

# ALCOHOL CONSUMPTION AND LONG-TERM LABOR MARKET OUTCOMES

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## SUMMARY

This paper examines whether alcohol consumption is related to long-term labor market outcomes. We use twin data for Finnish men and women matched to register-based individual information on employment and earnings. The twin data allow us to account for the shared environmental and genetic factors. The quantity of alcohol consumption was measured by weekly average consumption using self-reported data from three surveys (1975, 1981 and 1990). The average of an individual's employment months and earnings were measured in adulthood over the period 1990–2009. The models that account for the shared environmental and genetic factors reveal that former drinkers and heavy drinkers both have almost 20% lower earnings compared with moderate drinkers. On average, former drinkers work annually approx. 1 month less over the 20-year observation period. These associations are robust to the use of covariates, such as education, pre-existing health endowment and smoking. Copyright © 2015 John Wiley & Sons, Ltd.

Received 10 February 2015; Revised 03 September 2015; Accepted 26 October 2015

KEY WORDS: alcohol consumption; binge drinking; employment; earnings; co-twin control

## 1. INTRODUCTION

Alcohol is a commonly used drug worldwide. For example, an estimated 18 million adults in the USA have significant alcohol-related problems; 20% of men and 10% of women can be classified as heavy drinkers (U.S. Department of Health and Human Services, 2012). Alcohol misuse causes considerable health-related and other costs to the society.

There are two primary mechanisms through which (misuse of) alcohol may lead to undesirable labor market outcomes (e.g. Jones *et al.*, 1995). First, it leads to increased absenteeism from work in the short run and to health problems in the long run. Both of these erode people's ability to participate in the labor market and reduce their productivity at work (i.e. earnings capacity). Second, those who drink more heavily may face discrimination in the labor market. Table I provides a concise overview of the estimates for the relationship between alcohol consumption and labor market outcomes that have been presented in the literature. According to the US and Australian evidence, moderate alcohol consumers earn more than abstainers (Barrett, 2002; French and Zarkin, 1995; Hamilton and Hamilton, 1997; Heien, 1996) or abusers (Lee, 2003; Zarkin *et al.*, 1998). However, the group of abstainers is heterogeneous in terms of drinking history as it contains also former drinkers who may experience serious problems in the labor market owing to their poorer health. Former drinkers are found to earn less than those who have never drunk (French and Zarkin, 1995; Heien, 1996). The quantity of alcohol consumption also matters. Those US employees who

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Table I. Summary of previous research

Author(s) and publication year	Data	Outcome	Alcohol measure	Methods	Main findings
French and Zarkin (1995)	A sample of randomly selected employees at four US worksites in 1991, 1992 and 1993	Weekly wages	Dummy variables for former drinkers and for those who have never drunk. An estimate of the number of drinks consumed in the past 30 days.	Ordinary Least Squares (OLS)	Moderate alcohol users have higher wages than abstainers and heavy drinkers. Those who drink approx. 2–3 drinks per day have the highest wages.
Heien (1996)	National Household Survey on Alcohol Use from 1979 to 1984 and Quality of Employment Survey from 1972 to 1973	Annual earnings and weekly wage	A dummy variable for former drinkers and polynomial of the number of drinks consumed per month.	OLS	Moderate alcohol users have higher wages than abstainers and heavy drinkers. Former drinkers earn less than those who have never drunk. Income level is highest for those who consume 2–3 drinks per day.
Mullahy and Sindelar (1996)	Alcohol Supplement of the National Health Interview Survey in 1988	Dummy variables for unemployment and employment	Ethanol consumption, a dummy for diagnosed alcohol abuse and two dummies for heavy drinking pattern.	OLS and IV	Problem drinking results in reduced employment and increased unemployment, but the impacts were statistically insignificant.
Hamilton and Hamilton (1997)	General Social Survey data from 1985	Annual income	3 categories: non-drinkers, moderate drinkers and heavy drinkers calculated using frequencies and quantities of alcohol consumed.	OLS, selectivity-corrected regression	Moderate alcohol users have higher wages than abstainers and heavy drinkers.
Zarkin <i>et al.</i> (1998)	National Household Surveys on Drug Abuse in 1991 and 1992	Hourly wages	8 categories: non-drinkers, 2 light drinker categories, 3 moderate drinker categories and 2 heavy drinker categories. Calculated using the estimates of number of drinks consumed during the past 30 days.	OLS	Moderate alcohol users have higher wages than abstainers.
MacDonald and Shields (2001)	Health Survey for England	Occupational ranking, measured as the average earnings of individual's occupation	Drinking intensity and drinking frequency over the last 12 months.	IV-regression analysis	Moderate alcohol users have higher labor market attachment than heavy users.
Feng <i>et al.</i> (2001)	A random sample of working-age population from six southern states in the USA	A dummy variable for ever working in the past year	A dummy for problem drinkers.	Univariate probit model	No negative association between problem drinking and employment.
Barrett (2002)	Australian National Health Survey 1989–1990	Annual income prior the survey year	3 categories: non-drinkers, moderate drinkers and heavy drinkers calculated using frequencies and quantities of alcohol consumed.	Selectivity-corrected regression	Moderate alcohol users have higher wages than abstainers and heavy drinkers.

