THEORY AND EVIDENCE ON ALCOHOL REGULATIONS IN NORWAY

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May 2014

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Preface

First and foremost, I want to thank my supervisor, Tarjei Havnes, for all help throughout the process of writing this thesis. I am especially grateful for his availability in the final weeks, and for making the time to give not only constructive feedback but also encouraging words when it was very much needed.

I would like to thank Vinmonopolet AS and Statistics Norway for supplying the data used in this thesis. I am also grateful to Ingeborg Rossow from SIRUS for providing data, although in the end the data were not used in this thesis.

I would like to thank Espen Stokkereit for help with proofreading, and Andreas Kotsadam for making me aware of the link to behavioral economics, which in the end turned out to be a considerable part of this thesis.

Last but not least, I am grateful to Håkon Frede Foss for listening to every single problem encountered in the process and for helping to solve some of them.

All remaining mistakes and insufficiencies are of course my own.

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Chapter 1

Introduction

The impact of alcohol consumption on the social and economic environment is a topic of fierce debate in many countries. As usually the only legally distributed leisure drug, production, sales and even consumption of alcohol is often heavily regulated. Advocates of regulations seemingly have a strong case, as alcohol consumption has a number of adverse effects, both to the consumer and to society. Direct health risks to the consumer include cardiovascular disease, cirrhosis, cancer, depression, and even increased risk of suicide (Storvoll et al., 2010, Chapter 3). Alcohol consumption during pregnancy can have inhibiting effects on fetal development as well as adult outcomes for the child (Nilsson, 2008). Furthermore, alcohol consumption is related to increased risk of traffic accidents, both to the consumer and others, as well as criminal activity and the spread of sexually transmitted diseases.

In Norway, alcohol is strictly regulated. Limiting alcohol consumption is explicitly stated as a purpose of the law regulating alcohol, as a means of limiting the harm caused by alcohol consumption. The main policy tool is restricting alcohol access. Access is restricted in many ways, both through price, time, and location restrictions.

The adverse effects of alcohol do not automatically justify the regulations observed in Norway and many other countries. In this thesis, I first look at why regulations on alcohol could be justified. I argue that restrictions on alcohol could be welfare improving if there are negative externalities from alcohol consumption or if people have time inconsistent preferences. The external costs from alcohol consumption are not incorporated into the decisions on how much alcohol to consume exactly because they are external to the consumers making the

decisions. An unregulated market therefore leads to a too high alcohol consumption relative to the social optimum. If people have time inconsistent preferences, they are unable to follow their optimal consumption paths, and restrictions on alcohol could be welfare improving. I distinguish between naive and sophisticated consumers. While the naive consumers are blissfully unaware of their time inconsistencies, the sophisticated agents are able to accurately predict how their future preferences diverges from their current preferences, and they are eager to restrict their future selves in order to follow their preferred consumption paths from the present point of view. There is scope for improving welfare for both types, but while the naive can only be "forced" towards his optimal consumption path, the sophisticated agent can deliberately use policies as commitment devices in order to (at least partially) overcome his self control problems.

I then look at how different alcohol regulations could be welfare improving. Specifically, I look at restrictions on price, time, and location. If alcohol consumption entails a negative consumption externality, Pigouvian taxes improve welfare by forcing the consumers to internalize the external costs resulting from their alcohol consumption. To the naive time inconsistent consumer, restrictions on alcohol could be welfare improving by forcing him closer to his optimal consumption path than what he is able to achieve by the means of his insufficient self control. To the sophisticated time inconsistent agent, a policy forming a commitment device could increase his long term utility by allowing him to restrict the choice set of his future selves. I argue that time and location restrictions could form such commitment devices for the sophisticated time inconsistent consumers, and that even a short extra travel time to the nearest alcohol outlet could decrease alcohol consumption considerably.

Next, I turn to testing empirically the prediction that travel times affect alcohol consumption negatively using unique data from Norway. Norway is a large country divided by long fjords and rugged mountains. Off premise sales of beverages with a higher alcohol content than 4.7 percent by volume is only legal through a state monopoly (Vinmonopolet), and a license is required for all other alcohol sales, both off and on premise. Due to a limited number of Vinmonopolet outlets, there are large variations in travel times to the nearest outlet. In order to investigate the effect of travel times to the nearest Vinmonopolet outlet on alcohol consumption, it is not meaning full to look at cross sections. Alcohol consumption may vary between cities and the country side, as does travel times to the nearest alcohol

outlet. I therefore exploit variations in travel times to the nearest Vinmonopolet outlet due to the openings of a number of outlets between 2000 and 2012.

I use data on travel times between municipalities and sales data from both Vinmonopolet and other enterprises where alcohol sales are possible. During the period 138 new state monopoly outlets opened. Of these 118 opened in municipalities without a previous outlet. Mean travel times decreased by almost 10 minutes.

I exploit the variation in travel times between Vinmonopolet outlets and their customer bases due to the increased number of outlets, to investigate the effect of travel times on per person alcohol sales from Vinmonopolet. I use a fixed effects model to explain changes in per person alcohol sales by changes in travel times. I find a negative and highly significant relationship between mean travel time from Vinmonopolet outlets to its customer bases and the per person alcohol sales from Vinmonopolet. In particular, I find that a ten minute decrease in mean travel time in the customer base is related to an increase in per person alcohol sales from Vinmonopolet of 0.36 liters of pure alcohol per year. This is a 7.4 percent increase relative to the mean per person *total* alcohol sales between 2000 and 2010.

The effects of changes in travel time on alcohol sales are likely to differ between people, depending on their initial travel time to the nearest outlet. I therefore estimate some other specifications to allow for a non-linear relationship. First, I include travel time squared in my regression equation. This gives the expected signs and highly significant estimates for both the linear and squared coefficient. Using this model, I predict the effect of a ten minute decrease in mean travel time from the year 2000 mean travel time. A ten minute decrease in travel time is related to an increase in per person alcohol sales of 0.54 liters of pure alcohol per year.

I then estimate the model using the log of travel time. Again, the estimates are highly significant. The predicted increase in per person yearly alcohol sales from a ten minute decrease in travel time from the year 2000 mean travel time, is then 0.43 liters of pure alcohol.

Finally, I estimate a model where I allow for a linear relationship that differs between outlets for which the customer bases have different mean travel times. For the outlets with mean travel time below or equal to 30 minutes, I find that a ten minute decrease in mean travel time is related to an increase in per person alcohol sales from Vinmonopolet of 0.66

liters of pure alcohol per year. This is a 13.6 percent increase relative to the 2000-2010 mean of total per person annual alcohol sales. The estimate is highly significant. For the outlets with mean travel time between 30 and 60 minutes, a ten minute decrease in mean travel time is related to a highly significant increase in per person sales from Vinmonopolet by 0.36 liters of pure alcohol per year. For the last group of outlets, those with mean travel time for the customers above 60 minutes, the coefficient is not significant, and it is quite small. In all the specifications, travel times to the nearest Vinmonopolet outlet are thus negatively related to per person alcohol sales from Vinmonopolet. The effect of changes in travel time is smaller the higher are initial travel times.

These findings do not necessarily mean that shorter travel times are related to higher total per person alcohol consumption. Rather, it could be that the travel time to the nearest Vinmonopolet outlet only affects the composition of different forms of alcohol consumption. To investigate the possibility of substitution, I look at the effect of changes in travel time to the nearest Vinmonopolet outlets on per person alcohol sales through other channels than Vinmonopolet. The types of enterprises with potential to obtain licenses for alcohol sales are pubs and restaurants (on premise licenses) and grocery stores (off premise licenses). If there is substitution between alcohol from these sources and alcohol from the state monopoly, we would expect the relationship between the travel time to the nearest Vinmonopolet outlet and sales from pubs, restaurants, and grocery stores to be positive. For restaurants, the relationship is in fact positive. A ten minute decrease in travel time to the nearest Vinmonopolet outlet is related to a 22.2 NOK yearly decrease in per person sales from restaurants and cafes. However, this only to a very little extent compensates for the estimated increases in sales from Vinmonopolet, and the estimate is not significant.

For grocery stores and bars, there is a negative relationship between per person sales and the mean travel time to the nearest Vinmonopolet outlet in the customer bases. For bars, the estimate is very small and insignificant. A ten minute decrease in mean travel time is related to a 2.46 NOK increase in per person yearly sales. For grocery stores, the estimate is higher and highly significant. A ten minute decrease in mean travel time for the customer bases of grocery stores is related to a 209 NOK increase in per person sales per year. This in turn leads to a negative relationship between total per person sales and travel time, as sales from grocery stores constitute most of the total per person sales. A ten minute decrease in

travel time is related to a 171 NOK increase in total yearly per person sales. This could be due to a complementarity between alcohol acquired through different channels. However, it is also possible that sales in grocery stores are positively affected by increased proximity to a Vinmonopolet outlet, because people shop at grocery stores close to Vinmonopolet outlets while they are in the neighborhood.

Decreases in mean travel time thus seem to be related to not only an increase in alcohol sales from Vinmonopolet, but to an increase in actual alcohol consumption, as there is little evidence of substitution from alcohol from other sources.

In Chapters 2, 3, and 4, I discuss alcohol consumption and regulations in general. In Chapter 2, I present some of the adverse effects of alcohol consumption. In particular, direct health effects on the person consuming alcohol, effects of pregnant women's alcohol consumption, labor market outcomes, and crime effects. In Chapter 3, I present theory on externalities and time inconsistent preferences suggesting that restrictions on alcohol may improve welfare. Chapter 4 discusses how price, time, and location restrictions may improve welfare in the cases discussed in Chapter 3.

I then turn to an empirical investigation of regulation and consumption in Norway specifically. In Chapter 5, I present the historical and institutional background of consumption and regulations in Norway. Chapter 6 presents the data I use and some descriptive statistics. In Chapter 7, I present the empirical strategy, and the main results are presented in Chapter 8. Chapter 9 concludes.

Chapter 2

Adverse effects of alcohol consumption

There are a number of adverse effects from alcohol consumption. In this chapter, I discuss some of them. I categorize these effects into direct health effects, effects on children's health, effects on labor market outcomes, and effects on crime. By direct health effects, I mean effects on the health of the individual consuming alcohol. In the section on children's health, I discuss only how pregnant women's alcohol consumption may be harmful for the fetus, although parents' alcohol consumption may of course affect their children after they are born as well.

Direct health effects

It is widely accepted that alcohol consumption has a number of adverse health effects to the consumer. Alcohol consumption can lead to addiction, and it increases the risk of other diseases, some potentially fatal. These include cardiovascular disease, different forms of cancer, epilepsy, cirrhosis, and depression. Alcohol intoxication leads to impaired balance and movement skills and to a lengthened reaction time. This in turn increases the risk of accidents. Alcohol consumption is related to an increased risk of traffic accidents as well as fall accidents. Furthermore, alcohol abuse increases the risk of mortality by suicide (Rossow, 1996, Storvoll et al., 2010, Chapter 3, Babor et al., 2010, Chapter 2).

While a sustained high or moderate alcohol consumption without notable intoxication can lead to addiction and cirrhosis, some adverse effects are related to the amount consumed

on each occasion. These are effects that work through acute intoxication and include accidents and violence (Babor et al., 2010, Chapter 2). Drinking pattern, in addition to total consumption therefore plays a role in determining the adverse effects of alcohol consumption.

Using data from WHO in 2002, Rehm et al. (2006) estimate the fractions of European deaths that are due to alcohol consumption. They construct a measure of "alcohol attributable fractions" (AAFs) based on data on drinking patterns and the risk of different diseases for different drinking patterns. The AAF is a measure of the share of disease that would disappear with no alcohol consumption. They estimate that 6,1 percent of all European deaths are due to alcohol consumption.

Effects on children's health

Alcohol consumption during pregnancy can harm the fetus. Fetal alcohol syndrome is a pattern of birth defects caused by mothers' alcohol consumption during pregnancy. Characteristics of the fetal alcohol syndrome include stunted growth, abnormal facial characteristics, and brain damage. Furthermore, alcohol consumption during pregnancy is related to premature birth, low birth weight and an increased risk of miscarriage (Storvoll et al., 2010, p. 55, Andersen et al., 2012).

There is also evidence that mothers' alcohol consumption during pregnancy affect their children's adult outcomes. Nilsson (2008) investigates the effect of increased alcohol availability, following a policy change in Sweden, on education and work outcomes for those exposed to the policy while in utero. He exploits a policy experiment in two Swedish regions in 1967 where alcohol availability increased temporarily. During the experiment, regular grocery stores were allowed to sell strong beer (beer with a alcohol content of less than 5.6 percent by volume[1]). Before and after the experiment and in the other regions in Sweden, only the state run off premise alcohol monopoly, Systembolaget, was allowed to sell beverages with a higher alcohol content than 3.5 percent. Only people above the age of 21 were allowed to buy alcohol from Systembolaget, whereas the age limit in grocery stores was 16. The experiment increased the availability of lower alcohol content beverages for those above 21 years old, which was an intended outcome. For those between 16 and 21 years old, however,

[1] Throughout this thesis, references to alcohol contents are always alcohol content by volume.

availability of beer with a higher alcohol content increased.

Using a difference-in-differences strategy, Nilsson finds that those children exposed to the experiment while in utero have fewer years of schooling, lower high school and college graduation rates, are less likely to be employed, and have lower earnings than cohorts in utero before and after the experiment and in the other regions during the experiment. The number of years of schooling was 0.27 years lower for the treatment group, with larger effects for males than for females. Children in the treatment group were less likely to complete high school, by 4 percentage points. Finally, the exposed cohorts had 24 percent lower earnings on average.

