-statistic of 2.56) and the coefficient on the smoking dummy is still positive and statistically significant (1.25 with a t-statistic of 5.58) (see Table 27 in the appendix). When including an interaction dummy for smokers with the lowest level of education (11 years of schooling and less) along with the smoking dummy in tobit estimation, a statistically significant negative coefficient results on the interaction dummy (-1.72 with t-statistic -3.48) which almost cancels with the coefficient on the smoking dummy (1.75, $t=6.9$) (Table 28 in the appendix). Hence having the highest education level and being a smoker is associated with a large positive additional amount of debt compared to that of the average smoker versus the average non-smoker. By contrast having the lowest education level and being a smoker is associated with a debt reduction compared to the average smoker. Several forces may be at work here, it is unlikely, however, that this pattern of correlations is obtained when smoking is a primarily a measure of learning ability. Therefore I do not consider learning ability an important confounding factor either.

Reverse Causality and Tobacco Expenses: The Case of Former Smokers

As shown in Table 20 FORMERSMOKERS on average have considerably more debt than NEVERSMOKERS, and CURRENTSMOKERS have considerably more debt than both, NEVERSMOKERS and FORMERSMOKERS.

Table 20: Smoking Status and CARDDEBT

Category	Frequency	%	Mean of CARDDEBT
NEVERSMOKER	1,882	48	770
FORMERSMOKER	1,217	31	1,037
CURRENTSMOKER	823	21	1,739

As shown in Table 19 these differences also prevail in probit and tobit estimation of the variables PAYOFF and CARDDEBT respectively. Across all specifications CURRENTSMOKERS have

statistically significantly more debt than both NEVER- and FORMERSMOKERS, and FORMERSMOKERS have statistically significantly more debt than NEVERSMOKERS.

The status of FORMERSMOKERS as a measure of self-control problems is ambiguous. One may argue that people who used to smoke but managed to quit exhibit particularly strong self-control. On the other hand one may argue that FORMERSMOKERS have less self-control than NEVERSMOKERS but more than CURRENTSMOKERS. Clearly the former interpretation is not consistent with the pattern of correlations observed, while the latter is. The latter interpretation is also supported by the correlation with planning horizon. Planning behavior has been associated with self-control (Ameriks et al. (2003), Khwaja et al. (2006)). Ameriks et al. (2003) conclude that planning might serve as a tool for “effortful self-control”. Khwaja et al. (2006) regard a person’s planning horizon a “more general measure of self-control” and have found a strong correlation between planning horizon and smoking (but no such correlation between discount rates and smoking). The variable HORIZON in the HILDA data contains answers to almost exactly the same question as the variable that Khwaja et al. (2006) use. Participants were asked which horizon is most important to them, when planning their saving and spending and could choose between 6 response categories: 1. “the next week”, 2. “the next few month”, 3. “the next year”, 4. the next 2 to 4 years, 5. “the next 5 to 10 years”, and 6. “more than 10 years ahead”.

Table 21: Smoking Status and Planning Horizon

Category	Planning Horizon	Standard Deviation of Mean
NEVERSMOKER	3.31	0.04
FORMERSMOKER	3.20	0.04
CURRENTSMOKER	2.84	0.05

NEVERSMOKERS have a significantly higher level of planning horizon than FORMERSMOKERS, and the latter have a significantly higher level than CURRENTSMOKERS again. This supports an interpretation of FORMERSMOKERS as having a level of self-control between that of NEVER- and CURRENTSMOKERS. In turn the observed level of debt for former smokers between that of never and current smokers is consistent with a self-control interpretation of this correlation.

If there is a positive correlation between smoking status and credit card debt because people with more debt are more likely to smoke or more likely to smoke more, it is difficult to conceive why also former smokers should have higher levels of credit card debt. The only reason for why this might be the case is debt persistence, i.e. that people who used to smoke in the past did so because they used to have high debt in the past and were not able to pay off this high debt yet or can do so only slowly in time. If this is the case, however, one should expect people who just recently quit smoking to have higher levels of debt than people who have quit smoking a longer time ago. While in the HILDA data there is only information on credit card debt for the year 2002, there is information on smoking status for all years 2001 to 2003. This allows to identify those former smokers who were smokers in the previous year versus those former smokers who did not change status in the last year. In other words it allows to identify those former smoker who have quit in the previous year and those who have quit before the previous year.

Out of the 3922 observations in the sample, 3787 were also present in the survey of the year 2001. Out of these 3787 observations, 3368 did not change smoking status between 2001 and 2002, but 89 observations reported to be smokers in 2001 but former smokers in 2002. Another 125 observations reported to be NEVERSMOKERS in 2001 but FORMERSMOKERS in 2002. If the higher average debt of FORMERSMOKERS compared to NEVERSMOKERS is due to debt persistence, one should expect people who have just recently quit smoking to have more debt than people who have quit a longer time ago. If smoking is to a significant degree caused by credit card debt, then one should also expect that people who have just recently started smoking but quit again to differ from former smokers who quit over a year ago, as one would expect that the high credit card debt that induced them to smoke was incurred particularly recently.

I call QUIT a dummy variable that assumes value 1 if people have quit smoking during the previous year and 0 otherwise. Likewise I call SHORT a dummy variable that assumes value 1 if people have started smoking and quit again in the previous year, i.e. those who reported to have never smoked in 2001 and reported to be former smokers in 2002. In order to test

whether people who have just quit differ from former smokers in general, I estimate the following equation.

$$CARDDEBT_i = \max(0, \beta_0 + \sum_{k=1}^K \beta_k x_{ik} + \gamma * FORMER_i + \delta * (FORMER_i * QUIT_i) + \phi * CURRENT_i + \varepsilon_i)$$

If recent quitters differ significantly from former smokers in general, one should expect the coefficient on the interaction term between FORMERSMOKER and QUIT to be statistically significantly positive. This is not the case for any of the specifications used as shown in Column 1 of Table 22. For the extended specification without RISKAVERSION, for example, the coefficient is 0.08 with a t-value of 0.13.

Table 22: Coefficients on interaction dummies of FORMERSMOKER with QUIT and SHORT

CARDDEBT	FORMER*QUIT	FORMER*SHORT	FORMER*(QUIT+SHORT)
Standard	0.13	-0.16	-0.06
t	0.22	0.31	-0.15
Standard + All excluding RISKAVERSION	0.08	0.18	0.15
t	0.13	0.33	0.35
Standard + All including RISKAVERSION	0.11	0.04	0.08
t	0.18	0.08	0.19
Standard + All + endogenous	-0.02	0.06	0.02
t	-0.04	0.11	0.06

Using an interaction term between FORMERSMOKER and SHORT instead, shows that also people who recently started and then quit again also do not statistically significantly differ from FORMERSMOKERS. Finally, also when combining both dummy variables no statistically significant difference is found.

The lack of a difference between recent quitters and former smokers in general does not prove an explanation based on reverse causality and persistence of credit card debt wrong. It does make such an explanation less plausible though. Given the high cost of credit card debt

in terms of interest payments, it is reasonable to pay off the debt as quickly as possible. This should be so in particular for people with relatively high income, who can afford to pay off this debt more likely. However, the difference between average debt of FORMER- AND NEVERSMOKERS is larger among people with a wage above the median than a wage below the median, for example. A reverse causality explanation for the correlation between smoking and credit card debt is therefore possible, but unlikely.

The same points can be made with respect to the potential explanation that higher debt is due to higher expenses for tobacco products. Again if there was only a simultaneous relationship of this sort, i.e. that current smoking leads to current higher debt, one should not observe a higher level of debt for FORMERSMOKERS. Those could have higher debt levels if the debt they incurred as smokers is persistent and they can only pay it off in small steps. Then one would expect people who have only recently quit to have more debt than people who quit a longer time ago. This does not seem to be the case, however.

Moreover, unless people with higher income also smoke more, one would expect the difference between credit card debt between FORMER- and NEVERSMOKERS to be smaller among high income individuals than among low income individuals. First, people with higher incomes would be less likely to incur debt in the first place in order to finance their tobacco consumption. Second, after having quit smoking, people with higher incomes should be able to pay off their debt more quickly.

People with higher income do not seem to smoke more, however. The simple correlation between CIGARETTES and WAGE is slightly negative also when looking at smokers only or people with positive WAGE only. The partial correlation after controlling for the extended specification is small and positive but statistically not significant ($t = .71$). In tobit estimation on CARDDEBT the coefficient on an interaction term of FORMERSMOKER with an indicator for wage larger than the median (23 000) is not statistically significant (see Table 29 in the appendix). Thus former smokers with high wages do not seem to have statistically significantly less debt than former smokers with low wages. Therefore, while an explanation

based on the cost of tobacco products cannot be proven wrong, it does not appear to be plausible in light of the observed correlations.

4.5. Instrumental Variable Estimation

Instrument

If there is a variable that is correlated with smoking due to an unobservable correlation with self-control problems but uncorrelated with credit card borrowing instrumental variable techniques can be used to solve the reverse causality problem.

I think that an indicator of an individual's parent's divorce or separation, denoted PARENTSDIVORCE, when a person was 14 years of age is a possible instrument. The indicator is based on the following survey questions:

Were you living with both your own mother and father around the time you were 14 years old?

Why were you not living with both your parents at age 14?

For those who replied that they were not living with both their own parents and that the reason for this is that their parents separated or divorced the indicator assumes value 1. In the sample 9.4 % responded in this way.

The conjecture here is that if parents divorce in the presence of a child they display a tendency to favour their current well-being over their long-term goals which could be their child's well-being. This would indicate a self-control problem. One could then argue that a parent's level of self-control is correlated with the child's level of self-control either genetically or by upbringing. In any event, there is a statistically significant positive correlation between parent's divorce and cigarette consumption as will be seen below. The crucial question is of course whether parental divorce can be considered independent of credit card debt.

Certainly a divorce or separation can produce a lot of stress and direct costs that might translate into credit card debt. It is therefore important to note that the indicator I propose to use as an instrument regards the divorce or separation of the individual's parents, not the

individual's own separation or divorce. The individual's own marital status or divorce is controlled for. The divorce of a person's parents may still cause expenses for the person itself if it is recent. The indicator denotes the separation or divorce of a person's parents, when the person was 14 years old or younger, however. Thus for the youngest person in the sample (17 years old) the smallest possible time distance between parent's divorce and the interview date is 3 years, provided the divorce happened when this person was exactly 14 years old and not younger. For 95% of the sample (those older than 24 years) this event was at least 10 years before their interview date. Thus it is unlikely that costs directly associated with parent's divorce affect current credit card debt levels.

It may not be parental divorce as an event but rather the situation of growing up in a household that has endured a divorce that has a causal effect on credit card debt. This would be the case if growing up in such a household has lasting influences on a person's traits and life outcomes (other than self-control) that do affect credit card borrowing. Parental divorce is generally regarded to have an adverse effect on several life outcomes of a child. Some of these outcomes can be regarded important for credit card borrowing, namely income, education or wealth. The instrument has to be uncorrelated with credit card borrowing only after controlling for other explanatory factors, however. I can control for factors like wage, education, homeownership, occupation group, socio-economic index of the area and potentially other measures for wealth and resources. Moreover, the general view that parental divorce has numerous negative effects is itself controversial. Gruber (2004) provides a concise discussion of the state of knowledge in the field and provides several reasons for why the conventional wisdom that parental divorce has numerous negative effects on child outcomes can be called into doubt. Still Gruber himself concludes that children exposed to divorce have lower family incomes and less education.

Payoff Probability

I employ the estimation strategy due to Rivers and Vuong (1988) to test for weak exogeneity of smoking in the payoff equation. As this technique requires that the potentially endogenous explanatory variable is continuous, I use CIGARETTES as proxy for self-control problems in this analysis. The estimation problem can be described by the following system.

$$payoff_i^* = \beta_0 + \sum_{k=1}^K \beta_k x_{ik} + \gamma * SMOKING_i + \varepsilon_i$$

$$CIGARETTES_i = \delta_0 + \sum_{l=1}^L \delta_l x_{il} + \lambda * PARENTSDIVORCE_i + \eta_i$$

$$payoff_i = 1[payoff_i^* > 0]$$

Under the assumption that ε and η are bivariate normal distributed a test for exogeneity of CIGARETTES is given by the following procedure. First, the residuals $\hat{\eta}$ are obtained from a linear regression of CIGARETTES on X and PARENTSDIVORCE. Then $\hat{\eta}$ is used as an additional regressor in probit estimation of PAYOFF on X and CIGARETTES. A t-test on the coefficient of the residual $\hat{\eta}$ is a test of weak exogeneity of CIGARETTES.

I use the extended specification without the indicators for risk attitudes. Running a regression of CIGARETTES on this specification yields a coefficient on PARENTSDIVORCE of 6.05 with a t-value of 2.27. Thus the instrument fulfills the requirement of being partially correlated with the endogenous variable, here CIGARETTES (see Table 30 in the appendix). Including the residual from this regression in probit estimation on PAYOFF gives a t-value of 2.88 on the residual. Doing the same for probit estimation on PAYHABIT gives a t-value of 2.86 on the residual. Thus exogeneity of CIGARETTES is clearly rejected. I compute coefficients using the conditional maximum likelihood method. Once the parameters α , β and γ have been estimated, partial effects can be computed in the standard way. Standard errors are obtained from the estimated Hessian matrix, and the standard errors for the partial effects are calculated with the Delta method. Table 23 shows the coefficients, t-statistics and corresponding marginal effects on the payoff probability for PAYOFF.