*(Continues)*

Table I. (Continued)

Author(s) and publication year	Data	Outcome	Alcohol measure	Methods	Main findings
Lee (2003)	Australian Twin Registry mostly from 1988–1989	Mean earnings of the person's occupation	3 categories: non-drinkers, light drinkers and moderate drinkers calculated from frequencies and quantities of alcohol consumed.	OLS and twin differencing	A positive wage premium for moderate drinking.
MacDonald and Shields (2004)	Health Survey for England	A dummy variable for working status	Psychological and physical symptoms of drinking, a dummy for drinking every day and a dummy for drinking more than 45.3 units per week.	Univariate and bivariate probit and IV-Probit models	Problem drinking results in lower probability of working.
Norström (2006)	Macro data issued by the Statistics Sweden	Sickness absence rate or the number of illnesses recorded per insured person	Sales of liters of 100% alcohol per inhabitant.	OLS	An increase in per capita alcohol consumption is associated with an increase in sickness absence for men.
Johansson <i>et al.</i> (2007)	Finnish 'Health 2000' population survey	A dummy variable for working status	A dummy variable for diagnosed alcohol dependence.	Probit and IV-Probit models	Alcohol-dependent individuals have lower employment probabilities.
Sloan and Grossman (2011)	Data from 1982 to 1984 National Longitudinal Survey of Youth 1979	Annual earnings	5 categories for alcohol drinks consumed per week.	OLS	Heavy drinking in early adulthood is negatively associated with earnings at midlife for black men
Rose <i>et al.</i> (2014)	Finnish twin data	Self-reported financial situation ranking from 1 to 5	Rutgers Alcohol Problem Index	Mean difference test	Adolescent drinking predicts difficulties in financial situation later in life.
Paljärvi <i>et al.</i> (2015)	Register-based 11% random sample of Finnish individuals at ages 18–34 years linked to the data of National Institute for Health and Welfare	Register-based information on employment	Alcohol-related diagnoses recorded in the Hospital Discharge Register and the Cause of Death Register as proxy measure for problem drinking.	Generalized estimating equations	Adolescent drinking is negatively related to employment later in life.

consume approx. 2–3 drinks per day have the highest earnings (French and Zarkin, 1995; Heien, 1996). Adolescent drinking is also negatively associated with adulthood earnings (Rose *et al.*, 2014; Sloan and Grossman, 2011).

How alcohol consumption is related to individuals' labor market attachment is a highly policy-relevant question. Being employed is, for example, an important determinant of a person's social status, having spillover effects on all aspects of well-being. The existing empirical results are mixed. The US studies do not find a negative association between drinking and employment (Feng *et al.*, 2001; Mullahy and Sindelar, 1996), while the evidence from UK (MacDonald and Shields, 2001, 2004) and Finland (Johansson *et al.*, 2007; Paljärvi *et al.*, 2015) suggests that alcohol-dependent individuals have significantly weaker labor market attachment. Alcohol consumption is also positively related to sickness absence (Johansson *et al.*, 2009; Norström, 2006).

