# Mobile Self-scanning- Increasing Self-Control?

An experimental study on how mobile self-scanning affects consumer behavior

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Departmentment of economics, 2015-06-01

# Abstract

In the grocery store there are constantly occasions when choices are to be made. Sometimes it is hard to make the best choices. Therefore, consumers sometimes need tools to facilitate choosing the best groceries for their welfare. A mobile self-scanner can be such a tool. This article will study if a mobile self-scanner changes consumer behavior. To see if it works as self-control device, consumers with high and low self-control awareness will be investigated to see if they behave differently from each other. Data from an experiment at a Swedish supermarket will be analyzed together with a survey on impulsive items. Regression analysis will estimate if there are any significant differences in consumer behavior when using a self-scanner compared to when not using one, and also if there are any differences between consumers with high and low self-control when they use self-scanners. The results were that mobile self-scanners decrease spending for consumers with low self-control but consumers with high self-control did not change their behavior. This effect on consumers with low self-control can presumably be because a self-scanner is used as a self-control device. Consequently, mobile self-scanners are good for consumer welfare since it helps consumers make better choices.

*Keywords*: mobile self-scanning, self-control, commitment devices, hyperbolic discounting, inattentiveness

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# 1    Introduction

It is often heard that people say that they will start exercising next week and then after a week postponing it again, or as overheard in the lunch room one person said that he really should not eat this piece of chocolate and then he ate it anyways. It is hard to resist temptation and do what is better in the long run when there are instantaneous benefits. The grocery store is full of temptations, there are sweets, items on offer that one usually does not buy, and that Spanish ham that is so good but too expensive. Is it possible to change the process of shopping and resist these impulses?

## 1.2    Background

Mobile self-scanning is a service for consumers in the grocery store. A self-scanner is carried along the shopping trip, and for each grocery the bar code is scanned before packed into bags in the shopping cart. By doing this, consumers do not need to unpack groceries at the cashier and can pay at a payment terminal. Mobile self-scanning systems have become a common feature in most large supermarkets in Sweden (eg. City Gross, Coop, ICA, Willys). They were first introduced in Sweden in 1999, and according to Grahn (2009), the Swedish supermarket ICA was in 2009 the largest user of mobile self-scanning in the world. About 15-20 % of consumers use self-scanners, including both mobile and check-out systems (Grahn, 2009). Nevertheless, with such a large amount of consumers who use self-scanners, there is little research on how self-scanners affect consumer behavior.

Consumers have long been seen in economic theory as rational and fully informed decision makers. However, Hoch and Loewenstein (1991) explain that consumers often act against their better judgment, and particularly, consumers have self-control problems. Failure of self-control leads to impulsive buying and suboptimal choices for consumers. Self-control failure occurs when there are intertemporal choices; this is when costs and benefits occur in different periods in time. Consumers make choices that have instant rewards but are not in their long-term interest. In fact, when self-control fails consumers choose options that have a lower discounted utility than the alternative (Hoch & Loewenstein, 1991). For this reason, if consumers are aware of these problems, they have incentives to use self-control devices upon themselves in order to restrain choices, and by doing this, act in their long-term interest (O'Donoghue & Rabin, 1999). Self-control devices can be such that they are hard and cause real economical

punishments or they are soft and cause psychological consequences (Bryan, Karlan & Nelson, 2010). If mobile self-scanners can help consumers to control impulses, they can be used as self-control devices and consumers would make more optimal choices and it would therefore increase consumer welfare.

There is much research on changes in the process of buying such as methods of payment, where it is evident that consumers change behavior when using different methods of payment (Hirchman, 1979; Prelec & Simster, 2001), and in particular, credit cards increase impulsive buying (Thomas, Desai & Seenivasan, 2011). Moreover, research on real-time feedback devices, such as wearable electronics and electricity meters that similarly to self-scanners monitor consumption, have shown that consumers consume less when having real-time feedback (van Houwelingen & van Raaij, 1989; Gilbert & Zivin, 2014). However, there is little research on mobile self-scanners and consumer behavior. When this paper was written, only one paper, van Ittersum et al. (2013), was found which studied changes in consumer behavior when using a mobile self-scanner. Therefore this study is unique and has important implications for consumer welfare.

## 1.2   Purpose & research question

This paper will examine if mobile self-scanners have an effect on consumer behavior. To understand if self-scanners are used as self-control devices, consumers with high and low self-control awareness will be separated and it will be examined if these groups react differently to the use of a mobile self-scanner. Behavioral economic theories such as the hyperbolic discounting model will be used to explain self-control problems and the demand for self-control devices. Theories on mental accounting will describe how consumers perceive outcomes, assign financial activities to accounts, and keep mental budgets. Mental budgets are used for self-control purposes but they suffer from inattentiveness. Mobile self-scanning can increase monitoring and correct for inattentiveness and it is therefore a self-control device. If a self-scanner is used as a self-control device then the effect of a self-scanner on consumer behavior should be different between individuals with high and low self-control. Will a mobile self-scanner work as a self-control device? Will consumer behavior differ if consumers use a mobile self-scanner compared to when not using one?

## 1.3 Hypothesis

Hypothesis 1:    Consumer behavior changes when using a mobile self-scanner compared to not using one.

Hypothesis 2:    There is a difference in the effects of a self-scanner between consumers with high and low self-control.

This paper analyzes data collected from an experiment conducted in a large Swedish supermarket. Consumers who participated in the study were randomly assigned to two treatments: in one they used mobile self-scanning while in the other they did not. To investigate hypothesis one, regression analysis will be performed to estimate if a mobile self-scanner affects buying behavior in the store. To investigate hypothesis two, an interaction variable between low self-control and use of a mobile self-scanner will be used in order to analyze whether the effect of the scanner is different for consumers with high respectively low self-control when using a mobile self-scanner.

## 1.5 Demarcation

Focus of this paper is to investigate if there is an effect of a mobile self-scanner on consumer behavior. Particularly, impulsive behavior will be examined through looking at groceries that are especially prone to impulsive buying and through looking at differences in self-control awareness among consumers. There are other possible explanations for why there would be differences in consumer behavior such as, maximizing budgets and aiming to save time. These will not be considered in this paper for the reasons that firstly, there are space and time limitations, and secondly, if there is a difference between individuals depending on level of self-control then other explanations, such as the prediction that consumers use a self-scanner to maximize their budgets, are not so likely.

## 1.6 Disposition

This paper will be organized as follows. In the next section, section 2, theoretical background will be presented. Section 2 will be divided into two parts, one part explaining self-control failure and impulsive buying, and the second part explaining the decision making process through mental accounting. Section 3 presents previous research on self-scanners, real-time feedback devices, and methods of payment. Section 4 will explain the experiment and the surveys that were conducted. Section 5 presents the data; section 6 discusses the models used for the regression analysis and section 7

presents the results from the regression analysis. Section 8 discusses how the theory that is described applies to the use of a self-scanner and to the results. Lastly, section 9 concludes. Details on handling of data, regression diagnostics, and regression outputs are reported in the appendix.

## 2   Theoretical background

The theories that will be used in this paper are theories that depart from standard economic theory. This is because a mobile self-scanner changes the process of buying groceries which, if it affects consumer behavior, violates the assumptions of standard economic theory. According to standard economic model, consumers make decisions fully informed and fully rational. This means that there is no bounded rationality, meaning that individuals have full capacity to process information, preferences are invariant to how options are presented, and the value of an object is the same as a person's attitude for it. Hence, if yoghurt is described to contain 5 % fat or to be 95 % fat-free should not have an effect on the value attached over yoghurt (Wilkinson, 2008, p. 65-69).  However, extensive research documents the existence of several biases in consumer choices (Keys & Schwartz, 2007).  Consumers fail to control their impulses and they make suboptimal choices that are not in their long-term interest (Thaler & Shefrin, 1981). These inconsistencies in time preferences will be explained through the hyperbolic discounting model. Furthermore, mental accounting will explain how consumers experience and perceive outcomes and use mental budgets to track spending and constrain impulsive behavior (Thaler, 1985).

### 2.1 Intertemporal choice
Intertemporal choice is the study of decisions where there are costs and benefits occurring in different time periods. Intertemporal choices arise in a grocery store when there is a choice of buying a vice product or not (Wilkinson, 2008, p.320). A vice product is a product that with delayed considerations, it is not preferred to a virtue product, but with immediate considerations, it is preferred. A vice product is therefore more likely to be bought on impulse compared to virtue products (Wertenbrosch, 1998).  Items, such as vice products, where benefits occur before costs are called leisure goods (Wilkinson, 2008, p.320). A vice product is for example candy or other snacks. They give instant satisfaction but cause health problems in the long run.

Choices over time are assumed to follow the assumptions of the discounted utility model. The discounted utility model was introduced by Samuelson 1937 to analyze intertemporal choices. The model states that if the sum of the present value of one set of goods is higher than the sum of the present value of another set of goods, the first set is preferred to the second one. This is visualized in equation 1 (E1), where $u(c_t)$ is the utility of consumption at time t and $\delta$ is the discount rate, that can take values between 0 and 1, of which utility is discounted with a constant rate each year from t=0 to t=T (Loewenstein & Prelec, 1992).

$$\sum_{t=0}^{T} \delta^t u(c_t) > \sum_{t=0}^{T} \delta^t u(c'_t) \tag{E1}$$

The discounted utility model fails to explain behavior such as when consumers buy on impulse and make decisions where the sum of the discounted utility is lower for the option chosen than the alternative. It also does not explain the fact that consumers at one point want one thing but make different choices at another point in time. One reason that the model fails to explain this behavior is because the discount rate is the same between this year and the next as between the years 100 and 101 (Wilkinson, 2008, p. 265-267). In the hyperbolic discounting model the discount rate is not constant over time; it is larger in the near future. The hyperbolic discounting model will therefore be used to explain inconsistent time preferences that violate the assumptions of the discounted utility model and which cause self-control problems.

