# Genetic Variability and Collective Social Norms:

## The Case of Binge Drinking

***Jason F. Shogren***
*Department of Economics and Finance, University of Wyoming*

***Eric Nævdal***
*Department of Economics, University of Oslo*

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Eric Nævdal and Jason F. Shogren

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**Authors addresses**: Eric Nævdal, Department of Economics and HERO, University of Oslo
P.O. Box 1095 Blindern, N-0317 Oslo, Norway
E-mail: eric.navdal@econ.uio.no

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Jason F. Shogren, Department of Economics and Finance, University of Wyoming, Laramie, WY, 82055
E-mail: jramses@uwyo.edu


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## Abstract

This paper explores how collective social norms can have individual-level genetic foundation. Our study is the first we know to report a plausible link between genetically founded individual preferences in a fraction of a population and social norms governing behavior of all individuals. As our motivating example, we focus on patterns of Excessive Drinking in Social Situations (EDSS) across Europe that are possibly triggered by genetically caused variations in personality. The genetic trait is shyness, which correlates with eye color. We present empirical results indicating that alcohol consumption in social situations correlate with eye color and a model which suggests that conditions exist in which EDSS can emerge as a strategy in a larger fraction of the population than is genetically predisposed to EDSS. In addition, our model shows that alcohol taxes may be counter-productive in controlling the emergence of EDSS as a social norm.

## 1. Introduction

This paper explores how social norms can have a direct and *indirect* genetic foundation. Our model is the first we know to report a plausible link between genetically founded individual preferences in a fraction of a population and social norms governing behavior of all people. Our results show that conditions exist in which one particular social norm—binge drinking, or excessive drinking in social situations (EDSS)—emerges as a coping strategy in a larger fraction of the population than is genetically predisposed to binge drinking. The extent that this social norm emerges depends crucially on the fraction of genetically predisposed people in a population. When this fraction exceeds a threshold determined by economic, social and genetic factors, all people, shy or not, binge drink. A key implication of this result is that social norms may have a genetic causation, and that these norms can affect the behavior of people who do not share the genes that cause the behavior. In addition, our model suggests that increasing alcohol taxes to control the emergence of EDSS could be counter-productive—less total consumption, but more binge drinking.

Our paper is related to the emerging economic literature focusing on neuroscience to explain both behavior and preferences (see Camerer *et al.*, 2003 for a general overview). This approach seems pertinent when examining preferences for addictive substances as substances chemically affecting the production and functioning of neuro-transmitters form these preferences. Bernheim and Rangel (2004), for instance, study individual decision making by explicitly recognizing how dopamine may lead to cue-dependent preferences for alcohol consumption, and how such a process could cause and sustain alcoholism. Our study differs from theirs in several respects. They are concerned with alcoholism and individual choice, along the line of Becker and Murphy (1988).

Our study is concerned with EDSS,[1] and the effects of the neuro-chemical agent norepinephrine. Norepinephrine is strongly associated with the physiological manifestation of anxiety and relevant for shyness; whereas dopamine plays a role in the brain's perception of present and future pleasure derived from consumption. Furthermore, we focus on alcohol and neurochemistry in a social context with interacting people, whereas Bernheim and Rangel focus on individual decision-making. This does not mean that they disregarded social context; rather they consider how a person chooses an environment from a set of possible environments each with different implications for alcohol preferences. This set, however, is exogenous. In our model, the environment changes in response to changes in the aggregate of individual behavior.

The paper proceeds as follows. We first provide background on our motivating example of excessive drinking in social situations, focusing on Europe. We also evaluate alternative explanations for the emergence of EDSS that differ from our model. In the third section, we present the model and the main results. Section 4 extends the model to allow a person to exit a social situation when he does not like the level of drinking. The fifth section considers how a policy to increase the price of alcohol affects binge drinking. Finally, we offer our concluding remarks.

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[1] While a link exists between EDSS and alcoholism, many people engage in EDSS over a number of years or even a lifetime without ever becoming alcoholics. The theory of rational addiction is of less relevance to the present paper than may seem apparent. There is no alcoholism in the present model. We only model drinking behaviour in a social context. The theory of rational addiction works on the premise that the benefits gained today from drinking to e.g. forget bad memories or overcome shyness matter more to alcoholics than tomorrow's costs such as hangover or their future visits to the hospital for kidney or pancreas treatments. For these drinkers, the dynamic aspects of their behavior are important. The theory presumes, however, that people understand the physiological effects of alcohol and make cost-benefit judgments accordingly. This presumption has been contested, e.g. Gerena (2003). The physiological effects of alcohol consumption examined in our paper could be seen as subtler than those driving alcoholism and are therefore not assumed to affect individual decision-making.

## 2. Motivating Example: European Alcohol Use

A comprehensive study by Leifman (2002) confirms the mind-set that significant differences actually exist in drinking patterns across Northern and Southern Europe. The study finds that although the frequency of alcohol consumption occasions and average annual consumption figures are lower in the Nordic countries, excessive drinking in social situations (EDSS) is more predominant in northern Europe than in the South.[2] Leifman finds that 46.7% of Finnish males and 34.8% of Swedish males engage in heavy drinking at least once a month but not more often than once a week.[3] The corresponding number for Italian males is 16.2%. Further, average alcohol consumption of beer or spirits per drinking occasion can, depending on drinker age, be more than 4 times as high in Sweden and Finland than in Italy.

We now present our argument in five steps to explain how genetic variations translate into frequent EDSS in northern Europe. First, in a comprehensive study of shyness, Kagan (1994) found an active norepinephrine system, originating in the part of the brain called amygdale, to be highly correlated with shyness. Remarkably, Kagan also observed a correlation between an active norepinephrine system and several external physiological characteristics, the most prominent being blue eyes and tall ectomorphic bodies. The association between blue eyes and shyness has been replicated by among others Reznick *et al.* (1989) and Coplan *et al.* (1998).[4] Coplan *et al.* found that 30 percent of blue-eyed males in an unselected sample of preschoolers fell into the category 'socially wary'

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[2] Leifmann also finds signs of a convergence in drinking patterns between southern and northern Europe and suggests that this may be caused by increased cultural interaction.

[3] We do not include the small number of people who engage in heavy drinking more than once a week to exclude alcoholics.

[4] As noted in Reznick et al. (1989) and Coplan et al. (1998), a considerable number of studies have examined the link between pigmentation and personality reported here. The overwhelming majority have found support for this link (see the references sited therein).

whereas only three percent of the males without blue eyes did.[5] These physiological features are more common in northern European countries than in the south. This suggests that one may reasonably expect that shyness is more common among people of northern Europeans decent than southern Europeans. Schwartz et al. (2003) observed that the shy individuals in an earlier study by Kagan had a tendency to remain shy; and this shyness continued to manifest itself in the amygdala. This point matters for our purposes since it indicates that observed variations in shyness among children will partially continue into the age when alcohol consumption starts. This correlation between pigmentation and personality is also found in other animals. It is well known among animal breeders that selecting for pigmentation often implies selecting for personality traits and vice versa. Although the literature suggest both biochemical and evolutionary explanations for the link between shyness and eye color, a strong correlation between eye color and personality is sufficient for the argument. Even if the correlation may be caused by pure coincidence, the point remains that people of northern European background will have a higher propensity for a shy personality. See below for an evolutionary explanation suggested by Kagan.

Second, several coping strategies exist for shyness in social situations. The classic strategy is to use alcohol as self-medication, which can lead to excessive drinking, i.e., EDSS. Many studies confirm this view. See, for example, Carrigan and Randall (2003) who review the social phobics literature and Thomas *et al.* (2003) who examine the case of socially anxious people.[6]

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[5] To the extent that studies have included gender, the literature suggests that the link between eye color and personality is much stronger in males than females, e.g., Coplan et al. (1998). Most of these studies considered North Americans of similar background, which should to some extent control for cultural influences.

[6] Studies from medical and psychology literature also report mixed results in the effectiveness of self-medication. The suggestion that self-medication has mixed results does not imply non-optimality in the economic sense. Alcohol as self-medication is the optimal strategy given the prices of alternative coping strategies. We are concerned with the idea that people use this

Third, given the first two steps, it follows a larger fraction of the population in northern Europe should have a greater genetic disposition for EDSS. We examine the validity of this step by conducting a short survey in which we asked alcohol consumers about their motivation for drinking and compared the answers for individuals of different eye colors. The results of this survey are that blue eyed individuals were more likely to report that they consume alcohol to feel more relaxed in social situations and that they were more mindful of peers' alcohol consumption level when fixing their own. The details of the survey are given in the Appendix.

Fourth, if the fraction of the population with EDSS genetic disposition is sufficiently large, social reinforcement mechanisms could come into play. People frequently adapt to the behavior of others, see Banerjee (1992). If EDSS is atypical, it is considered anti-social. If EDSS is relatively common, it has a "legitimizing" effect and EDSS becomes socially acceptable.

Fifth, if steps 1-4 hold, we should observe a larger fraction of the population that engages in EDSS in northern Europe than in southern Europe. Our social norm hypothesis is that EDSS emerges as a strategy in a larger fraction of the population than the fraction genetically predisposed to EDSS.