Labor market outcomes

Johansson et al. (2012) find that work absence increased as a result of increased alcohol availability in Sweden. They look at the effect of a cut in the Finnish alcohol tax in 2004 on mortality, alcohol related illnesses, and work absence in Swedish regions near the Finnish border relative to other regions in the north of Sweden. The Finnish tax cut led to large differences in liquor prices between Finland and Sweden. The sales of liquor grew throughout Finland, but the growth was much larger in the regions close to the Swedish border, indicating cross border shopping. They use a differences-in-differences strategy and find that work absence increased by 12.5 percent for females and by 5.3 percent for males. For mortality and hospitalization, however, their estimates are small and imprecise.

Crime

There is a large literature on the relationship between alcohol consumption and crime. A relationship between criminal violence and alcohol consumption has been established (Room and Rossow, 2001). Rossow and Norström (2011) investigate the impact of changes in bar closing hours on the number of reported assaults, using a fixed effects model. They look at 18 Norwegian cities where closing hours changed between 2000 and 2010. Their outcome variable is the number of reported assaults in the city center during weekends at night time (10 pm to 5 am). They include the number of assaults outside the city center as a control variable. They find that each extra trading hour increased reported assaults by 16 percent. They also

find that the influence of trading hours was symmetrical, ie. extensions and restrictions in trading hours had similar impacts.

Markowitz et al. (2012) study the effects of alcohol control policies on self reported violent crime in the U.S. They look at the effect of sixteen different alcohol control policies. These include the number of liquor outlets per 1000 residents, drunk driving laws, alcohol price, and Sunday sales restrictions. They propose that an act of violence is a function of the alcohol consumption of the potential victim as well as alcohol consumption of the potential perpetrator, and that alcohol consumption in turn is a function of alcohol policy. They use a linear probability model to explain acts of violence by alcohol price and other alcohol control policies, using individual fixed effects and controlling for a number of characteristics associated with crime. They find a negative, but statistically insignificant, relationship between alcohol prices and the probability of being assaulted, and they find only small and insignificant coefficients on the other alcohol control policies. They then restrict the sample to only self reported assaults involving observed alcohol or drug use by the offender. They then find that a 1$ increase in beer price is associated with a 0.06 percentage point increase in the probability of being assaulted in a six month period. The result is significant at the 10 percent level.

Chapter 3

Why regulate alcohol?

There is a general consensus that there are negative effects from alcohol consumption. This fact, however, is not in itself reason enough to justify regulations. When making decisions about how much to consume, a rational and informed agent will take account of health effects, increased risk of accidents when driving, reduced ability to earn income etc. Yet, alcohol is heavily regulated in many countries. In this chapter, I discuss why state interference in the market may be justified. I present economic theory suggesting that an unregulated marked for alcohol may lead to non-optimal consumption, leaving scope for welfare improvement from regulations.

3.1 Externalities

The first argument for regulating alcohol is the presence of externalities. "An action creates an externality if it affects someone with whom the decision maker has not engaged in a related market transaction" (Bernheim and Whinston, 2008). That is, a party other than those choosing to perform the action is affected by it. The effect could be either positive or negative.

Let us think of an externality resulting from the consumption of alcohol. The externality is something which affects a third party: someone who is not the buyer (the consumer) or the seller of the good. The positive and negative effects to the buyer or seller will be incorporated

into the agreement on price (assuming they are aware of the effects). However, the buyer and seller do not take the external effect into account when deciding how much to buy and sell, and at what price, as they only maximize their own utility or profits. The externality is thus "a link between economic agents that lies outside the price system of the economy" (Hindriks and Myles, 2006). If the externality is positive (a benefit), an unregulated market will lead to a lower consumption than the social optimum. If the externality is negative (a cost), an unregulated market will lead to a higher consumption than the social optimum.

To show this, I use a simple economic model. Each individual has utility function $u(c_i)$ where c_i is individual i's consumption of alcohol. I assume conventional properties for the utility function:

$$\frac{\partial u_i}{\partial c_i} > 0 \quad , \quad \frac{\partial^2 u_i}{\partial c_i^2} < 0.$$

Individual i's alcohol consumption also causes some per unit cost α to society. Ie. there is a negative externality from alcohol consumption. I assume that α is constant and the same for all consumers. For simplicity, I let the supply curve be perfectly elastic.

Individual i takes the market price p as given, and his budget constraint takes the form $c_i p \leqslant y_i$. His optimization problem becomes

$$max_{c_i} u(c_i) \quad st. \quad c_i p = y_i.$$

All individuals maximize utility and consume until $u'(c_i) = p$. That is, until their private marginal benefit from alcohol consumption equals the price they face. This gives a standard market equilibrium. In an unregulated market the private marginal benefit will equal the private marginal cost, and a quantity q_1 will be sold at price p_1, as shown in Figure 3.1.

The social marginal benefit from alcohol consumption is not equal to the private marginal benefit however. The social marginal benefit from individual i's consumption is $u'(c_i) - \alpha$. In the social optimum, individual i's consumption is given by

$$u'(c_i) - \alpha = p, \tag{3.1}$$

where $u'(c_i) - \alpha$ is the social marginal benefit of individual i's consumption. Using this

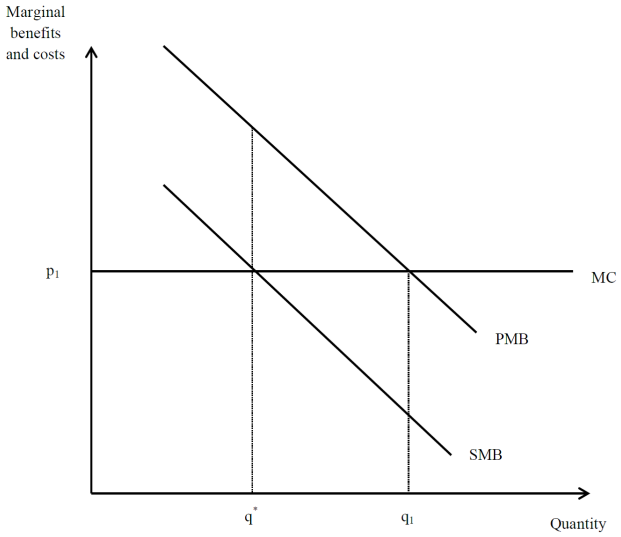


Figure 3.1: Externality from alcohol consumption

Social and private marginal benefit and marginal cost with a negative consumption externality from alcohol consumption.

and equation (3.1), we get that the social marginal benefit of the alcohol consumption of consumer i should equal the marginal cost of his consumption. The social optimal quantity is thus q^*, as shown in Figure 3.1, given by the equality of the marginal cost and the social marginal benefit. Since each individual consumer does not bear the external costs of their consumption, they do not take it into account when deciding on how much to consume. This leads to over consumption from a social perspective. The excess consumption in the unregulated market is $q_1 - q^*$.

It is easy to think how the adverse effects described in Chapter 2 can, at least partially, be external to the individuals deciding how much to consume. For instance, people who consume alcohol may to some extent take into account the costs from their increased health risk. However, they may not take into account (or even be aware of) the costs from their alcohol related damages induced on the government; hospital and rehabilitation expenditures etc. The drunk driver may take into account his own increased risk of an accident, when deciding whether to drink and drive, but he may not take into account the increased risk he imposes on all other drivers and pedestrians in his path. People committing crimes when

under the influence may take into account their risk and costs of being caught and punished, but not the costs to society from litigation, police work, administrating prisons etc.

3.2 Time inconsistency and self control problems

The second justification for public regulations on alcohol that I propose in this thesis is that people may have self control problems. In this section, I argue that if people have self control problems, public regulation could increase welfare by acting as a commitment device for the consumers or even by forcing consumers closer to their optimal consumption paths in a merely paternalistic way.

I follow O'Donoghue and Rabin (1999) and model the self control problems, using present biased time inconsistent preferences. The present bias means that the consumer puts larger weight on the present relative to the future. With time inconsistent preferences, the choices which maximize utility are different depending on what point in time they are evaluated at. People with time inconsistent preferences have self control problems. They are able to make an optimal plan for the future. However, they are not able to stick with their plan, because what seemed optimal at the time of planning no longer seems optimal when the actions have to be performed. Specifically, in the case of alcohol consumption, what the consumer perceives to be his optimal consumption path changes over time.

In this section, assume that consumers get some utility from consuming alcohol today, but are also aware of some costs occurring in the future related to alcohol consumption. The costs from alcohol consumption could be any of the negative effects related to alcohol consumption discussed in Chapter 2, but I think the most straight forward way to think of the cost in the model I present is as a hangover. You enjoy consuming alcohol today, but you must bear the cost tomorrow of a hangover.

Alcohol consumption in this set up entails an immediate reward and a delayed cost. Or, equivalently, restricting own consumption entails an immediate cost, the cost of not consuming as much as you want, and a delayed reward, the reward of avoiding the hangover. Due to his present bias, the consumer will always want to start the healthy lifestyle tomorrow rather than today, or to be more healthy tomorrow relative to today. The cost of being healthy relative to the reward seems higher when the cost is borne today and the benefit

comes tomorrow, than when the cost and reward are both borne in the future.

Model

I use a model with quasi hyperbolic discounting. Specifically I use a (β, δ)-model where the intertemporal preference function

$$U_t = u_t + \beta \sum_{s=t+1}^{T} \delta^{s-t} u_s$$

follows O'Donoghue and Rabin (1999). U_t is the intertemporal preferences from the perspective of period t, u_t are the instantaneous preferences in period t. $0 < \beta < 1$ is a discount factor which represents a bias toward the present. If $\beta = 1$ there is no time inconsistency. δ is the time consistent discount factor. In my model I assume $\delta = 1$ for simplicity. When $\delta = 1$ the agent only distinguishes between the present and the future. He does not discount between future periods. The consumer in this model only cares about alcohol consumption and does not get utility from any other source. I assume that instantaneous utility in period t is a function of alcohol consumption in period t and alcohol consumption in period $t-1$:

$$u_t = u(c_t,\, c_{t-1})$$

where

$$\frac{\partial u_t}{\partial c_t} > 0 \quad , \quad \frac{\partial^2 u_t}{\partial c_t^2} < 0$$

and

$$\frac{\partial u_t}{\partial c_{t-1}} < 0 \quad , \quad \frac{\partial^2 u_t}{\partial c_{t-1}^2} > 0.$$

Consumption today entails a reward today, and the marginal reward is decreasing in consumption. Consumption today also entails a cost tomorrow, and the marginal addition to this cost is increasing in consumption. I talk about period t as "today" and period $t+1$ as "tomorrow", though these periods could of course represent some other time intervals.

I make a few assumptions for simplicity. First, I assume that the agent is free to save and borrow as he pleases at an interest rate equal to 0. Furthermore, I assume that the

monetary of cost of alcohol, p, is constant. I denote his lifetime income by M. Since he can save and borrow at no interest rate, it is irrelevant when the income is received. Using these assumptions, I can state his lifetime budget constraint

$$p\sum_{s=t}^{T} c_s \leqslant M$$

which further gives his maximization problem

$$max \quad U \qquad st. \qquad p\sum_{s=t}^{T} c_s = M$$

where he maximizes with respect to consumption in all periods from t to T. The consumer makes a decision every day about how much to consume on that day.

This gives the first order conditions

$$\frac{\partial u_t}{\partial c_t} + \beta\delta\frac{\partial u_{t+1}}{\partial c_t} - \lambda p = 0$$

$$\beta\delta\frac{\partial u_{t+1}}{\partial c_{t+1}} + \beta\delta^2\frac{\partial u_{t+2}}{\partial c_{t+1}} - \lambda p = 0.$$

Combining these gives me the consumption Euler equation

$$\frac{\partial u_t}{\partial c_t} + \beta\frac{\partial u_{t+1}}{\partial c_t} = \beta\left(\frac{\partial u_{t+1}}{\partial c_{t+1}} + \frac{\partial u_{t+2}}{\partial c_{t+1}}\right). \tag{3.2}$$

From equation (3.2), it is evident that in period t the consumer puts less weight on the cost relative to the benefit of today's consumption than he does with tomorrow's consumption. The preferred consumption in period t is therefore larger than the preferred consumption in period $t+1$ as seen from period t. Clearly, this is also the case for periods t and $t+r$. The distinction here is between the present and the future only, not between future periods. Remember that I assumed that $\delta = 1$.

Now, let us look at the consumption Euler equation between periods $t+1$ and $t+2$, still

from the point of view of period t. Again, I use the first order conditions

$$\beta\delta\frac{\partial u_{t+1}}{\partial c_{t+1}} + \beta\delta^2\frac{\partial u_{t+2}}{\partial c_{t+1}} - \lambda p = 0$$

$$\beta\delta^2\frac{\partial u_{t+2}}{\partial c_{t+2}} + \beta\delta^3\frac{\partial u_{t+3}}{\partial c_{t+2}} - \lambda p = 0$$

to find the Euler equation

$$\frac{\partial u_{t+1}}{\partial c_{t+1}} + \frac{\partial u_{t+2}}{\partial c_{t+1}} = \frac{\partial u_{t+2}}{\partial c_{t+2}} + \frac{\partial u_{t+3}}{\partial c_{t+2}}. \tag{3.3}$$

It is now evident that in period t the preferred consumption in periods $t+1$ and $t+2$ is the same. Again, the relationship is the same for periods $t+1$ and $t+r$. The optimal consumption as seen from period t is thus the same for all future periods.