This paper explores the consequences of alcohol consumption for *long-term* labor market outcomes. We contribute to the debate in three major ways. First, the identification of the effect of alcohol consumption is challenging, because there are unobservable factors that are correlated with both alcohol consumption and the outcomes, such as labor market attachment and earnings. A consequence of this is that the Ordinary Least Squares (OLS) estimation does not produce an unbiased effect of alcohol consumption on the labor market outcomes. The

twin data allow us to account both for shared environmental factors, such as family background, neighborhood and shared peer effects, as well as for genetic factors, such as risk, time and other preferences (van Dongen *et al.*, 2012). Using data on non-identical (dizygotic (DZ)) twins is the same as controlling for sibling effects, because DZ twins originate from the same family and neighborhood. As also ordinary siblings do, the DZ twins share ~50% of the segregating genes. Using data on identical (monozygotic (MZ)) twins allows us to further control for inherited traits and preferences, because two MZ twins are genetically identical. The use of MZ sample is important, because there is a substantial genetic component in the risk of alcoholism (Van Eerdewegh *et al.*, 1998).

There are only two earlier empirical studies that have used twin data to estimate how alcohol consumption is associated with labor market outcomes (Lee, 2003; Rose *et al.*, 2014). In the study that uses the Australian twin survey data (Lee, 2003), the author finds a wage premium for moderate drinkers. However, the income data of the survey are deficient. The study therefore uses the average cross-sectional earnings of the occupation in which the individuals are employed as the response variable. An analysis of the Finnish twin data examines the relationship between adolescent drinking and different adult outcomes, such as perceived financial difficulties (Rose *et al.*, 2014). The data include no information on actual earnings, but the twins were asked to self-report their current financial situation ranking from 1 ('very good') to 5 ('very bad'). Adolescent drinking exacerbates marginally adulthood financial difficulties, even after controlling for the shared environmental and genetic effects.

The second reason why we can contribute to the debate is that our sample consists of twin pairs for whom we observe accurate administrative data on their prime working-age labor market attachment and earnings. Unlike the prior work, we can use the average of an individual's annual employment and earnings over the 20-year period. This is important, because cross-sectional measures are known to be inaccurate proxies for individuals' lifetime labor market attachment and earnings (Böhlmark and Lindquist, 2006; Haider and Solon, 2006). Moreover, using the register-based, long-term measures reduces measurement error due to non-response and reporting biases.

Third, we have access to relatively comprehensive information from three twin surveys that contain detailed, retrospective information on alcohol consumption. These data allow us to examine whether the labor market outcomes among abstainers are heterogeneous in terms of their drinking history. In our empirical specifications, former drinkers are distinguished from constant abstainers. To our knowledge, this distinction has not been made previously in studies that exploit twin data.

## 2. METHODS

### 2.1. Data sources and the sample

We use the Older Finnish Twin Cohort Study (of the Department of Public Health at the University of Helsinki). The twin data have been linked to the Finnish Longitudinal Employer–Employee Data (FLEED) of Statistics Finland.<sup>1</sup> The Finnish Cohort Study was originally compiled from the Central Population Registry of Finland. Initial twin candidates were persons born before 1958 with the same birth date, commune of birth, sex and surname at birth (Kaprio *et al.*, 1979). Our twin data contain only same-sex twin pairs. The fact the initial twin candidates include only those twins who have the same surname reduces substantially the number of twins separated at birth in the final data. Langinvainio *et al.* (1981, p. 192) reported that 51 twin pairs were separated at the age less than 1 year. This is only a very small share of the twin pairs in the original sample in 1975. A questionnaire was mailed to the candidates in 1975 to gather baseline data and to determine their

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<sup>1</sup>The twin cohort data linked to FLEED have been used in earlier studies (e.g. Hyytinen *et al.*, 2013; Maczulskij, 2013). Prior studies can be consulted for details about the response rates, attrition and representativeness of the twin sample (Kaprio *et al.*, 1979; see also Hyytinen *et al.*, 2013; Maczulskij, 2013). Hyytinen *et al.* (2013, p. 63) and Maczulskij (2013, p. 95) provided evidence for the representativeness of the twin sample by comparing it to a one-third random sample of all Finns using FLEED and covering the same age cohorts.