Our model takes the higher frequency of shyness among northern Europeans as a given, without explaining why. Kagan, for instance, suggests northern Europeans have an active norepinephrine system due to the cold climate. In a cold climate, there is a fitness gain to physiological adaptations that encourage high metabolic rates. One such adaptation is an active norepinephrine system caused by neuro-chemical processes in the amygdala which appears to have changes in pigmentation as a side effect. An alternative

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strategy with the expectation that it will work; see Kushner *et al.* (2000). Also remember we are concerned with EDSS, not alcoholism. Although a relationship between shyness and alcoholism has been reported, the relationship is not straightforward, Lépine and Pélissolo (1998), and not addressed herein.

explanation is that light eye pigmentation is the result of sexual selection processes, see Frost (2006). These explanations suggest that an evolutionary genetic selection process explains why blue eyes are more common in northern Europe. Furthermore, shyness in itself is not the trait selected for, but rather a side effect to the advantageous trait. We do not incorporate the evolution of the shyness and eye color in the model as the *cause* of shyness is not required to get our results. Rather we take it as given that evolution has resulted in blue eyes being common in Northern Europe and that this has had the effect that shyness is more common in the North than in the South. Nor do we incorporate the role of alcohol in the evolution of eye color/shyness as this evolution may precede the human manufacturing of alcohol.

Several studies have related shyness to genetic factors; even down to reporting correlations with specific variants of genes (see Arbelle *et al.,* 2003). The correlation between shyness and external physiological features also seems to indicate that genetics at least plays a part. A link between personality and pigmentation has been reported in certain animals, strengthening the argument for a genetic link in humans. Perhaps the best known example is Belyaev and Trut (1975) who found that in breeding for specific types of behavior one also selected for white fur as well as other physiological traits.

Alternative explanations for these observed variations in European drinking behaviour have been proposed: climate, culture and the effect of alcohol prices. We here consider each in turn, and argue that the rationales for these alternative stories are less compelling than our own.

First, does climate have a direct effect on drinking behaviour in that cold weather induces a preference for drinking? The basic idea is that alcohol gives the consumer a perception of feeling warm. There are several problems with this idea. The perhaps most important is that if excessive drinking is caused by the desire to feel warm one would expect that Northern Europeans engaged in relatively more drinking in everyday situations than people in warmer climates and that drinking would be concentrated in winter time. As documented by

Leifmann, however, Scandinavians drink less in everyday situations. Further, with the exception of drinking associated with Christmas celebrations, winter is not marked by particularly high consumption. The opposite seems to be the case, Lie Røhr (2006).[7] It has also been suggested that Seasonal Affective Disorder may induce excessive drinking in social situations. This is an interesting hypothesis, but it is not supported by the facts. First, although EDSS is more frequent in some (but not all) of the northern US states; these states are located at the same latitude as Southern Continental Europe where EDSS is historically not a big issue. Further, if Seasonal Affective Disorder or cold for that matter induces EDSS, one would expect behaviour in Alaska to exhibit EDSS. Among US states Alaska, however, only ranks as 25 with respect to overall binge drinking, below states like Texas and New Mexico (Substance Abuse and Mental Health Services Administration, 2004).

Second, are the observed drinking patterns side effects of other cultural variations across the European continent? Perhaps, but not likely. For instance people note a casual link between religion and drinking patterns—EDSS is less common in catholic countries and more in protestant countries. Although this holds for the most part, there are some interesting exceptions such as Ireland and Catholic parts of Scotland. The Church of England is also traditionally similar to the Catholic Church and cannot be called protestant in the sense of, say, Lutheranism. And although Germany as a whole is intermediate with respect to binge drinking, there seems to be a tradition for some binge drinking in the Catholic south (October fest.) Further, recent experience in Catholic Spain where binge drinking amongst teens and young adults appears to be a growing phenomenon suggests the role of religion is limited, whereas the effect of being exposed to peers from Northern Europe is considerable (Gual and Colom, 1997).

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[7] From our personal experience, most Scandinavians do not drink alcohol to stay warm. Drinking alcohol when it is cold makes you feel even colder. The real remedy against cold weather is to dress in layers, use a hat, sturdy footwear and abide by sensible building codes. If you must drink something to keep warm, drink hot cocoa.

Some have argued a liberal alcohol culture itself is conducive to a lack of binge drinking culture. Those countries lacking policies for reduction of alcohol consumption are those in which there is little evidence of EDSS. We do, however, believe this argument turns causality on its head. EDSS is a problem that creates externalities and it is in countries with a history of EDSS in which policies are in place. As a counter example, Denmark is permissive with relatively low alcohol prices and legal drinking age and a distinct culture for EDSS.[8]

Finally, do high prices cause people to lump consumption into short bursts of excessive drinking interspaced by long periods of abstinence? There are different ways of examining this question. One can examine a conventional model of an atomistic utility maximising consumer with alcohol consumption as an argument in an intertemporal utility function. Such a model yields such a price response only under peculiar assumptions about the preference ordering. However, if one recognizes that social drinking patterns evolve in a social context a price increase may have exactly this effect, e.g., if drinking occasions are organized as parties in which a host provides alcohol. It seems reasonable that hosts will arrange fewer parties if alcohol prices increase. We show below that in such a social context EDSS is more likely to evolve at higher price levels.

[8] One possible criticism of our work is that EDSS appears in many cultures in the world; some where blue eyes are not present in the population. However, when examining these cultures one may actually find support for our findings. The studies supporting more shyness among blue eyed individuals all compare Caucasians, presumably mostly people of European decent. In other studies where East Asian children have been compared to Caucasian children, East Asian children have been found to be more socially inhibited. As it is shyness/social inhibition in a fraction of the population that leads to EDSS emerging as social norm, finding binge drinking in East Asian cultures can be interpreted as supporting evidence for our work. It does appear that binge drinking does play a considerable role in both Korean and Japanese culture.

### 3. A Model of individual genetics and Social Norm Formation

Now consider our model of how social interaction between people in a group leads to the formation of a social norm for excessive drinking. We begin our analysis under the assumption all individuals participate in social situations. This assumption is helpful when developing the dynamics of the model. We then relax this presumption by allowing some people the choice to exit from a social situation if their drinking behavior is too removed from the social norm. This adds realism to the model and gives rise to qualitative predictions that seem to explain regional differences in drinking patterns.

Suppose two types of people exist (type 1 and 2). The types are distinguished by the level of alcohol consumption that provides a "comfortable" level of intoxication in social situations, as measured by blood alcohol content (BAC). Type 1 drinkers are comfortable with a BAC of $\alpha$; type 2 drinkers prefers $\alpha + f(\alpha)$. Think of $\alpha$ as the physical "comfort" level of intoxication, and $f(\alpha)$ as the extra "buzz" required by a shy person to be comfortable in a social situation. Our modeling of how alcohol consumption reduces shyness is consistent with the dose-related effect of alcohol on reducing stress; see e.g. Sher and Walitzer (1986).[9]

Assume $f'(\alpha) < 0$, i.e., if $\alpha$ is large, $f(\alpha)$ is small. This assumption reflects the idea that if a shy person is comfortable with a high BAC, his need for an extra "buzz" to cope with the social situation is relatively small. It is assumed that there is an upper level of $\alpha$ given by $R$, such that $f(\alpha) = 0$ for all $\alpha > R$. $R$ has the interpretation that if $\alpha = R$, then the comfort level of alcohol is so high that

[9] Sher and Walitzer (1986) reports reduced stress as a function of alcohol intake in a social situation both measured by heart beat rate and by individual self-reporting. This study only looks at relatively low levels of alcohol blood levels. ($<$ 0.850 g/Kg). Other studies have found significant stress reduction measured by reduced heart beat rate only at higher levels, Sher and Levenson (1983). The main point for our purposes is that stress in social situations is a decreasing function of blood alcohol content.

if the individual consumes $R$ there is no need for additional consumption to reduce the shyness effect.

Normalize the number of drinkers to unity, such that $n$ is the non-shy fraction of the population of type 1 and $(1 - n)$ is the shy fraction of type 2. Both types have preferences for conformity in that they do not want to be perceived as different from the norm. This preference translates into a desire to not deviate from the drinking norm, here taken to be the average drinking levels, denoted $\sigma$. A parameterization of these preferences is:

$$U(c) = -(c - z)^2 - \gamma(c - \sigma)^2, \tag{1}$$

where $z$ is $\alpha_1$ for type 1 and $[\alpha_2 + f(\alpha_2)]$ for type 2 drinkers. Let $\gamma > 0$, measure of the desire for conformity with the crowd. The value of $\gamma$ can reflect a desire to "be like the others" through real or perceived peer pressure. The peer pressure may be positive as in Bernheim (1994) or negative as in Akerlof (1980). Pressure can also reflect positive mutual externalities in conformity caused by something as prosaic as the belief it is less fun to be sober while others are not and vice versa. If $\gamma = 0$, a drinker does not care about conforming, if $\gamma > 0$, a drinker pays attention to the average level of intoxication.[10] Some empirical justification for a positive value of $\gamma$ is given in the appendix. Denote $c_i$, $i = 1,2$, as the optimal alcohol consumption of type $i$. Think of the model as a large population in which people continuously mixed with new people. The alcohol consumption levels that maximize utility as a function of $\alpha_i$ and $\sigma$ are given by:

$$c_1 = \frac{\alpha_1 + \gamma\sigma}{1 + \gamma}, \quad c_2 = \frac{\alpha_2 + f(\alpha_2) + \gamma\sigma}{1 + \gamma} \tag{2}$$

[10]Assume no one is a role model, and alcohol consumption levels are determined without strategic considerations and that inter-temporal strategic considerations do not affect the outcome. Alcohol price is excluded in our analysis. Although we recognize and appreciate that alcohol prices are important in any person's decision problem, we suppress price effects to focus on the interaction between personality and consumption (see Becker, Grossman and Murphy, 1991).