Table 23: Coefficients and Marginal Effects from instrumented Probit estimation

Variable	Coefficient	t	Marginal Effect	Mean
CIGARETTES	-0.02	-8.53	-0.01	17.88
WAGE	0.001	1.10	0.0003	28.40

Variable	Coefficient	t	Marginal Effect	Mean
RENTMORTGAGE	-0.13	-2.31	-0.05	0.53
HOMEOWNER	0.11	1.22	0.04	0.68
AGE	0.003	0.20	0.001	45.45
AGESQ	-0.000001	-0.01	-0.0000004	2279.43
MALE	0.17	3.75	0.07	0.48
MARRIED	-0.15	-2.49	-0.06	0.59
CHILDREN	-0.02	-0.98	-0.01	1.71
UNEMPLOYED	0.24	1.21	0.09	0.02
EMPTENURE	-0.002	-0.76	-0.001	5.71
HOMES	0.01	0.27	0.002	2.70
ED1: MA/PHD omitted				
ED2: graduate diploma	-0.16	-1.14	-0.06	0.07
ED3: bachelor	-0.12	-0.86	-0.05	0.18
ED4: advanced diploma	-0.11	-0.67	-0.04	0.11
ED5: certificate iii or iv	-0.15	-0.73	-0.06	0.18
ED6: certificate ii or iii	-0.12	-0.50	-0.05	0.05
ED7: undefined cert.	-0.19	-0.84	-0.07	0.05
ED8: year 12	-0.15	-0.82	-0.06	0.11
ED9: year 11 or less omitted	-0.01	-0.05	-0.01	0.22
FO1: Oceania omitted				
FO2: N/W Europe	-0.005	-0.10	-0.002	0.19
FO3: S/E Europe	-0.004	-0.05	-0.002	0.06
FO4: N Africa	-0.11	-0.62	-0.05	0.01
FO5: S/E Asia	-0.05	-0.32	-0.02	0.02
FO6: N/E Asia	0.17	0.66	0.06	0.01
FO7: S/C Asia	0.20	0.82	0.08	0.01
FO8: Americas	-0.33	-1.80	-0.13	0.01
FO9: SubSaharan A.	0.11	0.54	0.04	0.01
H1: excellent omitted				
H2: very good	0.03	0.34	0.01	0.40
H3: good	0.16	1.42	0.06	0.34

Variable	Coefficient	t	Marginal Effect	Mean
H4: fair	0.19	1.09	0.07	0.11
H5: poor	0.22	1.16	0.09	0.03
OG1: Legislators, Managers omitted				
OG2:Professionals	-0.09	-1.12	-0.03	0.19
OG3Technicians and Associate Professionals	-0.02	-0.26	-0.01	0.13
OG4:Office clerks	-0.04	-0.42	-0.01	0.09
OG5:Personal and Protective Services Workers	-0.04	-0.32	-0.02	0.07
OG6:Skilled Agricultural and fishery Workers	0.07	0.46	0.03	0.03
OG7:Craft and Related Trades Workers	0.06	0.54	0.02	0.06
OG8:Plant and Machine Operators and Assemblers	0.16	1.13	0.06	0.03
OG9:Elementary occupations	-0.16	-1.31	-0.06	0.04
OG11:Not in Labor Force	0.005	0.06	0.002	0.24
STRESS	0.01	0.42	0.005	0.66
AREA	0.01	0.81	0.004	5.93
CONSTANT	0.35	0.74		
No of Observations				
3715				
Log likelihood				
-21607				

The marginal effect on CIGARETTES is highly significant and increases by a factor of 10 from -.001 to -.01 (see Table 19). CIGARETTES is by far the largest influence on the payoff probability. Indeed few other variables are statistically significant. As in estimation without an instrument, men are more likely to pay off their debt than women. Different from before there is a statistically significant negative effect for being married. Higher payments for rent or mortgages decrease the payoff probability as expected.

It is surprising that many of the reasonable strong effects in estimation without an instrument have vanished in instrumental variable estimation. Home ownership and age do not play a role anymore. All education and health status dummies are statistically not significant now

but were highly significant before. Before analyzing these results further I present the results for CARDDEBT.

CARDDEBT

The model for instrumented estimation follows Smith and Blundell (1986).

$$CARDDEBT_i = \max(0, \beta_0 + \sum_{k=1}^K \beta_k x_{ik} + \gamma * CIGARETTES_i + \varepsilon_i$$

$$CIGARETTES_i = \delta_0 + \sum_{l=1}^L \delta_l x_{il} + \lambda * PARENTSDIVORCE_i + \eta_i$$

Assuming that ε and η are bivariate normal one can proceed analogously to the probit case. First, to test for endogeneity of CIGARETTES, one can use the residual from a linear regression of CIGARETTES on X and PARENTSDIVORCE, η , as an additional variable in tobit estimation of debt on X and CIGARETTES. If CIGARETTES is found to be endogenous one can proceed to obtain estimates of the coefficients and standard errors with conditional maximum likelihood estimation.

The linear regression of X on CIGARETTES is the same as in the probit case. The coefficient on the residual in the tobit estimation has a t-value of -3.15. Therefore exogeneity of CIGARETTES is clearly rejected.

Table 24 shows the results from maximum likelihood estimation. Column 1 shows the tobit coefficients, column 2 the t-statistics for the coefficients and columns 3 and 4 show the marginal effects for $E[y|X]$ and $E[y|X, y > 0]$ respectively.

Table 24: Tobit Estimation with instrumented CIGARETTES

Variable	Coefficient	t	$E[y X]$	t	$E[y X, y > 0]$	t
CIGARETTES	0.176	1.99	0.072	1.99	0.056	1.99
WAGE	0.002	0.41	0.001	0.41	0.001	0.41
RENTMORTGAGE	1.25	4.57	0.51	4.57	0.40	4.58

Variable	Coefficient	t	$E[y X]$	t	$E[y X, y > 0]$	t
HOMEOWNER	-0.95	-1.99	-0.40	-1.95	-0.30	-1.97
AGE	0.01	0.07	0.004	0.07	0.003	0.07
AGESQ	-0.00005	-0.03	-0.00002	-0.03	-0.00002	-0.03
MALE	-1.06	-1.90	-0.43	-1.91	-0.34	-1.91
MARRIED	1.28	1.35	0.52	1.37	0.40	1.36
CHILDREN	0.10	0.74	0.04	0.74	0.03	0.74
UNEMPLOYED	-3.15	-1.40	-1.09	-1.70	-0.90	-1.55
EMPTENURE	0.03	0.96	0.01	0.95	0.01	0.96
HOMES	-0.12	-0.59	-0.05	-0.59	-0.04	-0.59
ED1: MA/PHD omitted						
ED2: graduate diploma	1.74	1.66	0.77	1.54	0.58	1.58
ED3: bachelor	1.57	1.59	0.68	1.51	0.52	1.54
ED4: advanced diploma	1.58	1.34	0.69	1.26	0.52	1.29
ED5: certificate iii or iv	1.22	0.89	0.52	0.86	0.40	0.87
ED6: certificate ii or iii	0.77	0.44	0.33	0.43	0.25	0.43
ED7: undefined cert.	2.29	1.59	1.04	1.44	0.78	1.48
ED8: year 12	1.50	1.21	0.65	1.14	0.49	1.16
ED9: year 11 or less omitted	-0.33	-0.15	-0.13	-0.15	-0.10	-0.15
FO1: Oceania omitted						
FO2: N/W Europe	-0.07	-0.16	-0.03	-0.16	-0.02	-0.16
FO3: S/E Europe	0.25	0.35	0.11	0.35	0.08	0.35
FO4: N Africa	0.60	0.37	0.25	0.36	0.19	0.37
FO5: S/E Asia	1.02	0.68	0.44	0.64	0.33	0.66
FO6: N/E Asia	-1.54	-0.84	-0.58	-0.92	-0.46	-0.89
FO7: S/C Asia	-1.50	-0.89	-0.57	-0.97	-0.45	-0.94
FO8: Americas	2.48	1.53	1.15	1.37	0.85	1.41
FO9: SubSaharan A.	-0.82	-0.47	-0.32	-0.50	-0.25	-0.49

Variable	Coefficient	t	$E[y X]$	t	$E[y X, y > 0]$	t
H1: excellent omitted						
H2: very good	-0.60	-0.75	-0.24	-0.75	-0.19	-0.75
H3: good	-1.73	-1.21	-0.69	-1.24	-0.54	-1.23
H4: fair	-2.46	-1.16	-0.91	-1.30	-0.73	-1.24
H5: poor	-2.29	-1.01	-0.83	-1.16	-0.67	-1.09
OG1: Legislators, Managers omitted						
OG2:Professionals	0.25	0.38	0.10	0.38	0.08	0.38
OG3:Technicians and Associate Professionals	-0.11	-0.16	-0.04	-0.16	-0.03	-0.16
OG4:Office clerks	-0.20	-0.26	-0.08	-0.26	-0.06	-0.26
OG5:Personal and Protective Services Workers	-0.77	-0.79	-0.30	-0.82	-0.24	-0.81
OG6:Skilled Agricultural and fishery Workers	-0.40	-0.35	-0.16	-0.35	-0.13	-0.35
OG7:Craft and Related Trades Workers	-0.38	-0.42	-0.15	-0.42	-0.12	-0.42
OG8:Plant and Machine Operators and Assemblers	-1.88	-1.16	-0.70	-1.29	-0.56	-1.23
OG9:Elementary occupations	0.33	0.34	0.14	0.34	0.11	0.34
OG11:Not in Labor Force	-0.53	-0.70	-0.21	-0.71	-0.17	-0.71
STRESS	-0.13	-0.48	-0.05	-0.48	-0.04	-0.48
AREA	-0.03	-0.39	-0.01	-0.39	-0.01	-0.39
CONSTANT	-5.15	-1.69				
No of Observations	3715					
Log likelihood	-24737					

The coefficient and marginal effects on CIGARETTES increase by a factor of 18 compared to estimation without the instrument. Thus this increase is even more extreme than in the

PAYOFF case, where the marginal effect increases tenfold. This surprising increase is robust to changes in the specification.

The very large effect associated with CIGARETTES stands out in comparison with the rather modest effects associated with other statistically significant variables. A 1000 dollar increase in monthly rent and mortgage payments is associated with a 283 dollar increase in expected CARDDEBT. Being a home owner is associated with a 361 dollar decrease in expected CARDDEBT. Men have 1058 dollars less in expected CARDDEBT than women. Thus home ownership and rent and mortgage expenses still have the expected effect and there are no unreasonable coefficients on any of the control variables. As in the estimation for PAYOFF the surprising result is again that all education and health status dummies, that were highly statistically significant before, are not significant anymore when using instrumental variable estimation.

The extreme increase in coefficient values for CIGARETTES and the lack of significance for many variables that were important before call the validity of the instrument into doubt. Given the only limited knowledge that exists on many of the crucial relationships that underlie this analysis it is certainly possible that PARENTSDIVORCE does have an effect on credit card borrowing through some unobservable variables.

On the other hand, if the instrument is valid, exogenous variation in self-control problems might explain several results from instrumental variable estimation. As investment in education and health is a function of self-control problems, variation in true self-control problems can account for some variation in credit card borrowing that is due to education or health status. If so, then the significant effects measured on education and health status before instrumenting might have been only different channels for how self-control problems exert their effect. As education and health status have statistically and economically significant effects before instrumenting, the effect of self-control problems increases dramatically when using an exogenous measure of self-control problems. If this explanation is true, it would imply that the strongest influence on credit card borrowing are self-control

problems. Rather than differences in income, wealth or need, it would be differences in a personality trait that explain the variation in credit card debt.

4.6. Discussion

This empirical result is consistent with the literature that predicts higher credit card debt for people with self-control problems (Laibson (1997), Laibson, Repetto and Tobacman (2000), DellaVigna and Malmendier (2004)). DellaVigna and Malmendier (2004) discuss the possibility that the market mechanism could develop commitment devices for people with self-control problems, if people are aware of their problems. One form of commitment device might be high interest rates. The results of this chapter indicate, however, that existing commitment devices are not sufficient or that such commitment devices either do not yet exist in the credit card market or that people are not sufficiently aware of their self-control problems to demand such devices. Otherwise there should be no reason for why people with higher levels of self-control problems should still have higher levels of debt. Thus it seems that the market mechanism alone does not solve the problem.

How big a problem self-control problems are in this domain depends on the financial burden they imply. As in principle a debtor can decide to revolve his debt indefinitely the real burden from credit card borrowing are interest payments. It is therefore interesting to know how much interest payment is potentially due to self-control problems. As before I assume that the interest rate on credit card debt is 16%. I also assume that the estimated effects are stable and therefore a yearly interest rate applies. Table 25 shows the marginal effects and interest burdens associated with smoking the average number of cigarettes in the sample and with smoking the average number of cigarettes for smokers only with and without controlling for endogeneity. It also shows what percentage of average yearly wages these interest payments constitute.

Table 25: Yearly Interest Burden of smoking

	no IV	IV
E[CARDDEBT X]	0.0026	0.072

Effect of mean cigarette consumption (18)	46.8	1296
Yearly interest burden	7.49	207.36
Percent of average yearly gross wage	0.03%	0.74%
Effect of mean cigarette consumption, if positive (87)	226.2	6264
Yearly interest burden	36.19	1002.24
Percent of average yearly gross wage	0.13%	3.56%

Not controlling for endogeneity the effect associated with smoking is generally small. The interest burden of smoking the mean amount of cigarettes given positive cigarette consumption (87) is only \$36 per year and corresponds to only 0.1% of the average yearly gross wage. Controlling for endogeneity this interest burden increases to \$1002 per year which corresponds to 3.56% of average yearly wage. The large difference between the two estimates makes clear that it depends on the validity of the instrumental variable whether or not self-control problems are to be considered an important problem in credit card borrowing.

5. Conclusions

In chapter 2 I have argued that smoking can be regarded a measure of self-control problems. This chapter has shown that there is a strong negative correlation between any measure of smoking and the payoff probability and a strong positive correlation with credit card debt. These correlations persist across many different specifications. In particular, it does not seem to be the case that risk attitudes, stressful events, health status or occupation groups can explain the observed correlations. Furthermore, I argue that it is unlikely that unobservable characteristics that have been associated with smoking, like learning ability and time-discounting, are plausible candidates to explain the observed pattern of correlations.

Nevertheless it is still difficult to interpret these correlations in terms of self-control problems. The correlation may be due to reverse causality or due to the fact, that smokers incur higher expenses due to the cost of tobacco products and thus incur more debt. I suggest

two approaches towards solving these identification problems. First, I note that also former smokers differ statistically significantly from people who have never smoked. I argue that this difference is unlikely to be due to either reverse causality or expenses for tobacco products as the pattern of correlations observed does not support these interpretations. Second, I argue that an indicator of an individual's parent's divorce or separation is a potential instrument for CIGARETTES. Instrumental variable estimation still gives statistically significant coefficients on CIGARETTES but results in an extreme increase in their magnitudes. This calls the validity of the instrument into doubt. One interpretation of this large increase could be, however, that the exogenous measure of self-control problems grasps the effect of self-control problems that before was exerted through several other channels like education and health status.

If this result and its interpretation is valid, self-control problems are the dominant influence on credit card borrowing. Most debt would be due to self-control problems and the interest burden associated with this debt would be substantial. This result also indicates that any potential market solutions for self-control problems are unlikely to work. If high interest rates could serve as a commitment device one should not observe a large effect of self-control problems anymore, for example. This lack of market solutions for self-control problems possibly calls for government interventions in the credit card market.

By comparison the potential effect associated with smoking before instrumenting seems negligible. Even if after controlling for all observable potential confounding factors the correlations between smoking and credit card borrowing could be entirely attributed to self-control problems, the resulting interest burden would only constitute a very small part of average yearly gross wages. Thus whether to regard self-control problems as an important problem in credit card borrowing depends on whether the instrument is valid.