Table II. Mean characteristics of the sample

	Mean	Std.	Source
<i>Individual characteristics<sup>a</sup></i>			
Female	0.58	0.49	FLEED
Education (years)	11.3	2.15	FLEED
Age	45.9	5.22	FLEED
Married	0.53	0.34	FLEED
Ever divorced	0.16	0.34	Twin surveys and FLEED
Underage children	0.55	0.24	FLEED
<i>Long-term labor market outcomes</i>			
Earnings (€)	20,014	11,853	FLEED
Employment months	9.6	3.4	FLEED
<i>Alcohol consumption</i>			
Former drinker	0.06	0.25	Twin surveys 1975, 1981 and 1990
Constant abstainer	0.07	0.25	Twin surveys 1975, 1981 and 1990
Moderate drinker	0.82	0.39	Twin survey 1990
Heavy drinker	0.05	0.22	Twin survey 1990
Binge drinker	0.13	0.33	Twin survey 1990
<i>Other variables</i>			
Stressful life events index	1.39	1.19	Twin survey 1990
Smoking, measured in pack-years	6.6	11.0	Twin survey 1990
Number of diseases in 1975	0.54	0.81	Twin survey 1975

FLEED, Finnish Longitudinal Employer–Employee Data.

<sup>a</sup>The means of individual characteristics (except gender) were measured over the period 1990–2009.

zygosity.<sup>2</sup> Two follow-up surveys were conducted in 1981 and 1990. The 1990 survey was sent only to those twins who were born after 1930. The response rate for this latest survey was 77%, giving us 12,502 twin pairs in total. Importantly for our purposes, all three twin surveys contained information on alcohol consumption.

Similarly to, for example, Hyytinen *et al.* (2013) and Maczulskij (2013), the twin data are linked to FLEED using personal identifiers. There are no misreported ID codes, which implies very good match. As has been reported in the earlier studies (e.g. Hyytinen *et al.*, 2013), FLEED is an annual panel over the years 1990–2009 and covers the working-age population of Finland. We are thus able to track the labor market behavior of those twins who participated in the original twin surveys. FLEED is constructed from administrative registers on individuals, firms and establishments that are maintained by Statistics Finland. FLEED includes information on individuals' labor market status, and salaries and other sources of income, extracted from tax and other administrative registers. Thus, our employment and income data do not suffer from under-reporting or recall errors.

Our empirical analysis focuses on twin pairs for whom we observe information on alcohol consumption and subsequent earnings and employment. Excluding those men and women who are retired from the sample,<sup>3</sup> our final estimation sample includes 3305 twin pairs, that is, 6610 individuals. Table II provides descriptive statistics for our twin sample.

<sup>2</sup>The zygosity was determined based on parents' responses on similarity of appearance in childhood. The classification was redone for a subsample of twins using 11 blood markers. These two classification methods produced almost identical results. The probability of misclassification of a blood marker concordant pair was only 1.7% (Kaprio *et al.*, 1979; see also Hyytinen *et al.*, 2013).

<sup>3</sup>Information on retirement is based on the exact labor market status during the last week of each year. Using a specific age restriction when forming the estimation sample would exclude some individuals who stay particularly long in the labor market. We do not want to impose such a restriction, because it could bias the estimates. If heavy drinkers are more likely to get sick and retire early, there is also a potential selection bias related to the exclusion of the retired from the estimation sample. We have estimated models in which we use the full sample without any restrictions regarding age or retirement status. Compared with the results that are reported in Table V, the only difference is that in these re-estimated models, we do not obtain statistically significant effects for heavy drinkers when using earnings as the outcome variable. All other results remain intact.

## 2.2. Measures

We use as our primary outcome variable employment months, calculated as the average number of employment months per year over the sample period of 1990–2009. Our second outcome variable is lifetime earnings. We measure them by the logarithm of the average of annual wage and salary earnings and self-employment income over the period of 1990–2009.