By definition, $\sigma = nc_1 + (1 - n)c_2$, so in equilibrium $\sigma$ is determined by:

$$\sigma = n\frac{\alpha_1 + \gamma\sigma}{1+\gamma} + (1-n)\frac{\alpha_2 + f\left(\alpha_2\right) + \gamma\sigma}{1+\gamma} \tag{3}$$

Solving Equation (3) with respect to $\sigma$, yields the equilibrium value of average alcohol intoxication.

$$\sigma = n\alpha_1 + (1-n)\alpha_2 + (1-n)f\left(\alpha_2\right) \tag{4}$$

Inserting for $\sigma$ into (2) gives the equilibrium level of intoxication for the two types:

$$c_1 = \frac{(1+\gamma n)\alpha_1}{1+\gamma} + \frac{\gamma(1-n)\left(\alpha_2 + f\left(\alpha_2\right)\right)}{1+\gamma} \tag{5}$$

$$c_2 = \frac{\gamma n\alpha_1}{1+\gamma} + \frac{\left(1+\gamma(1-n)\right)\left(\alpha_2 + f\left(\alpha_2\right)\right)}{1+\gamma} \tag{6}$$

From Equation (5) we see the preference for conformity affects intoxication levels for both types of drinkers. Type 1s drink more than their comfort level, $\alpha_1$, and Type 2s drink less than their preferred level $\alpha_2 + f\left(\alpha_2\right)$. If $f(\alpha_2)$ is sufficiently large, this can translate into a considerable increase in average alcohol consumption per person in social situations.

We have so far assumed $\alpha_1$ and $\alpha_2 + f(\alpha_2)$ constant. But the "feel-good" level of intoxication, $\alpha_i$, responds to values of $c_i$ consistently above or below $\alpha_i$, NIAAA (2000). This adaptation occurs on a neuro-chemical level and is the reason why heavy drinkers exhibit high tolerance for alcohol. Preferences are adaptive as in von Weizsäcker (1971). We model this adaptation, which is physiological in nature, by assuming $\alpha_1$ and $\alpha_2$ are determined by the following differential equations.

$$\dot{\alpha}_i = F(c_i - \alpha_i)h(M - \alpha_i), \quad i = 1,2 \tag{7}$$

where $M$ is a physiologically determined upper bound for $\alpha_i$. No drinker can achieve a comfort level of drinking when $\alpha_i > M$. Assume $F(0) = h(0) = 0$. Furthermore, let $F'(\cdot) > 0$ and $h(M - \alpha_i) > 0$ for all $\alpha_i < M$.

We now have all the pieces to model the dynamic interaction of people who engage in repeated social intercourse involving drinking.[11] When analyzing the problem, we distinguish between two cases: $M > R$ and $M < R$. If $M > R$, two steady states exist. If $M < R$, one steady state exists. In both cases, there is only one stable steady state, which is given by $\alpha_1 = \alpha_2 = \min[M, R] = m$. We restrict our analysis to the set $[0, m]\times[0, m]$.

Figure 1 illustrates a phase diagram for possible time path of $\alpha_1$ and $\alpha_2$, in which we illustrate three paths, *a*, *b* and *k*. In Figure 1, we see every path in the state-space defined by $[0, m]\times[0, m]$ terminates in the one steady state, point *SS*. Note that lines $\dot{\alpha}_1 = 0$ and $\dot{\alpha}_2 = 0$ cannot intercept except at the point *SS*. This is a striking result. If $m = M$, everyone, in the long run, adapts to a level of intoxication that is the maximum physical level at which it is possible to be comfortable. If $m = R$, the shy fraction of the population adapts to the level in which the shyness effect disappears, and the rest of the population also adapts to this level. In the long run for both cases, the shyness effect implies that in long-

[11] This dynamic aspect leads to the introduction of a dynamic element, and raises the possibility of modelling the consumers' decision problem as a dynamic optimisation problem. The most important reason for suppressing this is that such an optimisation problem does not seem credible. It is worthwhile to point out again that we are not modelling alcoholism. The changes in $\alpha$ are changes in the comfort level. To illustrate, consider an individual that goes to a sequence of parties. A person starts with a comfort level of alcohol equivalent to 2 glasses of wine. At parties, however, he or she consistently drinks 4 glasses. After a number of parties the comfort level adapts with build-up of tolerance modelled by the differential equation in (7) and the comfort level increases. Although this is a process that all drinkers experience to some extent, it strains credulity to think that this effect is part of the calculation when the person decides on how many glasses of wine to drink at a given drinking occasion.

run equilibrium non-shy population mimics the drinking habits of shy people (i.e., $c_1 = c_2 = m$). Moreover, this result holds for all positive parameter values.[12]

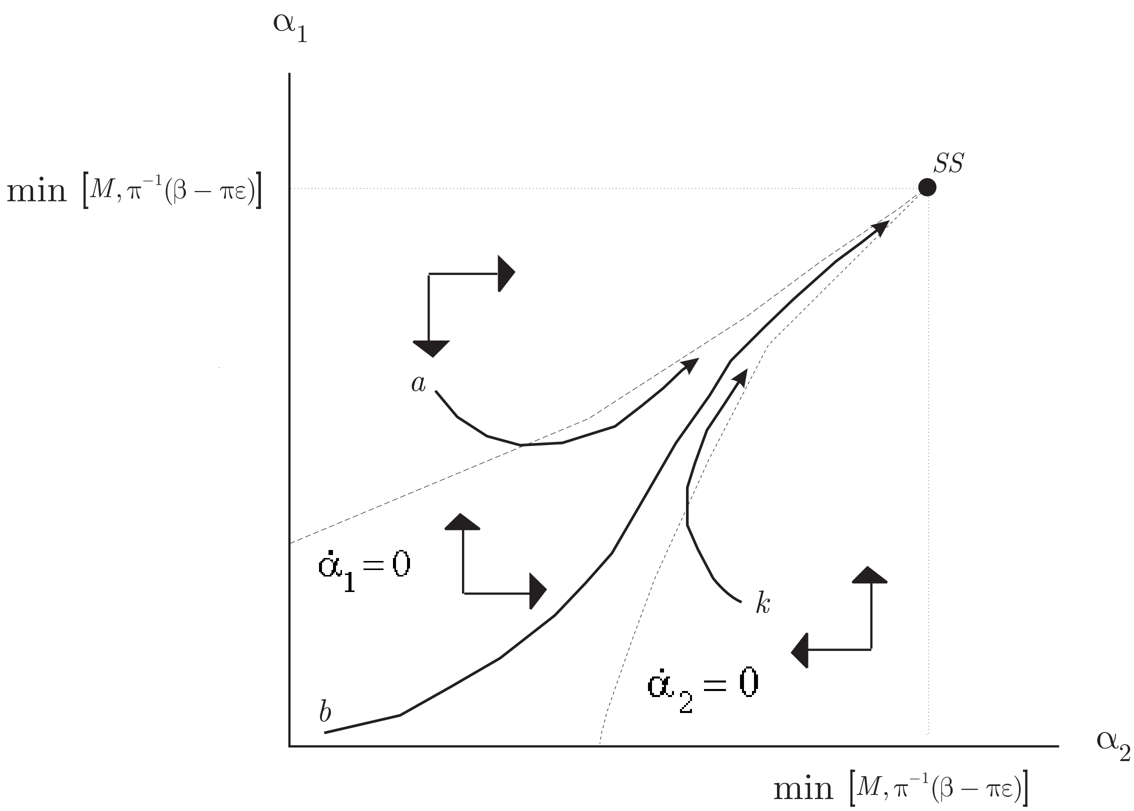


Figure 1, Phase diagram for $\alpha_1$ and $\alpha_2$

Now assume $\alpha_1 = \alpha_2 = \bar{\alpha}$, where $\bar{\alpha}$ is some common low initial comfort level. Figure 2 illustrates the development of $c_1$ and $c_2$ when ($\alpha_1$, $\alpha_2$) starts from point $b$ in Figure 1. We see $c_2$ starts out at a higher level than $c_1$. This is the initial shyness effect. Then $c_1$ and $c_2$ increases at an initially faster rate than $c_1$, which is caused by feedback from the effect of $c$ on $\alpha$. Because $c_2(0) > c_1(0)$, $\alpha_2$ initially increases more rapidly than $\alpha_1$. This is caused by the "bulge" towards the $\alpha_2$ –

[12] In contrast, if no shyness effect exists (e.g. if $n = 1$ or $\beta = 0$) or there is no preference for conformity ($\gamma = 0$), we know any initial level of $\alpha_1$ represents a steady state and consumption for the non-shy fraction of the population remains at this level.

axis in the path starting in point $b$ in Figure 1. Faster growth in $\alpha_2$ than $\alpha_1$ initially feedbacks into higher growth rates in $c_2$ than $c_1$. As $\alpha_2$ approaches its saturation point, growth in $c_2$ diminishes and $c_1$ catches up.[13]

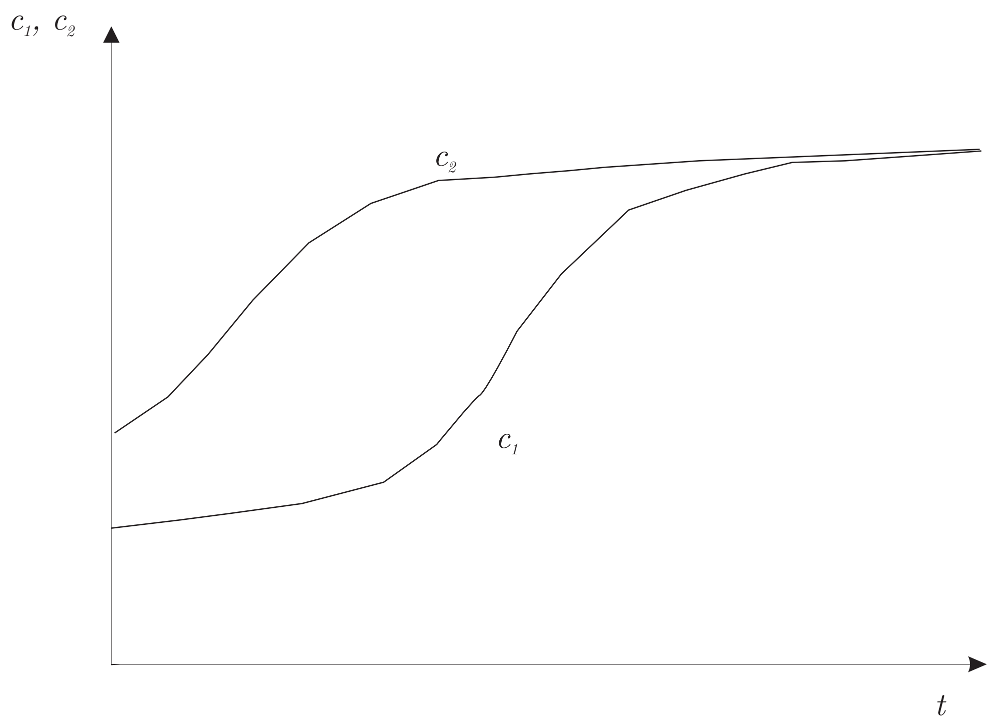


Figure 2. Alcohol consumption time paths

## 4. Norm Formation given Exit

In our model, EDSS emerges as a norm regardless of the strength of the shyness effect and the magnitude of the fraction of shy individuals. This result is robust with respect to functional forms with the model. As long as shyness affects drinking patterns in such a way that shy individuals has higher consumption