### 2.1.1 The hyperbolic discounting model

The hyperbolic discounting model explains the fact that people tend to be more impatient in the near future than in the far future. This phenomenon is called present bias. To capture this behavior, the hyperbolic discounting models place a larger discount rate in the near future and after that the discount rate declines (O'Donoghue & Rabin, 1999). Laibson (1997) presents two different hyperbolic discount functions: the quasi-hyperbolic and the generalized hyperbolic. The quasi-hyperbolic discount function has the same features as the generalized hyperbolic discount function but it is more easily tractable. Therefore, the quasi-hyperbolic discount function will be presented. Equation 2 (E2) states that the utility of consumption is the expected utility of consumption in

period t plus the sum of the discounted utility from t+1 to period T-t. $u(c_t)$ is the utility of consumption in time t, $\beta$ is a parameter for present bias that takes values between 0 and 1, and $\delta$ is the discount rate that takes values between 0 and 1.

$$u = E_t \left\{ u(c_t) + \beta \sum_{t=1}^{T-t} \delta^t u(c_{t+1}) \right\} \quad \text{(E2)}$$

The difference between the quasi hyperbolic function and the exponential function is the parameter $\beta$. Since $\beta$ does not depend on time t, it increases the discount factor between time t and t+1 and after t+1 the discount factor is constant. If a decision is to be made in time t+1, the marginal rate of substitution between time periods t+1 and t+2 will look like in equation 3 (E3) from the point of view of a decision maker at time t:

$$\frac{u'(c_{t+1})}{\delta u'(c_{t+2})} \quad \text{(E3)}$$

While when the decision is actually made at time t+1, equation 4 (E4) shows the marginal rate of substitution between period t+1 and t+2:

$$\frac{u'(c_{t+1})}{\beta \delta u'(c_{t+2})} \quad \text{(E4)}$$

From equation 3 and 4, it can be seen that time period t+2 is of less importance when the decision is made in time t+1 compared to when the decision was considered in time t. Preferences are inconsistent between time periods and consumers think that they will be able to resist temptation before going to the store, this would be at time t, but when there, at time t+1, they cannot resist temptation because utility of time t+2 is discounted more heavily than the consumer thought in time t. Because of the present bias, there is a conflict between preferences of today and those in the future. This conflict results in a dilemma since events that are costly today and beneficial in the future, such as going to the gym, will be postponed and events that are beneficial today and costly in the future, such as candy, will be carried out. For these reasons, hyperbolic preferences play an important role in self-control problems (Laibson, 1997).

When solving for equilibrium behavior, the consumer is portrayed as a sequence of temporal selves who make choices in a dynamic game. When solving for equilibrium behavior, agents are assumed to either be sophisticated, naïve, or partly naïve. This means that agents can be aware or unaware of being present biased. The sophisticated agents are completely aware of their present bias, the partly naïve agents are partly aware of their present bias while naïve agents are completely unaware. This makes it possible for the sophisticated and the partly naïve agents to use self-control devices in order to control their choices in the future (O'Donoghue & Rabin, 1999).

### 2.1.2 Commitment devices

Bryan et al., (2010) refers to self-control devices as commitment devices. He argues that a commitment device is an arrangement used to facilitate goals. There are hard and soft commitment devices. Hard commitment devices cause real economic penalties and benefits, for example, a commitment savings account for which interest payments are conditioned on that the money is kept on the account for a certain time. Soft commitment devices cause psychological consequences, for example, keeping a diary over food consumption (Bryan et al., 2010).

A commitment device is necessary if the present bias is strong enough to cause the present value to be positive with a hyperbolic discount rate while the present value is negative with a constant discount rate, or the other way around. For a commitment device to be necessary it needs to incur a cost of breaking the commitment that is large enough to add on to the initial cost or benefit and by that change sign of the present value with a hyperbolic discount rate. By doing so the present value of a constant discount rate has the same sign as the present value of a present bias discount rate (Bryan et al., 2010). A self-scanner can work as a soft commitment device that through monitoring spending; a self-scanner can cause psychological consequences if consumers do not act in their long-term interest. Although, Bryan et al., (2010) uses the terminology "commitment devices", to be clear in this paper "self-control devices" will be used.

### 2.1.3 Impulsive consumer behavior

It is now explained why individuals have self-control problems and how to model them, but it is also of importance to understand why it is sometimes easy to resist impulses and why it is sometimes not. Baumeister (2002) describes impulsive behavior as:

"Impulsive behavior is understood as behavior that is not regulated and that results from an unplanned, spontaneous impulse. In particular, impulsive purchasing involves getting a sudden urge to buy something, without advance intention or plan, and then acting on that impulse without carefully or thoroughly considering whether the purchase is consistent with one's long-range goals, ideals, resolves, and plans" (p.670).

According to Baumeister (2002), loosing self-control can lead to excessive buying of things that contradicts ones long-term goals. When exposed to an impulse to buy something, there are several factors that determine if one will give in to the impulse. If one of these factors fail, it is likely to lead to failure in self-control and impulsive buying as a consequence. The first factor is standards which identify goals, ideals, and norms that affect the choices made. The second factor is monitoring, a mean of keeping track of one's behavior to ensure that the right behavior takes place (Baumeister, 2002). In an experiment by Polivy et al. (1986), it was shown that people ate less candy if they were told to put their candy wrappers in front of them where they could see how many pieces they had eaten compared to when hiding the wrappers. The third factor is operational capacity, the strength to restrain from impulses. This depends on how much self-control a person has and how much has already been depleted (Baumeister, 2002). Tools that increase these factors would consequently decrease impulsive buying.

Khan, Humayun and Sajjad, (2015), summarize the findings so far on which factors that determine impulse buying in the article "Factors affecting impulse buying and percentage of impulse buying in total purchasing". In general purchasing, about 27 to 80 percent is impulse buying.  Demographic factors affect impulsive buying behavior, these are, gender, age, occupation and marital status. Moreover, consumer characteristics also have an effect, such as personalities with high self-control will buy fewer items on impulse. Product characteristics influence impulsive buying, for example, a hedonic product is more often bought on impulse (Khan et al., 2015). Hedonic products "provide more experiential consumption, fun, pleasure, and excitement" (Dhar & Werenbrosch, 2000, p.60). Additionally, consumer buying behavior, such as method of payment, influences impulsive buying. Furthermore, the time taken when doing the purchase, for example, time in the store is found to have a large effect on consumer behavior. Advertisement increases impulse buying too. Moreover, other characteristics that affect

impulsive buying are emotions, social interaction with shop staff, life style, and atmosphere in the store (Khan et al., 2015).

## 2.2 Mental accounting

It has been determined that consumers suffer from self-control problems. To constrain impulsive buying individuals can use self-control devices. Consumers also constrain themselves through mental budgeting. How consumers react to self-scanning as a self-control device, and how this affects mental budgets will be described through mental accounting. In mental accounting choices depend on the framing of an event. Hence, it breaks the assumptions of invariance to how a choice is presented; an object will no longer have the same value as a person's attitude towards it. Therefore, mental accounting is important to understand because when the process of a financial activity changes it will subsequently change how individuals make choices over outcomes (Thaler, 1999). To use a mobile self-scanner can be such a change in the process of financial activity.

Thaler (1999) defines mental accounting as "Mental accounting is a set of cognitive operations used by individuals and households to code, categorize and evaluate financial activities" (p.183). There are three components in mental accounting. Firstly, how decisions are made and how activities are evaluated depends on the perception and experience of outcomes. Secondly, there is assignment of activities to different mental accounts. Thirdly, accounts are given time horizons for which they open and close (Thaler, 1999).

Perceived utility depends on the value function. An example of the value function is presented in figure 2. The value of an outcome is on the vertical axis and the function looks different if it is for gains or losses relative a reference point. The size of the gain or loss is on the horizontal axis. The shape of the value function has three features; i) it is defined for gains and losses relative a reference point and not relative overall wealth, ii) it is concave for gains and convex for losses, and iii) it is steeper for losses than gains (Kahneman & Tversky, 1979).
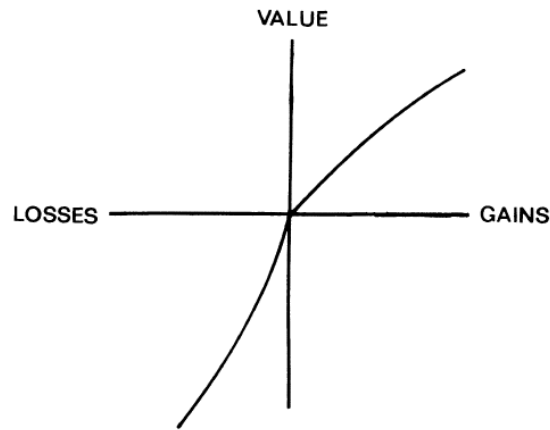
**Figure 1. Value function, (Kahneman and Tversky, 1979, p.279)**

Thaler (1985) explains that the shape of the value function results in diminishing sensitivity towards both gains and losses. Furthermore, the function is steeper for losses which cause loss aversion. As a consequence of the shape of the value function, there are certain ways that people can code their financial activities in order to achieve the outcome they want and increase their perceived utility. It is not until an account closes that a gain or loss is evaluated. At this point, the loss or gain is realized. The decision of when an account opens or closes can favor consumers through integrating losses according to the value function in figure 2. This can be summarized in four principles: segregating gains, integrating losses, integrate smaller losses with larger gains, and segregate smaller gains from larger losses (Thaler, 1985).

## 2.3   Inattentiveness & budgets

People allocate their spending into different spending categories, mental accounts, and how they spend their money depends on resources available in the affected category. Plans to spend, budgets, and actual spending do not necessarily occur at the same time (Heath & Soll, 1996). Individuals use mental accounts to budget expenses for two reasons. Firstly, it facilitates calculations of tradeoff between consumption and makes it easier to evaluate purchase decisions. Secondly, it serves as a self-control device since mental accounts for certain products can, for example, be put on low limits on goods where benefits occur before costs (Thaler, 1985). A budget is, according to the hyperbolic discounting model, set by the sophisticated to limit the choice set in future time periods when one suffers from present bias, like a soft self-control device (O'Donoghue & Rabin, 1999). For items to be booked to accounts and to keep track of

them, individuals need to cognitively be able to fully record, remember, and make trade-offs between purchases. Because these activities might be difficult cognitive processes, budgeting is affected by the expense tracking process (Heath & Soll, 1996).

Theory assumes that, when having a budget, consumers can keep track of their spending with certainty. To do so, consumers need to be able to sum up expenditures mentally and do so accurately. Van Ittersum et al. (2010) conducted a study to understand if consumers keep a budget and track their spending in two supermarkets in Atlanta. The result was that 84.6% claimed that they at least sometimes track their spending when buying groceries. Moreover, 87.6 % responded that they tracked their spending because of budget constraints. Consumers also had significant uncertainty in their estimates of total amount spent, contrary to what is assumed in economic theory (van Ittersum, et al., 2010).

To be able to accurately track a budget, consumers need to pay attention. However, research evidence suggests that attention is a limited resource (DellaVigna, 2009). Reis (2006), presents a model for inattentiveness where there is a cost to information. Consumers who are faced with too much information choose to only update their mental accounts occasionally. This is because it is not costless to absorb, revise, and process information. In between updates they suffer from choosing suboptimal consumption plans. This makes consumers slow to adjust to shocks and revise their consumption plans (Reis, 2006). In addition to the costs of information there are also cognitive limitations; a memory based model by Mullainathan (2002) simulates bounded rationality through limited memory. There are two pieces of evidence that are in focus, firstly, it is rehearsal, hearing something once makes it easier to remember it a second time around. Secondly, its associativeness, if an event is similar to a current event it is easier to remember it. Which decisions that are made, therefore depend on how information is presented and perceived. It is likely that limited memory causes over- and under reactions to information and some events may have prolonged effects because of rehearsal.