Preferred and actual consumption paths

In period t, the agent wants to consume according to the Euler equations (3.2) and (3.3). However, in period $t+1$, when he makes the decision about whether to drink and how much, the Euler equation describing the consumption in periods $t+1$ and $t+2$ has become

$$\frac{\partial u_{t+1}}{\partial c_{t+1}} + \beta\frac{\partial u_{t+2}}{\partial c_{t+1}} = \beta\left(\frac{\partial u_{t+2}}{\partial c_{t+2}} + \frac{\partial u_{t+3}}{\partial c_{t+2}}\right).$$

Since $\beta < 1$, the agent once again puts less weight on the future and regards the cost relative to the benefit of current consumption to be smaller than the cost relative to the benefit of future consumption. This is because both the cost and the benefit of future consumption are discounted, whereas only the cost and not the benefit of current consumption is discounted. As it turns out, he does not in period $t+1$ act according to the plan he made in period t.

Figure 3.2 shows the preferred consumption path from the point of view of period t. As is evident from the figure, the preferred consumption path in period t is one with a (relatively) high consumption in period t and a lower and constant consumption in all other periods.

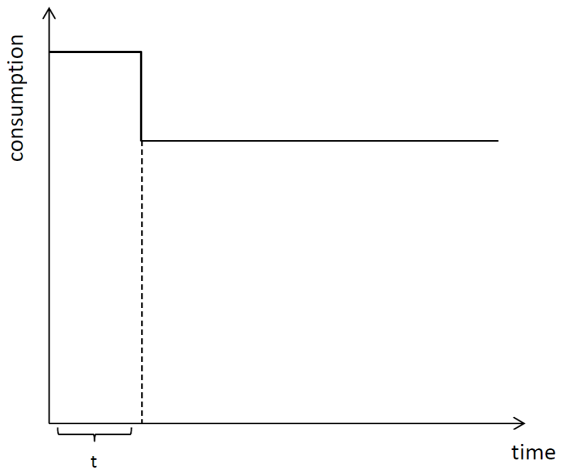


Figure 3.2: Preferred consumption path, period t perspective

However, the decisions about how much to consume in the future periods are made in the respective periods, and by the time the decisions are to be made the world has changed.

Following O'Donoghue and Rabin (1999), suppose there is a period 0 where the agent does not make a decision and puts the same weight on all future periods. This can be used to find the "long run utility" from doing something (consuming) in period t and make welfare analyses by comparing the long run utilities. In the model above, it is optimal from the period 0 perspective to consume the same amount in all periods, since the period 0 perspective weighs the utility costs relative to the utility gains of consumption equally in all periods. Policies that help consumers reach their period 0 optimal consumption path could then increase welfare.

In period 0, all periods are weighted the same and there is no consumption decision. The consumer therefore weighs the costs and the benefits from alcohol consumption equally. Since his period utility function $u(\cdot)$ is the same in all periods, his optimal consumption path is one with constant consumption. In period t the consumer discounts the cost but not the benefit from current consumption, and he discounts both the cost and the benefit of future consumption. He therefore wants a higher consumption today and a lower and constant consumption in all future periods. In period $t+1$, however, the consumer wants to consume at a higher level in period $t+1$ and then a lower and constant level for all remaining periods.

The history then repeats itself again and again. In period $t+2$, the world has again changed, and the agent has a new preferred consumption path. His actual consumption path will then be one where the consumption in each period is equal to the optimal consumption in that period from the point of view of the respective period.

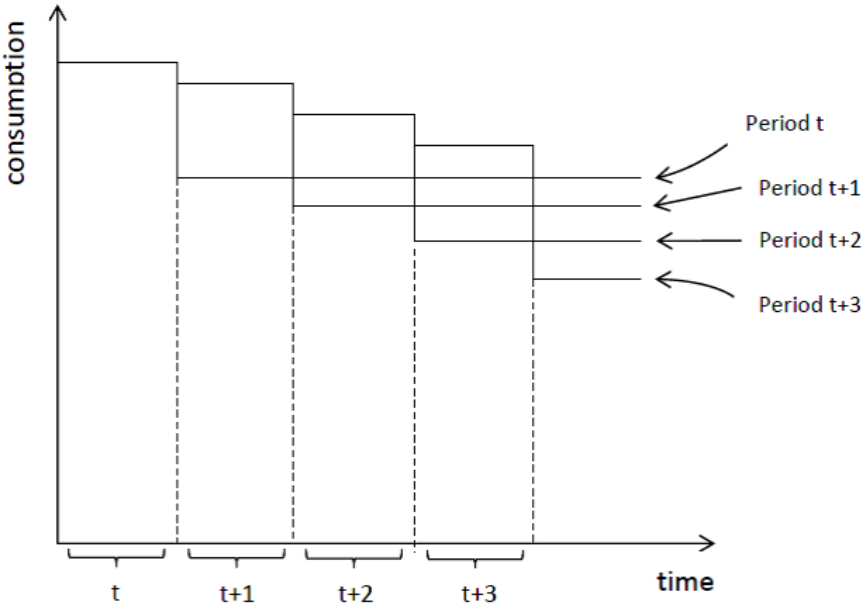
The consumer reconsiders his preferred consumption path in period $t+1$ and all future periods. In period $t+1$ he wishes to consume more than what he considered to be the optimal $t+1$-consumption in period t. But he did not budget for this, and in order to afford a higher consumption today he will have to (slightly) lower his consumption in all future periods. Next period he again has to lower his planned future consumption path in order to afford a higher current consumption than what he planned and budgeted for. The preferred consumption paths are shown in Figure 3.3a, and the corresponding actual consumption path is shown in Figure 3.3b. Due to financial constraints, consumption at some point falls below the preferred consumption path from the point of view of period t, that is the path shown in Figure 3.2.

Naive and sophisticated agents

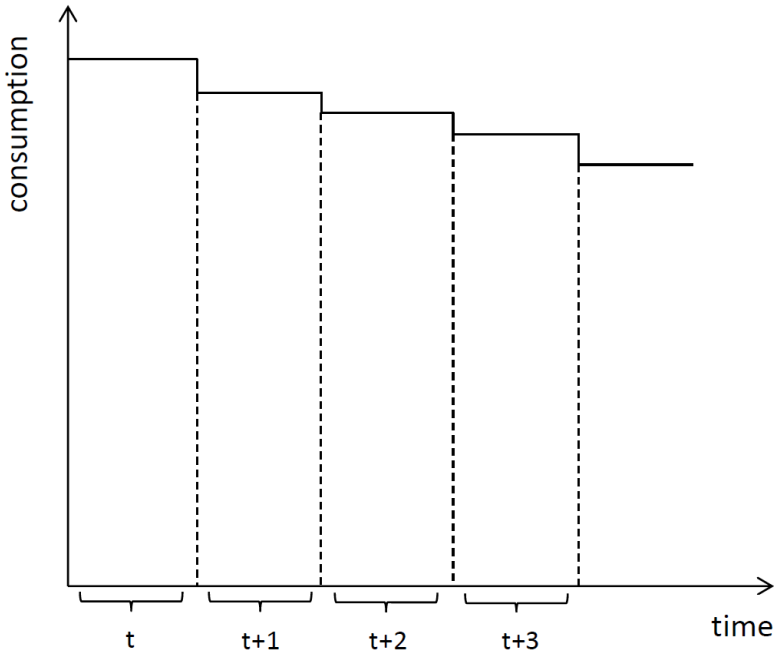
I now distinguish between two different types of time inconsistent agents, following O'Donoghue and Rabin (1999), the naive and the sophisticated agent. The two agents have the same utility functions and thus the same period 0 optimal consumption paths.

The difference between the naive and the sophisticated agent is that the naive agent is unaware of his own time inconsistency. He believes every period that his future preferences will be identical to his present preferences, and therefore that he will act tomorrow according to what seems optimal today. However, since he is in fact time inconsistent, when tomorrow comes he changes his mind and acts according to the intertemporal preferences as seen from that period.

The sophisticated agent is, however, aware of his own time inconsistency. He knows that what is optimal today may not seem optimal tomorrow. In fact, he is able to accurately predict his future preferences. He acts according to what he knows about his own future behavior. The sophisticated consumer does not, as the naive agent, hold the illusion in period t that he will act in period $t+1$ according to what seems optimal in period t. Rather,



(a) Preferred consumption paths



(b) Actual consumption path

Figure 3.3: Consumption paths periods t to $t+3$

the sophisticated agent acts in every period as if there is a different player in each period and uses backward induction to choose his actions. The sophisticated agent would like to restrict his future selves to follow the current optimal consumption path or some path closer to it. A commitment device, allowing him to influence the actions of his future selves by restricting their choice set, will therefore increase his long run utility. In order to restrict his future selves and overcome (some of) his self control problems, he will be willing to pay for a commitment device.

There is scope for improving welfare for both agents. The sophisticated and the naive agents behave differently despite the same preferences, and thus they also respond differently to regulations, which I will come back to in the next chapter. Some public regulations form commitment opportunities to the agent and will only improve welfare for the sophisticated agent. However, to the naive agent, the only possible policies to improve welfare are paternalistic policies "forcing" them towards their optimal consumption paths, as the naive agents are not aware of their problem and will not demand any restrictions on their own consumption behavior.

Chapter 4

How to regulate alcohol?

In this chapter, I discuss some regulations that may improve welfare when there are negative externalities from alcohol consumption or when consumers have self control problems. They are all restrictions on access, and I sort the regulations into three categories: restrictions on price, time, and location.

4.1 Price

I first look at how taxes can be used to correct the market under negative externalities from consumption. Externality correcting taxes are generally referred to as Pigouvian taxes. If there are external costs from alcohol consumption, and we are aware of them, it is possible to set taxes to achieve the social optimum as described in Chapter 3. The idea of Pigouvian taxation is to force the consumers to internalize the external costs from their consumption.

Remember that I assumed that the externality was constant per unit consumed and equal to α. In the social optimum the social marginal cost equals the social marginal benefit:

$$u'(c_i) - \alpha = p. \tag{4.1}$$

In the unregulated market, however, consumer i only takes account of the marginal cost from consumption that he faces, namely the price p. If the government set a per unit tax τ

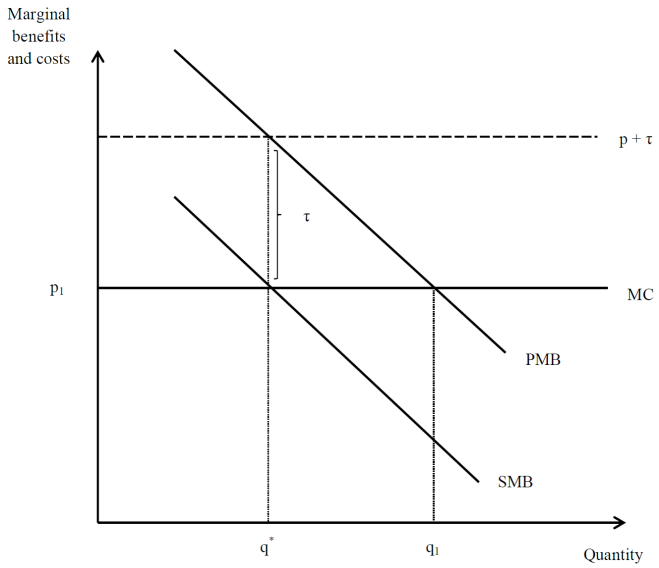


Figure 4.1: Pigouvian tax

Social and private marginal benefit and marginal cost with a negative consumption externality from alcohol consumption. Optimal Pigouvian tax rate τ leads to the social optimal quantity q^*

equal to the external cost α, the consumer will consume until

$$u'(c_i) = p + \tau. \tag{4.2}$$

When $\tau = \alpha$, equations (4.1) and (4.2) are the same. $\tau = \alpha$ therefore gives the social optimum. This is shown in Figure 4.1. It is possible to set the tax rate such that the marginal cost faced by the consumers is exactly so that they choose the optimal consumption level. With this tax in place, we see that the new, regulated market equilibrium gives us the optimal consumption q^*. The tax makes the consumer internalize the external costs. By setting the tax correctly the consumer will have to pay for the marginal damage he causes all other individuals by consuming alcohol.

In practice, however, this is not as easy. First, it might be hard to estimate the actual external costs from alcohol consumption. Second, even if we do know the actual external costs from drinking alcohol, they probably vary between consumers. There may be some consumers that society is especially concerned to keep away from drinking for different rea-

sons. For instance people who drive or pregnant women. External costs are also likely to be non-linear in consumption. It might be, for instance, that only alcohol consumption above some threshold level causes negative externalities, and that this threshold varies between consumers. In the model above this could be shown by giving the external cost α subscript i to capture the fact that it is individual. We could also allow the external costs to be a function of consumption and allow this function to vary between consumers. The external cost would then be $\alpha_i(c_i)$. In the model, it would be possible to set individual taxes to achieve optimal consumption for all individuals. Taxes for each individual i would then have to be set equal to the marginal external cost of his consumption at his socially optimal consumption level c_i^*. This would be obtained by setting $\tau_i = \alpha_i'(c_i^*)$ for all i. For the Pigouvian taxation to work perfectly it would then have to be a personalized tax. However, in practice, a personalized tax is hard to implement for both practical, political and ethical reasons.

4.2 Time restrictions

A rational agent with time consistent preferences should not change consumption pattern due to restrictions on times for alcohol sales, as long as these are inside a time frame when he prefers to shop and storage costs are not too large (Hinnosaar, 2012). He will simply buy what he plans to consume for the next few days or weeks and consume as planned. One could argue that time restrictions increases the cost to the time consistent consumer because he may have to go shopping at other times than what he prefers. However, this is only true if he never prefers to shop inside the allowed times for alcohol sales. Otherwise he could simply stock up. To the time consistent consumer time restrictions could reduce welfare since it reduces his choice set, but it should not cause (much) changes in his consumption. It is therefore not an effective way to restrict alcohol consumption if agents are time consistent.