[13] Our model shares features with Conlisk's (2003) dynamic preference model. In particular, our result that preferences are harmonized over time is consistent with Conlisk's results.

than non-shy individuals, EDSS emerges as a social norm. This result holds when shy and non-shy individuals treat one another symmetrically as peers and both participate in social situations. The joint effects of symmetric peer pressure and the physiological buildup of tolerance when drinking exceeds the comfort level ensure that shy individuals drink a little bit more than non-shy and non-shy individuals play catch-up. Symmetric peer pressure and participation, however, may be too strong assumptions. People may treat other individuals asymmetrically. If the number of individuals engaging in EDSS is small, they may be stigmatized rather than having the ability to influence drinking behavior in others. Introducing stigmatization could possibly reverse the finding that EDSS emerges regardless of the magnitude of $f(\cdot)$ and $n$. We examine a different mechanism that makes the emergence of EDSS depends on $n$. Consider the case in which people can exit from the social situation, i.e., too much drinking might cause non-shy people to leave a party; too little might cause shy people to stay home.[14] We model exit by providing shy people an outside option, e.g., staying home on Saturday to watch TV.[15] Assume exercising this option gives utility, $-A$. The shy person's maximization problem is:

$$\max\left[\max_{c_2}\left(-\left(c_2-\left(\alpha_2+f\left(\alpha_2\right)\right)\right)^2-\gamma\left(c_2-\sigma\right)^2\right),-A\right] \tag{8}$$

Inserting $\sigma$ and $c_2$ from (4) and (6) into (9), we derive values for $(\alpha_1, \alpha_2, n)$ that makes a shy person indifferent between the social activity and exiting:

$$\phi\left(\alpha_1,\alpha_2,n,A\right)=0 \tag{9}$$

[14] We do not incorporate exit as an option for Type 1 since it seems empirically irrelevant.

[15] We do not specify the behaviour of shy people after they exit social situations. Assume their behaviour outside the social context does not affect people who remain on the social scene.

If $\phi(\alpha_1, \alpha_2, n, A) > 0$, shy people participate; otherwise, they exit.[16] Figure 3 illustrates the condition in ($\alpha_1$, $\alpha_2$) space. For given values of $n$ and $A$, the value of $\alpha_1$ that makes a shy person indifferent is a concave function of $\alpha_2$.

Recall at any instant in time, $\alpha_1$ and $\alpha_2$ determine $c_1$ and $c_2$. If ($\alpha_1$, $\alpha_2$) lies above the curve $\phi(\alpha_1, \alpha_2, n, A) = 0$, shy people exit.[17] The dynamics of $\alpha_1$ and $\alpha_2$ depend on whether $(\alpha_1(t), \alpha_2(t))$ falls below or above $\phi(\alpha_1, \alpha_2, n, A) = 0$.

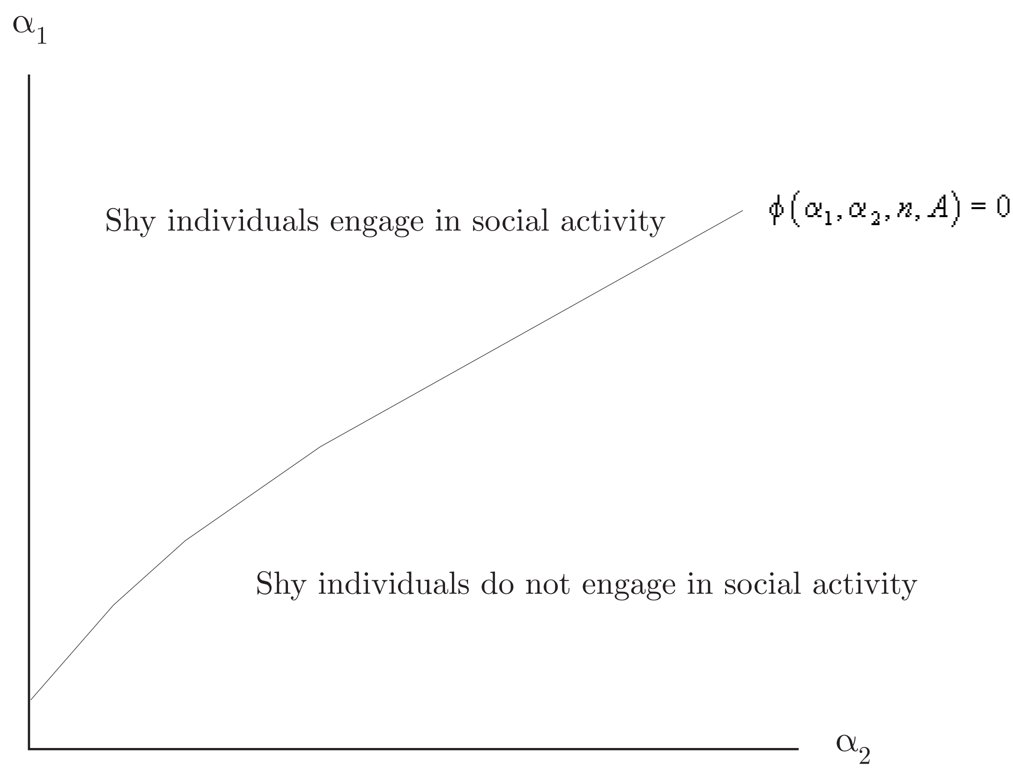


Figure 3, Participation constraint for shy individuals.

[16] To simplify, assume if $\phi = 0$, shy people do not participate.

[17] We draw the curve $\phi(\alpha_1, \alpha_2, n, A) = 0$ in Figure 3 such that the curve intersects the $\alpha_1$ – axis for a positive value of $\alpha_1$. This is not always the case. For sufficiently large values of $A$, the cost of exiting is too large and shy people participate for any value of $\alpha_1$. This implies the curve intersects the $\alpha_1$ axis with a positive value of $\alpha_1$. In contrast, if $A = 0$, for all sufficiently low values of $\alpha_1$, shy people exit and the curve intersects the $\alpha_2$ axis.

To illustrate how exit affects behavior, assume $\alpha_1 = \alpha_2 = \bar{\alpha}$ (as point $b$ in Figure 1). If $(\alpha_1(t), \alpha_2(t))$ is above $\phi$, $(\alpha_1(t), \alpha_2(t))$ traces a path similar to $b$ in Figure 1. If $(\alpha_1(t), \alpha_2(t))$ is below $\phi$, shy people exit. Non-shy people still socialize, without the pressure to conform since all the relatively heavy drinkers are gone. This can be modeled as setting $\sigma = \sigma_1$ in the optimization problem in (1). The solution to maximizing utility in (1) and finding the equilibrium is then that Non-shy people all choose $c_1 = \alpha_1$. Below the curve, the dynamics of $\alpha_1$ is:

$$\dot{\alpha}_1 = F(c_1 - \alpha_1)h(M - \alpha_1) = 0 \tag{10}$$

If $(\alpha_1(t), \alpha_2(t))$ crosses $\phi$, this implies a discrete jump in alcohol consumption for both groups. If $(\alpha_1(t), \alpha_2(t))$ crosses the $\phi$ from above, alcohol consumption in both groups has a discrete jump downwards and vice versa.

Given exit, consider the comparative static on how the fraction of non-shy people ($n$) affects the formation of drinking norms. In Figure 4Figure 3, the thick line from origin to the point $SS$ references the benchmark no-exit path of $(\alpha_1(t), \alpha_2(t))$ for a starting point close to origin. There are four lines illustrating the $\phi$-curve for different values of $n$. The figure is drawn so $n_1 < n^* < n_2 < n_3$. The curve $\phi(\alpha_1, \alpha_2, n_3, A) = 0$ corresponds to the case with the largest fraction of shy people; $\phi(\alpha_1, \alpha_2, n_1, A) = 0$ corresponds to the smallest fraction.