APPENDIX TO CHAPTER 3

A1.1 Additional Tables

Table 26: Standard Specification including endogenous regressors

Variable Name	Payoff		Debt	
	Coefficient	t	Coefficient	t
SMOKINGDUMMY	-0.31	-5.73	1.30	6.1
WAGE	0.001	0.97	0.01	1.69
RENTMORTGAGE	-0.14	-3.77	0.84	5.65
HOMEOWNER	0.28	5.21	-1.31	-6.03
AGE	-0.06	-5.61	0.30	6.85
AGESQ	0.001	6.89	-0.003	-7.47
MALE	0.20	4.27	-0.29	-1.53
MARRIED	0.08	1.47	-0.39	-1.87
CHILDREN	-0.04	-2.17	0.12	1.67
UNEMPLOYED	-0.25	-1.54	0.69	1.14
EMPTENURE	0.002	0.79	0.0004	0.03
HOMES	-0.05	-3.07	0.16	2.51
ED1: MA/PHD				
ED2: graduate diploma	-0.29	-1.89	1.64	2.52
ED3: bachelor	-0.32	-2.36	1.95	3.35
ED4: advanced diploma	-0.46	-3.26	2.62	4.34
ED5: certificate iii or iv	-0.64	-4.63	2.75	4.7
ED6: certificate ii or iii	-0.72	-4.4	2.89	4.25
ED7: undefined cert.	-0.69	-4.24	3.67	5.44
ED8: year 12	-0.55	-3.8	2.51	4.11
ED9: year 11 or less omitted	-0.80	-5.77	3.10	5.29
FO1: Oceania omitted				
FO2: N/W Europe	0.04	0.61	-0.20	-0.84
FO3: S/E Europe	0.18	1.97	-0.50	-1.34

FO4: N Africa	-0.06	-0.28	0.55	0.64
FO5: S/E Asia	0.26	1.64	-0.64	-0.97
FO6: N/E Asia	0.74	3.29	-3.23	-3.23
FO7: S/C Asia	0.74	3.36	-3.13	-3.3
FO8: Americas	-0.26	-1.3	0.76	0.99
FO9: SubSaharan A.	0.27	1.08	-1.00	-0.95
BORROWHOLIDAYS	-0.16	-3.04	0.88	4.14
BORROWCLOTHES	-0.30	-3.39	1.03	3
INVESTMETNS	0.41	8.91	-1.40	-7.36
OTHERDEBT	-0.000001	-1.74	0.00001	2.88
LIQUIDASSETS	0.00001	6.41	-0.00003	-6.31
CONSTANT	1.61	5.91	-9.88	-8.64
Pseudo R ²	0.15		0.05	
No of Observations	3,921		3,921	
log-likelihood	-2,224		-5,556	

Table 27: Tobit Estimation on DEBT including interaction between SMOKER and ED1

Variable Name	Coefficient	t
SMOKER	1.253128	5.58
ED1*SMOKER	4.075883	2.56
WAGE	0.0044994	1.28
RENTMORTGAGE	1.099626	7.03
HOMEOWNER	-1.477373	-6.53
AGE	0.2571653	5.66
AGESQ	-0.0030731	-6.5
MALE	-0.2453784	-1.16
MARRIED	-0.3422085	-1.56
CHILDREN	0.1474683	1.88
EMPTENURE	-0.0015778	-0.11
HOMES	0.1793287	2.75
ED1: MA/PHD		

ED2: graduate diploma	2.465285	3.34
ED3: bachelor	2.814277	4.17
ED4: advanced diploma	3.395356	4.83
ED5: certificate iii or iv	3.576783	5.1
ED6: certificate ii or iii	3.854209	4.94
ED7: undefined cert.	4.492041	5.73
ED8: year 12	3.41239	4.76
ED9: year 11 or less omitted	3.965092	5.67
FO1: Oceania omitted		
FO2: N/W Europe	0.0145865	0.06
FO3: S/E Europe	-0.3885432	-1
FO4: N Africa	-0.0851055	-0.1
FO5: S/E Asia	-0.767994	-1.11
FO6: N/E Asia	-3.347668	-3.25
FO7: S/C Asia	-3.1422	-3.21
FO8: Americas	1.204163	1.49
FO9: SubSaharan A.	-1.098884	-1.03
H1: excellent omitted		
H2: very good	0.5649503	1.79
H3: good	0.8026846	2.47
H4: fair	1.36028	3.39
H5: poor	1.530649	2.34
OG1: Legislators, Managers omitted		
OG2:Professionals	0.159609	0.42
OG3:Technicians and Associate Professionals	-0.4960465	-1.24
OG4:Office clerks	-0.0545267	-0.12
OG5:Personal and Protective Services Workers	0.239395	0.52
OG6:Skilled Agricultural and fishery Workers	-0.6983509	-1
OG7:Craft and Related Trades Workers	0.3119665	0.63
OG8:Plant and Machine Operators and Assemblers	0.6165503	1.07

OG9:Elementary occupations	0.0606421	0.11
OG10: Unemployed	0.5777778	0.82
OG11: Not in labor force	-0.3986453	-0.9
AREA	-0.1506542	-4.36
STRESS	0.2573178	2.41
CONSTANT	-10.21632	-7.68
Observations	3726	
log likelihood	-5288	

Table 28: Tobit Estimation on DEBT including interaction between SMOKER and ED9

Variable Name	Coefficient	t
SMOKER	1.75015	6.9
ED9*SMOKER	-1.723203	-3.48
WAGE	0.0043428	1.24
RENTMORTGAGE	1.102363	7.05
HOMEOWNER	-1.483156	-6.56
AGE	0.2653886	5.84
AGESQ	-0.0031744	-6.7
MALE	-0.1868463	-0.88
MARRIED	-0.3622516	-1.65
CHILDREN	0.153506	1.96
EMPTENURE	-0.0032475	-0.23
HOMES	0.177717	2.72
ED1: MA/PHD		
ED2: graduate diploma	1.882495	2.75
ED3: bachelor	2.186877	3.56
ED4: advanced diploma	2.767803	4.29
ED5: certificate iii or iv	2.886064	4.51
ED6: certificate ii or iii	3.18306	4.38
ED7: undefined cert.	3.832902	5.25
ED8: year 12	2.731601	4.15
ED9: year 11 or less omitted	3.801908	5.83

FO1: Oceania omitted		
FO2: N/W Europe	0.0085144	0.03
FO3: S/E Europe	-0.383321	-0.99
FO4: N Africa	-0.098635	-0.11
FO5: S/E Asia	-0.7607345	-1.1
FO6: N/E Asia	-3.332511	-3.25
FO7: S/C Asia	-2.992357	-3.09
FO8: Americas	1.129115	1.39
FO9: SubSaharan A.	-1.105666	-1.03
H1: excellent omitted		
H2: very good	0.528112	1.67
H3: good	0.8031943	2.47
H4: fair	1.349424	3.36
H5: poor	1.603617	2.45
OG1: Legislators, Managers omitted		
OG2:Professionals	0.1761326	0.46
OG3:Technicians and Associate Professionals	-0.4674242	-1.17
OG4:Office clerks	-0.0220412	-0.05
OG5:Personal and Protective Services Workers	0.271496	0.59
OG6:Skilled Agricultural and fishery Workers	-0.7236323	-1.04
OG7:Craft and Related Trades Workers	0.308811	0.62
OG8:Plant and Machine Operators and Assemblers	0.6506195	1.13
OG9:Elementary occupations	0.0469467	0.08
OG10: Unemployed	0.7363347	1.05
OG11: Not in labor force	-0.3647265	-0.82
AREA	-0.1486286	-4.3
STRESS	0.2528511	2.37
CONSTANT	-9.857557	-7.54
Observations	3726	
log likelihood	-5285	

Table 29: Tobit estimation with an interaction term between FORMERSMOKER and an indicator for wage above the median

Variable Name	Coefficient	t
FORMERSMOKERS	0.79	2.68
CURRENTSMOKERS	1.60	6.66
FORMERSMOKERS*HIGHWAGE	-0.21	-0.55
WAGE	0.00	1.35
RENTMORTGAGE	1.10	7.01
HOMEOWNER	-1.50	-6.63
AGE	0.25	5.49
AGESQ	0.00	-6.39
MALE	-0.26	-1.21
MARRIED	-0.31	-1.43
CHILDREN	0.14	1.74
EMPTENURE	0.00	-0.04
HOMES	0.17	2.63
ED1: MA/PHD		
ED2: graduate diploma	1.78	2.6
ED3: bachelor	2.15	3.51
ED4: advanced diploma	2.69	4.18
ED5: certificate iii or iv	2.86	4.47
ED6: certificate ii or iii	3.15	4.34
ED7: undefined cert.	3.80	5.21
ED8: year 12	2.69	4.09
ED9: year 11 or less omitted	3.28	5.15
FO1: Oceania omitted		
FO2: N/W Europe	-0.01	-0.05
FO3: S/E Europe	-0.37	-0.97
FO4: N Africa	-0.09	-0.1
FO5: S/E Asia	-0.72	-1.04
FO6: N/E Asia	-3.19	-3.1

FO7: S/C Asia	-3.02	-3.11
FO8: Americas	1.09	1.34
FO9: SubSaharan A.	-1.12	-1.04
H1: excellent omitted		
H2: very good	0.52	1.66
H3: good	0.75	2.32
H4: fair	1.32	3.3
H5: poor	1.44	2.2
OG1: Legislators, Managers omitted		
OG2:Professionals	0.16	0.41
OG3:Technicians and Associate Professionals	-0.49	-1.22
OG4:Office clerks	-0.03	-0.07
OG5:Personal and Protective Services Workers	0.24	0.52
OG6:Skilled Agricultural and fishery Workers	-0.69	-1
OG7:Craft and Related Trades Workers	0.30	0.61
OG8:Plant and Machine Operators and Assemblers	0.59	1.02
OG9:Elementary occupations	0.07	0.12
OG10: Unemployed	0.54	0.77
OG11: Not in labor force	-0.41	-0.93
AREA	-0.15	-4.33
STRESS	0.24	2.29
CONSTANT	-9.53	-7.29
Observations	3726	
log likelihood	-5287	

Table 30: Regression of extended specification and PARENTSDIVORCE on CIGARETTES

Variable Name	Coefficient	t
PARENTSDIVORCE	6.06	2.27
WAGE	0.01	0.46

RENTMORTGAGE	-0.68	-0.52
HOMEOWNER	-3.08	-1.59
AGE	1.50	4.28
AGESQ	-0.02	-5.21
MALE	4.93	2.87
MARRIED	-9.78	-5.38
CHILDREN	0.18	0.29
EMPTENURE	-0.17	-1.53
HOMES	1.72	3.12
ED1: MA/PHD		
ED2: graduate diploma	0.78	0.16
ED3: bachelor	3.96	0.94
ED4: advanced diploma	7.04	1.57
ED5: certificate iii or iv	10.66	2.4
ED6: certificate ii or iii	14.69	2.73
ED7: undefined cert.	9.65	1.8
ED8: year 12	8.06	1.73
ED9: year 11 or less omitted	21.85	4.94
FO1: Oceania omitted		
FO2: N/W Europe	0.28	0.14
FO3: S/E Europe	-3.29	-1.04
FO4: N Africa	-3.13	-0.4
FO5: S/E Asia	-10.20	-1.82
FO6: N/E Asia	-11.27	-1.66
FO7: S/C Asia	-8.48	-1.25
FO8: Americas	-7.30	-0.99
FO9: SubSaharan A.	-2.13	-0.26
H1: excellent omitted		
H2: very good	6.86	2.74
H3: good	15.12	5.85
H4: fair	22.81	7.01
H5: poor	21.88	4.06

OG1: Legislators, Managers omitted		
OG2: Professionals	-0.91	-0.29
OG3: Technicians and Associate Professionals	-2.19	-0.67
OG4: Office clerks	0.51	0.14
OG5: Personal and Protective Services Workers	6.12	1.54
OG6: Skilled Agricultural and fishery Workers	-2.37	-0.44
OG7: Craft and Related Trades Workers	3.64	0.86
OG8: Plant and Machine Operators and Assemblers	14.14	2.81
OG9: Elementary occupations	-1.63	-0.35
OG10: Unemployed	21.20	3.43
OG11: Not in labor force	0.51	0.14
AREA	-0.73	-2.58
STRESS	2.23	2.49
CONSTANT	-26.81	-2.64
Observations	3715	
adjusted R2	0.09	

Chapter 4: Self-Control Problems and Saving in Illiquid Assets

"Use whatever means possible to remove a set amount of money from your bank account each month before you have a chance to spend it"

Advice in New York Times "Your Money" column, 1993

1. Introduction

Research suggests that the largest share of wealth accumulation results from people's choices rather than from chance events (e.g. Venti and Wise (1998)). Standard preferences, however, cannot explain these choices satisfactorily (Bernheim, Skinner and Weinberg (2001)). The existence of self-control problems may be an additional factor that might help to explain the savings behaviour of people. However, on the one hand theoretical research and intuition suggest that self-control problems lead to "too much" consumption and thus may impede the accumulation of savings in general (O'Donoghue and Rabin (March 1999)). On the other hand one way to overcome self-control problems is the use of commitment devices. Illiquid assets are such commitment devices. They allow people to put away their money such that they can only access it at a future point in time. Thus, if people are aware of their self-control problems savings in illiquid assets could increase in the presence of self-control problems (Laibson, Repetto, and Tobacman (1998)). Given the negative effect to be expected on savings in general and the potentially positive one for savings in illiquid assets, it is unclear what the overall effect of self-control problems on savings in illiquid assets is.

This chapter is an attempt to shed light on this question. I use a sample of employees from an Australian household survey that have access to an illiquid asset in the form of retirement funds. These funds are illiquid in the sense that with a few well defined exceptions contributions made to them cannot be used for consumption until a certain age is reached. As discussed in chapter 2, I use smoking as an indicator for a high level of self-control problems. First, I look at the correlation between smoking and accumulated savings in these retirement funds when controlling for important characteristics. Then I discuss potential problems that can arise when looking for a self-control interpretation of the observed correlations. Similarly as in chapter 3 omitted heterogeneity or reverse causality might play a role. As a third step I look at the correlation between smoking and *liquid* assets and smoking and the ratio of illiquid to overall financial assets for additional evidence.

The existing empirical literature on the relationship between self-control problems and saving is, as of now, scarce. Ameriks et al. (2003) investigate the relationship between planning

behavior and wealth accumulation. They find that households that have a higher propensity to plan accumulate more wealth. From additional survey evidence they conclude that planning most likely serves as a form of "effortful self-control". In a related paper Ameriks et al. (2004, 2007) directly construct a measure of self-control problems from a custom designed survey. Regressing wealth on this measure, they find that self-control problems impede wealth accumulation. In particular they obtain a negative association of their measure with non-retirement (liquid) wealth, while getting a statistically insignificant coefficient on their measure with illiquid retirement wealth. Angeletos et al. (2001) simulate a life cycle consumption model that either incorporates agents with exponential or agents with hyperbolic time preferences. Their simulation results yield that agents with hyperbolic preferences hold higher levels of illiquid wealth throughout the life cycle. Accordingly hyperbolics hold lower levels of liquid wealth and higher levels of liquid debt than exponential agents throughout the life cycle. In a second step they compare their simulation results with data from the Survey of Consumer Finances. When looking at the share of wealth held in liquid assets the simulation with hyperbolic agents is a better approximation to the corresponding share from the survey than the simulation with exponential agents. In summary the two empirical investigations by Ameriks et al. (2003 and 2004) indicate that self-control problems impede wealth accumulation, particularly in liquid form and seem to have no effect on wealth accumulation in illiquid form. The simulation results by Angeletos et al. (2001) indicate that self-control problems affect wealth accumulation in liquid form negatively but wealth accumulation in illiquid form positively.