To quantify alcohol consumption, we derive a measure for weekly average consumption. The initial measure for alcohol consumption is the self-reported amount of alcohol consumed in 1975, 1981 and 1990. The twin survey gathered information on the frequency of alcohol consumption, measured by daily consumption per month, using a five-point scale (1 = ‘never’, 5 = ‘over 16 days a month’) and separately for different types of alcohol: beer, wine and spirits. The quantities of alcohol use were measured on a seven-point scale for each alcohol type, with the upper limits for consumption of more than 48 bottles of beer (10 bottles of wine) per week, or more than 20 bottles of spirits per month (Kaprio *et al.*, 1987). A unit of alcohol is defined as 12 g of pure alcohol. This information on alcohol consumption was converted into grams of pure alcohol consumed per week in 1990. In Finland, 280 g of pure alcohol per week (i.e. 24 units of alcohol) is a commonly used limit of heavy drinking for men, and 190 g per week (i.e. 16 units of alcohol) for women (Aalto, 2001; Salonsalmi *et al.*, 2012; Sillanaukee *et al.*, 1992).

The alcohol consumption was divided into four mutually exclusive categories: Former drinkers (those who were classified as abstainers in 1990 but did consume alcohol in 1975 or/and 1981)<sup>4</sup>; Constant abstainers (those who were classified as abstainers in 1975, 1981 and 1990); Moderate drinkers (those who consumed alcohol in 1990 but less than 280 (190) g per week); and Heavy drinkers (those who consumed alcohol in 1990 more than 280 (190) g per week).

We also have a measure for binge drinking. It is based on the question on pass out frequency during the past 12 months in the 1990 twin survey. Pass out frequency is zero for 87% of observations. For this reason, we used it as an indicator variable that obtains the value of one if the pass out frequency was positive (and otherwise it is zero).

We point out two things about our measures of alcohol consumption. First, the measures are predetermined for labor market outcomes. This is useful, because otherwise there might be a problem of simultaneity between alcohol consumption and labor market outcomes due to the positive income elasticity of alcohol consumption (Cawley and Ruhm, 2011). Second, according to Lemmens *et al.* (1988, 1992), heavy drinkers under-report, while light drinkers tend to over-report their actual alcohol consumption. This means that the measured twin-difference in alcohol consumption is smaller than the true difference for a twin pair in which one twin is a heavy drinker and the other is a lighter drinker. If this is true and if alcohol consumption is negatively associated with labor market outcomes (as the prior research summarized in Table I suggests), this kind of measurement error may lead, based on standard omitted variables reasoning, to an upward bias (i.e. estimates that are closer to zero). Our estimates of the effect of alcohol consumption on labor market outcomes are therefore likely to be conservative.

## 2.3. Descriptive evidence

Table III reports average employment months and lifetime earnings in euros, conditional on alcohol consumption. Compared with moderate drinkers, persons who are classified as heavy drinkers and former drinkers have significantly weaker labor market attachment and also lower lifetime earnings (Panel A).

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<sup>4</sup>The sample size is not large enough so that we could divide the group of former drinkers into smaller subgroups. For example, only 32 individuals out of 424 can be classified as former heavy drinkers. The group of former drinkers is a mixture of different types of individuals, making it difficult to separate the group further, because the decision to quit drinking is complex. It may, for example, be due to health-related reasons. A sick quitter may have stopped drinking alcohol because of a disease caused by the individual’s alcohol drinking or because of a disease unrelated to it. His or her labor market outcomes are likely to have been negatively affected in either case. Also, the former alcoholics may have quit drinking without having a disease that causes them to quit. Drinkers may have stopped drinking for many other reasons, too.

Table III. Alcohol consumption, binge drinking and long-term labor market outcomes

	%-Share	Employment months	Lifetime earnings (€)
<i>Panel A: Alcohol consumption</i>			
Former drinker	6.4	8.92	15,296
Constant abstainer	6.7	9.43	17,347
Moderate drinker	81.8	9.68	20,702
Heavy drinker	5.1	8.35	18,425
<i>F</i> -test statistics		18.36	34.19
		( $p < 0.001$ )	( $p < 0.001$ )
<i>Panel B: Binge drinking</i>			
Not binge drinker	87.2	9.62	20,143
Binge drinker	12.8	9.02	19,139
<i>F</i> -test statistics		20.39	8.39
		( $p < 0.001$ )	( $p < 0.01$ )
<i>N</i>		6610	6610

Heteroscedasticity-robust *F*-test statistics for the null hypothesis of equal group means.