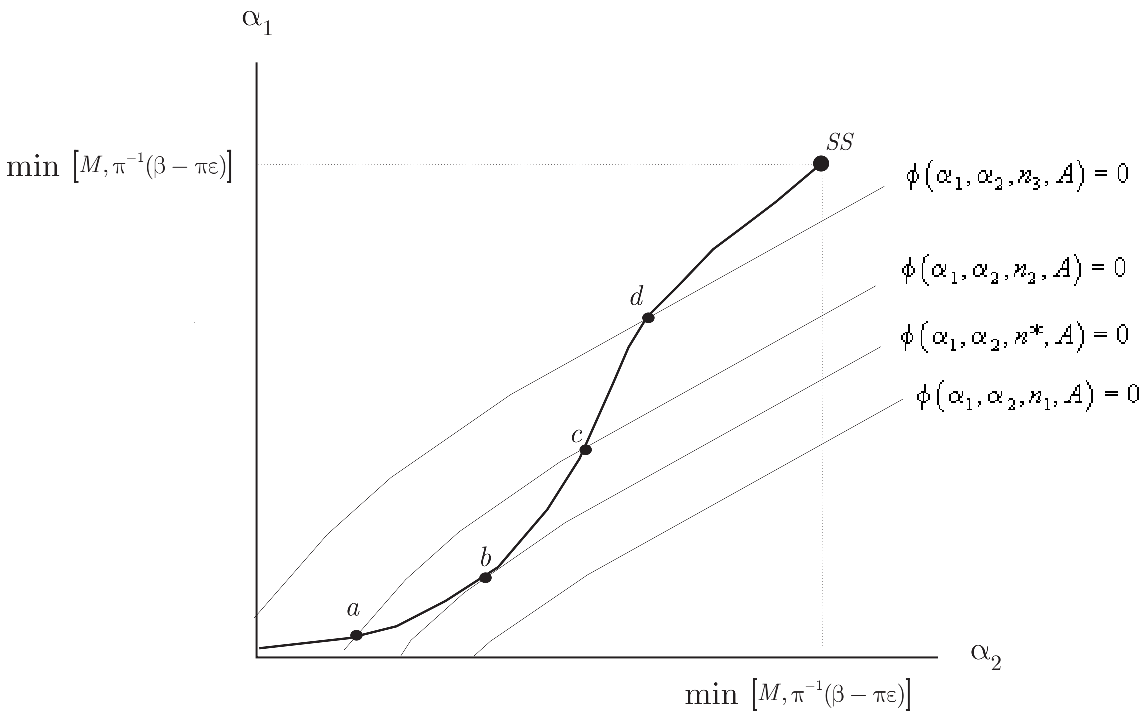


Figure 4. The dynamics of $\alpha_1$ and $\alpha_2$ for different values of n

Consider first the largest fraction of shy people, $\phi(\alpha_1, \alpha_2, n_3, A) = 0$. Since $(\alpha_1(0), \alpha_2(0))$ lies below the $\phi$-curve, shy people never enter social situations. Non-shy people have no pressure to conform, and consume $c_1 = \alpha_1$. It follows that $\dot{\alpha}_1 = 0$. This we dub the *sober/temperate society.*[18]

Second, consider the smallest fraction of shy people ($n = n_1$). Here we see the path of $(\alpha_1(t), \alpha_2(t))$ lies in its entirety above the path 0-SS. $(\alpha_1(t), \alpha_2(t))$ proceeds along the path towards *SS*, and is identical to the no-exit path—the *binge society.*

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[18] If $(\alpha_1(0), \alpha_2(0))$ had values of $\alpha$ larger than point *d* in Figure 4, this implies a path towards *SS*. But this result could only occur if circumstances outside the model forced $(\alpha_1(0), \alpha_2(0))$ there. The historical role of alcohol as an extremely efficient medium to store calories could possibly have brought this about in some societies.

Third, the intermediate case ($n = n_2$) reveals an interesting pattern. Here shy people do not exit immediately. But since $\alpha_1$ and $c_1$ grows slower than $\alpha_2$ and $c_2$, shy people acquire drinking habits that diverge from non-shy people. After an initial period, $\left(\alpha_1(t), \alpha_2(t)\right)$ reaches point $a$, and shy people then exit. Non-shy people remain and without incentive to adapt to non-shy drinking habits, they reduce their alcohol consumption, $\dot{\alpha}_2 = 0$—the *tipsy society*, since we see a small increase in alcohol consumption among non-shy people.

Finally, consider the threshold case, $n = n^*$. For $n < n^*$, alcohol consumption approaches a steady state with excessive drinking (point $SS$). For $n \geq n^*$, there are moderate or no increases in the long run steady state drinking levels among non-shy people. Figure 5 shows the relationship between $n$ and steady state values of $\alpha_1$.[19]

It may be thought that our results are counterfactual. Our model explains the variations in drinking patterns by predicting that EDSS does not emerge in some cultures because shy individuals exit from social situations and choose to, say, stay at home and watch television. This is not typical in say the Mediterranean culture. But this is exactly the point. Because this behavior is rare it does not fit the stereotypical image of an Italian or Spaniard. And because it is rare, these people exit from social situations rather than participate and affect their drinking culture.

[19] We do not shown the relationship between $n$ and steady state values of $\alpha_2$, because we have left unspecified the drinking behaviour of shy people if they exit.

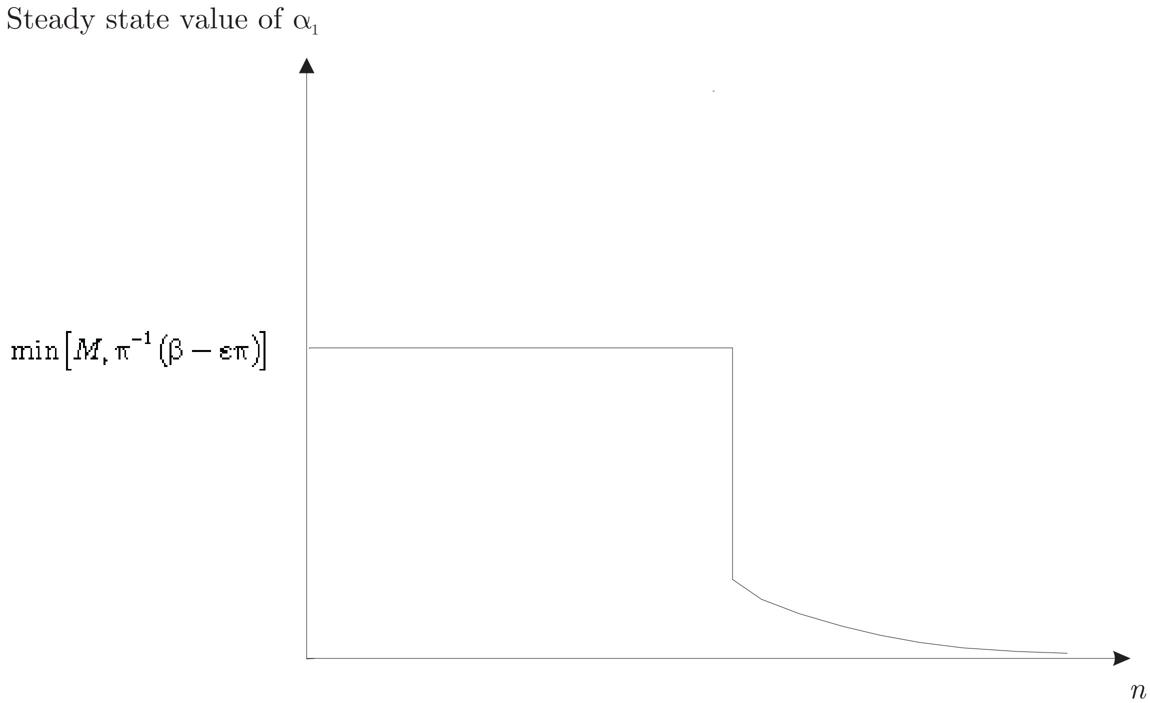


Figure 5. Relationship between $n$ and steady state values of $\boldsymbol{\alpha_1}$.

## 5. Prospects for Policy: Increasing Alcohol Prices

An open question is how our findings affect optimal alcohol policy. The model allows us to explore how alcohol prices affect the likelihood of EDSS emerging as a social norm. There is a large variety of social situations in which alcohol is consumed. For each such situation a set of demand conditions may be derived. Individual drinking behavior may vary from situations where each individual bears the purchasing cost of alcohol and situations where a host bears the entire cost. Here we consider two different possibilities: (1) fixed alcohol quantity, variable number of drinking occasions, or *parties*; and (2) variable alcohol quantity; fixed parties.

### *5.1 Fixed alcohol quantity/variable frequency of parties;*

A reduction in the frequency of social drinking situations would be expected to affect the shape of $\dot{\alpha}_i$. Let $\tau_1$ and $\tau_2$ be two different frequencies such that $\tau_1 >$

$\tau_2$. Thus $\tau_2$ corresponds to the frequency with a higher alcohol price. Write $\dot{\alpha}_i = F_\tau(c_i - \alpha_i)h(M - \alpha_i), \quad i = 1{,}2$ to indicate the differential equation for $\alpha_I$, conditional on $\tau$. We already assumed $\dot{\alpha}_i = \ F_\tau(0)h(M - \alpha_i) \ = \ 0$. If consumption in social situations is equal to the comfort level, the comfort level does not change. If $c$ is higher than $\alpha_I$, assume for a given level of $c$, it holds $F_{\tau_1}(y)h(M - \alpha_i) \ > \ F_{\tau_2}(y)h(M - \alpha_i)$. For a level of $c$ higher than $\alpha$, higher drinking frequency implies higher rate of adaptation. If it is assumed $\dot{\alpha}_i$ is a continuous function of $c$, it can be shown that there is an interval ($\alpha$, $\alpha + \xi$) such that following holds. If $y_1 > y_0$, then $F_{\tau_1}(y_1)h(M - \alpha_i) - F_{\tau_2}(y_1)h(M - \alpha_i) > F_{\tau_1}(y_0)h(M - \alpha_i) - F_{\tau_2}(y_0)h(M - \alpha_i)$. This can be proven formally. The basic idea is intuitive and is illustrated in Figure 6.