If smoking is an indicator of a higher level of self-control problems as I argue in chapter 2, my results from this chapter directly support the simulation results by Angeletos et al. (2001). I find that smoking is *positively* correlated to accumulated savings in illiquid retirement funds. On average, smokers have around 12% to 14% more savings in retirement funds than non-smokers. This result holds when controlling for standard characteristics, risk attitudes, cultural backgrounds and industry groups. Moreover, some possible explanations under the assumption that smoking is an indicator of low income, do not explain this result.

When assessing the possibility for a self-control interpretation of this correlation, I argue that most potential sources of bias that were discussed in chapter 3 are unlikely to be of concern here. First, most alternative interpretations of smoking are invalidated by virtue of the positive correlation that is observed between smoking and accumulated savings in retirement funds. Second, omitted variables are less likely to play an important role and if they do they should induce a downward bias on the estimated effect of self-control problems. Finally, reverse causality is less likely to be a problem. Even if there is a causal effect from the level of illiquid savings on the probability of smoking one would expect this effect to cause a negative correlation. Thus again, the observed positive correlation may underestimate the true effect of self-control problems on the level of illiquid savings. Hence self-control problems are a main candidate for the explanation of the observed correlation.

Additional evidence from the correlation between smoking and liquid assets supports this interpretation. If it is the commitment property that causes people with self-control problems to save more in illiquid assets, one should not observe such an effect when commitment is not possible as is the case for liquid assets. In my sample smoking is negatively correlated with the level of liquid assets. Moreover, if a self-control interpretation of the observed correlation is correct, one should observe that people substitute liquid for illiquid assets if they suffer from self-control problems. In a regression on the ratio of illiquid to overall financial wealth smoking also displays a positive and statistically significant coefficient. This result again is consistent with a self-control interpretation.

The chapter proceeds as follows. Section 2 discusses the theoretical background. Section 3 gives an outline of the relevant features of the Australian retirement savings system. Section 4 presents the data. Section 5 presents the relationship between smoking and accumulated savings in retirement accounts. Section 6 discusses whether the observed correlations can be interpreted in terms of self-control problems. Section 7 presents the evidence concerning liquid assets and section 8 concludes.

2. Theory Review

The theoretical literature suggests two mechanisms for how self-control problems might affect retirement saving. The first of these mechanisms is procrastination. Saving current resources for retirement entails immediate costs in the form of foregone consumption and delayed benefits in the form of future consumption. O'Donoghue and Rabin (1999) analyze the behavior of people who have to do such an action in the presence of self-control problems and compare it to behaviour in their absence. They find that people who are naive, in the sense that they are not aware of their future self-control problems, do such an action relatively later. Thus in the presence of self-control problems naive people can be expected to start saving relatively later. This should induce a negative correlation between a measure of self-control problems and accumulated savings. Moreover, the fact that saving for retirement is an especially important action likely aggravates procrastination as suggested by O'Donoghue and Rabin in a related paper (O'Donoghue and Rabin (2001)).

People might be sophisticated in the sense that they are fully aware of their future self-control problems, however. Then, as O'Donoghue and Rabin show, a "sophistication effect" that directly characterizes the implications of sophistication versus naiveté, mitigates procrastination and might even outweigh it. Therefore sophisticated agents might start to save for retirement earlier than agents who do not suffer from self-control problems. This could have the effect that people with self-control problems are indistinguishable from people without self-control problem or even save more.

The second mechanism for how self-control problems could affect retirement saving is the presence of commitment devices. People who suffer from self-control problems and are aware of it (sophisticates) have an incentive to protect future resources from their own future consumption urges. One way of protecting resources is to invest them in illiquid assets (Laibson (1997)). Laibson, Repetto and Tobacman (1998) and Angeletos et al. (2001) explicitly model defined contribution retirement plans as such an illiquid asset. They find that people who have self-control problems (modelled with hyperbolic discounting) accumulate more wealth in partially illiquid and less wealth in liquid form than exponential consumers. Thus

they predict that agents with self-control problems will save relatively more in partially illiquid assets and relatively less in liquid assets.

In summary the theoretical predictions of the effect of self-control problems on saving depend on the assumptions made for the level of awareness of people and on the presence of commitment devices. Naive agents are generally predicted to save less than agents who do not have self-control problems. This is so regardless of the presence of commitment devices, as people who are not aware of their self-control problems do not see the need to commit. Sophisticated agents, however, might also save more than agents without self-control problems, especially in the presence of commitment devices like illiquid assets.

One potential benefit of the empirical analysis that follows is to give an indication for which model of awareness is more appropriate. If people are naïve, one should always observe a negative effect of self-control problems on accumulated savings, regardless of whether commitment is possible or not. If people are sophisticated, one might observe a positive effect regardless of whether commitment is possible or not. Then one could conclude that O'Donoghue and Rabin's sophistication effect prevails over the present bias. If a positive effect is only observed when commitment is possible, one could conclude that the sophistication effect is not sufficient to overcome a present bias and people need outside help to overcome their self-control problems.

3. Retirement Income Provision in Australia

The data I use are a cross section from the Household Income and Labor Dynamics in Australia (HILDA) survey⁹. The illiquid asset I use for my analysis are savings in funds that are meant to provide income for retirement. In assessing the determinants of accumulated savings in funds that are meant to provide retirement income, it is important to understand the public policy

⁹ This chapter uses a confidentialised unit record file from the Household, Income and Labour Dynamics in Australia (HILDA) survey. The HILDA Project was initiated and is funded by the Commonwealth Department of Family and Community Services (FaCS) and is managed by the Melbourne Institute of Applied Economic and Social Research (MIAESR). The findings and views reported in this paper, however, are those of the author and should not be attributed to either FaCS or the MIAESR.

towards this savings channel. Here I discuss relevant features of the institutions that govern retirement income provision in Australia.¹⁰

3.1. Old Age Pension

The "Old Age Pension" is a targeted means tested entitlement program. It serves as a social welfare safety net for the elderly and is financed out of general revenue. The eligible population are women above 61.5 and men above 65 years of age. Claimants of this pension must also satisfy certain residency qualifications. Those eligible receive a flat rate maximum entitlement which is reduced at a rate depending on private income and assets. At a certain income and asset limit, the entitlement ceases altogether. The age pension also includes other non cash benefits. Examples are concessional public transport travel and subsidised medical care and medication.

Any single person receives a higher pension than each member of a married couple. These payments amount to around 25% of average income for a single person and to around 40% for a couple. In the year 2000 the full entitlement rate for a single person was 9529 dollars per year for a single person and 7953 dollars for a married person.

All payments are subject to means testing with respect to personal income and assets. For any dollar of private income in excess of 51 dollars per week, the rate decreases by 50 cents. Similarly the age pension is reduced by 1.50 dollars per week for every 1000 dollars of assets above a certain threshold. Family homes are exempt from the asset means test, but the asset thresholds are different for homeowners and non-homeowners, where the thresholds for homeowners are lower than those for non-homeowners. In the year 2000 the asset threshold for a single person who was a homeowner was 127 750 dollars, while that for a non-homeowner was 219 250 dollars. All income and asset thresholds are indexed to annual movements in the Consumer Price Index.

¹⁰ For a survey see Bateman and Piggott (1997). For up to date information see the Homepage of the Australian government www.ato.gov.au/super.

Around 80% of the retired of eligible age receive some age pension in Australia today. Around 70% of those who receive the pension obtain the full rate. Thus the Age Pension is a very important pillar of retirement income today. With the introduction of the Superannuation Guarantee, this should change in the future.

3.2. The Superannuation Guarantee

The Superannuation Guarantee is the second pillar of income provision for old age in Australia. Established in 1992 with the Superannuation (Administration) Guarantee Act, it requires that employers make a contribution on behalf of their employees to a complying retirement fund. Employers that fail to do so are subject to a penalty payment that is larger than the contributions that have to be made. The mandatory contribution rate has been gradually increased. From 2002 onwards it is 9% of gross wage and is meant to stay at this level.

While all employers are subject to the rules of the Superannuation Guarantee Act, some employees are exempt. These are employees below 18 and above 65 years of age, and those earning less than 450 dollars per month. Moreover the Superannuation Guarantee applies only to the first 80 000 dollars of earnings. Any earnings above that threshold are not subject to the mandatory employer contribution. The self-employed are not covered by the Superannuation Guarantee.

The contributions are paid into individual accounts with a pre-approved "complying superannuation fund". These funds are frequently organized along corporate or industry lines. Bateman and Piggott (2001) cite evidence that in 1999 out of 20.528 million retirement accounts, 6.184 million were with industry and 2.677 million with public sector funds. Additional 1.389 million funds were corporate funds. Thus about half of all retirement accounts were organized along corporate or industry lines. The other half were retail funds offered by banks or insurance companies.

The employer contributions are fully vested, i.e. the member is fully entitled to all accrued benefits, and fully funded, i.e. all contributions are invested. They are also fully preserved.

This means that accrued benefits must remain in the fund until the statutory preservation age for access to benefits is reached. Currently the preservation age is 55.

3.3. Voluntary Saving

Employees can also make voluntary contributions to their superannuation fund. Bateman and Piggott (1997) cite evidence from the Australian Bureau of Statistics, that in 1993 50% of all employees covered by the Superannuation Guarantee made voluntary contributions at an average rate of 5.7% of earnings. Bateman and Piggott (2001) report that voluntary contributions to superannuation funds accounted for 62% of total superannuation contributions in 1998-1999 and that 43% of all employees made voluntary contributions at an average rate of 6% of earnings. In other words mandatory contributions by employers only accounted for 38% of all contributions in that year.

In July 2003 the Australian government started a policy of co-contributions, where a voluntary contribution to a superannuation fund is matched to a certain degree and up to certain income thresholds by a government contribution. As the data I use are for the year 2002, this new policy is not relevant here.

3.4. The Liquidity of Superannuation Funds

Generally benefits in a superannuation fund cannot be accessed until the preservation age is reached and/or the eligible person retires. If funds are accessed illegally marginal tax rates are charged on the benefits and a penalty might occur. Thus savings in superannuation funds can be generally regarded as illiquid. They are not totally illiquid, however, as there exist certain early access rules. Accepted reasons for early access are "severe financial hardship" and "compassionate grounds", e.g. medical treatment. Strict conditions have to be met and approved by the Australian Prudential Regulation Authority for either early access reason to apply. Even then only a limited amount of benefits can be withdrawn from the fund.

The rules are more complicated in detail. Superannuation benefits fall into three categories: preserved benefits, restricted non-preserved benefits, and unrestricted non-preserved benefits.

Different conditions have to be met to obtain access to these different categories of benefits. From 1st of July 1999 all contributions made by or on behalf of an employee to a regulated superannuation fund and all earnings made on or after this date are classified as preserved. Thus at least for the 3 years prior to the interview year 2002 all voluntary contributions were automatically classified as the "most" illiquid category.

3.5. Taxation

Employer contributions are tax deductible, if they are made to a complying superannuation fund. The deductions are limited to certain amounts that increase with the age of the employee. From July 1995 onwards, deductions were limited to 9405 dollars of contributions for employees less than 35 years of age, 26125 dollars for those aged 35 to 49 and 64700 for those over 50. These thresholds increase annually according to an index. Voluntary contributions by employees are made out of after tax income and generally do not qualify for tax rebates. Employees who earn less than 31000 dollars a year can claim a tax rebate of up to 1000 dollars per year when making voluntary contributions, however. Other than the savings in superannuation funds, there are no forms of saving that are supported by government policy.

Fund income, i.e. the income of an investment fund, is taxed with a single rate of 15%, which is slightly lower than the lowest non-zero marginal tax rate. The tax treatment of different forms of income varies however. Contributions which have received tax concessions in the hands of the contributor (employer and some forms of employee contributions) are taxed. Contributions that are paid out of after-tax income are not taxed. The investment income of superannuation funds is subject to the same rules as non-superannuation funds.

Superannuation benefits may be taken as a lump sum, an annuity or may be placed in a rollover fund. Benefits that are rolled over are not subject to tax until they are withdrawn.

The tax treatment of benefits that are withdrawn depends on a number of factors, including the type of benefit (lump sum, annuity, pension), the size of the benefit, i.e. whether it is above or below so called Reasonable Benefit Limits (RBL), and the age at which the benefit is taken. If the benefit is allowed to be taken before the statutory preservation age they are taxed at a higher rate. The details of taxation of benefits are difficult. As my analysis concerns the accumulation of benefits and not their subsequent use and as every person, at least in principle, has the same choices on how to use their superannuation benefits and thus can also make use of the same tax regimes I can ignore these detailed tax rules here.

3.6. Conclusions

The interesting feature of the Australian system of retirement income provision for my analysis is that voluntary contributions can be made into superannuation funds and that these voluntary contributions account for a large share of overall contributions (62% in 1998-1999, for example). Once a voluntary contribution has been made into a regulated superannuation fund, the contributed resources become illiquid as they cannot be accessed before retirement or reaching the preservation age unless strict conditions are met and a considerable administrative effort is made. In light of the theory of self-control problems, superannuation funds can thus be seen as commitment devices that people can use to protect their own resources from their own consumption urges. The potential commitment property of superannuation funds makes them interesting objects of study when investigating the potential effects of self-control problems.

The tax treatment of contributions (and possibly fund income and benefits) might have important incentive effects on behaviour. It is unclear, however, what these effects are. The tax rebate on employer contributions can be regarded to favour wealthy individuals as a tax rebate is worth more at high marginal tax rates. On the other hand rebates are only granted up to a certain limit, hence the very wealthy don't benefit from them anymore. Also the disadvantage for the less wealthy is balanced by the extra tax rebates that can be claimed on voluntary contributions if the employee earns less than 31 000 dollars per year.

Likewise there may exist interactions between saving in superannuation funds and the rules for the Old Age Pension. One example is that low income employees might not consider it worthwhile to do any additional voluntary saving if they do not expect a higher income stream from their superannuation savings than what they could get under the Old Age Pension. It is unclear if and how these incentives or interactions interfere with the analysis of an effect of self-control problems on savings. Some potential problems are discussed after the presentation of the main results.

Finally, given that the Superannuation Guarantee Act came into force only in 1992 it is clear that older people must have saved in a different way for their retirement. It is unclear how that should affect the estimation to follow, though.