Inattentiveness has been proved in several studies to affect consumer behavior. Particularly, inattentiveness in relation to salience of price is of interest for mobile self-scanners. Kim (2006) investigated the role of integration of losses on the online

purchasing market. The results were that people bought less when shipping costs were added to the price of items. This result, and results from other experiments, such as Busse et al. (2013) on the "left digit bias", indicate that, when there is of lack of salience of a price there are cognitive difficulties in processing information, and therefore people do not fully react to the true price of an item. This creates problems with uncertainty in estimating budgets, and therefore failure in monitoring self-control (van Ittersum et al., 2010). A self-scanner would facilitate monitoring and therefore, increase consumer attention and avoid cognitive limitations since it displays costs saliently and sums expenses.

## 3 Previous research

The theoretical background to self-control problems, impulsive behavior and biases in decision making has been described. Empirically, there is little research on the effect of mobile self-scanning on consumer behavior. However, research on methods of payment and real-time feedback devices will be presented.

### 3.1 Mobile self-scanners & real-time feedback devices

One article can be found about mobile self-scanners and consumer behavior. This article by van Ittersum et al. (2013) focuses on the effect of real-time feedback and consumer behavior by studying smart shopping carts. Smart shopping carts are shopping carts that have built-in self-scanners. It was found that, the use of smart shopping carts influenced consumers differently depending on if they were budget or non-budget consumers. Budget consumers are consumers who are budget constrained and non-budget consumers are consumers who are not. Budget consumers increased their spending with a smart shopping cart while non-budget consumers decreased their spending. The reason for this is that budget consumers use the self-scanner to maximize budgets and by that consume their whole budget. They do so because without a self-scanner consumers are uncertain about the total amount spent and consequently consume less than their limit. Consumers do so to not overdraw their budgets (van Ittersum et al., 2013). Overdraft is much worse than spending too little because of loss aversion in the value function, see figure 1 (Khaneman & Tversky, 1979). Non-budget consumers have ambiguous effects, on one hand, item price is more salient which might decrease

spending, and on the other hand, there is less uncertainty about the price which stimulates spending (van Ittersum et al., 2013).

Research on real-time feedback devices indicate that monitoring decreases consumption of the item that is monitored. Many experiments have been performed with real-time feedback on home energy use (van Houwelingen & van Raaij, 1989). Gilbert and Zivin (2014) used smart electricity meters and measured energy consumption for households who receive data on their energy costs and consumption regularly and households who did not, and found that households who received data decrease their energy consumption.

## 3.2   Method of payment

Since groceries are scanned along the shopping trip, each purchase appears on the screen, and groceries do not have to be unpacked at the cashier, a self-scanner can assumedly be part of the payment process. Therefore, it is interesting to compare how consumers react to different methods of payment to how they would react to using a self-scanner. Early research by Hirschman (1979) concluded that spending was higher when using a credit card than cash. The same results are evident in subsequent research (Feinberg, 1986; Prelec & Simster, 2001). Furthermore, Thomas et al. (2011) found evidence that consumers who pay with credit card buy more unhealthy food than the ones paying with cash. This indicates that impulsive buying is easier when paying with credit card. As a result of using different methods of payment, there are three effects related to framing of the buying process. These are, the hedonic pain of payment, decoupling of payment, and recollection of payment.

The hedonic pain of payment means that some methods of payment have less or more perceived pain of paying (Prelec & Loewenstein, 1998). Cash has high pain of payment because of strong coupling between transaction and cost. This implies that when consumers buy vice products with cash, paying is very painful which stops the sudden urge to buy since the pain is not justifiable if the good is something that has a negative discounted utility value. Therefore, paying with cash can assumedly hinder impulsive buying behavior (Thomas et al., 2011). Payment decoupling is when the purchase and payment do not occur at the same time (Prelec & Loewenstein, 1998). In general, consumers prefer flat rates which increase decoupling and dislike "having the meter

running" as in a taxi car (Thaler, 1999). Raghubir and Srivastava (2008) showed that, different methods of payment result in different levels of payment decoupling and that people therefore spend more or less money depending on which method of payment that is used. Payment decoupling also has to do with the salience in parting, meaning that the decoupling and the pain is larger if it is more salient when parting from the money (Raghubir and Srivastava, 2008). Recollection of payment matters because past expenses will deplete budgets and therefore affect future spending. As Soman (1999) argues, for this to be effective, the pain of past payments needs to be fully recallable. Payments done by check have, according to by Prelec and Loewenstein (1998), a tighter coupling of each transaction and it is therefore easier to remember and keep track of spending compared to payment with credit card. Hence, what method of payment is used, and also the process of buying affects consumer behavior and ability to self-regulate.

## 4 Method

Data was collected from two sources. Firstly, an experiment by Emma Runnemark, Natalia Montinari, and Erik Wengström (2014), in which the author of this paper took part of the team that collected the data. In this experiment, consumers of a grocery store were allocated randomly to use a mobile self-scanner or not. At the end of the shopping trip, their receipts were collected and participants were asked to fill in a survey. The second source of data comes from a survey conducted by the author of this paper with students at the Lund School of Economics and Management. The survey was about subjective perceptions on which groceries are unhealthy and impulsive.

### 4.1 Participants

#### 4.1.1 First study

The population observed in the first study was consumers who buy groceries at City Gross in Sweden. Sampling method was a convenience sample, where consumers who agreed to take apart in the experiment participated. This sampling method most likely has biases since a convenience sample might differ from the real population and it is therefore not likely that every sample has the same probability of occurring. As a result, there can be problems with internal validity, meaning that the effects are not representable for the population. It is desirable to be able to generalize the results to

people who buy groceries in Sweden. For this, care is taken to look at the characteristics of the population in Lund and Malmö and of the grocery stores. In Lund, for example, 50 percent of the inhabitants have a university degree compared to the national average of 25 percent (Statistiska Centralbyrån, 2015). The benefits of choosing to do the experiment at City Gross are that, it is a large supermarket and therefore it sells more items than other stores sell. Because of this, it does not exclude certain groups of individuals, such as, conscious consumers who want Swedish meat. City Gross also has a very convenient mobile self-scanning system, which makes it easy for customers to adapt to the system. Possible causes of biases in the sample are the fact that, for most people, the only way to reach City Gross is by car which excludes the part of the population without a car, this in turn results in that the experiment most likely only studies how people behave when they do their major food purchases for the week and not the smaller every day purchases. Consequently, these biases result in problems with external validity of the results, meaning that with the results from this experiment it might not be possible to predict behavior at other supermarkets.

### 4.1.2  Second study

In the second study, a survey on vice products was performed to determine what groceries that consumers who participated in the experiment thought were impulsive and unhealthy. The sample was a convenience sample of students who agreed to take part of another experiment at Lund University School of Economics and Management. This convenience sample has the advantages that the characteristics of the sample are known and that participants did not know the content in the survey in advance. The survey was administered at the end of another economic experiment. One critical issue is that the average age of the participants is likely below 30 years old while average age for the sample from City Gross was 50 years old, see table 2. Another issue is that, the sample only included students who study business or economics at university level. According to table 3, 47 % of participants in the experiment, whose receipts were categorized, had a university degree. These sources of biases in the sample will be considered when interpreting the results and further research with an experiment on self-scanners that asks participants what groceries that they think are unhealthiness and impulsiveness can be interesting.

## 4.2 Design

### 4.2.1 First study

The experiment was conducted at a large grocery store (City Gross) in two locations in the county Skåne in Sweden. Data was collected both on weekdays and on weekends. Participants were randomly assigned two treatments: to use a self-scanner or not use a self-scanner. Participants were told that they would receive a lottery ticket (trisslott) for their participation. Only consumers shopping alone or in couples were eligible to participate. In order to participate in the experiment, customers needed to have a loyalty card, therefore this was the first question asked when consumers were approached. They were then asked if they wanted to participate in an experiment, and it was explained that, if they agreed to participate they would be randomly assigned to use a self-scanner, or to not use a self-scanner. To use a self-scanner, customers scan the bar code of each good before packing it in to bags. In the end of the shopping trip, customers pay at a scanner terminal where it is possible to pay both with credit card and cash. After shopping, receipts were collected and participants were asked to fill in a survey.

The survey consisted of several elements and took about 5-10 minutes. First, some personal information was collected including, age, occupation, income, and size of household. It followed by some questions about shopping habits of the consumer relating to grocery shopping and questions relating to their experience with a self-scanner and general attitudes towards technology. The second part of the survey included personality traits, measuring if the participant is a maximizer or a satisficer and a self-reporting impulsivity and self-control scale.

Questions relating to maximizer and satisficer traits were used from a scale developed by Schwartz et al. (2002), these traits will not be considered in this paper. The self-control scale was taken from Tangney et al., (2004) and it has been validated by Vischer et al., (2013) who show that the scale is measuring self-control well even though it is a short survey scale. Participants were asked to rate themselves on a five point scale ranging from 1, "not at all like me", to 5, "very much like me". The self-control scale is tested for correlation with many other scales by Tangney et al., (2004), among these were one that shows that participants with lower self-control also have low impulse control. Another relevant finding was that scores on self-control had a positive

correlation with a certain impulse control, namely, regulating eating. A person with high self-control has little problem with regulating eating.

### 4.2.2 Second study

In the second moment, a survey was conducted on a different group of individuals to categorize the groceries on the receipts in study one. The categories were unhealthy items, impulsive items, and items on offer. To determine which groceries that fall under each category, two different surveys were administered, in these surveys participants were asked to rate items on an impulsive and unhealthy scale. This classification was aimed at determining which items that qualified as impulsive and unhealthy, the items that had a score above the median value of impulsiveness and unhealthiness were categorized as impulsive and unhealthy.

The survey was conducted on computers and half the students were asked to rate according to perceived unhealthiness and half the students were asked to rate according to what degree they believe that they buy the item on impulse. The definition of unhealthiness simply stated that participants were to rate items according to how bad they thought the items were for their health. The reason for this definition to not be so specific is because the aim of the survey was to understand which products consumers thought to be unhealthy when they buy them and not what experts say is unhealthy. The definition of impulsive buying was rephrased and defined according to Gutierrez (2004). It stated that an impulse purchase, contrary to planned buying, is immediate and spontaneous buying where the customer has no prior plans to buy and does not actively look for a product. Impulse buying besides spontaneity is an intense and exciting urge to buy regardless of purchase decision consequences.

The dimensions on the questions were chosen to be from 1, not so much, to 5, very much, according to Andersson (1985). All basic groceries were not included because it was more interesting to be able to ask more specifically on products that were difficult to categorize. Basic groceries, such as sugar and marzipan for baking, that contain much sugar were ignored. These were ignored since, baking is a time consuming activity, and it was therefore not assumed to be of short term benefit when in the super market. Moreover, dairy products for everyday use were not included, as well as unprocessed meet products, and basic carbohydrates. Pasta and bread were included as references but did not get high enough rates to be considered as impulsive or unhealthy food, as a

consequence, it can be concluded that excluding basic carbohydrates can be justified. To avoid that all categories had high scores on the scale and therefore, even though it was stated not to, participants would rate items compared to earlier items rated, some items that were expected to have a low score on the scales were included. Lastly, the survey had a question which asked if there were any items that had not been included which participants often buy on impulse. Cream and dessert cheese were suggested in this question, and since the survey was performed several times these were included in the following sessions. All together there were 74 respondents on unhealthy items and 76 on impulsiveness rating. Items that had a score above median value (which was 2.43 for impulsiveness and 3.43 for unhealthiness) were considered impulsive or unhealthy when categorizing receipts from the experiment in study one. If items were both unhealthy and impulsive they were noted both in their respective categories, and in a separate unhealthy and impulsive category. See categorization in table A3 in the appendix.