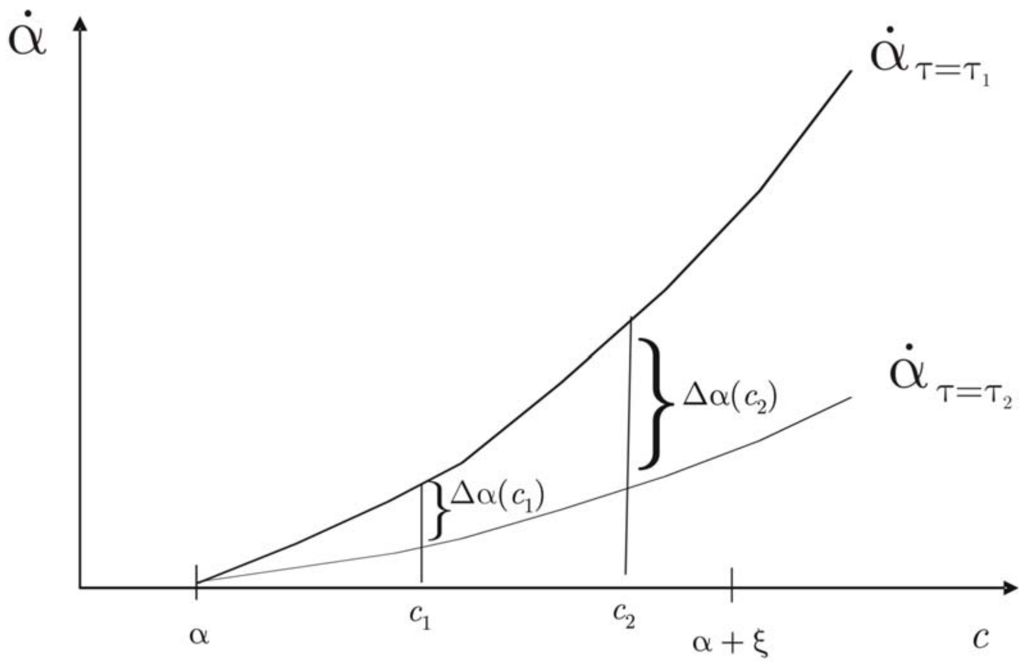


Figure 6, Effect of changes in drinking frequency on the rate of change in $\alpha$

We illustrate with two levels of $c$ above a given level of $\alpha$. Think of the low level, $c_1$, as the level of a non-shy individual, adapting consumption levels to a population with several shy individuals with high consumption. The high level, $c_2$, is the level of a shy individual. If both $c_1$ and $c_2$ lies in the interval $(\alpha, \alpha + \xi)$, the reduction in $\dot{\alpha}$ is largest for the shy individual. The existence of such an interval with the discussed properties is assured. This is the case regardless of whether  is concave or convex in the interval. However, if $c_1$ and/or $c_2$ were large enough to lie outside this interval, the conclusion could be reversed. It has not been possible to derive functional forms from the literature.

Let us now examine the impact of higher taxes/lower frequency on the development of drinking patterns. Consider the curve from the origin to SS in Figure 1. Think of this curve as function that gives $\alpha_1$ as a function of $\alpha_2$. The slope of this function at any point in $(\alpha_1, \alpha_2)$ space is given by $d\alpha_1/d\alpha_2 = \dot{\alpha}_1/\dot{\alpha}_2$. If $\tau$ increases from $\tau_1$ to $\tau_2$, it is straightforward to see the path from the origin towards the steady state shifts as illustrated in Figure 7. But these paths are drawn conditional on no exit from social situations. Now assume the participation constraint is given by the curve marked $\phi(\cdot)$. In this case, if alcohol prices are low, $(\alpha_1, \alpha_2)$ converges towards $\left(\alpha_1^*, \alpha_2^*\right)$, at which point shy individuals exit. $\left(\alpha_1^*, \alpha_2^*\right)$ is a point of the type we call a *tipsy society*. There is some increase in $\alpha_i$ relative to the starting point.

Alternatively, if prices are high, the path lies above the participation constraint and the society converges towards the state *SS* with a fully-fledged binge culture. This result seems counterintuitive as it implies that if prices increase, the likelihood of a bingeing culture emerging increases. Conversely, if prices are low, alcohol consumption in social situations is likely to be low. The explanation for this result is the lower drinking frequency when prices are high implies that consumption by shy drinkers does not increase too fast relative to non-shy drinkers. Non-shy drinkers and shy drinkers have consumption patterns that move closer together. This reduces the likelihood that shy people exit. But if shy people do not exit, the culture is on a path towards a bingeing culture. The higher the price, the slower this path converges towards *ss*; and the smaller the likelihood that the system hits the participation constraint and halts this development.

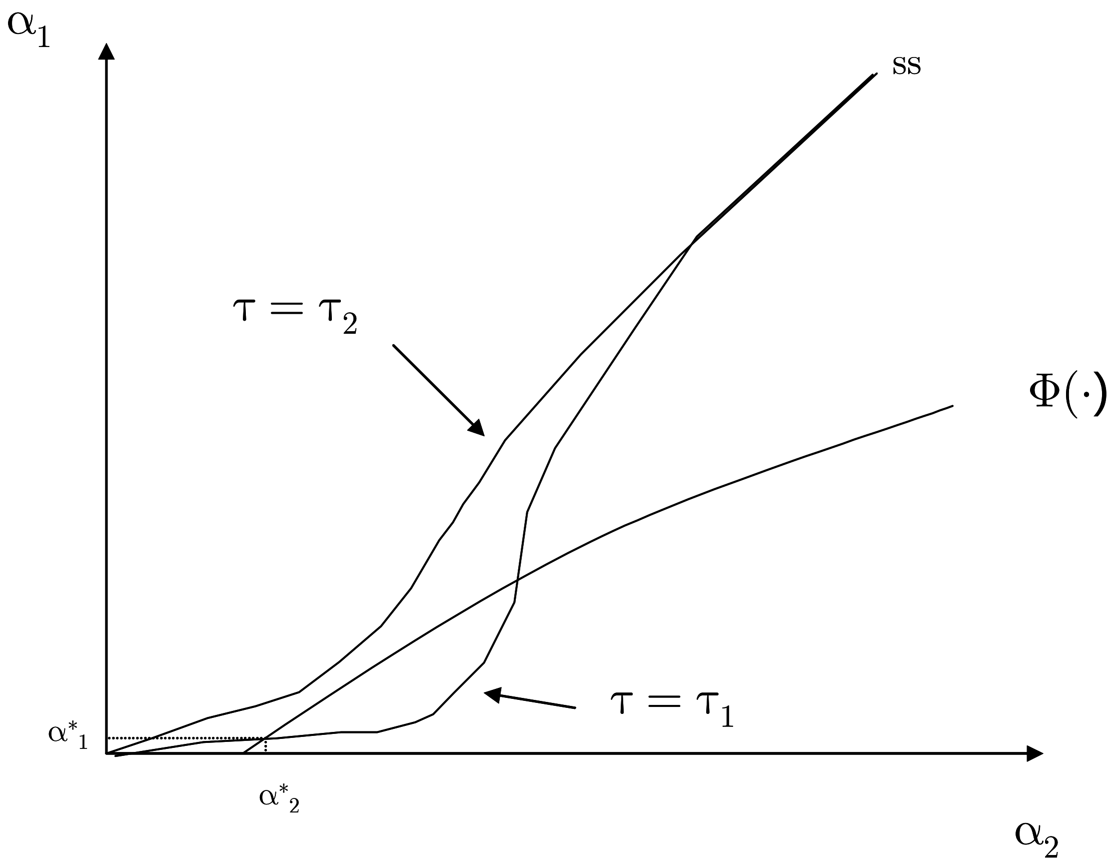


Figure 7, Development of drinking patterns for different drinking frequencies.

*5.2 Variable alcohol quantity at social situations/fixed frequency of parties*

We model this by assuming utility from drinking in social situation is given by:

$$U(c_i) = -(c_i - z_i)^2 - \gamma(c_i - \sigma)^2 - pc_i, \quad i = 1,2. \tag{11}$$

Here $p$ is the relative price of alcohol measured in appropriate units. With this specification of utility, it is straightforward to calculate the equilibrium response to changes in $p$ for consumers of type 1 and 2 and find that is negative.[20] If $p$ is large enough, no alcohol consumption occurs. We omit analysis of this case and focus on the case where maximization of (11) results in positive values of $c_1$ and $c_2$. (Note that this is consumption conditional on participation in drinking situations. Below we examine the case where $c_i = 0$ due to withdrawal from drinking situations.) For our purposes we want to examine the effect of $p$ on $\dot{\alpha}_i$, $i = 1,2$. This is done in Figure 8, where effect of a price increase from $p_0$ to $p_1$ is illustrated.