4. Data

The goal of the analysis is to investigate the effect of self-control problems on accumulated savings in illiquid assets like superannuation funds. The sample is thus selected in such a way that first, people have access to an illiquid asset in the form of a superannuation fund, and second, they are covered by the Superannuation Guarantee. Being covered by the Superannuation Guarantee implies a mandatory savings scheme. Thus all individuals in the sample face the relatively homogenous situation of receiving mandatory employer contributions into their retirement accounts and all face the decision on what to contribute beyond these mandatory savings, i.e. whether to make voluntary contributions. As noted in the previous section, voluntary contributions account for a large share of overall contributions.

This implies several operations on the original sample in order to arrive at the sample used for estimation: From the original sample of 13041 observations I first drop all observations (2925) that correspond to persons who said they had retired or who never were in paid work but consider themselves retired. Next I drop 507 observations for the unemployed, 1578 observations for those who are not in the labour force, and 1479 observations that correspond to the self-employed. This leaves a sample of 6552 observations of employees. In order to

make sure that the employers of these employees comply with the Superannuation Guarantee. I drop 865 observations for people who responded that their employers did not make contributions on their behalf or if they did not know whether this was the case. The Superannuation Guarantee is written in terms of defined contribution funds. Some people still have defined benefit funds, however. It is unclear which rules apply to defined benefit schemes and which properties savings in such funds have. Therefore I only keep those observations that report that their largest fund is of the defined contribution type. While the remaining subjects in the sample may also have other types of funds, I can be sure that they have access to the sort of defined contribution funds that are of interest in my study. Finally I make sure that all subjects fulfil the age and income requirements necessary for the Superannuation Guarantee to apply. I also make sure that the illiquidity property of savings in superannuation funds applies. This is the case if the person in question is below the statutory preservation age which currently is 55. Hence I delete all observations corresponding to people with age below 18, above 55, and with a monthly income of less than 450 dollars. The remaining sample has 3301 observations. After deleting observations that report missing values for any of the variables of the main specification described later 2570 observations remain. In order to exclude potential outliers I delete observations corresponding to the upper and lower 1 % of the distribution of accumulated savings in superannuation funds and the upper 1% of the wage distribution (I already excluded people with wages below 5400 dollars per year to assure that people are covered by the Superannuation Guarantee). Finally I drop all those observations which report contributions rates of their employers below 8% (212) and above 9% (246). In the year 2002, in which the data of the cross-section are collected, the mandatory employer contribution rate was 8 or 9%. Thus any other reported contribution rate must constitute an error of the respondent and the overall precision of his responses are called into doubt. (As will be presented later, this final operation does not change the main result but increases the precision of the estimates.) Then I obtain the 1764 observations that constitute my sample.

From the many operations performed on the original sample and the large reduction in sample size it is obvious, that the sample is not representative of the whole population. Evidently this sample can only be representative of the group of people that is the target of

the Superannuation Guarantee in Australia. Being the target of this main pillar of the Australian system of retirement income provision, it can certainly be regarded a subgroup that is interesting in itself.

4.1. Accumulated Savings in Superannuation Funds

The outcome of interest are accumulated savings in superannuation funds. I call this variable FUNDVALUE. The variable is based on the following survey question:

Taking all your superannuation funds together, including any that you may have stopped contributing to, what would be their approximate value if you were able to retire or resigned today?

In order to increase the precision of the responses, survey participants first had to choose a range of possible values, for example "5000 or less", "5000 to 20 000", etc., and then were asked to give their best estimate of the exact value within this range. This estimate is the value used for FUNDVALUE.

On average the level of FUNDVALUE in the sample is \$42 189. The distribution of FUNDVALUE is extremely uneven, however. Almost 50% of the sample have a level of FUNDVALUE of less than \$20 000 and almost one fourth of the sample have less than \$8 000. At the other extreme the top 10% of the distribution have a FUNDVALUE between \$110 000 and \$450 000. Thus the distribution is heavily skewed to the right, with a skewness coefficient of 2.97. Normalizing FUNDVALUE by age, by gross wage measured in units of thousands or by both does not change this feature of the distribution significantly or even increases the skewness.

Table 31: Financial Characteristics

Variable	Mean	Median	St.dev.	Skewness	Min.	Max.
FUNDVALUE	42,189	20,000	62,143	2.97	300	450,000
FUNDVALUE/AGE	1,028	532	1,391	2.97	11	11,250
FUNDVALUE/WAGE	1,113	526	1,831	5.27	9.46	27,655
FUNDVALUE/AGE/WAGE	27	14	41	4.62	.35	522

Table 31 summarizes these normalized measures of FUNDVALUE. For each year of age, people have on average \$1028 in accumulated savings in superannuation funds. For each \$1000 of yearly gross wage they have on average \$1113 in FUNDVALUE. For each year and \$1000 of wages people have an average of \$27 in FUNDVALUE. The range of the distributions for FUNDVALUE and normalized FUNDVALUE shows that individual differences are huge. The upper half of the distribution of the raw measure of FUNDVALUE on average has more than 8 times the amount of savings in superannuation funds than the average of the lower half. The upper quarter on average has 32 times more in FUNDVALUE than the average in the lowest quarter. For the measure of FUNDVALUE normalized on age and wage, these ratios are approximately 7 and 16.

Table 32: Relation of FUNDVALUE to Household Wealth

Variable	Mean	Median	St.dev.	Min.	Max.
HHFINANCIAL	132,257	64,645	202,034	300	2,679,575
HHTOTAL	432,516	327,500	506,552	1,200	7,939,249
FUNDVALUE/HHFINANCIAL	0.45	0.41	0.31	0.0003	1
FUNDVALUE/HHTOTAL	0.16	0.08	0.19	0.0002	1

In order to assess the importance of savings in superannuation funds relative to overall wealth, Table 32 relates FUNDVALUE to levels of financial and total wealth of the household the individual belongs to. The variable HHFINANCIAL is the sum of liquid assets like savings in bank accounts and investments in stocks and bonds and superannuation wealth of the household. It is computed from the household survey and therefore is at the household level. Similarly the variable HHTOTAL is the sum of HHFINANCIAL and non-financial wealth, which comprises the home value, the value of other property and vehicles. Household total wealth on average is more than 3 times larger than household financial wealth, which most likely reflects home equity. The ratio FUNDVALUE/HHFINANCIAL measures the ratio of an individual's savings in a superannuation fund as a share of the overall financial wealth of the household he belongs to.

On average FUNDVALUE accounts for 45% of overall financial wealth of the corresponding household. For 50% of the sample, FUNDVALUE accounts for more than 41% of overall household financial wealth. Not surprisingly these numbers are much lower when taking into account home equity. Then FUNDVALUE on average constitutes only 16% of overall wealth and for 50% of the sample FUNDVALUE constitutes less than 8% of overall wealth. HHTOTAL is net of any debts these households have, however. Total household wealth including debt is much lower than this and often even negative. Thus individual superannuation wealth is clearly an important part of overall household financial wealth for a large part of the sample. It is less important when putting it in relation to overall household wealth including home equity.

4.2. Control Variables

Table 33 gives definitions and means for the control variables.

Table 33: Control Variables

Variable	Definition	Mean
WAGE	Wage before tax	40,035
BEQUEST	(1) if received inheritance or bequest	0.01
FULLTIME	(1) fulltime employed (0) parttime employed	0.77
EMPTENURE	Tenure with current employer in years	5.68
JOBTENURE	Tenure at current job in years	8.72
AGE	Age	37.41
MALE	(1) male, (0) female	0.53
CHILDREN	Number of children	1.35
MARITAL	marital status	1.35
	legally married	0.58
	in relationship	0.14
	separated	0.03
	divorced	0.05
	widowed	0.01
	no relationship	0.2

Variable	Definition	Mean
EDUCATION	highest education level achieved:	
	PhD or MA	0.04
	Graduate diploma or certificate	0.07
	Bachelor	0.22
	Advanced Diploma	0.1
	Certificate iii or iv	0.21
	Certificate i or ii	0.06
	undefined certificate	0.03
	12 years of school	0.12
	11 years of school	0.17
OCCUPATION	International Standard Classification of Occupations 1-digit	
	Legislators, Senior Officials and Managers	0.1
	Professionals	0.23
	Technicians and Associate Professionals	0.18
	Office clerks	0.16
	Personal and Protective Services Workers	0.11
	Skilled Agricultural and fishery Workers	0.01
	Craft and Related Trades Workers	0.1
	Plant and Machine Operators and Assemblers	0.06
	Elementary occupations	0.05
	Armed Forces	0.001
CULTURE	Father's country of birth	
	Oceania and Antarctica	0.68
	North/West Europe	0.15
	South/East Europe	0.08
	North Africa and Middle East	0.01
	South East Asia	0.03
	North East Asia	0.01
	Southern and Central Asia	0.01
	Americas	0.01

Variable	Definition	Mean
	Sub-Saharan Africa	0.02
RISK	Attitudes towards financial risk	
	not willing to take any risk	0.46
	take average risk	0.43
	take above average risk	0.1
	take substantial risk	0.02

In a mandatory system like that of Australia accumulated savings for retirement must be an increasing function of wage and age. Thus age and wage are the most important control variables. WAGE denotes gross wage in the last financial year. Additionally I use indicators of long term earning power like EDUCATION and OCCUPATION. EDUCATION is organized in 9 groups which in the HILDA survey denote the highest level of education achieved by an individual. Occupation groups are the 1-digit International Standard Classification of Occupations (ISCO) groups. I also have information on a person's tenure in her current job, denoted JOBTENURE, and with her current employer, EMPTENURE, which possibly also grasp earning power as they reflect a person's experience in a certain job and a certain organisation. I expect WAGE, any earning power measures like EDUCATION and OCCUPATION, and AGE, JOBTENURE, and EMPTENURE that grasp job experience to be positively related to the amount of retirement wealth. An additional measure of long term earning power might be an indicator for whether the person works full time or part time, denoted FULLTIME. I also include a dummy that indicates whether the person has received any inheritances or bequests called BEQUESTS.

The standard demographic controls are marital status, MARITAL, a dummy for male respondents, MALE, and the number of children a person has, CHILDREN. It is not clear what to expect from MALE after controlling for wage. As wages for men are typically higher than for women, MALE, might be considered another indicator for long term earning power and thus be positively correlated with FUNDVALUE. People who are legally married are likely to share a household which might enable them to save on some common expenses. They also

might be more likely to invest into home equity which would leave less money to invest into retirement funds. The opposite is true for those who separated, divorced or do not live in a relationship. Thus it is unclear which sign to expect on the dummies for marital status. I expect the number of children to be negatively related to retirement savings as children probably limit the funds that are available for saving.

In this form the specification is very similar to the two papers by Ameriks et al. (2003) and (2004) who use wage, age, education, employment groups, marital status, number of children and a dummy for male respondents in their wealth regressions.

In order to control for specific characteristics of my sample and the question that I wish to investigate, I add additional variables. As remarked in section 3 Superannuation funds are often organized along corporate and industry lines in Australia. There may be differences between industries as to how employees are informed and encouraged to make voluntary contributions. There may also be systematic differences in investment success across different types of funds. Therefore I control for industry groups according to the International Standard Classification of Industries (ISIC)¹¹ 2-digit level for industries. A short description of industry groups is in the appendix.

Cultural backgrounds might play a role in saving behaviour. The literature on the topic is inconclusive, however. Guiso, Sapienza and Zingales (2006) review some literature that supports an effect of cultural background on savings, while Carroll, Rhee and Rhee (1994 and 1999) do not find such an effect. Lacking direct measures, I include dummies for a person's father's country of birth classified according to the International Standard Classification of Countries (ISCC) to account for this possibility.

As superannuation funds are fully invested, individuals who put their money into such a fund expose themselves to market risk. Risk averse individuals might prefer safer forms of investment like low yielding savings accounts. Thus the degree of risk aversion might explain why some people make more voluntary contributions than others. In order to account for this

¹¹ see <http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=2>

possibility, I include a variable based on a survey question on risk attitudes. Participants were asked the following question:

"Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash? That is, cash used for savings or investments."

Possible answers were:

1) I'm not willing to take any risk, 2) I take average financial risk, 3) I take above average financial risk, and 4) I take substantial financial risk.

I include dummies for these answer categories in estimation.

5. Smoking and Superannuation Fund Value

The top row of Table 34 shows means for FUNDVALUE normalized by age and wage for smokers and non-smokers for the whole sample.

Table 34: FUNDVALUE/AGE/WAGE for different groups by smoking status

Group	Non-Smokers	Smokers
All	26.46	30.30
Men	25.53	29.74
Women	27.44	31.04
Married	29.49	36.28
Unmarried	21.34	25.81
PHD/MA/BA/Adv.Dipl.	25.71	28.74
Lower education	26.89	30.64
Managers, Professionals, Technicians	25.91	26.76
Other Occupations	27.13	32.69
Father born in Australia	28.91	32.75
Father not born in Australia	21.57	24.69

Overall smokers have a higher level of normalized FUNDVALUE than non-smokers as shown in the first line of Table 34. One might suspect that this is due to an obvious correlation in the

population, like for example, that men are more likely to smoke than women and men also have a higher earning power. As the comparisons across subgroups show, however, the pattern that smokers have a higher average fund value than non-smokers persists in almost every subgroup considered here. It is true for men and women, married and unmarried people, people with high education levels as well as those with lower ones, and those whose father's were born in Australia or outside of Australia. Thus smoking must grasp some characteristic that affects many groups in the sample in a similar way.

In order to get a better understanding of what sort of characteristic smoking might grasp, Table 6 shows the partial correlations of smoking with all other control variables but the INDUSTRY dummies.