For the time inconsistent consumer, however, time restrictions may matter. Let us assume alcohol sales are prohibited on some day, say Sundays. First, let us think of how this affects a naive time inconsistent consumer. Time restrictions may have no effect or a large effect on the naive agent's alcohol consumption depending on his shopping pattern. If he usually goes shopping every day and buys what he wishes to consume on that day, he will buy in advance what he expects to consume on Sundays. However, on Saturdays his beliefs about

his Sunday consumption wishes are false. Using the model described above, when Sunday comes he actually wishes to consume more than what he had expected the day before. Since he was not able to foresee this, he did not shop enough and he is not able to consume more than what he had planned for. He regrets buying too little. Still, this restriction may have increased his welfare from the period 0 perspective, because it made him stick with his plan although he did not want to. Time restrictions can thus be welfare improving to the naive agent, but it is involuntary and works in a paternalistic way as he himself does not see the need for the restrictions. For a different shopping pattern, time restrictions may have no effect. For instance, he may shop for a few days every time he shops and go back to the store "as often as necessary". Since his beliefs about future consumption are false he will always have to go shopping again sooner than expected. But as long as the last day before he has to stock up is never a Sunday, the restriction does not affect his consumption.

The sophisticated agent can actively use time restrictions as a commitment device. He is aware of his self control problems and uses the time restrictions as a way of limiting the choice set of his future selves. By not buying more on Saturdays than what he plans to consume on Sunday, he makes it impossible for his Sunday-self to deviate from his plan and consume too much from the Saturday-self perspective. For the sophisticated agent the commitment will always "work", since he actively uses it to his advantage. He can plan his shopping trips so as to ensure that on Sundays his alcohol stock is exactly what he wants his Sunday-self to consume.

I have focused on alcohol sales for off premise consumption in this discussion since that is the main topic of my empirical investigation. However, we could of course use a similar logic for time restrictions on on premise alcohol sales. It then seems natural to think of the time periods as some period shorter than a day and assume that the future cost of present consumption occurs some periods later. Let us think of limits on closing hours for bars. For the naive agent this restriction again works merely as a paternalistic policy and could either reduce his consumption or leave it unchanged. He plans his arrival at the bar so that he will be able to drink the amount he prefers in the remaining open hours. However, when planning to go to the bar, the naive agent is not able to accurately foresee how much he will want to drink, since the consumption decision takes place in the future. Since he under estimates his the consumption preferences of his future self, he may arrive at the bar too late to be able

to drink as much as his future self prefers. If his future self is "done" drinking before the bar closes, the restriction has no effect on his consumption. If at the time of closing he would prefer to continue drinking, however, his consumption is reduced due to the restriction.

For the sophisticated agent the policy can again be used intentionally as a commitment device and help him reduce his consumption. The sophisticated agent wants to go to the bar and drink some amount and nothing more. However, he knows that at the bar his preferences look different and he will want to consume more. Since he knows that the bar closes at some point, he can then time his arrival so that his future self only has limited time to spend at the bar and is only able to consume the amount that his current self plans.

4.3 Location

Licensing systems is a frequently used alcohol policy. Alcohol is then geographically restricted, and some consumers may have a considerable travel distance to their nearest alcohol outlet. This entails a cost to consumers as they need to pay for gas or public transport and there are opportunity costs from the time they spend on travel. The travel cost per unit decreases with the amount bought per shopping trip.

Now, let us assume that there are also some storage costs. Otherwise the "travel distance tax" could be reduced to almost zero per unit by buying a lifetime supply of alcohol at once. There might, of course, be other obstacles to doing that, for instance liquidity problems. I denote the storage costs per unit by $\lambda(x, c)$. The storage cost per unit is a function of how much alcohol you buy, x, and your consumption level, c. The more you consume (the higher is c) the shorter you will have to store the goods you buy, and the lower is therefore the storage cost per unit of alcohol you buy. Furthermore the more you buy, that is the higher is x, the higher is the storage cost per unit since each unit will have to be stored for a longer time period. The first units of alcohol bought do not cause a storage cost, since they are immediately consumed. For a high consumption individual the amount of alcohol which does not entail a storage cost, because it is immediately consumed, is larger than for a low consumption individual. When buying more alcohol than for immediate consumption, the storage costs per unit start to rise. The more you buy the longer is the mean storage time per unit and the higher is therefore the per unit storage cost. The per unit storage cost

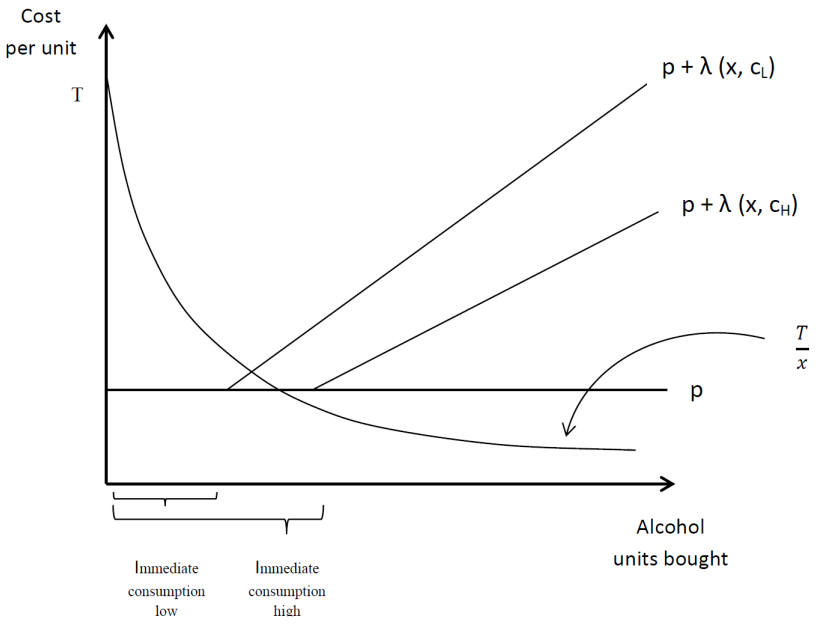


Figure 4.2: All costs

Per unit travel costs, storage costs and price for a high and low consumption individual

rises more quickly for the low consumption individual. Since he consumes less of what he has bought every day, he will have to store every alcohol unit longer than the high consumption individual.

Figure 4.2 shows the travel cost, price, and storage costs per unit bought. The storage costs are drawn for a high consumption individual, $\lambda(x, c_H)$, and for a low consumption individual, $\lambda(x, c_L)$. I assume they start out with the same stock of alcohol at home. The storage costs are drawn on top of the price. The travel cost per unit $\frac{T}{x}$ is decreasing in the amount of alcohol bought, since there is a fixed cost per trip to the alcohol outlet. The more you buy, the lower the price per unit. The total costs per unit of alcohol bought for a high and a low consumption individual are shown graphically in Figure 4.3. As is evident from the figure, there is now a unique cost minimizing amount of alcohol bought per trip for each consumption level (and each travel distance).

For a time consistent consumer the travel distance works similar to a tax. There is an extra cost of acquiring alcohol due to the travel distance. He will then adjust his shopping

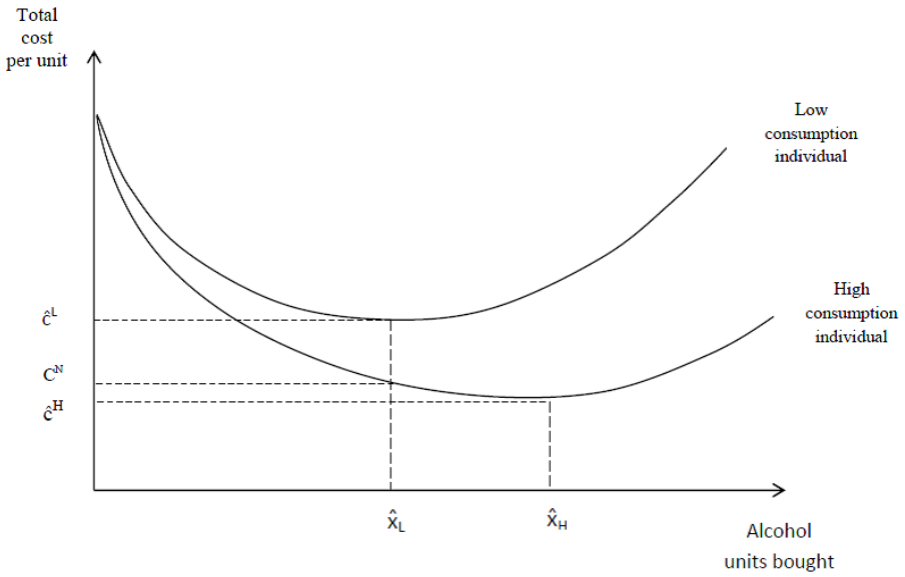


Figure 4.3: Total per unit cost of alcohol

Total per unit costs for a high and low consumption individual

pattern so that he buys the amount which minimizes his per unit cost. That is, he will buy either $\hat{x}_L$ or $\hat{x}_H$ depending on his consumption level. The "travel tax" is his excess cost per unit due to the travel and storage costs. For a low consumption individual this is $\hat{c}^L - p$.

For the time inconsistent consumers, however, the travel distance works in a different way. Let us first discuss the naive. I assume that the agents are either high or low consumers. The naive agent believes he is a low consumer and shops accordingly. He shops $\hat{x}_L$ to minimize the cost of what he believes to be his consumption. However, his future selves are in fact high consumers, and the cost minimizing amount would therefore be $\hat{x}_H$. His actual per unit cost of buying $\hat{x}_L$ is c^N, rather than $\hat{c}_L$ as he was expecting. He buys too little according to what he consumes as he has put too much weight on the storage costs believing what he buys will be stored longer than it will. Since he is not able to plan accurately, he pays a higher per unit price than he would have, had he been able to plan accurately. However, his actual costs are lower that what he estimates while in the store due to saved storage costs. The "travel tax" is higher for a naive time inconsistent consumer than for a time consistent consumer of the same consumption type because the naive time inconsistent consumer is not able to buy the

cost minimizing amount. Since he pays a "travel tax" on alcohol due to location restrictions he consumes less.

In contrast, the sophisticated time inconsistent consumer knows his actual consumption type, and he is therefore able to minimize his cost if he wants to. However, he is interested in restricting his future selves and can use the "travel tax" as a commitment device. Since the cost of shopping is always borne today while some of the benefits (not having to travel every time you want to consume) occur in future periods, it will always be tempting to postpone the shopping trip. Now, let us assume that there is some critical alcohol stock $\bar{X} \geqslant 0$. When the agent's alcohol stock reaches this level, he will find it worthwhile to go to the store. Let us assume that the agent's per day consumption $c > \bar{X}$. This means that the agent will be willing to accept lower consumption today than what he finds optimal in order to postpone the shopping trip to the future. Knowing this, the sophisticated agent can plan his shopping so that he has a low but sufficient amount on the last day. That is, an amount which is higher than the critical amount, $\bar{X}$, in order to keep him from buying more immediately, but lower than c which is what he will consume if he gets the chance. This way the sophisticated agent can force his future self to consume less than c, but he is not able to force the consumption all the way down to $\bar{X}$. The sophisticated agent can then at a price restrict the behavior of his future selves. The price he pays is the cost increase from not buying the cost minimizing amount, $\hat{x}$, but rather an amount in the neighborhood of $\hat{x}$ ensuring that his alcohol stock on the last day is strictly between c and $\bar{X}$.

If the travel distance is quite short, so that the cost minimizing amount $\hat{x}$ is not very far away from his daily consumption c and shopping trips are quite frequent, the commitment device offered by the "travel tax" could actually help him reduce his consumption considerably. If, for instance, he goes shopping every other day, he can buy enough for today's consumption and just enough, slightly more than $\bar{X}$, to keep his tomorrow self from buying more. The travel tax helps the sophisticated agent consume less. Even with very low monetary travel costs, there might still be a "mental cost" from having to travel to an alcohol outlet in which case the sophisticated agent can still use this mental cost to his advantage. Knowing his future self would rather not be bothered to go to the shop, he can give his futures self just enough alcohol to abstain from shopping.

4.4 Further remarks

The restrictions on price, time, and location respectively, work differently depending on the assumptions we make about the consumers. Taxes are the same for everyone and may be harder for the consumers to avoid relative to the time and location restrictions. This is an advantage when dealing with externalities because the very nature of the external cost makes the consumer unwilling to adjust his consumption in order to reduce the externalities. Another advantage of taxation relative to the other restrictions is that it generates revenue to the government. This in turn leads to less need to generate revenues using other distortionary taxes which could further improve welfare. A time consistent consumer should prefer a monetary tax over a "travel tax" of the same size.

Location restrictions differ between consumers depending on where they live. This could make it hard to target the right individuals with a "travel distance tax". Assume we want to target high consumption individuals because they generate a higher external cost from consumption. There may be no systematic relationship between the travel tax and the consumption level of individuals. The travel tax is then not able to target the high consumers specifically. Furthermore, high consumption individuals could choose to live close to an outlet in order to reduce the cost of alcohol. If this is the case, the travel tax would actually affect the high consumers, who we wished to target, to a lesser extent.

However, the "flexibility" of the travel tax to some extent allows different consumers to impose different tax levels on them selves. This in turn could be an advantage when dealing with sophisticated time inconsistent consumers relative to the monetary tax which affects everyone the same. Sophisticated agents may to some extent choose their tax level according to what is necessary in order to overcome their self control problems. The choice of where to live could in itself be a commitment device. Sophisticated agents could choose to live further away from alcohol outlets in order to impose a higher travel tax on themselves and restrict their future consumption.