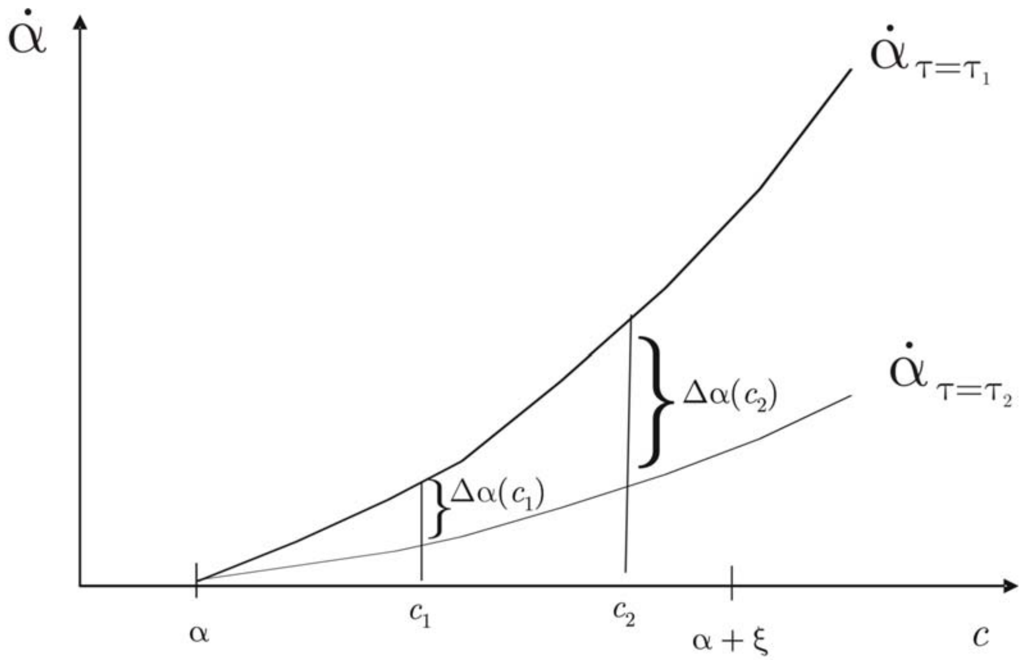


Figure 8, Effect of changes in drinking frequency on the rate of change in $\alpha$

The consumption for shy people is reduced from $c(\alpha_2, p_0)$ to $c(\alpha_2, p_1)$ and consumption for non-shy individuals is reduced from $c(\alpha_1, p_0)$ to $c(\alpha_1, p_1)$. The

[20] With these parameters, the derivative of equilibrium values of $c_1$ and $c_2$ with respect to $p$ is ½.

result is that the reduction in $\dot{\alpha}_2$ is larger than the reduction in $\dot{\alpha}_1$. Note the reduction in $c$ caused by changes in price may be short a short run effect. If $\dot{\alpha}_i$ remains positive, then $c_i$ increases over time as consumption adapts to changes in the comfort level.

Having the price as an argument in the objective function, however, also implies the participation constraint shifts. It is a straightforward exercise to show an increase in prices shifts the participation constraint so for every value of $\alpha_2$, the value of $\alpha_1$ required to maintain Type 2 individuals in social situations increases. These two effects are summed in Figure 9.

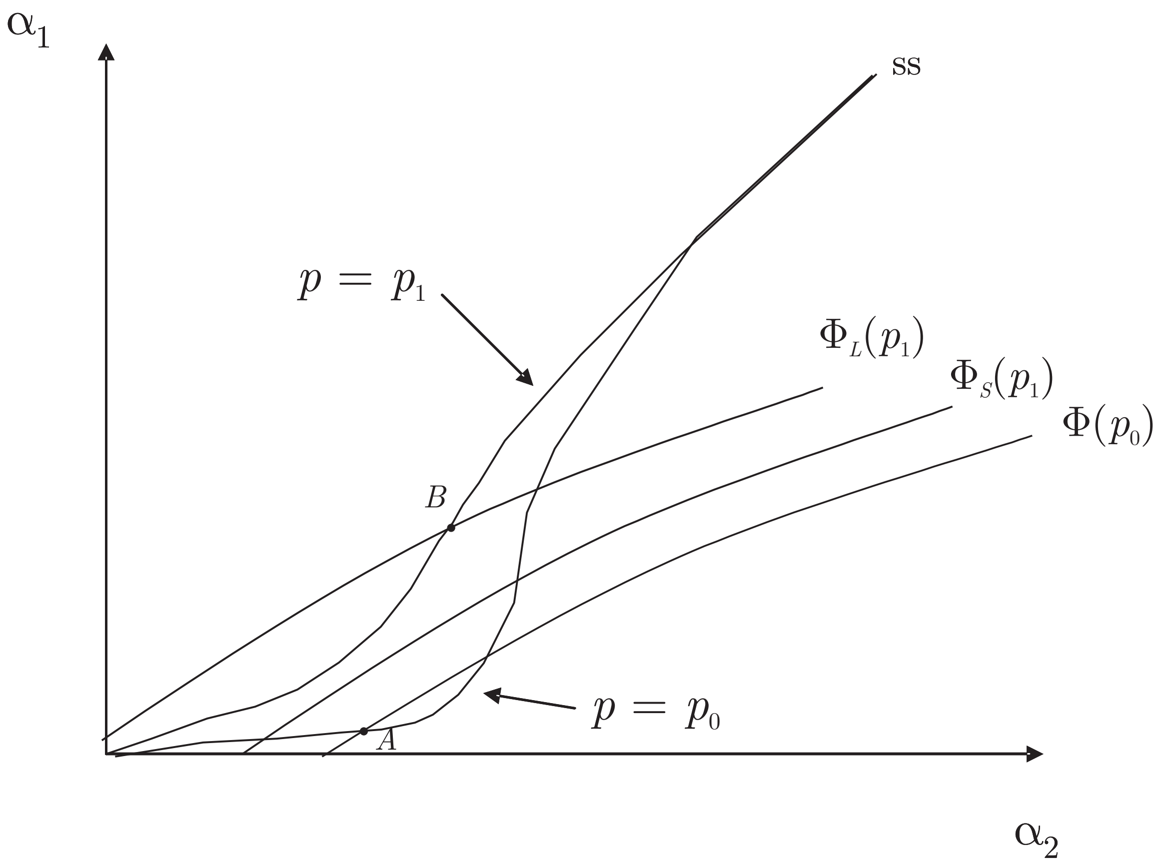


Figure 9, The effect of prices on long run equilibria.

Here the path labeled $p = p_0$ is the path of ($\alpha_1$, $\alpha_2$) when prices are "low," conditional on no exit and the path $p = p_1$ is the path of ($\alpha_1$, $\alpha_2$) when prices are "high," conditional on no exit. The shift is due to changes in $\dot{\alpha}_i$ resulting from reduced consumption. The curve $\Phi(p_0)$ illustrates the participation constraint for the low price. Two possible curves are drawn for the participation constraints when $p = p_1$. The curve labeled $\Phi_S(p_1)$ shows the shift when participation sensitivity to price changes is small. The curve $\Phi_L(p_1)$ shows the participation constraint when sensitivity is large. Assume the social group's initial comfort levels imply $\alpha_1 = \alpha_2 = 0$, but that some regulator fears the emergence of an EDSS norm. The regulator has to choose between the high and the low price. From Figure 9, we see the low price results in the point $A$ emerging as the long run equilibrium. The long run equilibrium with the high price depends on the price sensitivity of the participation constraint. If price sensitivity is low, the shift in the participation constraint is not large enough to offset the shift in ($\alpha_1(t)$, $\alpha_2(t)$) and an EDSS emerges. If the price sensitivity is high, then ($\alpha_1(t)$, $\alpha_2(t)$) converges to the point $B$. The path with a high price does not converge towards $ss$, but still implies higher steady state values of $\alpha_i$, and therefore also $c_i$, than the equilibrium, $A$, with a low price.

### *5.3 The Effect of Prices Summed Up*

We find an unexpected ambiguity in the effectiveness of using price instruments as a policy tool for restraining consumption—*increasing prices may increase the likelihood of EDSS emerging as a norm.* This result is consistent with the empirical literature on the relationship between price and alcohol consumption, see Chaloupka *et al.* (2002) for an excellent review. Increasing prices leads to: (1) lower frequency of consumption occasions, (2) short-term reduction in consumption per drinking occasion, and (3) reduced likelihood of participation in alcohol consumption occasions. These effects are the same as we have used or derived in the model. Our results still indicate that these effects may increase the probability of an EDSS norm emerging in the long run. The effects of these three different factors, however, are not equally robust.

First, the frequency effect is robust with respect to choice of functional forms. Reduced drinking frequency through increased prices leads to increased likelihood of EDSS except under unrealistic assumptions. Second, in the present model the effect of short-term reduced consumption per occasions increases the likelihood of an EDSS. This effect is not entirely robust as alternative specifications of the utility function may lead to a reduced likelihood of EDSS emerging. This could, however, only happen if an increase in prices brings about a substantially larger reduction in consumption among shy individuals than non-shy individuals.[21] Third, in our model the shift in the participation constraint has the unambiguous effect of reducing the likelihood of an EDSS. We have, however, only drawn a participation constraint for Type 2 individuals. If we also included a participation constraint for Type 1 individuals, one could see that they may exit before Type 2 individuals. In this case, their exit leads to a more rapid path towards EDSS. Which types exit first depends crucially on the distribution of the two types. The effect via the participation constraint can therefore also imply that higher prices lead to the emergence of EDSS.

Which of these effects dominate depends on the social organization of drinking culture. If drinking culture is dominated by occasions in which a host bears the cost of alcohol consumption, it is reasonable to expect an increase in price will reduce frequency rather than participation and short-term consumption per occasion. In this case, a price increase unambiguously increases the likelihood of EDSS. If the price of alcohol is borne by each individual consumer, the picture is less clear. To some extent the social organization of drinking culture is probably

[21] In Figure 8, both types reduce their consumption by the same amount. This is an artefact of quadratic utility; quadratic utility implies the effect of prices on $c$ is symmetric, i.e., the reduction is the same for both types. It can be shown, however, that non-zero third derivatives may imply one type reduces consumption more than the other. If Type 1 individuals' price elasticity is sufficiently higher than Type 2's, then $\dot{\alpha}_1$ may be reduced more than $\dot{\alpha}_2$ and this shifts the $(\alpha_1(t), \alpha_1(t))$- curve south east except at the origin and *ss*.

endogenous and responds to changes in prices, which is a topic for future research.