Table 35: Partial Correlations SMOKER and control variables

Variable	Coefficient	t	Variable	Coefficient	t
AGE	0.03	2.89	Managers, Legislators, Senior Officials omitted		
AGESQ	-0.0004	-3.43	Professionals	-0.02	-0.49
WAGE	-0.01	-0.55	Technicians and Associate Professionals	-0.01	-0.23
FULLTIME	0.05	1.51	Office clerks	-0.01	-0.19
EMPTENURE	-0.003	-1.7	Personal and Protective Services Workers	0.02	0.47
JOBTENURE	0.002	1.3	Skilled Agricultural and fishery Workers	-0.01	-0.13
BEQUEST	-0.11	-1.25	Craft and Related Trades Workers	0.03	0.58
CHILDREN	-0.005	-0.47	Plant and Machine Operators and Assemblers	0.02	0.33
MALE	0.004	0.15	Elementary occupations	0.03	0.46
Legally married omitted			Armed Forces	-0.49	-1.16
in relationship	0.12	3.76	Oceania omitted		
separated	0.27	4.08	North/West Europe	-0.02	-0.59
divorced	0.15	3.11	South/East Europe	-0.02	-0.5
widowed	0.03	0.26	North Africa and Middle East	0.13	1.19
no relationship	0.11	3.14	South East Asia	0.06	0.91

Variable	Coefficient	t	Variable	Coefficient	t
MA/Ph.D. Omitted			North East Asia	-0.19	-2.04
Graduate diploma or certificate	-0.01	-0.13	Southern and Central Asia	-0.04	-0.46
Bachelor	-0.02	-0.37	Americas	0.02	0.22
Advanced Diploma	0.06	0.96	Sub-Saharan Africa	0.08	1.01
Certificate iii or iv	0.10	1.65	substantial risk omitted		
Certificate i or ii	0.20	2.8	above average	-0.14	-1.73
undefined certificate	0.11	1.36	average	-0.14	-1.91
12 years of school	0.11	1.67	not any	-0.10	-1.38
11 years of school	0.18	2.77	CONSTANT	-0.01	-0.05
Observations	1745.00				
adjusted R2	0.07				

The partial correlations in this sample reveal a similar picture as the partial correlations of the sample used in Chapter 3. Most job related variables, like FULLTIME, EMPDURE, JOBTENURE or OCCUPATION groups are not statistically significantly correlated with the smoking dummy. Financial characteristics like WAGE and BEQUEST are also not statistically significantly correlated. As in chapter 3, instead many education groups are statistically significantly correlated with smoking, giving a higher smoking frequency at any lower education group than for the omitted group Master/Ph.D.. The other characteristics that are strongly correlated with smoking are age and marital status. The marginal effect of age on the probability to smoke is positive between 18 and 50 and turns negative thereafter. In general the increase associated with an additional year of age is quite small though, with the largest increase in smoking probability of 1.8% at age 18. The associations with marital status are much stronger. Any other marital status but being legally married is positively correlated with smoking with the exception of being widowed. Being separated, for example, is associated with a 27% increase in the smoking probability. Some education categories are significantly more likely to smoke than the highest education category. Being in the lowest education group (11 years of schooling or less) is associated with a 18% increase in smoking

probability when compared to the highest (omitted) education group Masters/Ph.D. One CULTURE dummy is also statistically significant. Being from North/East Asia is negatively associated with the likelihood of smoking. Attitudes towards financial risk are only weakly statistically significantly correlated with smoking. Being willing to take on only above average or average risk rather than substantial risk, the omitted category, is associated with a 14% reduction in smoking probability.

In summary age and marital status exhibit the largest and most statistically significant correlations with smoking. A lower education level achieved is generally also associated with higher smoking levels and so is a higher willingness to take financial risks. Apart from one indicator of father's country of birth no other variables are statistically significantly correlated with smoking. In particular there is no statistically significant correlation between measures of earning power and the likelihood of smoking.

It is plausible to assume that there is a direct causal effect from risk attitudes to smoking. As smoking is a risky behaviour it is likely that people who are less risk averse are more likely to engage in this habit. The link between risk attitudes and smoking is well documented (Viscusi (1991), Viscusi and Hersh (2001)). Thus risk attitudes is a particularly important control variable.

5.1. FUNDVALUE Regressions

I follow the set-up in the papers by Ameriks et al. (2003, 2004, 2007) and regress the stock of wealth (here savings in illiquid retirement accounts) on smoking and the explanatory variables. I do not use the normalized FUNDVALUE as age and wage are controlled for in the regression. The left side of Table 7 shows the results from a linear regression of the log of FUNDVALUE on the log of wage, and on AGE and a squared term in age and all control variables of the standard specification. The right side shows the regression on the log of FUNDVALUE on the standard specification plus the additional indicators for CULTURE, RISK and INDUSTRY (the coefficients on the industry dummies are in the appendix).

Table 36: Regression results standard and extended specification on log(FUNDVALUE)

Variable	Standard Specification		Extended Specification	
	Coefficient	t	Coefficient	t
SMOKER	0.12	2.16	0.14	2.57
AGE	0.14	6.72	0.14	6.78
AGESQ	-0.001	-4.09	-0.001	-4.03
Log(WAGE)	0.73	12.92	0.68	11.58
FULLTIME	0.04	0.59	0.06	0.81
EMPTENURE	0.04	8.01	0.03	7.02
JOBTENURE	0.01	3.53	0.01	3.62
BEQUEST	0.34	1.68	0.22	1.12
CHILDREN	-0.06	-2.72	-0.08	-3.13
MALE	0.24	4.13	0.26	4.23
Legally married omitted				
in relationship	-0.06	-0.79	-0.10	-1.36
separated	-0.18	-1.18	-0.18	-1.2
divorced	-0.46	-4.08	-0.44	-3.97
widowed	-0.65	-2.2	-0.65	-2.23
no relationship	-0.10	-1.34	-0.16	-2.01
MA/Ph.D. Omitted				
Graduate diploma or certificate	0.13	0.83	0.11	0.7
Bachelor	0.01	0.08	0.03	0.19
Advanced Diploma	0.09	0.62	0.09	0.59
Certificate iii or iv	0.02	0.15	0.03	0.24
Certificate i or ii	-0.26	-1.53	-0.25	-1.45
undefined certificate	-0.13	-0.69	-0.11	-0.58
12 years of school	0.06	0.41	0.09	0.61
11 years of school	-0.06	-0.39	-0.06	-0.4
Legislators, Senior Officials and Managers				
Professionals	-0.27	-2.95	-0.28	-3
Technicians and Associate Professionals	-0.27	-2.94	-0.33	-3.57

	Standard Specification		Extended Specification	
Office clerks	-0.13	-1.36	-0.10	-1.01
Personal and Protective Services Workers	-0.37	-3.37	-0.32	-2.92
Skilled Agricultural and fishery Workers	-0.37	-1.66	-0.30	-1.26
Craft and Related Trades Workers	-0.37	-3.24	-0.39	-3.14
Plant and Machine Operators and Assemblers	-0.40	-3.17	-0.34	-2.46
Elementary occupations	-0.40	-2.88	-0.30	-2.15
Armed Forces	-0.22	-0.22	-0.74	-0.76
Oceania and Antarctica				
North/West Europe			-0.11	-1.59
South/East Europe			-0.16	-1.78
North Africa and Middle East			-0.19	-0.77
South East Asia			-0.56	-3.78
North East Asia			-0.68	-3.05
Southern and Central Asia			-0.94	-4.63
Americas			-0.34	-1.66
Sub-Saharan Africa			-0.22	-1.2
substantial risk omitted				
above average			-0.02	-0.09
average			0.02	0.13
not any			-0.22	-1.28
CONSTANT	-1.38	-2.16	-0.99	-1.4
Observations	1,745		1,745	
adjusted R2	0.49		0.51	

Even after controlling for other explanatory variables smoking is positively correlated with FUNDVALUE. This is so for the standard specification as well as when adding CULTURE, RISK and INDUSTRY dummies. Indeed when adding the additional controls, the correlation on SMOKER slightly increases in magnitude and in statistical significance. This suggests that some additional factor grasped by smoking plays a role in saving for retirement in superannuation funds even after controlling for education, marital status and risk attitudes, all of which have

some explanatory power for smoking. Smoking is associated with a 12 or 14% increase in FUNDVALUE according to these regression results. The magnitude of the association between smoking and FUNDVALUE is comparable to the effect of a 15-20% increase in yearly gross wage, having 3 more years of tenure with one's employer or having 2 children less.

Many other variables are highly statistically significant and exhibit the expected sign. Age is highly significant and has a positive effect, but at a decreasing rate. At the lowest age in the sample, 18, one more year of age is associated with a 12% increase in FUNDVALUE, at age 30 this is 11% and drops to 8% at age 54. As expected WAGE plays an important role in determining FUNDVALUE. A 1% higher yearly gross wage is associated with a 0.7% increase in FUNDVALUE. Both EMPTENURE and JOBTENURE are positively related to FUNDVALUE. Assuming that a linear relationship holds, having been with the same employer for ten years is associated with a 40% increase in FUNDVALUE and having done the same job for 10 years is associated with a 10% increase.

As expected the number of children is negatively associated with the amount of savings in a superannuation fund. One more child is associated with a reduction in FUNDVALUE of 6-8% assuming a linear relationship again. Men have around 25% higher FUNDVALUE than women. This is consistent with the conjecture that being male grasps earning power beyond what is measured by gross wage. FULLTIME, however, which indicates whether a person works full or part-time, does not seem to grasp additional earning power as conjectured.

Any other marital status than being legally married is associated with lower levels of FUNDVALUE. With the exception of the dummy for being in a relationship this is consistent with the hypothesis made that married people may be able to save on many common expenses. Other factors may be at work here as well. Marriage might signal a more conservative lifestyle or more traditional values and these may be correlated with a taste for saving. While all the dummies indicating a lower education than the highest level, Masters/Ph.D., have a negative sign, only few of them are statistically significant. This is surprising given that EDUCATION might signal long term earning power. It may be explained by the fact that many dummies for occupation groups are statistically significant. Being in a

certain occupation group reflects education and may even signal whether an individual was able to use her education to enter a certain income group. Thus occupation groups might be the more direct measure for long term earning power. It is not surprising then, that all occupation group dummies exhibit a negative sign given that the probably wealthiest group "Legislators, Senior Officials and Managers" is the omitted category.

People whose fathers were born in South/East Europe and anywhere in Asia have considerably lower levels of FUNDVALUE than people whose fathers were born in Australia. The coefficient is especially strong on the dummy for Southern and Central Asia, which indicates that *ceteris paribus*, people of this descent have 94% less accumulated savings. This is surprising. One explanation might be that recent immigrants do have a low level of trust in the institutions of their new home country. Another explanation might be that immigrants, who typically come from poor backgrounds in their old home country, might use considerable resources to support family members who are still in that country.

Some INDUSTRY dummies are also statistically significant. They do not lend themselves to any interpretation though. Compared to the left out industry group of "Agriculture and Hunting", people working in coal or lignite mining or radio and television equipment have considerably higher levels of FUNDVALUE, for example.

Surprisingly the risk dummies are not statistically significant. This result might be due to the fact that people investing in superannuation fund actually do not have any choice as to the risk level of the investment. They simply invest in the fund their employer has chosen. Moreover, superannuation funds have to conform to certain prudence criteria so that at least the perceived risk of investing in these funds might be low.

Many of the coefficients are large in magnitude. This may cast some doubt as to their validity. It has to be taken into account, however, that the dependent variable is the stock of savings and all of the large coefficients are on dummy variables that denote a singular event in a person's life or a fixed characteristic of this person. Thus the differences indicated by the dummies can have a cumulative effect. Coefficients similar in magnitude and same in sign have been found in other wealth regressions. In Ameriks et al. (2003), for example, the effect of age on

the log of gross financial assets is .17 for the linear age term and -.001 for the quadratic term. Here the corresponding numbers are .14 and -.001. Being previously married versus currently married is associated with a 50% reduction in gross financial assets in Ameriks et. al. (2003) whereas here the relevant numbers are a 45% reduction for being divorced and a 65% reduction for being widowed.

Similar as in Ameriks et al. (2003) this regression has a remarkably high explanatory power. The standard specification explains 49% and the extended specification explains 51% of the variance of the log of FUNDVALUE.

5.2. Robustness

In this section I explore several problems that might arise from the data or from potential interactions of voluntary saving with other features of the retirement income system in Australia.

Outliers

One concern might be that the result is due to outliers. The sample used for the regression in table 7 is already reduced by the upper and lower 1% of the distribution of FUNDVALUE. It is also reduced by the lower 1% of the wage distribution. Trimming the sample by another percent at the top and the bottom of the distribution of FUNDVALUE and running the same regression with the extended specification reduces the coefficient to 0.1249 and the t-statistic is 2.25. When trimming another 5% of the distribution at the top and the bottom, the coefficient on SMOKER is only significant at the 10% level, with a value of 0.1 and a t-statistic of 1.87. Thus large and small values do indeed play an important role in identifying the effect of interest.

Tax incentives

In section 3 I discuss potential incentive effects from taxation rules or the interaction with the Old Age Pension. One conventional explanation of the positive correlation between SMOKER and FUNDVALUE might be the following. Smokers might on average have lower wages, for example, because the data show that they have lower levels of education. Smoking might

therefore be a measure of low earning power beyond what is grasped by WAGE. People with a gross wage below 31 000 dollars a year can take advantage of the special incentive program described in section 3. For a certain amount of voluntary contributions they receive a tax rebate. Thus a positive correlation may come about because SMOKER is an indicator for low income, and this indicator measures the effect of this extra incentive program. If a dummy like SMOKER can pick up the effect of the incentive program, this hypothesis can be tested by including a dummy variable that exactly denotes the eligible income group, i.e. a dummy for wages below 31 000 dollars a year. Including such a dummy results in a coefficient on smoker of 0.1465 ($t=2.61$), leaving it practically unchanged. The coefficient on the wage dummy itself is -0.16 and also statistically significant (see Table 41 in the appendix). Thus it does not seem to be the case, that there is a positive effect on FUNDVALUE from being eligible for extra tax rebates.

A similar effect might result from the fact that only the first 80 000 dollars of yearly income are subject to mandatory employer contributions. Only on the basis of mandatory contributions and after controlling for wage, high income people might have relatively less savings in superannuation funds than average and low income people. If SMOKER is an indicator for low income versus high income, then SMOKER might pick up this effect. Again I directly include a dummy variable that indicates people with more than 80 000 dollars of yearly wage. This dummy is not significant, and leaves the coefficient on SMOKER practically unchanged.

It also has to be noted that any interactions of voluntary saving with anticipated income from the Old Age Pension cannot explain the coefficient on SMOKER. The Old Age Pension gives low income people an incentive to save less as their income stream from the Old Age Pension might be just as high as the ones from their savings in superannuation funds. If SMOKER indicates low income, one should observe a negative correlation with FUNDVALUE in this case.

Normalized FUNDVALUE

The above regression is performed on FUNDVALUE without the normalizations on wage and age because age and wage are included as control variables. Also when regressing on a

normalized measure, the log of $FUNDVALUE/AGE/WAGE$, with the exception of the coefficients on age and wage the results do not change significantly (see Table 43 in the appendix). In particular the effect of the smoking dummy is still positive and statistically significant with a value of .14 and a t-statistic of 2.56, thus practically unchanged. Only the coefficients on age, squared age and the log of wage are smaller in magnitude and reduced in statistical significance. This is to be expected.

Other measures of smoking

In chapter 3 also the number of cigarettes smoked per week and the distinction between never, former and current smokers was used in estimation. When using cigarettes as proxy for self-control problems the coefficient is positive but not statistically significant. Using both, a dummy for former smoker and current smokers in estimation gives a statistically significant coefficient only for current smokers. This coefficient is .11 with a t-statistic of 1.88 when using the extended specification. Thus only the *SMOKER* gives statistically significant results in the *FUNDVALUE* regressions.