Time and location restrictions form commitment devices to the sophisticated time inconsistent agent helping him to partially solve his self control problems. O'Donoghue and Rabin (1999) make an interesting point about addiction and commitment devices. The existence of a commitment device could actually lead to increased consumption for the sophisticated

agent. Alcohol is a potentially addictive commodity, but it is also appreciated by the consumer. Let us assume that from the period 0 perspective a moderate consumption is optimal. If the cost or risk of addiction is high enough, the sophisticated time inconsistent consumer may abstain from consumption all together in fear of addiction. If the sophisticated agent has a commitment device, however, he is able to reduce the consumption of his future selves and a potential addiction would therefore not be as bad. Since he is able to reduce the consequences of a potential addiction, the threat of addiction is not as daunting. According to O'Donoghue and Rabin (1999, p. 119) "it is even possible to construct models where addictive goods are Giffen goods". Alcohol consumption could then be increasing in the price because high costs of alcohol form a commitment device to the sophisticated consumers.

Chapter 5

Consumption and regulation in Norway

In the previous chapters I have discussed adverse effects of alcohol consumption, when alcohol regulations may be welfare improving, and how these regulations work. In the second part of this thesis, I turn to testing one of the predictions of Chapter 4 empirically. The prediction is that higher travel times to the nearest alcohol outlet will lead to lower alcohol consumption.

A lot of research has been done on the effects of alcohol policy, though the outcome variable is often crime or health indicators rather than consumption. Popova et al. (2009) performed a meta study of the effects of availability of alcohol, based on 59 articles published between 2000 and 2008. The articles included look at effects of density of alcohol outlets on alcohol consumption, drinking patterns, and damage caused by alcohol. Most of the articles reviewed did not look at consumption and drinking pattern specifically but rather on other damage variables. However, they look at 13 studies where drinking pattern or consumption was examined. In the research reviewed alcohol outlet density was associated with higher alcohol consumption, higher frequency of drinking, as well as higher quantities consumed on each occasion.

Norström and Skog (2005) investigate the effect on alcohol sales of introducing Saturday sales from the Swedish alcohol monopoly outlets. In February 2000, Saturday openings were introduced in six counties in Sweden, and it was implemented in the rest of Sweden 17 months later. They regress the sales in the experimental regions on sales in the control regions and use a dummy equal to one after the partial implementation of Saturday sales. They then include a second dummy equal to one after the national implementation. They estimate that

the partial implementation of Saturday open alcohol outlets led to a 3.7 percent increase in total alcohol sales, and the national implementation led to a 3.6 percent increase in total alcohol sales.

Nilsson (2008) investigates the Swedish strong beer experiment in 1967-68. The experiment allowed for sales of strong beer from grocery stores in two Swedish regions, whereas before and after the experiment and in other Swedish regions, only beverages with alcohol content below 3.5 percent could be sold from grocery stores. This thus increased availability of strong beer. Consumption of strong beer increased almost tenfold in the experimental regions during the experiment. It fell back after the experiment but to a higher level than the pre experiment level. Liquor consumption decreased more in the experimental regions and wine sales increased less relative to the rest of the country, suggesting substitution from liquor and wine to strong beer. The relative decline in liquor and wine, however, did not compensate for the increase in strong beer.

In this chapter I present the historical and institutional background for alcohol consumption and regulation in Norway.

5.1 Historical background

Before World War 2

Alcohol has been consumed and condemned since ancient times[1]. Already in the old Norwegian scripture *Håvamål*, there are warnings against excessive consumption of alcohol. It has been estimated that the production of grain in the 12th century was around 150 kilos per person. In the face of widespread food shortages, beer was likely a luxury commodity restricted to festivities. Wine was even rarer. In the 16th century, alcohol consumption in Norway became more widespread, especially among the higher classes of society. Alcoholic beverages other than beer were not common in Norway before the 17th century, when liquor had its breakthrough. In the 16th and 17th centuries, restrictions on alcohol were mainly regulating consumption in specific situations, for example on holidays or before church service.

In the 18th century, famines made it increasingly necessary to use grain and potatoes

[1]This section is based on Hauge (1996) and NOU (1995) unless otherwise specified.

for foods rather than liquor production. Using grain for liquor production was repeatedly prohibited during bad years for farming, and in 1757 a general ban on the production of liquor was introduced. Alcohol sales outside the cities were banned, though licenses could be granted. The ban on alcohol production was lifted in the cities in 1792. In 1816, the ban was lifted for the rest of the country, and a liberal policy towards alcohol production and sales was adopted. These policies were justified using arguments of free trade and liberalism. Little thought was put into social aspects of alcohol consumption. Alcohol consumption grew and reached a peak of 13 liters of pure alcohol per person in the 1830s. At that time, liquor accounted for 80-90 percent of the total alcohol consumption.

As a response to the increase in alcohol consumption, different taxes were introduced in the 1820s and 1830s. A tax was first placed on the size of the boilers used for liquor production. Later, a tax was placed on small scale liquor sales in order to target consumption rather than production. However, this tax was easy to get around as people could go together and buy larger quantities. A license system for on premise liquor sales was introduced, and the municipalities were given the rights to determine the number of licenses. In the 1840s, liquor production was banned for half the year (the summer half). Liquor production was then heavily taxed to the degree that for all practical purposes home production of liquor was banned. It was decided that liquor sales could not be combined with the sales of other goods. The rationale behind this decision was that otherwise taxes would be less effective as a policy tool, since it would be possible to set low prices on liquor in order to attract customers who would then spend money on other goods.

In the 1830s, a moderation movement emerged and was later replaced by an abstinence movement. The moderation movement had argued that beer and wine were positive alternatives to liquor. In the period after the 1850s, however, beer and wine were viewed in much the same way as liquor, and restrictions on beer and wine emerged. Taxes were placed on off and on premise sales of beer and wine in the 1850s. A tax was placed on the amount of malt used in production of beer which led to a considerable price increase. The malt tax was replaced by a beer tax graded by alcohol content in 1913 (NOU, 2007). In 1869, a general license system for all alcoholic beverages for on premise consumption was introduced, and a municipal license system for off premise beer and wine sales followed in 1882. A scheme for alcohol sales called "samlag" was introduced in 1871. Samlag were corporations with permission to

sell liquor for on and off premise consumption in its municipality, where the whole profit was to go to charitable purposes within the municipality. With the samlag system, a principle of the absence of economic interests in alcohol sales were introduced. The system functioned in parallel with private licenses, though few new licenses were issued in cities where samlag was established. Local referendums were to decide whether a municipality should give licenses to any alcohol sales.

During the first world war, import possibilities were limited, and the need for self sufficiency increased. Temporary bans were placed on liquor, wine, and beer. When the war ended, people had become accustomed to the ban on alcohol. A referendum in 1919 voted for a continued ban of liquor and fortified wine. It was decided that all wine imports should happen through a state monopoly, and Vinmonopolet AS was established in 1922. Wine sales could take place through Vinmonopolet or the established liquor samlag. In 1926, a new referendum voted to remove the ban on liquor and fortified wine. After the referendum, Vinmonopolet AS was given the sole right to sell fortified wine and liquor. Samlag existed until 1938 when Vinmonopolet was also given the sole right to sell wine.

WW2-today

During the second world war, there were quotas on liquor and wine. Beer production was also reduced, and there was a considerable decrease in alcohol consumption during the war.

Figure 5.1 shows alcohol sales per person above the age of 15 in Norway between 1946 and 2012. As is evident from the graph, alcohol sales have grown after the second world war. The increase in alcohol sales during this period was driven by an increase in wine and beer sales. Liquor sales have decreased and are now at a lower level than right after the war. Total sales reached a peak in 1980 and fell gradually in the 1980s and early 1990s before it started to rise again. Between 1993 and 2001, alcohol sales increased by 20 percent. In the last few years, sales have started to decline again (NOU, 2003).

In 1989, a new law regulating alcohol took effect, and the local referendums on whether to give licenses for on and off premise alcohol sales were abolished. The new law included a mission statement declaring its mission to limit damage caused to society and individuals from alcohol consumption. The existing alcohol regulations are written in this law, though

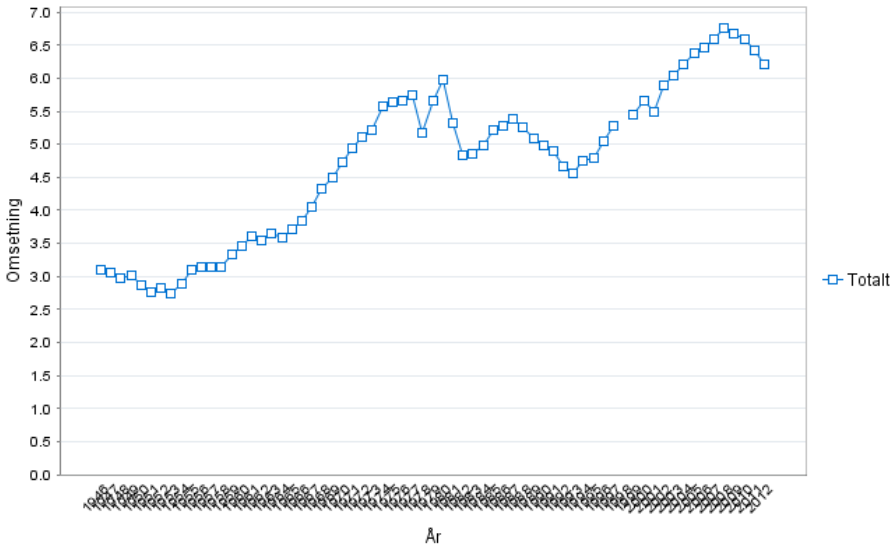
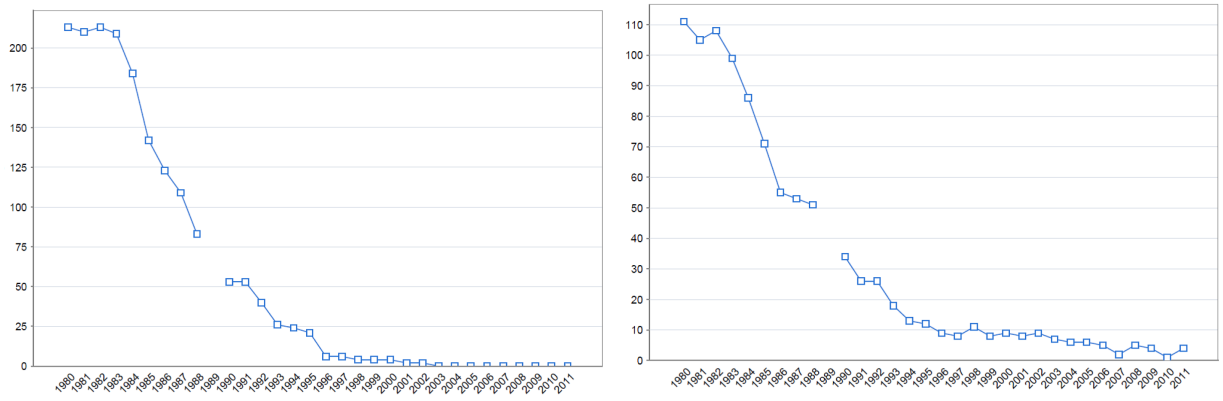


Figure 5.1: Alcohol sales in Norway 1946-2012

Notes: Alcohol sales are measured in liters of pure alcohol per person above the age of 15 years old. Source: RusStat (SIRUS).

some changes were made to it in 1997 and took effect in 1998. The changes made reduced the scope for municipal discretion. The sales times for alcohol had previously followed the opening hours for the particular outlets (bars, restaurants or shops) which was restricted through different legislation. Unless the municipalities decided otherwise, there were no restrictions on alcohol sales beyond the opening hours of the particular outlets. The new regulations, however, imposed maximal legal hours for off and on premise alcohol sales and also stated "normal" hours. Some municipalities operated with alcohol sales at times that after the changes in 1998 were no longer legal. For them the introduction of maximal legal hours led to more restrictive time limits. For other municipalities, however, the changes lead to less restrictive time limits. Some municipalities had exercised time limits on alcohol sales before 1998 that were more restrictive than the normal time introduced but upon the introduction of normal time limits adopted these (Hauge and Lohiniva, 2002).

Alcohol availability in the form of numbers of alcohol outlets has increased considerably in the last decades. Figures 5.2a and 5.2b show the number of municipalities without any outlets with licenses to sell alcohol for off and on premise consumption respectively. Since



(a) No off premise licenses

(b) No on premise licenses

Figure 5.2: Number of municipalities without license for alcohol sales 1980-2012

Notes: Number of municipalities without licenses for off or on premise alcohol sales between 1980 and 2012. Source: RusStat (SIRUS).

2002, all Norwegian municipalities have had outlets with license for off premise alcohol sales, and in 2011 there were just 4 municipalities without any outlets with licenses for on premise alcohol sales.

The number of Vinmonopolet outlets has more than doubled during the 20 years between 1992 and 2012. The last county in Norway to get a Vinmonopolet outlet was Sogn og Fjordane in 1991 (Hauge, 1996). Today, 85 percent of the Norwegian population lives in a municipality with a Vinmonopolet outlet (Vinmonopolet, 2014a).

5.2 Present regulations

Alcohol is strictly regulated in Norway today, both on and off premise sales, imports, and production[2]. Limiting alcohol consumption is explicitly stated as a purpose of the law as a means of limiting the harm caused by it. Availability is restricted in many ways, both through price, time, and location restrictions as discussed in Chapter 4.

Price restrictions are imposed primarily through taxation. Alcohol is a heavily taxed

[2]This section is based on Alkoholloven (1989) unless otherwise specified.

commodity. Alcoholic beverages are taxed per liter at a rate which is increasing with the alcohol content of the beverage. An illustrative example from Vinmonopolet's web pages show that alcohol taxes constitute almost two thirds of the retail price for liquor compared to circa 40 percent and 25 percent of the retail price on wine and beer respectively. The Value Added Tax is calculated on top of the alcohol tax. Taxes are not the only restrictions on price however. It is illegal to use discounts on alcohol for off premise alcohol sales (Vinmonopolet, 2014b, Toll og Avgiftsdirektoratet, 2013).