## 5    Data

### 5.1   Independent variables

| Variable | Description | Participants |
|---|---|---|
| **Number** | Number of participants | 437 |
| **Single** | Participants who shopped alone | 282 (65%) |
| **Female** | Female participants | 318 (56%) |
| **Male** | Male participants | 252 (44%) |
| **Treatment** | Participants assigned a self-scanner | 217 (50%) |
| **Cash** | Participants who used cash | 57 (13%) |
| **Malmo** | = 1 if participants shopped in Malmö store | 267 (61%) |
| **Malmo** | = 0 if participants shopped in Lund store | 170 (39%) |
| **Weekend** | = 1 if participants shopped on a weekend | 236 (54%) |
| **Weekend** | = 0 if participants shopped on a weekday | 201 (46%) |
| **Budget consumers** | Participants who write budgets and include most items | 313 (79%) |

Table 1. Descriptive statistics independent variables

| Variable | Description | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| **Age** | Age of participants | 49.881 | 14.399 | 15 | 88 |
| **Household** | People in household | 2.522 | 1.239 | 1 | 12 |
| **Sharechild** | Share of children in household | 15% | 0.224 | 0 | 100 % |
| **Tot_self** | Total score in self-control scale | 46.837 | 6.877 | 26 | 64 |

Table 2. Descriptive statistics independent variables

| Variable | Description | Participants | SD |
|---|---|---|---|
| **voc_dum1** | Student | 25 | 0.233 |
| **voc_dum2** | Employed | 301 | 0.461 |
| **voc_dum3** | Self-employed | 22 | 0.219 |
| **voc_dum4** | Retired | 79 | 0.386 |
| **voc_dum5** | Other | 7 | 0.126 |
| **edu_dum1** | Primary and secondary school | 47 | 0.310 |
| **edu_dum2** | Upper secondary school | 163 | 0.484 |
| **edu_dum3** | Collage/university | 207 | 0.499 |
| **edu_dum4** | Other | 19 | 0.204 |
| **income_dum1** | Below 15 thousand SEK | 35 | 0.275 |
| **income_dum2** | 15-25 thousand SEK | 78 | 0.387 |
| **income_dum3** | 25-35 thousand SEK | 75 | 0.381 |
| **income_dum4** | 35-45 thousand SEK | 98 | 0.421 |
| **income_dum5** | 45-55 thousand SEK | 59 | 0.346 |
| **income_dum6** | 55-70 thousand SEK | 49 | 0.319 |
| **income_dum7** | More than 70 thousand SEK | 31 | 0.260 |
| **self_low** | Self-control score below 46 | 170 (42%) | 0.496 |
| **self_low2** | Self-control score below 42 | 87(22%) | 0.414 |

**Table 3. Descriptive statistics independent variables, vocation, education, income and self-control dummy variables**

In table 1 and 2, it can be seen that altogether there were 437 participants in the experiment. About 60 % of the data collected was from the store in Malmö and 54 % was collected on weekends. Only participants in couples or by themselves could participate, out of them 65 % shopped alone. The average age was 50 years old. Only 13 % of participants paid with cash and a few more women, 56 %, than men participated. In table 3, it can be noted that income is distributed across all categories. For vocation, on the other hand, almost 70 % of participants were employed while the second largest group was retired, representing 18 % of participants. 79 % of participants were categorized as budget consumers.

The self-control awareness scale consisted of thirteen questions where participants rated their self-control. The answers on each question were from 1 to 5 and they were reversed if needed. All thirteen questions were then summed up to a self-control score. A higher score means higher self-control awareness. The self-control score is used as a control variable and to interact with treatment of a self-scanner. Participants will be divided into groups of levels of self-control. These are groups are: the lowest 40 % self-control scores, which have a score below 46, and the lowest 20 % self-control scores,

which have a score below 42. The 40 % lowest self-control scores will be named self_low in the regression analysis and "low self-control" in the text. The 20 % lowest self-control scores will be named self_low2 in the regression analysis and "very low self-control" in the text. These groups were chosen because at 40 % there seemed to be a significant difference between individuals above and below this level of self control and then the 20 % lowest scores were used because this group is half the size of the above group. For the reason that the self-control score is a discrete variable, the percentages cannot be exactly 20 % and 40 %. The descriptive statistics will focus on the group of individuals that have the 40 % lowest self-control score and look at their characteristics.

For regression analysis and in the descriptive statistics, individuals are divided into subgroups in order to see if there are differences in their characteristics and behavior. These are individuals who shop alone, budget and non-budget, high and low earning, and young and old. The levels that the groups are divided by are chosen based on the following. Individuals who shopped alone were reported in the data. Budget and non-budget consumers is a variable that is based on two questions from the survey. These are: Do you write a shopping list before you shop groceries? Answer options: Always, sometimes, seldom, never. What does your shopping list contain? Answer options: Everything, most of it, only the most important things. A variable was created and defined as budget consumers which included individuals who had answered that they always or sometimes write a shopping list and who reported that they include most or all of their items on the list. The limit for high and low earning was chosen based on the average salary in Sweden which is 32 900 SEK for men and 28 200 SEK for women (Statistiska Centralbyrån, 2015a). Therefore, a wage above 35 000 SEK was considered a high wage because it is above the average wage. The age chosen between young and old individuals was 40 years old. This age was chosen on the basis of the average life expectancy in Sweden, which is 83,7 for women and 80,1 for men, and then divided by two (Statistiska Centralbyrån, 2015b). This age is also probably the upper limit of participants who participated in study two.

## 5.2 Dependendent variables

| Variable | Mean | SD | Min | Max |
|---|---|---|---|---|
| Total amount spend | 441.320 | 364.566 | 21.060 | 1944.200 |
| Number of items | 21.034 | 16.011 | 1 | 88 |
| Number of offers | 7.073 | 6.998 | 0 | 40 |
| Number of unhealthy itens | 2.909 | 3.759 | 0 | 23 |
| Number of impulsive  items | 3.043 | 3.906 | 0 | 24 |
| Number of both unhealthy and impulsive items | 2.016 | 3.070 | 0 | 21 |
| Sum of unhealthy and impulsive items | 3.936 | 4.542 | 0 | 27 |
| Share of items that are impulsive | 15.5 % | 0.180 | 0 | 100 % |
| Share of items that are unhealthy | 14 % | 0.159 | 0 | 100 % |
| Share of items that are offers | 34 % | 0.233 | 0 | 100 % |
| Share of items that are unhealthy and impulsive | 9.5 % | 0.137 | 0 | 100 % |
| Share of items that are either impulsive or unhealthy | 20% | 0.196 | 0 | 100% |

Table 4. Dependent variables

## 5.3 Self-control

| Characteristics | Mean self-control | SD | Min | Max |
|---|---|---|---|---|
| Overall | 46.809 | 6.862 | 26 | 64 |
| Income=  more than 35 000 SEK/month | 47.604 | 6.246 | 26 | 64 |
| Income= less than 35 000 SEK/month | 45.747 | 7.496 | 28 | 64 |
| Use a self-scanner | 46.688 | 6.724 | 28 | 64 |
| Do not use a self-scanner | 46.929 | 7.013 | 26 | 64 |
| Age<40 | 45.510 | 7.543 | 28 | 62 |
| Age>40 | 47.319 | 6.602 | 26 | 64 |

Table 5. Self-control

| Dependent variable | Overall | Self-control below 46 | Self-control  below 46 & self-scanner | Self-control below 46 & no self-scanner |
|---|---|---|---|---|
| Total | 442.330 | 433.884 | 388.150 | 480.707 |
| Number of  items | 21.082 | 20.565 | 19.291 | 21.869 |
| Number of offers | 7.089 | 6.712 | 6.233 | 7.202 |
| Number of unhealthy items | 2.915 | 3.276 | 2.988 | 3.571 |
| Number of impulsive items | 3.050 | 3.241 | 2.918 | 3.571 |
| Number of unhealthy and impulsive items | 2.021 | 2.206 | 1.802 | 2.619 |
| Number unhealthy or impulsive items | 3.945 | 4.312 | 4.105 | 4.524 |

Table 6. Dependent variables and low self-control

| Dependent variable | Overall | Self-control above 46 | Self-control above 46 & self-scanner | Self-control above 46 & no self-scanner |
|---|---|---|---|---|
| Total | 442.330 | 449.838 | 461.508 | 438.270 |
| Number of items | 21.082 | 21.326 | 21.867 | 20.789 |
| Number of offers | 7.089 | 7.282 | 7.681 | 6.885 |
| Number of unhealthy items | 2.915 | 2.617 | 2.4159 | 2.815 |
| Number of impulsive items | 3.050 | 2.894 | 2.929 | 2.859 |
| Number of unhealthy and impulsive items | 2.021 | 1.859 | 1.726 | 1.991 |
| Number unhealthy or impulsive items | 3.945 | 3.652 | 3.619 | 3.684 |

Table 7. Dependent variables and high self-control

Participants' level of self-control is of interest for this study, and therefore it is examined more thoroughly in the descriptive statistics. In table 5, it can be seen that the average score of self-control is lower for participants who are below 40 years old, it is also lower for participants who have lower earnings. Presumably, self-control is higher for individuals who earn more because they are older, or vice versa, but when testing if average income is different between individuals who are above or below 40 there was no significant difference. Average age was also observed for individuals who earn above and below 35 000 SEK per month. For the high earning group it was 48 years and for the low earning group it was 51 years. This reasoning can therefore be dismissed and indications are that young and lower earning individuals have lower self-control. The average self-control score is the same for participants who were assigned a self-scanner and for those who were not. This statistics is important because participants were asked to fill in the survey after shopping their groceries and this means that they were not affected by their treatment when answering the self-control scale, and the randomization was successful.

Table 6 and table 7 state the average of the dependent variable for individuals with high and low self-control and when they use a self-scanner and not. In table 6, for average amount spent, amount of items, and items on offer, less money was spent and fewer items were bought by individuals with low self-control. For the categories with unhealthy and impulsive items, the average amount bought was higher for individuals with low self-control than the ones with high self-control. For all categories of items, fewer items are bought by individuals with low self-control who use a self-scanner than those without a self-scanner. It is only when using a self-scanner that consumers with

low self-control on average bought the same amount of vice products as individuals with high self-control. In table 7, the average amount of items that individuals with high self-control bought is presented. For this group of individuals, a self-scanner does not have as strong of an effect. It can be seen that for some categories it is in the opposite direction and for some, the average amounts are the same.