Among abstainers, those who are former drinkers have a particularly low level of earnings in comparison with the other groups. Binge drinkers have also a significantly weaker long-term labor market attachment and lower earnings (Panel B). The null hypothesis of equal group means is rejected for all measures in Panels A and B.

Figures 1 and 2 depict the employment months and average annual earnings by alcohol consumption status over the period of 1990–2009. It is important to note that these figures do not control for any differences between the individuals (i.e. between the former drinkers, constant abstainers, moderate drinkers or heavy drinkers). Year 1990 was a peak of an economic cycle, with low unemployment. In 1991–1994, Finland experienced a major economic crisis as GDP dropped sharply and unemployment increased to a record level. From 1995 onwards, a period of steady recovery followed, but unemployment declined only slowly. The economy developed relatively favorably until the financial crisis hit in 2008.

As can be seen from Figure 1, labor market attachment is clearly strongest for those who are moderate drinkers and constant abstainers (Figure 1). Interestingly, employment for heavy drinkers has improved

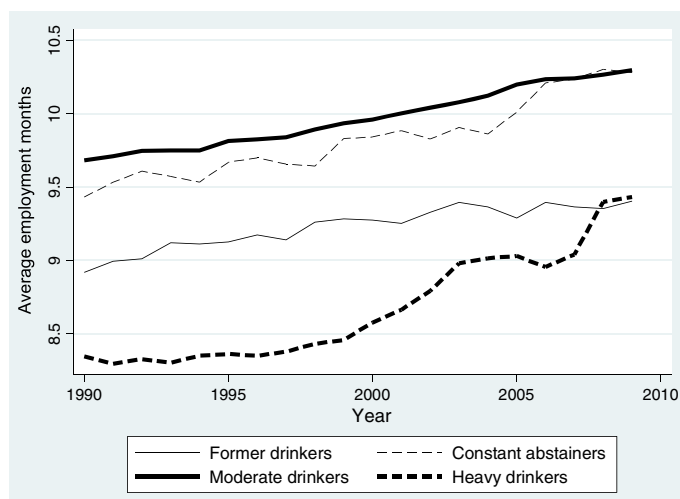


Figure 1. Average employment months by alcohol consumption status over the period 1990–2009

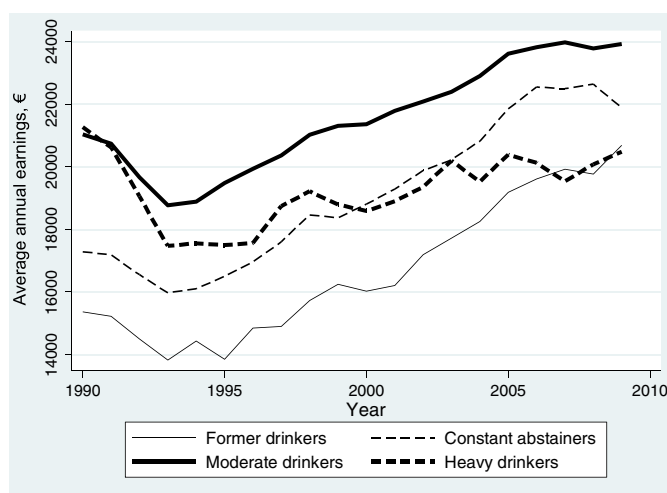


Figure 2. Average annual earnings by alcohol consumption status over the period 1990–2009. Note: Earnings are deflated using the consumer price index (base year 2000)

Table IV. A cross-tabulation of alcohol consumption patterns within twin pairs ( $N=3305$ )