Location restrictions are imposed by means of a license system and an off premise alcohol monopoly (Vinmonopolet). Producing or selling alcohol for on or off premise consumption is illegal unless a license is obtained. Only Vinmonopolet outlets are allowed to sell alcoholic beverages with alcohol contents above 4.7 percent by volume. For all on premise alcohol sales and off premise alcohol sales for lower alcohol content beverages, a license is required. There is scope for considerable municipal discretion. The municipalities can decide the maximum number of Vinmonopolet outlets in their municipality and approve their location. Furthermore, licenses to sell alcohol for on and off premise consumption are granted by the municipalities. The municipalities can decide whether and how many licenses to issue as well as on what terms these are issued. For instance, serving food could be a requirement for on premise alcohol sales.

Time restrictions are imposed on all alcohol sales. All off premise alcohol sales are prohibited on Sundays as well as on some public holidays and on election days. Alcohol sales from Vinmonopolet is allowed between 08:30 and 18:00 on weekdays and between 08:30 and 15:00 on Saturdays. No licenses can be given for off premise sales after 20:00 on weekdays and after 18:00 on Saturdays nor for on premise beer and wine sales between 03:00 and 06:00 or on premise liquor sales between 03:00 and 13:00. However, within these maximal legal time frames, the municipalities are free to decide the legal sales hours. All in all, though the maximum legal hours stated in the law puts some limitations on the municipal autonomy, there is scope for considerable municipal variety.

The legal drinking age is 18 for beer and wine and 20 for liquor, and it is illegal to buy alcohol for minors. The highest legal blood alcohol concentration when driving is 2 per mile (Vegtrafikkloven, 1965). Advertisement for alcoholic beverages is illegal. It is also illegal to sell alcohol to customers who are intoxicated, and alcohol consumption in public space is

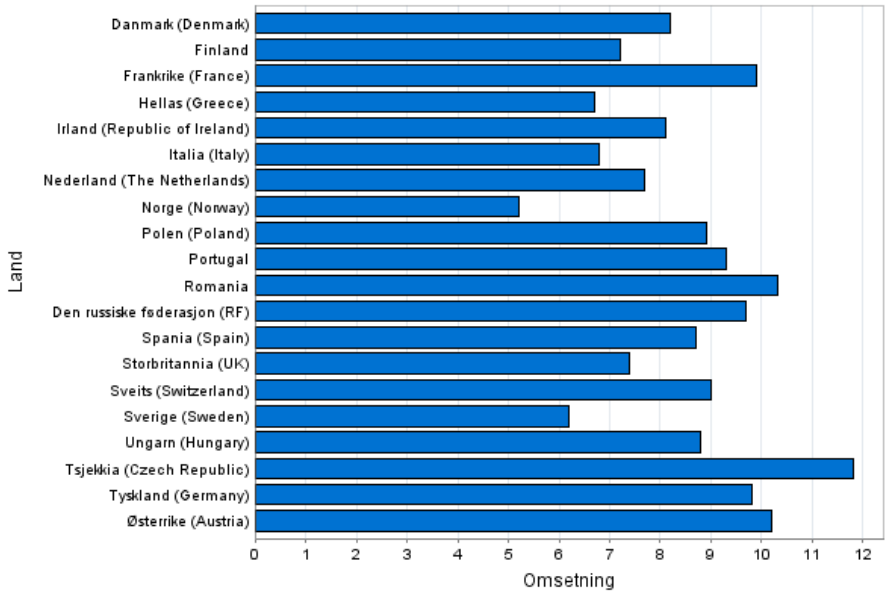


Figure 5.3: Alcohol sales in Europe 2010

Notes: Total alcohol sales measured in liters of pure alcohol per person. Source: RusStat (SIRUS).

prohibited.

5.3 Drinking pattern in Norway

Figure 5.3 shows alcohol sales in liters of pure alcohol per person in European countries[3]. As is evident from the figure, alcohol sales in Norway are the lowest in Europe, despite the increase in Norwegian alcohol sales since the second world war.

According to Horverak and Bye (2007), the 10 percent highest alcohol consumers in Norway accounted for 46 percent of the total consumption in 2004, while the 50 percent with the lowest consumption accounted for only 6.2 percent of the total consumption. This indicates that alcohol consumption varies a lot between individuals. There are some problems in obtaining data on drinking patterns however. People systematically under-report own consumption, and the sample may not be representative with respect to alcohol consumption.

[3]Note that the numbers deviate from the numbers in Figure 5.1 because Figure 5.1 shows alcohol sales in liters of pure alcohol per person *above the age of 15*.

However, surveys have been performed by SIRUS (and it's predecessor Statens institutt for alkoholforskning) about every fifth year since 1962 with some shorter and some longer intervals. These surveys indicate some interesting patterns, where we might hope that the bias in the measures is not changing too much over time. Alcohol consumption in Norway is concentrated around the weekends (Fridays and Saturdays), with low and even consumption during the week. A similar pattern exists in the other Nordic countries. This is in contrast to southern European countries, where alcohol consumption tends to be more spread out and in conjunction with meals (Storvoll et al., 2010).

Alcohol consumption also varies between demographic groups. Strand and Steiro (2003) use Norwegian survey data between 1993 and 2000 to look at differences in alcohol consumption between different demographic groups. They find that male consumption is twice as high as female consumption. They also find that alcohol consumption increases with education and income levels for both males and females.

Chapter 6

Data and descriptive statistics

6.1 Data

For my purposes, I would ideally want a measure of actual alcohol consumption in Norway. Such data are hard to come by and often unreliable, and sufficiently detailed data are not available for Norway. Instead, I use data on alcohol sales from Vinmonopolet outlets. The data include alcohol sold in every outlet each month between January 2000 and April 2012, measured in liters of pure alcohol. These data are aggregated to the municipal level and bimonthly frequency, in order to align with the data on sales through other outlets.

In order to get a measure of alcohol sales through other outlets, I use data on sales measured in NOK from all enterprises with licenses to sell or serve alcohol, excluding Vinmonopolet. I categorize the data into different groups depending on the type of enterprise determined from five digit NACE-codes. The groups are quite specific, allowing me to exclude sales from some business categories which clearly do not sell or serve alcohol. I use the sales data from groups such as "pubs[1]", "restaurants and cafes[2]", and "Retail sale in non-specialized stores with emphasis on food, beverages and tobacco[3]". The data could, however, include enterprises without license to sell alcohol (not all restaurants, cafes or grocery stores have licenses), and they do include all sales from enterprises with alcohol licenses. These data are

[1]The NACE-codes used are 55400, 55401 and 56301.
[2]The NACE-codes used are 55301 and 56101.
[3]The NACE-codes used are 47111, 47112 and 52110.

on the municipality level for every two months between January 2000 and April 2012.

To construct a measure of travel times, I use data on travel distance between Norwegian zip codes obtained from Infomap Norge AS. The data consist of travel time (in minutes) between all Norwegian zip codes. I match the zip codes to their (current) respective municipalities and use the mean travel time between all zip codes in one municipality and all zip codes in a second municipality as a measure of the average travel time between the two municipalities. I use the mean travel time between all zip codes located in a municipality as a measure of the within municipality travel time.

A key issue in analyzing the data is to define the costumer base of the individual sales outlets, Vinmonopolet and others. While one could in principle imagine several alternative criteria, I here take the most immediate route. Using the travel time data and the data on Vinmonopolet outlets in each year, I match all municipalities with their closest municipality (in terms of travel time) where a Vinmonopolet outlet is operating. For municipalities with an outlet this is the municipality itself. For each municipality, I next construct a variable with the travel time to the nearest municipality with a Vinmonopolet outlet. This is defined as the travel time for customers in that municipality. The costumer base of a particular outlet is then assumed to be the total population of municipalities to which it is matched, i.e. the municipalities to which it is the nearest outlet. Using the definitions of the customer bases, I construct variables for per person sales by dividing the total sales by the total population in the customer bases.

I use municipal characteristics from Statistikkbanken at www.ssb.no, as listed in Table 6.1. These include population, education, and income characteristics. The population data are quarterly, and education and income data are yearly. Using the definition of the customer base, I construct the mean travel time in the customer base. This is a weighted average of the travel time to the nearest outlet for the municipalities which are represented in the customer base. It is weighted by the population in each municipality. To construct the customer base for pubs, restaurants, and grocery stores, I follow an analogous approach. Since there are grocery stores in all municipalities in all time periods, the customer group for grocery stores is always the population in the municipality itself. Notice that I do not construct travel time for these other sales outlets. Because we do not have any plausibly exogenous variation in these travel times, we will not consider sales from these outlets directly, but only to assess

Table 6.1: Control variables used in the regressions

Variable	Description	Source
meaninc	Mean income	Statistikkbanken No. 03068
GS	Share of the population with primary school as the highest obtained education	Statistikkbanken No. 09429
VG	Share of the population with high school as the highest obtained education	Statistikkbanken No. 09429
uni_k	Share of the population with higher education less than four years as the highest obtained education	Statistikkbanken No. 09429

substitution effects from openings of new Vinmonopolet outlets.

Since I control for characteristics in the customer base, I have constructed weighted means of the controls for the municipalities in the customer base. The means are again weighted by the population in the respective municipalities.

There have been some changes in the municipalities during the period. Some municipalities have merged, and some have had changes in the municipality ID numbers. I have restructured the data so that it includes only the current municipalities in Norway by matching non existing (previous) municipality ID numbers with their current municipality ID. I have used a mean (education and income variables) or sum (population and sales) of the merged municipalities in the period before the merge.

The final data set includes one observation for all current Norwegian municipalities every two months between January 2000 and April 2012. There are 74 time periods and 428 municipalities in the data set, in total 31 672 observations. Each observation includes a municipality ID, time variables, liters of pure alcohol sold from Vinmonopolet, sales (in NOK) for restaurants, pubs, and grocery stores, total population, mean travel time to the nearest Vinmonopolet outlet for the customer bases, and the weighted mean of the control variables for the respective customer bases. Remember that the customer bases can differ between Vinmonopolet, pubs, restaurants, and grocery stores in the same municipality. There are in total 11 495 observations of municipalities with a Vinmonopolet outlet and 31 672, 28 422 and 8 267 observations of municipalities with positive sales in grocery stores, restaurants,

and pubs respectively. All variables regarding the customer bases for Vinmonopolet, pubs, and restaurants (travel time, education, population, and income) are missing if there is no outlet of the respective type.

6.2 Descriptive statistics

Tables 6.2 and 6.3 show mean and standard deviations for the main outcomes and the explanatory and control variables included in my analysis in the years 2000 and 2010. Sales per two months at Vinmonopolet averages at 0.28 liters of pure alcohol in 2000 and 0.40 in 2010. There is considerable variation across municipalities. The range in per person sales from Vinmonopolet in the year 2000 is from 0.02 to 0.87 liters, with a standard deviation of 0.12.

In year 2000, sales per person in grocery stores, restaurants, and bars averages at 3 242, 327, and 30 NOK, respectively. In 2010, the corresponding numbers are 4 878, 438, and 45.

Figure 6.1 shows per person sales from Vinmonopolet and total sales from grocery stores, restaurants, and bars over time. The data display a clear seasonal pattern. Total alcohol sales are highest in the last two months of the year, with the holiday season, new year, and traditional end-of-year gatherings, and during the summer. The lowest total sales are in the first two months of the year. To get a clearer picture of the aggregate trend over the period, I also include a moving average process, that smooths out the seasonal variations. The figure documents a considerable rise in sales over the period from all outlets. Sales at Vinmonopolet grows from under 1.8 liters per capita in 2000 to almost 2.5 liters per capita in 2010, where it seems to stabilize. Sales at grocery stores and restaurants both grow by over 60%, while sales in bars more than doubles. One should note that sales in grocery stores are substantially higher than sales in bars or restaurants. Sales in grocery stores will thus account for a large fraction of the total sales in the three categories.

From Table 6.2, we also find that the customer bases of Vinmonopolet outlets and the travel time to this outlet for the customer base, varies considerably across municipalities. In 2000, the average customer base consists of about 46 190 individuals, but ranged from under 3 500 to over 500 000. In the same year, mean travel time was on average 34.5 minutes, and and below 105 minutes for all outlets. The mean value of both the customer bases and the

Table 6.2: Summary statistics, outcome variables

Outcome variables		**2000**			**2010**	
Sales per person from:	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
Vinmonopolet (liters)	582	0.28	0.12	1 188	0.40	0.17
Grocery stores (NOK)	2 568	3 242	932	2 568	4 878	1 493
Restaurants (NOK)	2 350	327	321	2 271	438	632
Bars (NOK)	565	30.4	41.9	708	44.7	71.5

Notes: Sales are measured per capita in the customer base of the outlet. Sales at Vinmonopolet is measured in liters of pure alcohol. Sales from other outlets are measured in NOK.

Table 6.3: Summary statistics, explanatory variables and control variables

Variable		**2000**			**2010**	
	N	*Mean*	*SD*	*N*	*Mean*	*SD*
Customer base	582	46 190	61 603	1 188	24 653	49 295
Travel time	582	34.45	20.47	1 188	26.34	18.00
Income	582	219 406	28 488	1 188	333 585	32 728
Primary school	582	0.376	0.055	1 188	0.324	0.054
High school	582	0.452	0.033	1 188	0.454	0.040
Higher education	582	0.149	0.034	1 188	0.180	0.036

Notes: Customer base is the total population in the municipalities included in the customer bases of each municipality with a Vinmonopolet outlet. Travel time is the weighted mean travel time in minutes for the municipalities included in the customer bases of each municipality with a Vinmonopolet outlet. Income is measured in NOK. Primary school, high school and higher education are the fractions of the population with the different education levels as their highest obtained education.