It seems that there are some systematic differences between individuals depending on their reported self-control, so in the next sections OLS regression analysis will be performed.

# 6 Model specification

## 6.1 Independent variables

When deciding on which variables to include, literature was reviewed in order to understand which variables that determine impulsive buying; research on what determines impulsive buying was presented by Khan et al., (2015). These factors will be used when building the model. The independent variables are presented in table 1, 2, and 3.

Caution was taken to look at economic theory and not use statistical arguments for inclusion of variables. This is because of the risk of coming to the wrong conclusion about variables as a result of type I and type II errors. The risk of inappropriate specifications when too many tests are performed is higher if starting with a simple model and including variables, a procedure called specific to general. This study will therefore use the method general to specific in order to minimize this problem. The thought behind a general to specific modeling technique is that any improvement in the sense that it makes the model more parsimonious is an improvement (Verbeek, 2012, p.62-65).

For some regressions there was a problem with multicollinearity for the education and vocation dummy variables. Multicollinearity is a problem when there is too much correlation between independent variables. This is only a problem if the relationship between them is close to one. This can be tested with the "variance inflation factor", VIF, and a value above 10 can be considered a problem (Verbeek, 2012, p.44-45). When the VIF test was performed, it indicated that the vocation dummy variables had a value of

higher than 10 if dummy variables for income, vocation and education were included. Because of this, income was included as a normal variable since the estimates of different income groups was not of interest, and education and vocation were excluded in some models where the VIF value was too high. When this was done the VIF value was below 10 for all variables and, in fact, it was not above three in any of the models. Consequently, it can be concluded that the models do not suffer from multicollinearity.

After deciding upon a model that seemed appropriate a Ramsey RESET test was performed to find the functional form. In a RESET test additional forms of explanatory variables are added and the null hypothesis is that the coefficients in front of the additional forms are zero (Verbeek, 2012, p.71). If the Ramsey RESET test was significant, other functional forms of variables were considered.

## 6.2 Dependent variables

The dependent variables that will be used are the total amount spent, the number of items bought and then subcategories of items that are connected to impulsive buying. The subcategories are vice products, such as, unhealthy items, impulsive items, and items that are on offer. These subcategories are chosen because, according to literature about impulsive buying, there is evidence that unhealthy food, triggers impulsive buying since immediate pleasure urges a desire (Wretenbrosch, 1998). Even though consumers know that the food is unhealthy and that they will experience regret afterwards, they will still buy unhealthy food on impulse (Thomas et al., 2011). Moreover, Khan et al., (2015) state that, advertisement triggers impulsive buying, hence, how many items that are bought on offer will be used as a dependent variable. It is interesting to investigate vice products as a dependent variable because if fewer impulsive items are bought with a mobile self-scanner it strengthens the argument that a mobile self-scanner can be used as a self-control device. This would mean that a self-scanner not only works to monitor costs but that it also hinders impulses, urges, to buy something. If there is less impulsive buying that indicates that a self-scanner increases self-control.

## 6.3 Models

Two sets of models will be estimated with OLS regression to test the effect of a mobile self-scanner and if this effect depends on level of self-control. All models will be estimated with individuals who bought three items or more to exclude behavior of individuals who only went into the store determined to buy a single item.

Model 1 (M1) will test the total effect of a mobile self-scanner.

$$dependent\ variable_i \qquad\qquad (M1)$$
$$= \alpha_i + \beta_1 age_i + \beta_2 treatment_i + \beta_3 tot\_self_i + \beta_4 single_i$$
$$+ \beta_6 income_i + \beta_5 edu\_dum *_i\ ^1 + \beta_5 household_i$$
$$+ \beta_5 weekend_i + \beta_5 malmo_i + \varepsilon_i$$

It will be estimated twice, first including all individuals then a subsample of individuals with low self-control. To control for non-linearity, the self-control variable will be estimated with different forms, used both as the total score and as dummy variables with individuals in the sample with the 20 % and 40 % lowest self-control scores.

Model 2 (M2) will include an interaction effect between treatment and individuals with low self-control.

$$dependent\ variable_i \qquad\qquad (M2)$$
$$= \alpha_i + \beta_1 treatment_i + \beta_2 treatment_i * self\_low_i$$
$$+ \beta_3 self\_low_i + \beta_4 single_i + \beta_5 income_i + \beta_5 edu\_dum *_i\ ^2$$
$$+ \beta_5 household_i + \beta_5 weekend_i + \beta_5 age_i + \beta_5 malmo_i + \varepsilon_i$$

The dummy variables for self-control will be both low self-control and very low self-control. These regressions will be tested for three different subgroups of individuals, budget/non-budget individuals, individuals who shop alone, and with individuals who are below 40 years old. The reason for testing the sample when only including budget and non-budget individuals is because earlier research on self-scanners presents results that consumers who buy on budget spend more with a mobile self-scanner, and consumers who do not use a budget buy less with a mobile self-scanner (van Ittersum et al., 2013) . The subgroup of individuals that shop alone was estimated because they can be assumed to behave differently than individuals who shopped in pairs if there is an effect of the interaction between consumers. For example, consumers who shop alone might be more attentive and susceptible to self-control devices, and secondly, it is more likely that it is the behavior of the person who answered the survey whose behavior is

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[1] All education dummy variables, see table 3.
[2] All education dummy variables, see table 3.

observed in the store. Regression analysis with consumers who are younger than 40 years old was estimated because the survey in study 2, which was designed to categorize receipts, had a low average age. Therefore, these groceries may only be bought on impulse by this age group since the categories of the items may be different depending on individual characteristics, as age.

# 7 Results

## 7.1 Dependent variable: Total amount spent

Since a self-scanner saliently presents price of items on a screen, the total amount spent in the store is analyzed to understand if consumers react to the price, and therefore spend less when using a mobile self-scanner. If so, this indicates that consumers use self-scanners to track budgets and facilitate monitoring budgets. The results from model 1 are presented in table 8. The use of a self-scanner was insignificant for the whole sample, and it can therefore not be rejected that a self-scanner has no effect on how much a consumer spends in the store. In the regression on a subsample of individuals with low self-control the use of a mobile self-scanner was significantly different from zero on a 5 % significance level with a coefficient of -129.885, meaning that consumers with low self-control bought items for almost 130 SEK less than consumers with low self-control who did not use a self-scanner.

| Column | Dependent variable | Subgroup |
|---|---|---|
| 1 | Total self-control score | None |
| 2 | Total self-control score | Individuals with self-control below 46 |
| 3 | Self-control below 46 (low self-control) | None |
| 4 | Self-control below 42 (very low self-control) | None |

| VARIABLES | (1) Total | (2) Total | (3) Total | (4) Total |
|---|---|---|---|---|
| tot_self | -2.934 | -5.566 | | |
| | (2.781) | (7.631) | | |
| self_low | | | 49.496 | |
| | | | (39.048) | |
| self_low2 | | | | 67.410 |
| | | | | (45.845) |
| Treatment | -26.030 | -129.884** | -25.620 | -26.707 |
| | (36.449) | (59.134) | (36.387) | (36.453) |
| Age | -0.805 | -1.536 | -0.820 | -0.780 |
| | (1.132) | (1.801) | (1.130) | (1.132) |
| Weekend | 58.962 | 97.848 | 59.172 | 57.820 |
| | (37.916) | (61.471) | (37.931) | (37.686) |
| Malmo | -27.674 | 36.455 | -26.531 | -29.154 |
| | (38.792) | (62.510) | (39.112) | (38.801) |
| Household | 26.891 | 58.382* | 26.040 | 27.207 |
| | (18.578) | (30.878) | (18.485) | (18.601) |
| Income | 57.288*** | 38.491* | 58.151*** | 58.543*** |
| | (13.309) | (21.185) | (13.451) | (13.428) |
| education: primary school | -63.444 | | -61.399 | -55.034 |
| | (62.266) | | (62.155) | (63.928) |
| education: upper secondary school | 66.816 | 207.364*** | 70.140 | 73.134 |
| | (68.374) | (67.618) | (68.204) | (69.330) |
| education: university/collage | 50.610 | 198.155*** | 54.600 | 54.111 |
| | (68.956) | (68.118) | (68.752) | (69.456) |
| education: other | - | 120.760* | - | - |
| | | (69.164) | | |
| Single | -11.544 | 32.464 | -6.010 | -8.413 |
| | (37.182) | (58.104) | (37.605) | (36.783) |
| Constant | 364.627** | 316.393 | 198.707 | 202.429* |
| | (154.456) | (317.978) | (121.176) | (118.525) |
| Observations | 366 | 150 | 366 | 366 |
| R-squared | 0.125 | 0.191 | 0.126 | 0.126 |

Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

**Table 8. Total amount spent**

Model 2 was estimated to analyze the interaction effect of using a self-scanner and having low self-control on total amount of money spent in the store. In table 9, column 1 and 3 are with all individuals and column 2 and 4 are with individuals who are 40 years old or younger.

The interaction effect is significant and negative for all regressions, and individuals with very low self-control have stronger effect of a self-scanner compared to those with low self-control. The effect is also stronger in column 2 and 4 where only individuals who are below 40 years old are included. The independent variables for self-control, these are low and very low self-control, are significant and positive indicating that individuals with low self-control who do not have self-scanners, have a positive effect on spending. The effect of treatment, which is using a self-scanner, is insignificant for all results when not interacted with low self-control. These results prove that the use of a self-scanner has no significant effect on the total amount spent by individuals with high self-control and that individuals with low self-control spend less when using a self-scanner than when not using a self-scanner.