It may seem paradoxical that even if prices reduce all three factors (frequency, consumption, and participation), a norm with high consumption per drinking occasion may become more likely. But this behavior is exactly the pattern that has emerged in Europe, where frequency of drinking occasions and total alcohol consumption is far lower in the north than in the south, but where consumption per occasion is much higher. The fact that EDSS has emerged in spite of extraordinary efforts of raising the real price of alcohol through high taxes and reduced availability lends credence to our conclusions. At a minimum, our model provides a plausible rationale for why prices have been relatively unsuccessful in reducing EDSS in Northern Europe.

## 6. Concluding remarks

If genes are responsible for geographical variations in shyness, our results have some intriguing implications. First, our model suggests variations in the frequency of certain genes may explain geographical variations in individual behavioral as adaptation to genetic baggage. Second, these adaptations may aggregate into social norms and provide a genetic explanation for variations in social phenomena. Third, the social norm is only loosely connected to the trait that has an advantage in an evolutionary selection process. In this perspective it is somewhat ironic that southern Europeans attribute the EDSS behavior in northern Europe to "living in a cold climate." The argument is living in the cold makes people drink too much. If Kagan is correct in his hypothesis of how a high frequency of shy individuals in northern Europe has evolved, this may, in a roundabout sort of way, be supportable. It is an open question whether the emergence of EDSS in itself provides some evolutionary advantage. At a first glance the answer appears to be "no" since mortality risk arises with EDSS. Alternatively, the short-term gains from applying a social lubricant that promotes interaction between people in a population with many shy individuals may outweigh the long-term costs of mortality risk on both a social and a personal level. This remains to be established in future work.

A possible test of the relevance of the model would be if similar EDSS patterns emerged in other areas of the world where blue eyes are common. Data from the US suggest that EDSS patterns in the US follow the same blue-eye gradient as Europe. The 5 US states with the highest prevalence of binge drinking are in order: North Dakota, Wisconsin, South Dakota, Minnesota, and Montana, (Substance Abuse and Mental Health Services Administration, 2004). These are also the states with the highest fractions of the population of Scandinavian ancestry (U.S. Census Bureau, 2004). States with smaller but significant population fractions of Scandinavian ancestry such as Iowa and Nebraska also have high prevalence of binge drinking, (8th) and (9th). The only exception appears to be Washington State where 6.2 percent of the population is of Norwegian ancestry, but ranks as 44th with respect to the prevalence of binge drinking. It is interesting to note that states such as Idaho and Wyoming which could be expected to be similar to Montana and the Dakotas but have few people of Scandinavian ancestry rank lower with respect to the prevalence of binge drinking. Wyoming is 14th and Idaho 43rd, suggesting that a high frequency of Scandinavians could be of some importance in explaining the observed patterns.

One possible explanation for the high prevalence of binge drinking in states with a large fraction of people of Scandinavian decent is that immigrants to these regions brought their drinking culture with them. This appears not to be the case. Scandinavian migrants to the Northern Midwest were, or became, very religious, Smith (1978). A strong temperance movement emerged. Local temperance societies started to appear in towns across the US in the mid 1800s. The Independent Order of Good Templars, for example was founded in 1852. According to the Bentley Historical Library at the University of Michigan (2005), "[t]he Good Templars lodges were very successful in recruiting Scandinavian immigrants in the late nineteenth and early twentieth centuries and many lodges operated for years in the native tongues of the immigrants." North Dakota was among the first states to prohibit the sale of alcohol (in 1889). Returning migrants often formed the backbone of similar movements in Norway (also see e.g., Zahl and Andrews (2003) who stress how Norwegian immigrants to Minnesota promoted temperance in public policy and social services.) It seems likely that the Scandinavian communities that emerged in the second half of the 19th century did not tolerate binge drinking, and the current binge drinking patterns must have emerged later. This anecdotal evidence suggests that binge drinking in states with a large Scandinavian population emerged independently as a social norm, which does not contradict our hypothesis that genetic factors are the cause of the observed EDSS patterns. Further collaboration for the possibility that blue eyes may code for social behavior that may translate into excessive drinking is that Basset and Dabbs (2001) in two different samples found that prison inmates with blue eyes had a higher propensity for a history with high alcohol consumption than brown-eyed inmates.

A confounding factor we have not addressed here is how gender relations affect the formation of drinking habits. As previously noted, Coplan et al. (1998) found that the shyness/eye color correlation was only significant in males. It is a straightforward exercise to generalize the findings herein to a model in which males and females only partially consider each other peers.

In conclusion, we show by example how geographical variations in the distribution of personality may be compounded by social reinforcement mechanisms to affect behavior of all individuals in a social group. The example we study is variations in drinking patterns in social situations. Our findings have implications on several levels. To the best of knowledge, our study is the first to report a plausible link between genetically founded individual preferences and social norms governing behavior of all individuals. Further, we show this link is not smooth but may exhibit threshold effects. Finally, we have identified several intriguing counterintuitive results on pricing strategies that policymakers might find useful to consider as they further extend alcohol policy in individual European countries and in their attempts to create an integrated policy for the European Union. We find conditions under which a policy promoting increased alcohol prices could backfire—higher prices increases the likelihood of a bingeing culture, which would offset the welfare gains from less total alcohol consumption. Although our model is aimed at explaining a social norm dichotomy in Europe, this dichotomy also exists to some extent in the USA. We are therefore less certain about the positive effects of increases in alcohol taxes espoused by a large number of prominent US economists.[22] Although we have every reason to believe that high prices helps reducing consumption in areas where EDSS is already established as a social norm, our results indicate that higher prices may actually trigger EDSS in areas where this is not currently a major problem. Since the role of prices is less clear-cut than previously assumed given social norms and genetics, additional research to evaluate the effectiveness of alcohol prices/taxes as policy tools seems worthwhile.

[22] A large number of distinguished economists, including 4 Nobel laureates, signed the petition "Economists' Declaration on Federal Alcohol Excise Taxes." The petition was organised by Coalition for the Prevention of Alcohol Problems and is available at http://www.cspinet.org/new/pdf/letter-alcohol.pdf.

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## Appendix. Survey of relationship between eye color and alcohol consumption in social situations

A survey was conducted in two different Economics classes in the spring 2006. Students were asked only to respond in their grandparents were of European ancestry. In addition the questions were phrased in Norwegian in classes with lectures in Norwegian. Given these precautions, and also that we inspected the respondents when collecting the responses makes us confident that our sample is homogenous group representative of Norwegian young adults with an interest in economics. A total of 198 students were asked about their use of alcohol in social situations. Of these three students answered that they do not drink alcohol in social situations and two reported eye colors that were not easily put into any categories. These 5 responses were removed from the survey. In addition to sex, and age, the following questions were asked:

**On a scale of 0 to 6 indicate how much you agree with the following statements.**

1. I drink alcohol to feel more comfortable in social situations and/or have done so in the past.

   I do not agree 0—1—2—3—4—5—6 I agree

2. In a given social situation I adjust my alcohol consumption to match how other people are behaving.

   I do not agree 0—1—2—3—4—5—6 I agree

After the students had completed these questions they were asked the following question about their eye color.

3. What is your eye color? Please circle: Blue Not Blue. If not blue please specify_______

It should be noted that this final question was only known to the students after they had answered the other questions as we did not want the answers affected by the eye color question.

Of the 193 used answers 127 reported blue eyes, 27 reported brown eyes and 39 reported various shades of green. The large fraction of respondents that reported various shades of green represented represents a challenge as they need to be categorized. Unfortunately, the genetics of eye color (and presumably shyness) is still not well understood except that the old textbook description of a single gene with two alleles is too simple. However, alleles for brown eyes dominate both green and blue. Further, blue eyed individuals and green eyed individuals are in general the most genetically similar. Therefore we perform two tests. One test where blue eyed individuals and individuals with shades of green are lumped together and one where individuals with green eyes are removed from the sample. The results are summarized in Table 1 and 2. The statistical test is a standard $t$-test assuming non equal variances.

Table 1. Survey responses. Blue eyed and brown eyed individuals only

| | Question 4 | Question 4 | Question 5 | Question 5 |
|---|---|---|---|---|
| | *Browns* | *Blues* | *Browns* | *Blues* |
| Mean | 2 | 2.602362 | 2.444444 | 3.275591 |
| Variance | 2.692308 | 2.937852 | 2.333333 | 3.300431 |
| Observations | 27 | 127 | 27 | 127 |
| t statistic for difference in means | -1.7186 | | -2.47902 | |

Table 2. Survey responses. The category "Others" include individuals with green and blue eyes

| | Question 4 | Question 4 | Question 5 | Question 5 |
|---|---|---|---|---|
| | *Browns* | *Others* | *Browns* | *Others* |
| Mean response | 2 | 2.644578 | 2.444444 | 3.376506 |
| Variance | 2.692308 | 2.882001 | 2.333333 | 3.225566 |
| Observations | 27 | 166 | 27 | 166 |
| t statistic for difference in means | -1.88383 | | -2.86482 | |

In both treatments, the difference in means is significant at the (one sided) 5% level for Question 4 and (one sided) 0.5% level for Question 5. The inclusion of green eyed individuals in the blue eyed category had negligible effect on the mean and variance.

With respect to Question 4, our simple statistical test appears to support the premise that blue eyed individuals are more likely to use alcohol as self-medication. At least they are more willing to report that they do and we see no plausible alternative explanation to the reported differences. With respect to Question 5, the question was included in order to justify the assumption made in the main text that alcohol consumption in social situations is affected by preferences for conformity. The difference in means surprised us. However, a stated preference for conformity may be interpreted as a symptom of shyness. As such the difference in means in Question 5 may even be a better measure of the shyness effect as it reveals the effect of shyness/eye color on consumption without the respondent having to admit to using alcohol as a relaxant in social situations.

Note the ranking scale used in this survey is ordinal, so that we can not make statements about the strength of the measured effects nor the magnitude in differences. However, the data clearly indicates a systematic difference between brown eyed individuals and the others.