	Former drinker	Constant abstainer	Moderate drinker	Heavy drinker
Former drinker	51 (1.5%)			
Constant abstainer	42 (1.3%)	101 (3.1%)		
Moderate drinker	273 (8.3%)	190 (5.7%)	2340 (70.8%)	
Heavy drinker	7 (0.2%)	6 (0.2%)	262 (7.9%)	33 (1.0%)

notably after 2000, as overall labor market conditions gradually improved.<sup>5</sup> Although there was a general decrease in average earnings in each group during the economic depression of the early 1990s, the earnings gaps were already distinct in 1990 when we start measuring our labor market outcomes (Figure 2). The only exception is the group of heavy drinkers, whose earnings were at the same level with those of moderate drinkers in 1990. Their earnings dropped a lot in the economic crisis and have since then developed less favorably than the earnings of the other groups. The earnings gaps of the other groups remained quite stable relative to each other during the period 1990–2009. We can also see that there is annual variation in earnings. This implies that it is important to measure labor market outcomes over a longer time period.

Table IV documents a cross-tabulation of alcohol consumption patterns within twin pairs. There is a sufficient amount of within twin-pair variation in the data, which is necessary for identification. Roughly 24% of the observations in the four drinking behavior groups differ between the twins.

#### 2.4. Statistical methods

Following, for example, Böckerman *et al.* (2015), we used four different types of regression analyses: First, we used OLS to regress our labor market measures on alcohol consumption for a combined sample of DZ and MZ twin individuals. Second, we took twin differences and re-ran the same regression using the same combined sample. In this twin-differenced model, all factors that two twins share (e.g. the shared environmental factors,

<sup>5</sup>Paljärvi *et al.* (2015) showed that individuals who had early limited drinking problems improve their employment considerably as they age, whereas those who had persistent drinking problems experience a constant decline in their employment.



business cycle effects and age) are eliminated. Third, we repeated the previous within twin-pair regression using the DZ sample. Finally, we ran the within twin-pair regression using the MZ sample. Both the shared environmental and genetic factors are differenced out in this last twin-differenced model. It is reasonable to assume that time-invariant risk and/or time preferences that affect alcohol consumption and labor market choices are at least partially genetically inherited. This implies they are better differenced out in the MZ sample than in the DZ sample.

### 3. RESULTS

#### 3.1. Main results—long-term labor market outcomes

The estimates of alcohol consumption on average employment months are reported in Table V (Panel A). The baseline estimates using the standard OLS specification reveal that heavy drinkers have substantially weaker labor market attachment compared with moderate drinkers; that is, heavy drinkers work, on average, approx. 1.5 months less each year over the 20-year observation window ( $\beta = -1.47$ , 95% CI:  $-1.92$  to  $-1.02$ ). Former drinkers have also weaker labor market attachment ( $\beta = -0.60$ , 95% CI:  $-0.98$  to  $-0.21$ ). These results are in accordance with the earlier empirical studies described in Table I and the graphical illustration in Figure 1.

The results do not change much when we focus on the twin-differenced DZ–MZ model (column 2) and DZ model (column 3) that both control for the shared environment. These estimates show that being either a former drinker or a heavy drinker is associated with a decrease in average employment months of approximately  $\sim 1$ . The results for the MZ sample (column 4) confirm these findings even when both the shared environmental and genetic factors are controlled for. The estimates reveal that former drinkers and heavy drinkers work approx. 0.9 months less each year over the 20-year observation period.

The estimates of alcohol consumption on earnings are reported in Panel B of Table V. The baseline OLS estimates show that abstainers and heavy drinkers earn considerably less than moderate drinkers. The point estimates reveal that being either a constant abstainer or a former drinker is associated with a decrease in average annual earnings of  $\sim 15$ – $32\%$ . For heavy drinkers, the earnings drop is even bigger, being  $\sim 36\%$ . The results for the combined DZ–MZ sample (column 2) and DZ sample (column 3) confirm these findings. Finally, the within MZ twin-pair regressions (column 4) reveal that being a former drinker or a heavy drinker is negatively associated with subsequent earnings at the 10% significance level also when the genetic factors are accounted for (the estimate for former drinkers:  $\beta = -0.20$ , 95% CI:  $-0.41$  to  $0.01$ , and for heavy drinkers:  $\beta = -0.18$ , 95% CI:  $-0.38$  to  $0.02$ ). If taken literally, these results would imply that former drinkers and heavy drinkers earn approx. 20% less each year compared with moderate drinkers over the 20-year period. The within MZ twin-pair regressions suggest that there is no longer statistically significant relation between being a constant abstainer and earnings. The negative relation in columns 1–3 may thus be related to genetic factors.<sup>6</sup> The statistical insignificance in the smaller MZ sample is also driven by the smaller (absolute) point estimate.