In summary the analysis suggests that the assumption that smoking measures lower earning power cannot account for the observed correlation between *SMOKER* and *FUNDVALUE*. The positive relationship between *FUNDVALUE* and smoking is not very robust, however. When trimming successively more shares from the tails of the distribution of *FUNDVALUE* the statistical significance and the magnitude of the coefficient on *SMOKER* decreases. When additionally trimming 5% at the top and bottom tail of the distribution of *FUNDVALUE* the *SMOKER* is only significant at the 10% level but still has a positive sign. Moreover, the use of cigarettes does not give statistically significant results and there does not seem to be a statistically significant distinction between former smokers and people who have never smoked as in the case of credit card borrowing.

The question of interest here is, of course, to what extent the positive correlation between *SMOKER* and *FUNDVALUE* can be regarded a causal effect of self-control problems on the level of savings in illiquid assets.

6. A Self-Control Interpretation

Even if SMOKER does measure higher levels of self-control problems one may not be able to conclude that self-control problems are the driving force behind a correlation between smoking and FUNDVALUE. I now turn to the discussion of potential problems that might occur in interpreting the results in terms of self-control problems.

Confounding Factors

In chapter 3 I first explored whether there are additional observable characteristics that might confound the correlation between SMOKER and the outcome variable. The first of these characteristics was risk aversion, which is already controlled for in the extended specification above. The same is true for group effects. Additional to occupation groups INDUSTRY dummies according to the two-digit classification of industries are included as control variables.

Another possibility discussed in chapter 3 was that smokers are on average less healthy and therefore incur more health related expenses which translate into credit card debt. As the result in this chapter is that smoking is associated with higher levels of FUNDVALUE, this is not a plausible explanation here. Health status might nevertheless play a role in saving for retirement. The inclusion of health status dummies in the extended specification results in insignificant coefficients on them, however. The coefficient on SMOKER actually increases slightly in size and statistical significance (see Table 42 in the appendix).

Likewise, stressful temporary events, can be plausibly expected to have no explanatory power for the observed correlation between SMOKER and FUNDVALUE. While stressful events like a recent separation or an accident might make people more likely to smoke, they should make people less likely to save, if these events are associated with costs.

In summary, all the observable characteristics of people that were considered to have a confounding influence on the correlation between SMOKER and credit card debt, are either already controlled for or can be plausibly expected to have no confounding influence on the observed correlation between SMOKER and FUNDVALUE.

Unobservable confounding factors

Some studies point to the importance of numeracy for wealth accumulation and retirement saving (see Ameriks et al. (2003) or Banks and Oldfield (2006)). This suggests a role for cognitive ability in wealth accumulation. Heckman et al. (2006) also find a negative correlation between cognitive ability and smoking status, namely that people with lower cognitive ability are more likely to smoke. Thus cognitive ability might be an important variable to include in the regression. Alternatively smoking might grasp cognitive ability as well as self-control problems.

At the time the subjects of the survey were interviewed the decision people faced when deciding how much to save in superannuation funds was not comparable in difficulty to general investment decisions. People did not face a wide array of choices but were required to make their voluntary contributions to the same fund their employer already makes contributions to on their behalf. The only decision they had to make was how much to contribute additionally. Thus the choice on how much to save in superannuation funds was less a question of cognitive ability than one of investing the necessary effort into acquiring information.

Moreover one expects cognitive ability to be positively correlated with wealth accumulation and negatively correlated with smoking probability. Thus one would expect that the omission of cognitive ability induces a downward bias on the coefficient on true self-control problems and thus the coefficient on SMOKER could be regarded a lower bound for the effect of self-control problems on savings in illiquid assets.

The same is true if smoking itself is a measure of both, low cognitive ability and high self-control problems. Then the observed correlation can be expected to understate the correlation between pure self-control problems and FUNDVALUE.

Finally, as described in Chapter 2, a study has found smoking to grasp time-preference rather than learning ability (and therefore presumably cognitive ability) in a different context (Munasinghe and Sicherman (2005)).

Reverse Causality

While it is hard to conceive of a reason for why the level of illiquid savings should affect a person's level of self-control, it may be, that it affects the probability that people smoke, independently of their level of self-control. Analogous to the possibility that credit card debt causes stress and anxiety which in turn make people more likely to smoke, low levels of savings in illiquid retirement accounts could make people more likely to smoke.

Several points can be made against an effect of the level of savings in superannuation funds on personal conditions that might make people more likely to smoke. First, the existence of the Superannuation Guarantee and the Old Age Pension in Australia guarantee that some level of retirement wealth proportional to a person's wages or a minimum level of income is provided by default. Second there is evidence that people do not worry much about retirement income. Lusardi (2001) cites evidence from the 1997 Retirement Confidence Survey in the U.S. that only 36% of American workers have tried to determine how much they need to save to fund a comfortable retirement. With 44% this number is not much bigger for people who were close to retirement. Moreover, many of those who answered that they had thought about it could not give a figure. Thus Lusardi concludes that almost three quarters of the people asked, had not given retirement funding adequate thought in the U.S. Lusardi also reports that about one third of households surveyed in the U.S. Health and Retirement Study, which only surveys Americans over the age of 50, said that they had "hardly thought" about retirement.

Some results from the literature that tries to explain the drop of consumption at retirement that is observed in most countries can be interpreted in a similar way. Banks, Blundell, and Tanner (1998) present evidence that this drop to a large part is due to *unexpected* unfavourable information about retirement income at the point of retirement. This suggests that people may indeed save too little for retirement and that this results in lower than expected wealth at retirement. They only realize this at the point of retirement, however.

People do not seem to give retirement funding adequate attention. If people do not give retirement funding much thought, however, low levels of savings in retirement funds can be hardly regarded a cause for anxiety or stress, which would induce people to take up smoking.

Even if there is a causal effect from levels of savings in retirement accounts to the likelihood of smoking, one would generally expect that low levels of savings make people more likely to smoke. Thus this causal effect should induce a negative correlation between FUNDVALUE and SMOKER. The observed positive correlation may thus again constitute a lower bound for the true relationship between self-control problems and savings in illiquid assets.

Interactions of SMOKER and CONTROLS

At the same level of self-control problems a lower level of education may induce a higher level of smoking. Thus some part of the variation in FUNDVALUE that is due to education is reflected in the correlation with SMOKER. Low education is typically expected to lead to lower levels of savings but to a higher likelihood of smoking. Given that I observe a positive correlation between smoking and FUNDVALUE, if this effect exists, it is likely to understate the true effect of self-control problems.

Conclusions

In summary, while it is certainly possible that the observed correlation between smoking and FUNDVALUE is due to some combination of the influence of unobservable confounding factors and interactions of smoking with observables, the main candidate for explaining the observed positive correlation between SMOKER and FUNDVALUE is the existence of self-control problems in combination with a sufficient degree of awareness. Any other interpretation of smoking itself would not plausibly give rise to the positive correlation that is observed. If cognitive ability or numeracy is an important omitted variable, one would have to expect that the observed correlation is a lower bound for the true relationship between self-control problems and accumulated savings. The same can plausibly be said about reverse causality. If it exists, one would expect lower savings to cause people to smoke more likely. Thus this effect should again induce a downward bias on the coefficient on a hypothetical true measure of self-control problems.

Within the theory of self-control problems, there are two potential explanations for the observed positive correlation between SMOKER and FUNDVALUE. One explanation is that the sophistication effect outweighs the present-bias effect in the terminology of O'Donoghue and

Rabin (1999). The other explanation is that people who suffer from self-control problems and are aware of them make use of commitment devices. Thus the observed correlation rules out that people are entirely naive about their self-control problems. If they were, there could neither be a sophistication effect outweighing a present bias nor would agents see the need to make use of commitment devices. Whether it is the former or the latter explanation can be investigated when comparing saving in illiquid assets with a situation when no commitment devices are available. This is the case for liquid assets.

7. Smoking and Liquid Assets

If the use of commitment devices by sophisticated agents with self-control problems is the correct explanation for the observed correlations, one should observe a negative correlation of SMOKER with liquid assets. If assets are liquid, they cannot serve as a commitment device. Ameriks et al. (2004, 2007), for example, find that their measure of self-control problems is negatively correlated with non-retirement financial assets. One should also observe a substitution of illiquid for liquid assets for people who have high levels of self-control problems. I investigate these hypotheses using information on liquid assets in the HILDA data and on the ratio of FUNDVALUE to all financial wealth, which is the sum of FUNDVALUE and liquid assets. In the survey people were asked the following questions:

1. *"Do you have any of these types of accounts held with banks, credit unions, building societies, cash management trusts or other financial institutions? We are interested in accounts in your name only."*

People were shown the following list of accounts:

cheque a/c, savings a/c, keycard/EFTPOS a/c; other transaction a/c; fixed terms deposits, cash management trusts.

2. *And what is the amount held in all these types of accounts combined?*

While some of these accounts like fixed terms deposits are not entirely liquid they are certainly far more liquid than retirement saving funds that can be only accessed after the

preservation age is reached. Therefore I use the answer to this question as my variable for liquid assets, called LIQUID. If people responded that they do not have any of these accounts, LIQUID is set to zero. I trim the upper 1% of the distribution of LIQUID (corresponding to liquid asset value between 97000 to 270000 dollars). From LIQUID and FUNDVALUE I construct a variable FINANCIAL that is the sum of both variables. Then I take the ratio of FUNDVALUE to FINANCIAL, called RATIO, which gives me the ratio of illiquid to all financial assets. Table 37 gives descriptive statistics for these variables.

Table 37: Liquid assets, overall financial assets and the ratio of illiquid to all financial assets

Variable	Mean	Median	St.dev.	Min	Max
LIQUID	4,107	400	10,225	0	97,000
FINANCIAL	46,113	23,300	63,603	300	452,000
RATIO	0.87	0.98	0.21	0.01	1

The modest amounts of average liquid wealth show that the largest part of wealth accumulation for the sample in financial form occurs in superannuation funds. Indeed 635 observations out of 1764 report zero liquid assets. Thus it is not surprising that for almost 50% of the sample FUNDVALUE and FINANCIAL are identical. Table 9 shows the results from tobit estimation on LIQUID and linear regressions on RATIO and the log of FINANCIAL with the extended specification without the industry dummies. (The industry dummies were supposed to control for industry specific superannuation funds).

Table 38: Tobit estimation on LIQUID, regressions on log of FINANCIAL and RATIO

Variable	Tobit Liquid		Log(FINANCIAL)		RATIO	
	Coefficient	t	Coefficient	t	Coefficient	t
SMOKER	-1,630.58	-1.98	0.07	1.21	0.04	4.02
AGE	52.91	0.18	0.10	4.99	0.02	5.94
AGESQ	1.45	0.38	-0.001	-2.46	-0.0003	-5.32
WAGE	1,085.37	1.3	0.68	12.13	0.02	1.4
FULLTIME	-1,973.52	-1.91	-0.03	-0.45	0.04	2.97
EMPTENURE	89.76	1.34	0.03	7.39	0.001	0.93

	Tobit Liquid		Log(FINANCIAL)		RATIO	
JOBTENURE	-32.67	-0.6	0.01	2.77	0.001	1.81
BEQUEST	6,793.66	2.4	0.45	2.3	-0.06	-1.69
CHILDREN	-1,359.07	-3.78	-0.06	-2.8	0.001	0.25
MALE	-2,791.27	-3.29	0.22	3.78	0.02	2.12
Legally married omitted						
in relationship	7,317.60	6.66	-0.02	-0.22	-0.06	-4.21
separated	8,320.59	3.95	-0.07	-0.45	-0.08	-2.89
divorced	10,842.26	6.99	-0.24	-2.16	-0.13	-6.2
widowed	14,077.98	3.36	-0.29	-0.95	-0.16	-2.8
no relationship	12,060.72	10.71	0.17	2.21	-0.17	-11.49
MA/Ph.D. Omitted						
Graduate diploma or certificate	-3,642.18	-1.57	0.08	0.51	0.03	1.04
Bachelor	-99.29	-0.05	0.01	0.04	-0.01	-0.23
Advanced Diploma	21.14	0.01	0.03	0.23	-0.01	-0.21
Certificate iii or iv	-644.05	-0.3	-0.04	-0.31	-0.0003	-0.01
Certificate i or ii	-2,375.67	-0.95	-0.39	-2.32	0.03	0.9
undefined certificate	510.43	0.18	-0.19	-1.03	0.004	0.11
12 years of school	-1,107.47	-0.5	-0.03	-0.19	0.03	1.01
11 years of school	-393.33	-0.18	-0.15	-1.05	0.01	0.36
Legislators, Senior Officials and Managers						
Professionals	28.26	0.02	-0.27	-3.03	0.002	0.14
Technicians and Associate Professionals	-1,361.99	-1	-0.27	-3.04	0.01	0.3
Office clerks	-543.08	-0.37	-0.06	-0.59	-0.002	-0.13
Personal and Protective Services Workers	-203.91	-0.13	-0.28	-2.61	-0.003	-0.16
Skilled Agricultural and fishery Workers	-1,311.62	-0.38	-0.21	-0.98	-0.03	-0.61
Craft and Related Trades Workers	256.98	0.15	-0.29	-2.57	-0.01	-0.58
Plant and Machine Operators and Assemblers	387.12	0.2	-0.32	-2.55	0.00	0.08

	Tobit Liquid		Log(FINANCIAL)		RATIO	
Elementary occupations	-111.05	-0.05	-0.30	-2.24	0.01	0.32
Armed Forces	957.78	0.07	-0.09	-0.1	-0.21	-1.12
Oceania and Antarctica						
North/West Europe	1,183.58	1.22	-0.09	-1.41	-0.01	-1.18
South/East Europe	-2,230.60	-1.7	-0.15	-1.7	-0.004	-0.24
North Africa and Middle East	9,139.70	2.53	0.03	0.11	-0.11	-2.25
South East Asia	2,792.35	1.31	-0.51	-3.47	-0.06	-1.96
North East Asia	3,672.95	1.12	-0.48	-2.2	-0.09	-2.11
Southern and Central Asia	3,774.77	1.23	-0.74	-3.76	-0.10	-2.65
Americas	-2,511.08	-0.8	-0.32	-1.56	0.04	1.01
Sub-Saharan Africa	-3,003.03	-1	-0.17	-0.87	0.03	0.89
substantial risk omitted						
above average	-3,791.24	-1.46	-0.10	-0.54	0.04	1.26
average	-3,313.63	-1.38	-0.01	-0.05	0.02	0.63
not any	-6,509.25	-2.71	-0.27	-1.64	0.05	1.58
CONSTANT	-9,544.70	-0.99	0.32	0.49	0.19	1.53
Observations	1,707		1,707		1,707	
adjusted R2			0.45		0.24	

The coefficient on SMOKER in tobit estimation on LIQUID is negative and statistically significant. This indicates that smokers on average hold less liquid assets. This is consistent with a self-control interpretation. Smokers might find it more difficult to control their consumption out of liquid assets and therefore have lower levels of savings in this category. Alternatively they may exhibit lower levels of liquid assets simply because they put relatively more money into illiquid asset classes.