Furthermore, the variables that significantly affect spending are intuitive, these are that, the more individuals who are in the household the more is spent in the store, high income leads to more spending, and age has a negative effect on spending. This means that older individuals spend less than younger individuals on food, maybe because they have fewer children or exercise less and therefore eat less. This variable is only significant in model two but close to significant in the other models.

| Column | Dependent variable | | Subgroup |
|---|---|---|---|
| 1 | Self-control below 46 (low self-control) | | None |
| 2 | Self-control below 46 (low self-control) | | Individuals below 40 years old |
| 3 | Self-control below 42 (very low self-control) | | None |
| 4 | Self-control below 42 (very low self-control) | | Individuals below 40 years old |

| VARIABLES | (1) Total | (2) Total | (3) Total | (4) Total |
|---|---|---|---|---|
| 1.treatment | 28.919 | 130.109 | 9.529 | 120.136 |
| | (47.545) | (84.309) | (40.820) | (78.485) |
| 1.self_low | 115.602** | 397.640*** | | |
| | (58.140) | (140.927) | | |
| 1.self_low2 | | | 160.778** | 423.635** |
| | | | (73.533) | (167.759) |
| 1.treatment#1.self_low2 | | | -180.889** | -425.527** |
| | | | (88.786) | (190.613) |
| 1.treatment#1.self_low | -134.664* | -340.685** | | |
| | (74.989) | (158.658) | | |
| age | -0.789 | -16.223* | -0.554 | -16.489 |
| | (1.120) | (9.531) | (1.129) | (10.028) |
| household | 26.999 | 158.819*** | 28.041 | 161.732*** |
| | (18.673) | (56.793) | (18.601) | (59.852) |
| weekend | 61.625 | -20.885 | 56.830 | -37.635 |
| | (38.118) | (73.984) | (37.673) | (75.945) |
| malmo | -24.361 | 30.514 | -29.441 | 75.374 |
| | (39.407) | (66.420) | (39.008) | (67.042) |
| income | 56.449*** | 20.743 | 56.915*** | 21.912 |
| | (13.499) | (24.573) | (13.381) | (24.458) |
| education: primary school | -85.245 | -355.799* | -68.900 | -237.418 |
| | (61.902) | (193.736) | (64.361) | (178.203) |
| education: upper secondary school | 58.742 | 27.048 | 65.790 | 55.258 |
| | (66.199) | (193.198) | (69.773) | (191.563) |
| education: university/collage | 46.373 | 78.957 | 52.541 | 137.758 |
| | (66.798) | (171.523) | (69.523) | (178.394) |
| education: other (omitted) | - | - | - | - |
| Single | -1.222 | 94.110 | -5.635 | 53.826 |
| | (37.617) | (71.482) | (36.556) | (69.615) |
| Constant | 178.019 | 211.419 | 180.133 | 210.786 |
| | (121.521) | (349.888) | (120.284) | (355.489) |
| Observations | 366 | 90 | 366 | 90 |
| R-squared | 0.134 | 0.290 | 0.136 | 0.290 |

Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

Table 9. Regression output dependent variable total

Table A1, in the appendix, the regression outputs for model 2 on a subsample of different groups of individuals are presented. Because of the findings by van Ittersum et al., (2013), regressions were estimated first with individuals who are categorized as

budget individuals and then for individuals who are categorized as non-budget. Regressions were also estimated on individuals who shopped alone. The results for interaction and treatment were not significant for any of the subgroups of individuals. Although, for individuals who shopped alone, the coefficients did have the same sign as when regressing on the whole sample, and the p-value was close to 10 %.

In regression analysis with number of items as dependent variable, similar effects to total amount spent were estimated and the results will therefore not be presented. The effect on total amount spent is more interesting, and moreover, it is rather the price than the number of items that is presented on the screen of the self-scanner.

Robustness of the results in model 1 and 2 was tested in three ways. Firstly, the same regressions were estimated on the whole sample, before only individuals who bought three items or more were included. The same results as the ones presented in table 8 and 9 were evident. Secondly, the regressions were estimated including vocational dummy variables that were excluded because of multicollinearity and other explanatory variables that were excluded because they did not have any significant effect on total amount spent. These variables were the share of children in the household and gender of participant one. To include these variables did not change the results. Thirdly, a tobit regression censored at 24, which is the least amount spent by individuals who bought 3 items or more, was estimated. The results from the tobit regressions confirmed the results of the regressions that were not censored.

## 7.2 Dependent variable: Vice products

The regressions on vice products will be estimated with the previous restriction of three items or more and also constrained to those that bought at least one vice product. This is to see if there is an effect of a self-scanner on buying an extra item when one item is already bought. The effect of a self-scanner on amount of items that are vice products is interesting to analyze in two ways. These are number of vice products and the share of vice products. The share of vice products is number of vice products in relation to how many items that are bought. When deciding on which independent variables to include in OLS regression there was a problem with endogenity. This is because number of vice products bought most likely depends on number of items bought and number of items bought depends on number of vice products bought, which means that it is a simultaneous regression (Verbeek, 2012, p.146). If number of items is not included as a

variable there is still a problem with endogenity because of the omitted variable bias. When number of items is excluded, treatment and self-control will likely catch some of the effect of number of items, and therefore the estimates are inconsistent. From earlier regressions, see table 8, it is proven that number of items significantly depends on the other independent variables and they are therefore correlated which leads to biased estimations (Verbeek, p.144-145). Since data was collected from an experiment, it is not possible to use an instrumental variable, and therefore number of vice products cannot be estimated as dependent variable. The share of items that are vice products will be estimated instead.

For share of offers, neither model 1 or 2 had significant results for treatment. This is true in respect to the whole sample, when testing for self-control awareness differences, and using different subgroups. It can therefore be concluded that treatment does not have a significant effect on the share of items that are offers. The regression output on model 2 is in table A2 in the appendix.

For share of total amount of items that are, unhealthy, impulsive, sum of impulsive and unhealthy, and both impulsive, and unhealthy, results were similar. Results in models 1 were that, the regressions were not significant for treatment when the whole sample was included, nor were they when only including individuals with low self-control. Results from model 2 were not significant for treatment in any regressions with the whole sample. However, using a self-scanner for individuals with low self-control was significant for some of the regressions for individuals who were below 40 years old. Results are presented in table 10. The interaction effect of using a self-scanner and having low self-control was significant for share of unhealthy items and for share of items that are either impulsive or unhealthy. Additionally, the interaction effect was almost significant on a 10 % significance level for share of impulsive items, since the p-value is 0.102. The signs of the interaction effect for all regressions are positive and they are therefore different from the results when regressing treatment on the total amount spent. It means that the share of vice products increases when using a self-scanner for individuals with low self-control.

| VARIABLES | (1) Share impulsive | (2) Share unhealthy | (3) Share impulsive & unhealthy | (4) Share Impulsive or unhealthy |
|---|---|---|---|---|
| 1.self_low | -0.044 | -0.097* | -0.052 | -0.057 |
|  | (0.060) | (0.052) | (0.073) | (0.053) |
| 1.treatment | -0.022 | -0.092* | -0.000 | -0.055 |
|  | (0.060) | (0.053) | (0.073) | (0.053) |
| 1.self_low#1.treatment | 0.136 | 0.140** | 0.103 | 0.140* |
|  | (0.089) | (0.068) | (0.095) | (0.073) |
| Age | -0.005 | -0.004* | -0.006 | -0.003 |
|  | (0.003) | (0.002) | (0.003) | (0.003) |
| Household | -0.006 | -0.001 | -0.007 | 0.002 |
|  | (0.009) | (0.009) | (0.013) | (0.011) |
| Weekend | 0.056 | -0.001 | 0.011 | 0.010 |
|  | (0.037) | (0.035) | (0.044) | (0.036) |
| Malmo | 0.027 | 0.059* | 0.054 | 0.048 |
|  | (0.042) | (0.032) | (0.048) | (0.039) |
| Income | 0.002 | 0.002 | -0.005 | 0.000 |
|  | (0.012) | (0.010) | (0.015) | (0.011) |
| Single | -0.051 | -0.014 | -0.026 | -0.041 |
|  | (0.036) | (0.034) | (0.050) | (0.038) |
| Constant | 0.335*** | 0.330*** | 0.411*** | 0.319*** |
|  | (0.096) | (0.081) | (0.121) | (0.097) |
|  |  |  |  |  |
| Observations | 63 | 66 | 54 | 72 |
| R-squared | 0.173 | 0.144 | 0.128 | 0.113 |

Robust standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

**Table 10. Regression output dependent variable impulsive products, second set of models**

# 8 Discussion

The purpose of this paper was to investigate if there is an effect of a mobile self-scanner on consumer behavior. It was further assumed that there is an effect of a mobile self-scanner because it is used as a self-control device. Therefore, consumers with different levels of self-control awareness were investigated to see if they behaved differently when using a self-scanner. Behavioral economic theories were used to describe the process of decision making and intertemporal choice when the assumptions of standard economic theory do not hold. The implications of the theories were that, failure of self-control results in impulsive buying and choices that are not in line with ones long-term goals. A self-scanner can be used as a self-control device to facilitate monitoring of mental budgets and improve consumer welfare. This is because monitoring of mental budgets suffers from inattentiveness among consumers. In the discussion below, the above theories will be applied to self-scanning and consumer behavior in the

supermarket in order to understand what effects are predominant. Then the results will be analyzed to identify if these effects are true in this study.

## 8.1 Self-scanners as self-control devices

The choice to use a self-control device depends on characteristics of the individual in terms of knowledge about self-control problems. Hence, consumers who are sophisticated would choose a mobile self-scanner if it works as a self-control device, and if effort costs to use a mobile self-scanner are lower than loss in benefit from suffering from present bias. Self-scanning would be a predetermined choice by previous selves, and through mental budgets it is possible to limit impulsive buying with a self-scanner and to stay on budget. A self-scanner does not have any direct economical punishments but presumably, there are psychological consequences such as feelings of guilt and pressure to do what is optimal if breaking the commitment.

Self-scanners are efficient self-control devices since mental budgeting often suffers from cognitive limitations. When a mobile self-scanner is used all items are displayed saliently on the screen of the self-scanner. This implies that, all items will be put into mental accounts since all costs are noticed. Therefore, there will be less effect of inattentiveness since no cognitive effort will be required to track expenses, calculate prices, and remember these. Moreover, no items will be forgotten or missed and there will be no memory limitations. This affects future purchases as there is a stronger recollection of purchases that depletes mental budgets. Monitoring of optimal consumer behavior, such as tracking budgets, is enhanced similarly to when using real-time feedback devices, and according to Baumeister (2002), monitoring hinders impulsive buying. The effect of monitoring along with a stronger recollection of purchases would result in less impulsive buying, less spending in the grocery store and therefore, more optimal choices by individuals.

Another effect of self-scanning is that less willpower and cognitive energy is exhausted because monitoring requires less energy in the decision making process. Self-control is therefore not depleted, which is another one of Baumeister's (2002) factors that hinder impulsive buying. Furthermore, the value function which was proposed by Kahneman and Tversky (1979) indicates that people are loss averse, and using a mobile self-scanner possibly increases the sense of a loss every time a good is scanned as every good

is presented on the screen with a mobile self-scanner. "Segregation of losses" causes consumers to buy fewer items and especially less impulsive items because the psychological pain hinders impulses.

## 8.2   Can a self-scanner be compared effects of methods of payment?

Since the final payment is made either by credit card or by cash, the effect of using a mobile self-scanner is questionable with regard to when parting with money occurs and if it can be connected to methods of payments. If parting occurs when each good is scanned this could be assumed to be a close coupling between purchase and payment, but if consumers do not react as if scanning each good is a purchase, and do not perceive the digital numbers on the screen as costs, then there may be less coupling with a self-scanner. Similarly, the pain of payment with a mobile self-scanner depends on when consumers react to the purchase, if the mental purchase occurs when it is scanned and appears on the screen or in the event of payment, by credit card or cash, in the payment terminal. Supposedly, consumers do not react as if the complete transaction is made when items are scanned, but it can still have some effect on pain of payment since costs are salient on the mobile self-scanner. To conclude this argument, the effect of a mobile self-scanner on pain of payment depends on when consumers react to the payment, it can be assumed that there is a stronger recollection of payment, and also, that a mobile self-scanner has a somewhat increased effect on pain of payment and it may result in a closer coupling between purchase and payment. If these effects are true, then the use of a mobile self-scanner would lead to less spending and less consumption of vice products, similar to results in methods of payment.