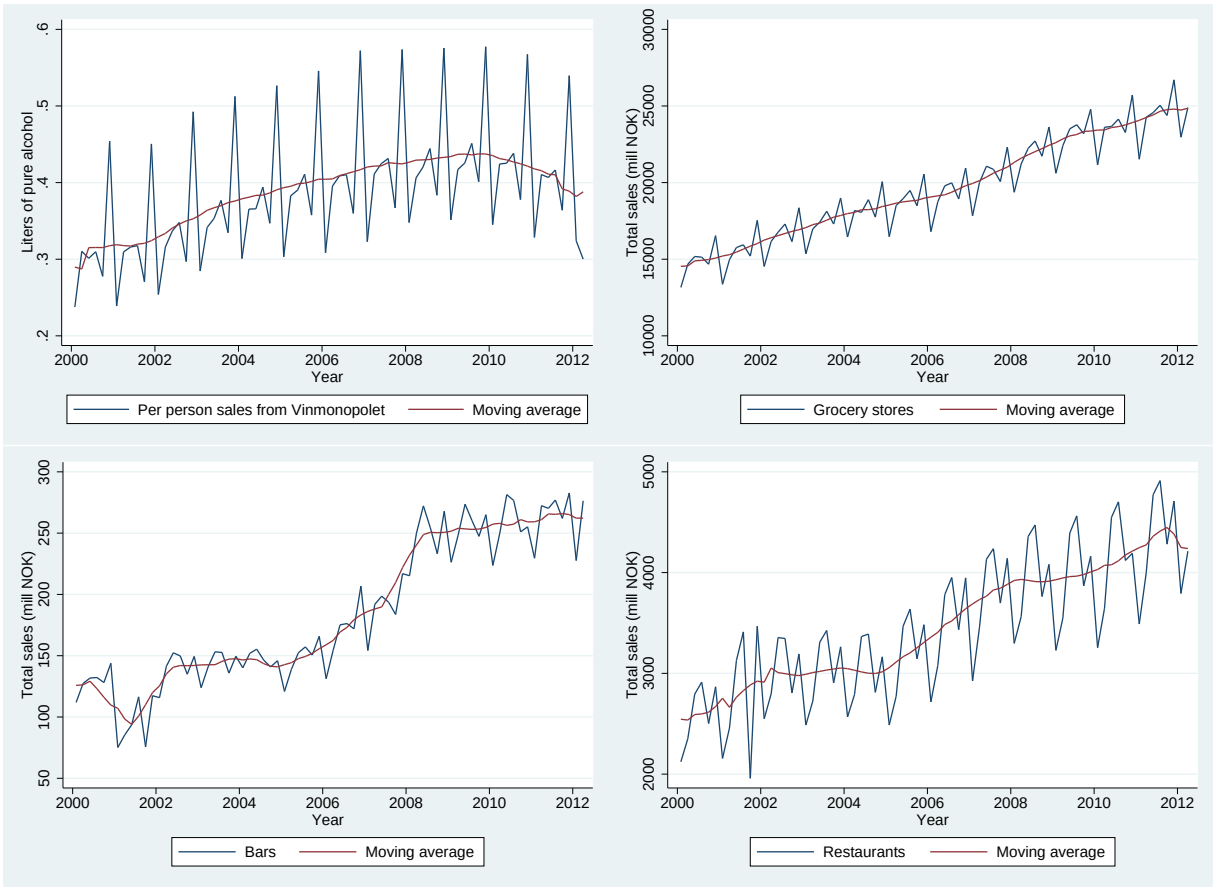


Figure 6.1: Total sales from Vinmonopolet

Notes: Numbers are in liters of pure alcohol for Vinmonopolet and in millions of NOK for grocery stores, bars and restaurants.

travel time is lower in 2010.

The first panel in Figure 6.2 shows how the total number of Vinmonopolet outlets evolves from 2000 to 2012. Vinmonopolet opened 138 new outlets in 127 different municipalities during this period. 8 outlets in 8 municipalities were closed. 118 of the municipalities in which an outlet has opened did not have an outlet at the beginning of the period. Of course, as new outlets opens, the customer bases and travel times must necessarily fall. The evolution of mean travel time in the customer bases and mean size of customer bases are shown in the last two panels of Figure 6.2. While mean customer bases are cut in half, from almost 50 000

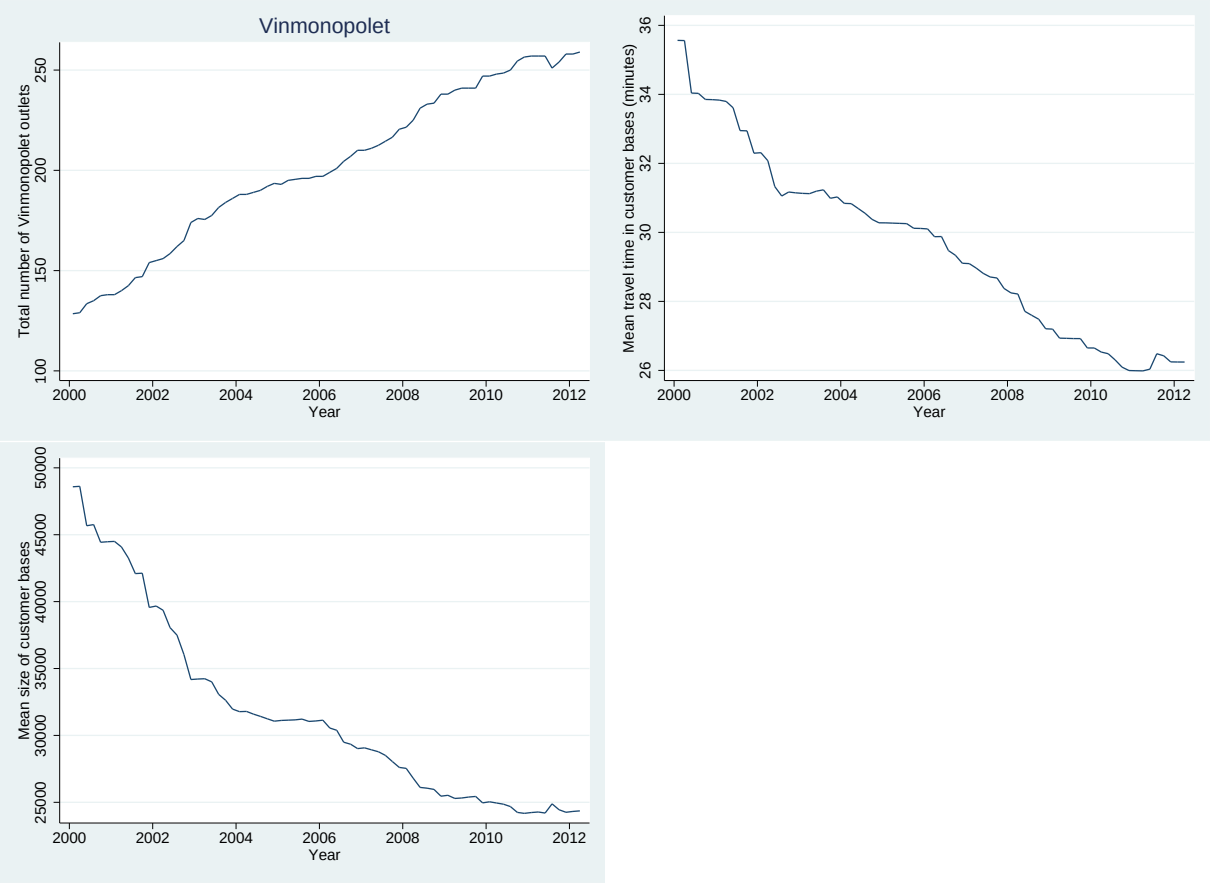


Figure 6.2: Number of Vinmonopolet outlets, travel time and size of customer bases

to less than 25 000, mean travel time falls by about ten minutes, from 36 to 26 minutes.

Figure 6.3 shows a scatter plot of mean travel time and per person alcohol sales from Vinmonopolet after I have removed time and municipality effects. As is evident from the graph, there is a clear negative relationship between mean travel time and per person alcohol sales from Vinmonopolet, and the relationship seems to be convex.

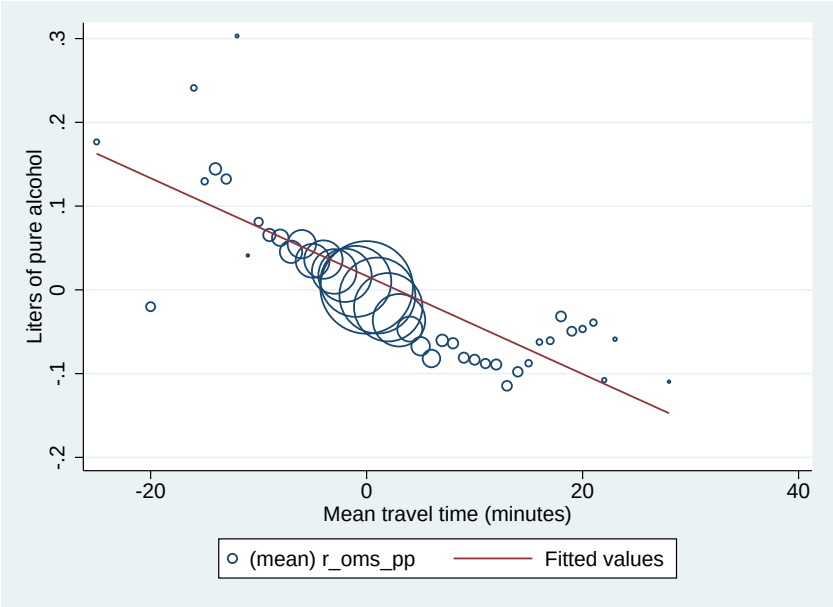


Figure 6.3: Sales per person and mean travel time

Chapter 7

Empirical strategy

Above, I argued that travel time to the nearest alcohol outlet may affect alcohol consumption, both because it works as a tax increasing the costs of alcohol to consumers, and because it may be intentionally used by consumers to overcome self control problems. To investigate the prediction empirically, I now investigate how travel time to the nearest alcohol outlet for off premise alcohol sales affects alcohol consumption. As mentioned in Chapter 5, off premise sales of alcoholic beverages with alcohol content above 4.7 percent by volume, is only allowed from the state off premise alcohol monopoly Vinmonopolet AS. Norway is a large country, divided by long fjords and rugged mountains. A limited number of outlets means that some people have long travel times to their nearest Vinmonopolet outlet, and there are considerable differences in travel times.

In order to investigate how travel time to the nearest off premise alcohol outlet affects alcohol consumption, a cross sectional analysis would not be meaningful. There may be differences between alcohol consumption in cities and in the country side. At the same time, travel times are likely to be higher in the country side than in cities. Instead, I look at changes in travel times over time. I use data as described in the previous chapter from 2000 to 2012. I exploit variation in travel time to the nearest Vinmonopolet outlet, due to openings of a number of new Vinmonopolet outlets during the period, and look at how changes in travel time affects per person sales from Vinmonopolet.

My main interest is to look at the effect of travel times on alcohol consumption. If I do find an effect of travel time on alcohol sales from Vinmonopolet this does not necessarily

mean that alcohol consumption increases as travel times decreases. It might be that what I find is instead an effect of people consuming alcohol from Vinmonopolet rather than through different channels. For this reason, I also look into the possibility of substitution between different channels for acquiring alcohol, by investigating the effect of changes in travel times to the nearest Vinmonopolet outlet on sales in other enterprises selling alcohol.

Sales from Vinmonopolet

My main interest is the effects of travel time (in minutes) on sales of alcohol, and I start with the basic regression equation

$$V_{i,t} = \alpha_i + \rho_t + \gamma TT_{i,t} + \beta \mathbf{X_{i,t}} + \epsilon_i \tag{7.1}$$

where $V_{i,t}$ are sales from Vinmonopolet in municipality i at time t measured in liters of pure alcohol per person in municipality i's customer base. The time period is bimonthly. $TT_{i,t}$ is the weighted mean travel time to municipality i from the potential customer base of municipality i at time t, measured in minutes. $\mathbf{X_{i,t}}$ is a vector of controls containing weighted means of municipality level variables in the customer base. α_i captures the municipality-fixed effects and ρ_t the time-fixed effects. ϵ_i is the error term. I cluster the standard errors at the municipal level to account for correlated shocks in municipalities.

The parameter of interest is γ. It captures the effect of changes in the mean travel time of the customers on per person alcohol sales for the Vinmonopolet outlets. If the predictions of Chapter 4 are correct, we would expect the coefficient to be negative.

I use municipality fixed effects because there may be unobserved heterogeneity at the municipality level. Alcohol sales per customer may be higher or lower in some municipalities, and this may be correlated with the travel time of the customers. By using municipality fixed effects, I control for the average differences between municipalities that are constant over time, reducing the risk of omitted variables bias. Using fixed effects, we are in effect relating changes in alcohol sales to changes in travel time. I use time fixed effects to account for shocks to alcohol sales that are the same across municipalities (Wooldridge, 2009, Chapter 14). This addresses, for instance, the concern about confounding the decreasing trend in travel times with the increasing trend in alcohol sales, or openings of Vinmonopolet outlets

being correlated with the seasonal pattern in alcohol sales. In addition, I include controls for the education and income of the customer bases to account for differing demographic trends across municipalities.