The latter interpretation is supported by the results from the regression on RATIO. Smokers have a ratio of illiquid to overall financial assets that is 4% higher than non-smokers. Thus it seems that smokers systematically hold a higher share of financial wealth in illiquid form than

non-smokers. This is consistent with an interpretation of smokers being people with self-control problems who are aware of these and thus hold a higher share of financial wealth in illiquid form as a commitment device.

When regarding both, liquid and illiquid assets together, smoker does not have any explanatory power. Given the opposite effects on liquid and illiquid assets, this is to be expected.

Thus overall these results lend support to a self-control interpretation of the positive correlation between SMOKER and FUNDVALUE. People with a high level of self-control problems invest money in illiquid assets in order to prevent themselves from spending this money later. As a result of this or indeed as a result of their low ability to control their spending out of liquid assets, people with high self-control problems have lower levels of liquid assets. Hence people with high levels of self-control problems have a higher ratio of illiquid to total financial assets. These results are consistent with the hyperbolic consumption model (Laibson (1997), Laibson, Repetto, and Tobacman (1998), Angeletos et al. (2001)). The results also suggest that a sophistication effect only as in O'Donoghue and Rabin (1999), is not sufficient to overcome the present bias of people with self-control problems. Otherwise one should observe that people with self-control problems also save more when no commitment is possible, for example, when assets are liquid. Hence commitment devices are a valuable tool for people with self-control problems without which they would accumulate less savings.

The observed correlations between SMOKER and liquid and illiquid assets also speak against alternative interpretations of the SMOKER dummy. No other plausible interpretation of smoking as a measure for underlying character traits can explain both, the positive correlation with illiquid and the negative correlation with liquid assets. Smoking as a measure of cognitive ability, standard time-discounting or anxiety would all imply a negative correlation between SMOKER and FUNDVALUE and a negative correlation between SMOKER and LIQUID.

8. Conclusions

In this chapter I find that in a sample of employees that can make voluntary contributions to an illiquid retirement fund smokers, on average, have higher levels of accumulated savings than non-smokers. This is so when comparing means as well as when controlling for a large number of characteristics in a linear regression.

Self-control problems in combination with sophistication and the commitment property of illiquid assets are a plausible candidate for explaining this positive correlation. This interpretation is supported by the fact that smokers, on average, have a lower level of liquid assets and a clearly higher share of illiquid to overall wealth. One conclusion from this overall pattern of correlations is that it is sophistication in combination with the commitment property of illiquid assets that drives the positive correlation, rather than a sophistication effect as in O'Donoghue and Rabin (1999) alone. More importantly, no interpretation of smoking other than as an indicator of self-control problems can plausibly explain the overall pattern of correlations.

The results are not very robust, however. The statistical significance of the correlation between the smoking dummy and FUNDVALUE relies on the tails of the distribution of FUNDVALUE and other measures of smoking, like cigarettes, are not statistically significant. The coefficient on smoker in the liquid asset regression is barely significant at the 5% level. Only the coefficient on SMOKER in the regression of the ratio of illiquid to overall financial wealth is robustly positive and highly statistically significant. Thus the results have to be regarded with caution.

If the positive correlation and a self-control interpretation of this positive correlation can be upheld it constitutes the first empirical result that is consistent with a theory of people that suffer from self-control problems and use illiquid assets as commitment devices (Laibson (1997), Laibson, Repetto and Tobacman (1998), Angeletos et al. (2001)). The existing results on the effect of self-control problems on wealth as in Ameriks et al. (2007) show that self-control problems impede the accumulation of wealth in liquid form but there is no empirical study yet, that shows that self-control problems lead to higher wealth in illiquid form.

The result has several interesting implications. First of all, it suggests that people are at least somewhat sophisticated. If people were not aware of their future self-control problems at all, there could neither be a sophistication effect as in O'Donoghue and Rabin (1999) nor would people make use of commitment devices. Thus in modelling self-control problems theoretically, it probably makes sense to regard people as being aware of their self-control problems. Second, it suggests that commitment devices are important as sophistication alone does not seem to induce people to save more or even prevent them from saving less.

If the observed correlation can be entirely attributed to self-control problems, the results also suggest that self-control problems are quantitatively important. It is impossible to find a cardinal measure for self-control problems. The smoking dummy would indicate, however, that two different observable levels of self-control problems can make a difference of around 12% to 14% in accumulated savings for retirement. This suggests that self-control problems are an important additional factor for explaining the differences in wealth accumulation among individuals and households as conjectured in Bernheim, Skinner and Weinberg (2001). It therefore also implies that self-control problems are a factor that should be considered in savings policy.

APPENDIX TO CHAPTER 4

A1.2 Additional Tables

Table 39: Description of Industry Dummies

Number	Description	Number	Description
Industry1	Agriculture,hunting	Industry40	electricity, gas, steamsupply
Industry2	Forestry,logging	Industry41	watercollection / purification
Industry5	Fishing, fish hatcheries/farms	Industry45	construction
Industry10	Miningofcoal/lignite	Industry50	maintenance of motorvehicles
Industry11	Extractionofoilandgas	Industry51	wholesaletrade
Industry13	miningofmetallores	Industry52	retailtrade
Industry14	othermining	Industry55	hotelsrestaurants
Industry15	food/beverages	Industry60	landtransport,pipelines
Industry16	tobacco	Industry61	watertransport
Industry17	textiles	Industry62	airtransport
Industry18	wearingapparel,dressing	Industry63	supporting transport activities
Industry20	wood,cork,strawplaiting	Industry64	post/telecommunications
Industry21	paperproducts	Industry65	financialintermediation
Industry22	publishing,printing,media	Industry66	insurance, pension funds
Industry23	coke,refinedpetroleum,nuclear fule	Industry67	auxiliary to financial
Industry24	chemicals	Industry70	realestate
Industry25	rubber,plastics	Industry71	renting of machinery equipment
Industry26	non-metallic mineral products	Industry72	computer
Industry27	basicmetals	Industry73	research/development
Industry28	fabricated metals,except machinery	Industry74	otherbusinessactivities
Industry29	machineryequipment	Industry75	publicadministration, defence
Industry30	office, computing machinery	Industry80	education
Industry31	electricalmachinery	Industry85	health/socialwork
Industry32	radio,televisionequipment	Industry90	sewage/refusal disposal
Industry33	medical,precision/optical instruments	Industry91	membership organizations
Industry34	motorvehicles	Industry92	recreational,cultural, sports
Industry35	othertransportequipment	Industry93	otherservices

Number	Description	Number	Description
Industry36	furniture	Industry99	extraterritorial organiza-

Table 40: Coefficients on Industry Dummies from Regression on FUNDVALUE with extended specification

Industry	Coefficient	t	Industry	Coefficient	t
Industry2	0.46	0.77	Industry41	0.37	0.63
Industry10	0.64	1.72	Industry45	0.24	1
Industry11	-0.07	-0.16	Industry50	0.28	1.06
Industry13	0.51	0.97	Industry51	0.26	1.11
Industry14	0.16	0.27	Industry52	0.05	0.22
Industry15	0.11	0.42	Industry55	0.15	0.62
Industry16	-0.94	-0.96	Industry60	0.09	0.36
Industry17	-0.92	-1.56	Industry61	-1.85	-1.89
Industry18	0.86	1.94	Industry62	0.18	0.49
Industry20	0.65	1.91	Industry63	0.17	0.61
Industry21	0.58	1.49	Industry64	0.33	1.26
Industry22	0.00	0	Industry65	0.30	1.2
Industry23	-0.07	-0.09	Industry66	0.82	2.68
Industry24	-0.10	-0.28	Industry67	0.26	0.8
Industry25	0.32	0.61	Industry70	0.18	0.63
Industry26	-0.13	-0.39	Industry71	1.16	2.22
Industry27	0.22	0.52	Industry72	0.26	0.94
Industry28	0.03	0.12	Industry73	0.30	0.58
Industry29	0.16	0.59	Industry74	0.11	0.47
Industry30	0.47	0.48	Industry75	0.59	2.56
Industry31	0.59	1.12	Industry80	0.25	1.1
Industry32	1.43	2.4	Industry85	0.31	1.37
Industry33	0.23	0.24	Industry90	0.07	0.15
Industry34	0.23	0.72	Industry91	-0.14	-0.38
Industry35	0.14	0.44	Industry92	0.17	0.7
Industry36	0.58	1.73	Industry93	0.46	1.02

Industry	Coefficient	t	Industry	Coefficient	t
Industry40	0.66	1.57	Industry99	1.18	1.21

Table 41: Regression with dummy for wage below \$31000

Variable	Coefficient	t
SMOKER	0.15	2.61
AGE	0.14	6.73
AGESQ	-0.001	-3.98
WAGE	0.59	8
FULLTIME	0.04	0.49
EMPTENURE	0.03	6.95
JOBTENURE	0.01	3.56
BEQUEST	0.23	1.16
CHILDREN	-0.07	-3.01
MALE	0.25	4.16
Legally married omitted		
in relationship	-0.10	-1.34
separated	-0.19	-1.26
divorced	-0.45	-4.02
widowed	-0.66	-2.25
no relationship	-0.15	-1.93
MA/Ph.D. Omitted		
Graduate diploma or certificate	0.10	0.63
Bachelor	0.01	0.08
Advanced Diploma	0.08	0.54
Certificate iii or iv	0.02	0.17
Certificate i or ii	-0.25	-1.47
undefined certificate	-0.11	-0.6
12 years of school	0.09	0.58
11 years of school	-0.07	-0.45

Variable	Coefficient	t
Legislators, Senior Officials and Managers		
Professionals	-0.29	-3.08
Technicians and Associate Professionals	-0.34	-3.64
Office clerks	-0.11	-1.1
Personal and Protective Services Workers	-0.32	-2.89
Skilled Agricultural and fishery Workers	-0.29	-1.23
Craft and Related Trades Workers	-0.39	-3.16
Plant and Machine Operators and Assemblers	-0.34	-2.45
Elementary occupations	-0.29	-2.07
Armed Forces	-0.77	-0.8
Oceania and Antarctica		
North/West Europe	-0.10	-1.55
South/East Europe	-0.16	-1.81
North Africa and Middle East	-0.19	-0.74
South East Asia	-0.56	-3.78
North East Asia	-0.67	-3.04
Southern and Central Asia	-0.92	-4.49
Americas	-0.34	-1.66
Sub-Saharan Africa	-0.23	-1.25
substantial risk omitted		
above average	-0.02	-0.11
average	0.02	0.09
not any	-0.23	-1.31
LOWWAGE	-0.16	-1.95
CONSTANT	0.05	0.06

Table 42: Regression with dummies for health status

Variable	Coefficient	t
SMOKER	0.15	2.62

Variable	Coefficient	t
AGE	0.15	7.19
AGESQ	-0.001	-4.48
WAGE	0.67	11.41
FULLTIME	0.07	0.99
EMPTENURE	0.03	6.67
JOBTENURE	0.02	4.17
BEQUEST	0.23	1.15
CHILDREN	-0.07	-2.68
MALE	0.27	4.32
Legally married omitted		
in relationship	-0.08	-1.02
separated	-0.17	-1.16
divorced	-0.42	-3.77
widowed	-0.61	-2
no relationship	-0.12	-1.55
MA/Ph.D. Omitted		
Graduate diploma or certificate	0.13	0.82
Bachelor	0.05	0.34
Advanced Diploma	0.11	0.69
Certificate iii or iv	0.09	0.59
Certificate i or ii	-0.21	-1.24
undefined certificate	-0.12	-0.63
12 years of school	0.11	0.72
11 years of school	-0.02	-0.15
Legislators, Senior Officials and Managers		
Professionals	-0.27	-2.87
Technicians and Associate Professionals	-0.31	-3.35
Office clerks	-0.12	-1.17
Personal and Protective Services Workers	-0.33	-2.92
Skilled Agricultural and fishery Workers	-0.31	-1.31

Variable	Coefficient	t
Craft and Related Trades Workers	-0.43	-3.46
Plant and Machine Operators and Assemblers	-0.35	-2.53
Elementary occupations	-0.29	-2.08
Armed Forces	-0.67	-0.7
Oceania and Antarctica		
North/West Europe	-0.10	-1.5
South/East Europe	-0.16	-1.82
North Africa and Middle East	-0.19	-0.75
South East Asia	-0.53	-3.54
North East Asia	-0.66	-2.99
Southern and Central Asia	-0.92	-4.43
Americas	-0.30	-1.44
Sub-Saharan Africa	-0.23	-1.25
substantial risk omitted		
above average	-0.08	-0.45
average	-0.05	-0.28
not any	-0.30	-1.7
excellent health omitted		
very good	0.05	0.65
good	-0.01	-0.1
fair	-0.02	-0.2
poor	-0.10	-0.39
CONSTANT	-1.06	-1.49

Table 43: Regression on FUNDVALUE/AGE/WAGE

Variable	Coefficient	t
SMOKER	0.14	2.56
AGE	0.08	3.92
AGESQ	-0.001	-2.5
WAGE	-0.33	-5.58

Variable	Coefficient	t
FULLTIME	0.06	0.82
EMPTENURE	0.03	7.03
JOBTENURE	0.01	3.63
BEQUEST	0.22	1.11
CHILDREN	-0.07	-3.1
MALE	0.26	4.24
Legally married omitted		
in relationship	-0.10	-1.36
separated	-0.18	-1.19
divorced	-0.44	-3.97
widowed	-0.65	-2.24
no relationship	-0.16	-1.99
MA/Ph.D. Omitted		
Graduate diploma or certificate	0.11	0.7
Bachelor	0.02	0.18
Advanced Diploma	0.09	0.58
Certificate iii or iv	0.03	0.23
Certificate i or ii	-0.25	-1.45
undefined certificate	-0.11	-0.58
12 years of school	0.10	0.62
11 years of school	-0.06	-0.4
Legislators, Senior Officials and Managers		
Professionals	-0.28	-3.01
Technicians and Associate Professionals	-0.34	-3.59
Office clerks	-0.10	-1.02
Personal and Protective Services Workers	-0.32	-2.93
Skilled Agricultural and fishery Workers	-0.31	-1.28
Craft and Related Trades Workers	-0.39	-3.14
Plant and Machine Operators and Assemblers	-0.34	-2.46
Elementary occupations	-0.30	-2.14

Variable	Coefficient	t
Armed Forces	-0.75	-0.77
Oceania and Antarctica		
North/West Europe	-0.11	-1.6
South/East Europe	-0.16	-1.77
North Africa and Middle East	-0.20	-0.78
South East Asia	-0.56	-3.78
North East Asia	-0.67	-3.05
Southern and Central Asia	-0.94	-4.62
Americas	-0.34	-1.66
Sub-Saharan Africa	-0.22	-1.19
substantial risk omitted		
above average	-0.02	-0.1
average	0.02	0.12
not any	-0.22	-1.3
CONSTANT	3.95	5.58
Observations	1745	
adjusted R2	0.21	

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