## 8.3   Results from descriptive statistics

In table 6 and 7 it can be predicted from previous research and from the hyperbolic discounting model that there is more spending and more vice products bought by individuals with low self-control (e.g. Khan et al., 2015; Wertenbrosch, 1998; Baumeister, 2002).

Evidence in the data suggests the opposite for the first three categories. Individuals with high self-control spend more in the store, buy more items in total, and more items on offer. This result may be confusing at first since it could be expected that individuals with low self-control buy more. However, there are two pieces of information to consider. Firstly, outputs from regressions on total amount spent in table 8, show that

higher income results in more money spent in the store. Moreover, according to table 5, individuals with higher income also have higher self-control. This could therefore be one reason that individuals with high self-control spend more. Secondly, from table 6, the average amount of money spent for individuals with low self-control who do not use a self-scanner is, in fact, higher than the average amount spent by individuals with high self-control. Therefore, the reason that individuals with low self-control buy fewer items than individuals with high self-control is probably that the commitment effect of a self-scanner on individuals with low self-control is very strong. For impulsive and unhealthy items, table 6 and 7 indicate that individuals with low self-control buy more of these products than those with high self-control as predicted by research. This indicates that vice products are bought on impulse as a consequence of failure of self-control. Another implication is that it can be concluded that the categorization in study 2 contains good measurements on which items that impulsive and unhealthy.

If a self-scanner would be used as a self-control device then there should be less spending and fewer vice products bought by individuals with low self-control who use a self-scanner compared to those who do not. In table 6, for all categories of items, fewer items are bought by individuals with low self-control who use a self-scanner compared to those who do not use a self-scanner. Therefore, it seems that consumers with low self-control change behavior when using a self-scanner. The same conclusions cannot be drawn from table 7 for individuals with high self-control. For them, the effect is the opposite for total amount spent, number of items and items on offer. For vice products, fewer items are bought with a self-scanner than without one for individuals with high self-control but the effect is not as strong as for individuals with low self-control.

The effect of a self-scanner does presumably, according to the descriptive statistics, have different effects on individuals with high or low self-control. Individuals with low self-control seem to use self-scanning as a self-control device whereas individuals with high self-control may not. They are rather affected by the fact that the pain of payment may be less for mobile self-scanners since digitalization possibly decouples purchase from payment.  Furthermore, another reason could be the one of maximizing budgets. In previous research on self-scanners, by van Ittersum et al., (2013), a self-scanner will decrease price and budget uncertainty, and because of loss aversion in the value function, consumers rather spend too little than too much when they are uncertain

about how much they spend. If they know exactly how much is spent, they spend more. Another reason for higher spending can be because individuals with high self-control awareness may use self-scanners to save time rather than as self-control devices.

## 8.4 Results from regression analysis

### 8.4.1 Total amount spent

These findings in the descriptive statistics are supported by doing regression analysis on total amount spent. Firstly, model 1 was estimated. The results in table 8 were that, treatment was only significant and negative for individuals with low self-control, which means that the effect of a self-scanner does not have an effect on the whole sample but only for individuals with low self-control which is evidence for both hypothesis one and two. In model 2, the same result was evident, see table 9. The interaction effect between treatment and low self-control was negative and significant both for the whole sample and for a subsample of individuals who were below 40 years old. A self-scanner and high self-control had no significant effect, and low self-control without a self-scanner had a significant and positive effect. The effect of a self-scanner was even stronger on individuals with very low self-control and for younger individuals.

These results, that there is only an effect of a self-scanner on consumers with low self-control and that this effect is stronger for lower levels of self-control and for young people, indicate that a self-scanner is used as a self-control device. For this group, enhanced monitoring of expenses hinders impulsive buying and increases self-control. A tool that is possibly less needed among individuals with high self-control awareness. These findings from the regression analysis on total amount spent consolidate with the findings from the descriptive statistics. However, using a self-scanner had no statistically significant effect on spending when having high self-control and therefore there is no evidence in the regression analysis for the indications in the descriptive statistics that a self-scanner increases spending for individuals with high self-control.

The same regressions were estimated for subsamples of individuals to understand if there is a difference on the effects of a self-scanner on these subsamples. It can be concluded that there were no, or not very robust, results for using a self-scanner when regressing on subsamples of individuals who use a budget, do not use a budget, and for individuals who shop alone. The reasons that no effects are observed may be that

samples were too small when dividing the sample into subsamples and therefore no statistically significant effect can be concluded. Hence, significant results on individuals who shopped alone would increase robustness of the results. Furthermore, no evidence was found that budget and non-budget individuals, the way they were defined in this paper, spend differently in this sample.

### 8.4.2 Vice products and offers

In the regression analysis on share of items bought that are offers, unhealthy and impulsive, referred to as vice products, the effect of using a self-scanner was problematic to interpret. In model 1 and 2, all regressions had insignificant results for the use of a self-scanner on share of offers. For unhealthy and impulsive items, treatment was only significant in model 2, and only when interacting with low self-control, and regressing on a subsample of individuals who were below 40 years old. The coefficient of using a self-scanner and having low self-control was positive which means that using a self-scanner when having low self-control increases the share of vice products that are bought. This is compared to using a self-scanner and having high self-control, or not using a self-scanner and having low self-control. This result is the opposite of what can be expected from the hyperbolic discounting model on commitment devices. The reason that the result is significant only for individuals that are below 40 years old can be because, when doing the categorization in study two, the age of the participants was likely between 20 and 30 years old, and therefore, the items that are considered impulsive or unhealthy only applies for a younger age group.

The sign of the coefficient for the interaction variable between using a self-scanner and having low self-control is not in line with predictions by the hyperbolic discounting model, research on impulsive buying, and commitment devices, for this there can be several reasons. Firstly, people might have a "fun" factor when they use a self-scanner if they do not use one very often. Secondly, they might buy more vice products because it is easy to pick another item and scan, this can be compared to a low pain of payment. Thirdly, there is possibly a shame effect of showing vice products to the cashier, or other people in line. When consumers do not need to show their groceries they therefore buy more vice products.

There are other likely reasons for the coefficients of the interaction variables to be positive. Mainly, how large the share of vice products is out of number of items depends

on how many items that are bought, and therefore the share of vice products will increase when number of items decrease. As been seen in regression analysis in table 8 and table 9, the use of a self-scanner, when having low self-control, decreases number of items and this is likely why a self-scanner has a positive effect on share of vice products. Consequently, it can be concluded that the share of vice products is an inadequate dependent variable to measure the effect of a self-scanner on vice products.

Unfortunately, as have been discussed when deciding on the models, it is problematic to run an OLS regression analysis on number of impulsive items both when including and excluding number of items as control variables. This is since when it is included the model suffers from simultaneity, and when it is excluded, the model suffers from omitted variable bias. Therefore, the indicators from the descriptive statistics may be more informative than a regression analysis for vice products. Additionally, further research which includes instrumental variables for number of items can be very interesting since the descriptive statistics indicates that number of vice products is fewer for individuals with low self-control who use a self-scanner compared to those who do not use one.

## 8.5 Summary of discussion

Evidence in data analysis supports hypothesis one and hypothesis two. There was a change in total amount spent when using a self-scanner compared to when not using a self-scanner. This effect was only found for consumers with low-self-control and therefore consumers with high and low self-control awareness react differently to using a self-scanner. For vice products the results were ambiguous, the descriptive statistics indicated that using a self-scanner decreased amount of vice products bought but interpretation and performing OLS regression analysis was problematic because of endogenity. More research needs to be conducted to make conclusions about these results. The fact that the use of a self-control device limits impulsive buying is supported by the hyperbolic discounting models. A self-scanner limits the present biased agent since there is an enhanced recollection of costs of each grocery. Consumption is more easily monitored and assigned to accounts, and it is easier to track budgets. It therefore hinders impulsive buying. Moreover, the value function and segregation of losses may increase pain of payment which also hinders impulsive buying. The results on total amount spent indicate that a mobile self-scanner is used as a self-control device because

the change in behavior is only evident in individuals with low self-control. Assumedly, for individuals with high self-control, self-control does not fail so easily and therefore, a self-scanner does not have as strong of an effect, if any.

## 8.6 Further research

There are many areas of interest for research on consumer behavior when using a self-scanner since little has been written so far. From this sample it can be concluded that there is a significant and negative effect of a self-scanner on total amount spent and number of items bought for individuals with low self-control. It can therefore be interesting to understand if this is true for the population of Sweden, and also, in other cultures. Furthermore, there was evidence in the descriptive statistics that individuals with low self-control bought less vice products when using a self-scanner compared to when not using one. Further research on vice products when including data with instrumental variables would be of value. By doing so, it is possible to see if the effect of a self-scanner is not only on total amount of items, which may be an effect of that numbers are salient, but to see that a self-scanner actually stops consumers from adding an impulsive item. The data can also be investigated using a probit or logit approach and by that investigate if probability of buying at least one impulsive item increases when using a self-scanner and thereby avoid the enodgenity problem.

There was some evidence in the descriptive statistics that individuals with high self-control spend more when using a self-scanner compared to when not using one. This effect was not found in regression analysis, but with a larger sample there is reason to do more research on individuals with high self-control. With a larger sample it is also possible to connect to earlier research and investigate if individuals with high self-control use self-scanning to maximize budgets. Furthermore, a sample of individuals who shop alone would make the results more robust, for the reasons that it is hard to determine if it is the person who answered the survey whose characteristics were observed in the supermarket.

Lastly, research on how consumers look upon self-scanners would make it clear when they perceive that the transaction takes place. To do so creates knowledge on if consumers view a self-scanner as part of the payment process or if it is rather like a real-time feedback device.

# 9    Conclusion

Little research has been conducted on mobile self-scanners before this study. None investigated individuals with different levels of self-control awareness. This study presents evidence that consumer behavior changes when using a self-scanner and that there are differences in how consumers with high and low self-control awareness react to using a self-scanner. Individuals with low self-control spend less in the store when using a self-scanner while individuals with high self-control have no statistically significant change in behavior when using a self-scanner. A mobile self-scanner can increase consumer welfare because consumers buy on impulse when they are grocery shopping, and therefore do not make optimal decisions. They do so because they have self-control problems. Self-scanning changes consumer behavior as the use of a mobile self-scanner is a change in the process of a financial activity. A mobile self-scanner makes it easier to monitor and recall expenses and therefore works as a self-control device that controls impulsive buying and tracks mental budgets. It can be concluded that using a mobile self-scanner is good for consumer welfare because it monitors consumption and that it can work as a self-control device for individuals with low self-control.