Substitution

As previously mentioned, a negative effect of travel time on alcohol sales from Vinmonopolet does not necessarily mean that alcohol consumption increases as travel time decreases. It might be that what I find is instead an effect of people consuming alcohol from Vinmonopolet rather than through different channels. To investigate the possibility of substitution, I look at how the travel time to Vinmonopolet outlets affects sales in other enterprises selling alcohol. This is implemented by estimating equation (7.1) after replacing the dependent variable with sales from the other outlets. The outcome variable is either sales per person from pubs, sales per person from restaurants and cafes, sales per person from grocery stores or total sales per person from all outlets in the three categories. They are measured in Norwegian kroner (NOK) per person in the customer group.

Notice that the travel time is to the nearest Vinmonopolet outlet, so we now expect γ to be positive if sales are substitutes to sales from Vinmonopolet outlets. Notice also that the customer bases are defined for the particular outlets. The customer bases for pubs, restaurants, and grocery stores in the same municipality may differ. The customer base of the grocery stores are always restricted to the municipalities themselves since all municipalities have observations for grocery store sales in all time periods. In the grocery store and total regression, I therefore use controls for the municipality.

If alcohol sales through other channels than Vinmonopolet respond to the changes in travel time to the nearest Vinmonopolet outlet caused by the openings of new outlets, this is an indication of substitution: people drink less through other channels as the availability of alcohol through Vinmonopolet increases, or potentially complementarity: people drink more at pubs and restaurants as availability through Vinmonopolet increases.

It should be noted that the data I use for these regressions are quite rough. They capture all sales within their categories. Sales from shops, cafes, and restaurants without licenses are included and so is sales from other sources than alcohol sales within the categories.

Since alcohol sales may constitute only a small part of total sales, we might see only small relative changes in the sales numbers, even if there are considerable changes in alcohol sales. Furthermore, alcohol sales as share of the total sales likely differs between the four categories. For this reason, I look at the changes in sales in levels rather than the relative changes. As long as non-alcohol sales are not correlated with the travel times, the roughness of the numbers should not bias the estimates.

Chapter 8

Main results

Sales from Vinmonopolet

The main estimate for how travel times to Vinmonopolet affects sales of alcohol through Vinmonopolet are presented in the first column of Table 8.1. The estimate of γ is -0.006 and is highly significant. From Figure 6.2, it was evident that the mean travel time to Vinmonopolet outlets from their customer bases decreased by almost ten minutes during the period I investigate. If mean travel time in the customer base decreases by ten minutes, the model predicts an increase in sales per person every two months of 0.06 liters of pure alcohol. This corresponds to a yearly increase of 0.36 liters of pure alcohol. Between 2000 and 2010, an average of 4.85 liters of pure alcohol was sold per person each year from all (legal) sources[1]. An increase of 0.36 liters of pure alcohol then constitutes a 7.4 percent increase in alcohol sold. This suggests that the decrease in travel time since year 2000 accounts for a non-negligible part of the 30 percent increase in alcohol sales over the period.

From Figure 6.3, it looked like the relationship between travel time and per person alcohol sales might be non-linear. This seems intuitively plausible as well. For instance, there may be a threshold level for travel time above which the alcohol outlet is perceived to be "too far" away, so that people with travel times above this threshold level do not buy anything from Vinmonopolet. For the customers with travel times above this threshold level, changes in travel time will not affect how much they buy as long as the change does not push them

[1]This mean in calculated using numbers from RusStat (SIRUS) from 2000 to 2010.

Table 8.1: Main results sales from Vinmonopolet

	(1) Sales per person	(2) Sales per person	(3) Sales per person	(4) Sales per person
Travel time (TT)	-0.006***	-0.014***		
	(0.001)	(0.001)		
TT^2/1000		0.089***		
		(0.012)		
ln(TT)			-0.208***	
			(0.022)	
TT<30 mins				-0.011***
				(0.001)
TT 30-60 mins				-0.006***
				(0.001)
TT>60 mins				-0.001
				(0.002)
Observations	11495	11495	11495	11495

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Estimate of γ based on equation (7.1) and 8.1.
Used in all specifications are municipality fixed effects, time fixed effects and control variables listed in Table 6.1 and meaned over the customer bases. The outcome variable is measured in liters of pure alcohol. Standard errors in parentheses, clustered at the municipality level.

below the threshold travel time. More generally, changes in travel time may have different consequences for sales depending on the initial travel time. The same absolute change in travel times may force some people to drive rather than walk, while it may have little impact on people that are already driving.

In order to allow for a non-linear relationship between travel time and per person alcohol sales, I estimate a few different specifications. First, I add travel time squared to equation 7.1. Column 2 in Table 8.1 shows the coefficients of travel time and travel time squared from this specification. The linear and the squared coefficients are -0.014 and 0.089, respectively, and they are both highly significant. I then predict the increase in alcohol sales from a 10 minute decrease in travel time, starting from the year 2000 mean travel time. The model predicts an increase in yearly per person alcohol sales by 0.54 liters of pure alcohol.

Next, I estimate equation 7.1, but using the log of travel time. The estimate from this specification is shown in column 3 in Table 8.1. The estimate is -0.208 and again highly significant. Using this model, the predicted increase in yearly per person alcohol sales from a 10 minute decrease in travel time from the year 2000 mean is 0.43 liters of pure alcohol.

One potential issue with the parametric specifications above is that they may be vulnerable to outlier bias. I therefore use a fourth specification, with regression equation 7.1

$$V_{i,t} = \alpha_i + \rho_t + \sum_{k=1}^{3} \delta_k D_{i,t}^k + \sum_{k=1}^{3} \gamma_j D_{i,t}^k \cdot TT_{i,t} + \beta \mathbf{X_{i,t}} + \epsilon_i. \tag{8.1}$$

D^1 takes the value 1 if $TT_{i,t} \leqslant 30$. D^2 takes the value 1 if $TT_{i,t} \in (30, 60]$. And finally, D_3 takes the value 1 if $TT_{i,t} > 60$. α_i, ρ_t, $\mathbf{X_{i,t}}$ and ϵ_i are defined in Chapter 7. The parameters of interest are now γ_1, γ_2 and γ_3. They capture the effect of changes in travel time on per person alcohol sales, for the Vinmonopolet outlets for which the mean travel time in the customer bases are in the three respective intervals.

The results of regression equation 8.1 are presented in column 4 of Table 8.1. Estimates conform to expectations, in that the impact of travel time is decreasing in the initial level. The estimate of γ_1, that is the effect of changes in travel time on per person alcohol sales from the outlets with mean travel time of 30 minutes or less, is -0.011 and highly significant. A ten minute decrease in travel time is then related to a increase in yearly per person alcohol sales of 0.66 liters of pure alcohol. This is a 13.6 percent increase relative to the per person

Table 8.2: Main results substitution

	Groceries	Restaurant	Pub	Total
Mean travel time	-3.487***	0.370	-0.041	-2.849**
	(0.963)	(0.366)	(0.156)	(1.027)
Observations	31612	28324	8268	31612

* p < 0.05, ** p < 0.01, *** p < 0.001

Notes: Estimates of γ based on equation (7.1) using municipality fixed effects, time fixed effects and control variables listed in Table 6.1 and meaned over the customer base. The outcome variables are sales per person measured in NOK from grocery stores, restaurants, pubs and total sales per person. Standard errors in parentheses, clustered at the municipality level

average between 2000 and 2010. The estimate of γ_2 is -0.006 and again highly significant. When mean travel time is between 30 and 60 minutes, a ten percent decrease in mean travel time is related to a decrease in yearly per person sales of 0.36 liters of pure alcohol. γ_3 is -0.001 and insignificant.

Substitution

The results from equation (7.1), with sales per person in grocery stores, restaurants, pubs, and in total as the outcome variables, are presented in Table 8.2. If there is in fact substitution between alcohol sales from Vinmonopolet and alcohol sales from grocery stores, restaurants or bars, we would expect the coefficients to be positive. People living further away from a Vinmonopolet outlet compensate by buying more alcohol through other channels.

As is evident from Table 8.2, γ is only positive when the outcome variable is sales per person in restaurants and cafes. This indicates that there might be substitution between alcohol sales from restaurants and from Vinmonopolet. However, the coefficient is not significant and it is quite small. γ is equal to 0.37. A ten minute decrease in the mean travel time to the nearest Vinmonopolet outlet of the customer bases for the restaurants, would then entail a decrease in yearly per person sales from restaurants and cafes of 22.2 NOK. 22.2 NOK would perhaps pay for a quarter of a liter of beer in a restaurant. For beer with an alcohol content of 4.5 percent by volume, this is then equivalent to 1.125 centiliters of pure alcohol per year, or 0.01125 liters.

When the outcome variable is per person sales from either pubs, grocery stores or total sales per person, γ is negative. However, for pubs the estimate of γ is -0.041. A ten minute decrease in mean travel time is then related to a 2.46 NOK decrease in per person sales from pubs per year. This change is very small and furthermore, the estimate is insignificant. The estimate of γ when sales in grocery stores is the outcome variable is -3.487. A ten minute decrease in mean travel time is then related to a 209 NOK increase in yearly per person sales from grocery stores. The estimate is highly significant, though it is quite small. The data show no indication of substitution between alcohol bought from grocery stores and alcohol from Vinmonopolet, but rather of complementarity. However, as I mentioned in Chapters 7 and 6, the outcome variables in the regressions presented in Table 8.2 include sales from businesses within the three categories that do not have license to sell alcohol as well as non-alcohol sales from the businesses with an alcohol license. It is not unlikely that people who travel to get to their closest Vinmonopolet outlet also do their grocery shopping close to the Vinmonopolet outlet even if it is not in their municipality. This could then explain the negative relationship between grocery store sales and the travel distance to the nearest Vinmonopolet outlet. The grocery stores close to Vinmonopolet outlets could get more customers as other people shop there while they are in the neighborhood in order to buy alcohol from Vinmonopolet. In this case, what is captured is a relationship between alcohol from Vinmonopolet and groceries from the grocery stores rather than alcohol.

The coefficient is again negative and significant when the outcome variable is total per person sales. The estimate of γ is -2.849. This is driven by the negative relationship between grocery store sales and travel distance to the nearest Vinmonopolet outlet.

Chapter 9

Conclusion

Alcohol consumption has a number of adverse effects, and limiting alcohol consumption is a stated objective of Norwegian alcohol policy. Restrictions on access are the main means used in order to achieve this objective. Off premise alcohol sales for beverages with alcohol contents above 4,7 percent are restricted to a state monopoly. All other alcohol sales, on and off premise, require a license. The state monopoly and license system form geographical restrictions on alcohol availability.

Economic theory would suggest that the travel distance to alcohol outlets matters for alcohol consumption, both because it constitutes a cost to the consumers, and because it forms a commitment device for time inconsistent consumers. In order to test this prediction empirically, I use data on liters of pure alcohol sold from Vinmonopolet, combined with data on travel times between Norwegian municipalities, to investigate the effect of changes in travel time on per person alcohol sales.

In my baseline regression I find that a ten minute decrease in travel time is related to an increase in yearly per person alcohol sales from Vinmonopolet of 0.36 liters of pure alcohol, and the estimate is highly significant. This constitutes a 7.4 percent increase in alcohol sold relative to the year 2000-2010 mean. To allow for non-linearities in the relationship I estimate a few other specifications giving higher predicted increases in yearly per person alcohol sales with the highest being 0.66 liters of pure alcohol per person per year.

I also look at how sales per person in other enterprises where alcohol sales are possible are affected by the mean travel time in the customer bases to the nearest off premise state

monopoly outlet. These include pubs, restaurants, and grocery stores. If there is substitution between alcohol sales from the off premise state monopoly and alcohol sales from grocery stores, restaurants or pubs, we would expect a positive relationship between travel time to an off premise state alcohol monopoly and sales in pubs, restaurants, and grocery stores. I find some evidence of substitution from restaurants. However, the estimate is very small and insignificant. For pubs and grocery stores the relationship is in fact positive and for grocery stores it is highly significant. This does not necessarily mean that there is complementarity. It could rather be an effect of increased non-alcoholic sales due to more favorable location caused by the openings of Vinmonopolet outlets nearby.

I find that per person alcohol sales from Vinmonopolet increases as the mean travel time of the customer bases decrease. I find some evidence of substitution from restaurants. However the estimate is insignificant and small and only to an almost negligible degree compensates for the increase in sales from Vinmonopolet. For pubs and grocery stores there is no indication of substitution, the relationship is in fact negative. I conclude that decreases in travel time are related to an increase in alcohol consumption, as alcohol sales from Vinmonopolet increases while there is little evidence of substitution.

Some final words of caution are in order. First, alcohol consumption may not equal the amount of alcohol sold. Sales could differ from actual consumption due to home production of alcohol, cross border shopping (and smuggling), and tourist imports. In principle, there could be a relationship between the time trend in travel distance to the nearest Vinmonopolet outlet and the trend in use of these other channels. If so, then my estimates will be biased. Second, implicit in my design is an assumption that everyone in a municipality shops in the municipality with an outlet, with the mean shortest travel time. This is obviously not true for everyone. The closest municipality with an outlet may vary within a municipality. There may also be other reasons to shop in a municipality other than the nearest one, for instance if people work in a different municipality. It is perhaps not unlikely that there is a relationship between the number of "external shoppers", that we have assumed out of the model, and the travel time across municipalities. Some municipalities get a lot of incoming commuters. If these are mostly urban municipalities, where the travel distance is low, and the people who commute there use the Vinmonopol outlets there, then there would be a positive relationship between the number of external shoppers and the travel time. However,

since this is unlikely to vary much over the time period I consider, this should be captured by the municipality-fixed effects in the model and should not bias the results.

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