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# Appendix

## Handling data

Data was collected from three sources; from an experiment where there were surveys and receipts and then to categorize receipts there was another survey that was in electronic format. In the experiment some of the receipts were missing for several logistic reasons, for these individuals their observations were dropped. Some surveys also had missing values where the participant had forgotten, or skipped, certain questions and there were also a few where they had missed that there were two sides of the survey which resulted in missing values on all these questions. In Verbeek (2012) it is stated that, if data is missing by some individuals then these observations can be dropped only if data is missing randomly. If they are not missing randomly there is a risk for the sample to be biased because of sample selection bias (Verbeek, 2012, p.19). It can be believed that, especially when the back side was forgotten, that this data is missing randomly. There were some questions that seemed to be purposely avoided, such as, some calculus questions, and there were other questions that could be suspected to be misunderstood. These questions were therefore looked on with carefulness, and mostly avoided, because of risk for sample selection bias and measurement error. Individuals who had missing values in variables that were included in the regression were automatically excluded. Furthermore, there were some missing values in the electronic survey, these can be assumed to be random since they were few and randomly distributed among the items. The missing values in the electronic survey were probably because they were missed by participants because of its format.

Outliers can occur because of measurement errors or if the distribution has a very fat tail. If there are outliers then they can either be discarded but if it is measurement error then this should be corrected (Verbeek, 2012, p.47-48). A summary statistics on all variables was performed in order to detect any missing values or mistakes in data. One outlier was found and it can be assumed to be a mistake, it was therefore corrected to be a missing value. As for outliers that cannot be assumed to be mistakes, none were excluded because of the risk of manipulating the data.

## Regression diagnostics

For the OLS estimators to be consistent and efficient the error terms need to be uncorrelated with each other, have a constant variance and be independent of the

explanatory variables ( Verbeek, 2012, p.33-35). The first assumption is not a problem for cross-sectional data if it is randomized (Verbeek, 2012, p.112), the second assumption means that error terms need to be homoskedastic and the last assumption has to do with endogenity. These problems will be discussed below.

Hetroskedasticity means that error terms do not have constant variance. This is a common problem in cross-sectional data since, for example, when estimating individual data, error terms for individuals with high scores, or who bought many items, can be expected to be larger than error terms for low scores, or who bought little items. To know if the model is hetroskedastic, a test for hetroskedacity will be performed (Verbeek, 2012, p.106-107). The test showed that the hypothesis that the error terms are homoskedastic can be rejected and it can therefore be concluded that the model is hetroskedastic. With hetroskedastic error terms, the OLS estimator is still unbiased but it is not the best estimator since the standard errors are not correct. To estimate the model, standard errors can be transformed into hetroskedastic consistent standard errors and standard errors will then be efficient (Verbeek, 2012, p.94-103).

Another problem is when error terms are correlated with explanatory variables. When this happens the model is endogenous and estimates are inconsistent. Reasons for endogenous models are because of measurement error in a variable, omitted variable bias, or simultaneity. Firstly, measurement error is when a variable is measured incorrectly. Secondly, omitted variable bias means that, one variable is not included in the model and this variable is correlated with one of the explanatory variables. Thirdly, simultaneity is when a dependent and independent variable are simultaneously dependent on each other (Verbeek, 2012, p.137-147). Since data is collected from an experiment, there are no instrumental variables available to include instead of an endogenous variable. Therefore, carefulness was taken to avoid inclusion of endogenous variables and to consider the risk of omitted variable bias. For this reason number of items was chosen to not be included in regressions of the dependent variables with number of unhealthy, impulsive and items on offer and instead the share of these items out of total amount of items was estimated. Another variable that was excluded was time in the store, since this variable can also be assumed to be endogenous. This is because, how long time spent in the store, depends on how much is bought, and how much is bought, depends on how much time is spent in the store.

Through looking at the error terms it was apparent that they were not normally distributed. and a normality test could reject the hypothesis that they were normally distributed. That the error terms are not normally distributed is, according to Verbeek (2012, p.35), not a problem since the OLS estimators will still be valid based on asymptotic theory.

# Regression output

## Table A1. Regression output: Total amount spent - subgroups

| Column | Subgroup |
|---|---|
| 1 | Single consumers |
| 2 | Non-budget consumers |
| 3 | Budget consumers |

| VARIABLES | (1)<br>total | (2)<br>total | (3)<br>total |
|---|---|---|---|
| 1.treatment | 18.403 | -115.147 | 40.499 |
|  | (58.668) | (169.158) | (52.562) |
| 1.self_low | 134.291* | 21.128 | 106.986 |
|  | (74.588) | (152.176) | (73.764) |
| 1.treatment#1.self_low | -114.690 | 53.265 | -100.978 |
|  | (99.716) | (200.905) | (92.563) |
| age | -1.237 | 3.143 | -1.489 |
|  | (1.644) | (3.474) | (1.310) |
| household | 19.982 | -43.986 | 33.098 |
|  | (24.428) | (44.821) | (21.916) |
| weekend | 110.080** | 126.223 | 50.372 |
|  | (49.605) | (109.630) | (44.782) |
| malmo | -55.241 | -130.7683 | -31.762 |
|  | (48.605) | (104.135) | (44.506) |
| income | 62.499*** | 130.044*** | 49.877*** |
|  | (17.886) | (34.267) | (15.425) |
| education: primary school | -48.585 | -395.648*** | -7.020 |
|  | (90.373) | (137.391) | (69.534) |
| education: upper secondary school | 41.833 | -112.180 | 148.056** |
|  | (92.451) | (145.728) | (63.789) |
| education: university/collage | 29.948 | -313.444** | 126.520* |
|  | (87.135) | (142.321) | (65.293) |
| education:other (omitted) | - | - | - |
|  |  |  |  |
| single |  | -80.283 | -15.153 |
|  |  | (105.455) | (45.313) |
| Constant | 200.158 | 440.050 | 143.551 |
|  | (160.089) | (312.826) | (126.473) |
|  |  |  |  |
| Observations | 241 | 71 | 264 |
| R-squared | 0.132 | 0.269 | 0.132 |

Table A1. Budget, non-budget and alone shoppers

## Table A2. Regression output: Share of items that are offers

| Column | Dependent variable | Subgroup |
|---|---|---|
| 1 | Self-control below 46 (low self-control) | None |
| 2 | Self-control below 42 (very low self-control) | None |
| 3 | Self-control below 46 (low self-control) | Individuals below 40 years old |
| 4 | Self-control below 42 (very low self-control) | Individuals below 40 years old |

| VARIABLES | (1) Share items on offer | (2) Share items on offer | (3) Share items on offer | (4) Share items on offer |
|---|---|---|---|---|
| 1.self_low | 0.003 | | -0.106 | |
| | (0.035) | | (0.087) | |
| 1.treatment | -0.006 | -0.021 | -0.030 | -0.057 |
| | (0.030) | (0.026) | (0.077) | (0.065) |
| 1.self_low2 | | -0.070* | | -0.160* |
| | | (0.036) | | (0.087) |
| 1.self_low2#1.treatment | | 0.025 | | 0.137 |
| | | (0.051) | | (0.112) |
| 1.self_low#1.treatment | -0.025 | | 0.051 | |
| | (0.046) | | (0.102) | |
| age | 0.003*** | 0.002*** | 0.017*** | 0.0182*** |
| | (0.001) | (0.001) | (0.006) | (0.006) |
| household | 0.013 | 0.012 | -0.025 | -0.034 |
| | (0.010) | (0.010) | (0.026) | (0.028) |
| weekend | -0.011 | -0.013 | -0.012 | -0.007 |
| | (0.024) | (0.024) | (0.054) | (0.052) |
| malmo | 0.064** | 0.067*** | 0.020 | 0.005 |
| | (0.025) | (0.024) | (0.052) | (0.050) |
| income | -0.014* | -0.015* | -0.008 | -0.005 |
| | (0.008) | (0.008) | (0.016) | (0.016) |
| education: primary school | 0.119** | 0.109* | 0.152 | 0.124 |
| | (0.058) | (0.060) | (0.096) | (0.083) |
| education: upper secondary school | 0.094* | 0.081 | 0.125 | 0.107 |
| | (0.050) | (0.052) | (0.086) | (0.090) |
| education: university/collage | 0.129** | 0.114** | 0.060 | 0.020 |
| | (0.051) | (0.052) | (0.080) | (0.087) |
| education: other (omitted) | - | - | - | - |
| single | -0.021 | -0.023 | -0.139** | -0.123** |
| | (0.024) | (0.023) | (0.056) | (0.055) |
| Constant | 0.132 | 0.175** | -0.058 | -0.042 |
| | (0.083) | (0.081) | (0.171) | (0.173) |
| Observations | 334 | 334 | 80 | 80 |
| R-squared | 0.068 | 0.078 | 0.182 | 0.192 |

Robust standard errors in parentheses, significance: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A2. Share of items that are offers

# Categorization

## Table A3. Vice products

| Unhealthy | Impulsive | Sum of impulsive and unhealthy | Both impulsive and unhealthy |
|---|---|---|---|
| Other snacks | Dark choclate | Dark choclate | Other snacks |
| Milk chocolate | Nuts | Nuts | Milk choclate |
| Ice-cream | Dried fruits | Dried fruits | Ice-cream |
| Candy | Bottled water | Bottled water | Candy |
| Chips | Cereal bar | Cereal bar | Chips |
| Cake | Other snacks | Other snacks | Cake |
| Pastries | Milk chocolate | Milk chocolate | Buns |
| Buns | Ice-cream | Candy | Cookies |
| Cookies | Candy | Chips | Chocolate bars |
| Swedish cheesecake | Chips | Sugar-free pastilles | Diet soda |
| Chocolate bars | Sugar-free pastilles | Cake | Soda |
| Diet soda | Cake | Buns | Energy drinks |
| Soda | Buns | Pastries | Froozen pizza |
| Lemonade | Cookies | Cookies | "Risifrutti" a Swedish rice porrage snack |
| Energy drinks | Natural sweets | Swedish cheesecake | Dessert cheeses |
| Choclate drinks | Popcorn | Chocolate bars | |
| Waffel mix | Chocolate bars | Sugar-free pastilles | |
| Ready-made froozen dishes | Smoothie | Natural sweets | |
| Froozen pizza | Diet soda | Popcorn | |
| Ready-made pie or pierogi | Soda | Chocolate bars | |
| "Risifrutti" a Swedish rice porridge snack | Energy drinks | Smoothie | |
| Ready-made froozen meat products | Dip for chips and vegitables | Diet soda | |
| Nutella- hazelnut cream | Ready made sandwiches | Soda | |
| Peanutbutter | Froozen pizza | Lemonade | |
| Ready-made potato pruducts | "Risifrutti" a Swedish rice porrage snack | Energy drinks | |
| Ready-made cold sauces | Sugar-free gum | Choclate drinks | |
| Tobacco products | Dessert cheese | Waffel mix | |
| Vanilla sauce | | Ready made froozen dishes | |
| Dessert cheese | | Froozen pizza | |
| | | Ready-made pie or pierogi | |

"Risifrutti" a Swedish
rice porrage snack

Färdiga köttprodukter
från frysdisken

Nutella- hazelnut
cream

Peanut butter

Ready-made potato
pruducts

Ready-made cold
sauces

Tobacco products

Vanilla sauce

Dessert cheese

Dip for vegetables
and chips

Ready-made
sandwiches

Sugar-free gum

Table A3. Vice products