We stratified our preferred twin-differenced models by gender to examine the potential gender heterogeneity in the associations (Table VI). The results for the combined sample of DZs and MZs show consistently that former drinkers and heavy drinkers have weaker labor market attachment and lower earnings compared with moderate drinkers both among men and women. For example, women who are former drinkers work approx. 1.5 months less each year. The only major difference compared with the estimates that use the pooled sample of men and women is that the earnings of constant abstainers are lower (than those of moderate drinkers) for women but not for men. The point estimates for former drinkers are larger for men. One reason for this may

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<sup>6</sup>The difference between DZ and MZ estimates suggests that factors related to genetic endowment are significantly correlated with the outcomes of interest and drinking patterns. If, for example, the risk and/or time preferences are to some degree genetically inherited, they are better differenced out in the MZ sample than in the DZ sample. It is worth pointing out here that the point estimates for DZs and MZs are not always statistically significantly different from each other.

Table V. Alcohol consumption and long-term labor market outcomes

	OLS level: DZ and MZ			Twin differences: DZ and MZ			Twin differences: DZ			Twin differences: MZ				
	$\beta$	95% CI		$\beta$	95% CI		$\beta$	95% CI		$\beta$	95% CI			
<i>Employment</i>														
Alcohol use														
Former drinker	-0.595***	(0.195)	-0.212	-0.839**	(0.253)	-0.343	-0.757**	(0.322)	-1.389	-0.126	-0.940**	(0.340)	-1.715	-0.164
Constant	0.037	(0.186)	0.402	-0.105	(0.297)	0.477	-0.410	(0.350)	-1.096	0.276	0.649	(0.552)	-0.435	1.732
abstainer														
Heavy drinker	-1.467***	(0.229)	-1.017	-1.124***	(0.283)	-0.570	-1.275***	(0.348)	-1.957	-0.593	-0.818*	(0.486)	-1.771	0.135
<i>Log(earnings)</i>														
Alcohol use														
Former drinker	-0.322***	(0.055)	-0.213	-0.283***	(0.069)	-0.147	-0.318***	(0.088)	-0.491	-0.146	-0.198*	(0.107)	-0.408	0.013
Constant	-0.146***	(0.051)	-0.247	-0.192**	(0.079)	-0.347	-0.241**	(0.096)	-0.429	-0.052	-0.057	(0.133)	-0.318	0.204
abstainer														
Heavy drinker	-0.363***	(0.063)	-0.486	-0.342***	(0.070)	-0.478	-0.424***	(0.091)	-0.603	-0.246	-0.180*	(0.103)	-0.383	0.022
N	6610			3305			2104				1201			

MZ, monozygotic; DZ, dizygotic; OLS, Ordinary Least Squares. Heteroscedasticity-robust standard errors are in parenthesis. Reference category: moderate drinkers. OLS level models include controls for gender, age and its square.

\*\*\*, \*\*, \* Statistically significant at least at the 1%, 5% and 10% levels, respectively.

Table VI. Within twin-pair regressions on alcohol consumption and long-term labor market outcomes by gender

	Employment				Log(earnings)							
	Twin differences: DZ-MZ		Twin differences: MZ		Twin differences: DZ-MZ		Twin differences: MZ					
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI				
<i>Males</i>												
Alcohol use												
Former drinker	-1.162** (0.487)	-2.117	-0.207	-1.246* (0.742)	-2.703	0.211	-0.333** (0.140)	-0.608	-0.059	-0.437** (0.194)	-0.819	-0.055
Constant	0.530 (0.544)	-0.538	1.597	1.967* (1.010)	-0.017	3.951	-0.019 (0.154)	-0.320	0.282	-0.013 (0.328)	-0.657	0.632
Abstainer												
Heavy drinker	-0.897** (0.379)	-1.640	-0.153	-0.659 (0.723)	-2.080	0.762	-0.321*** (0.092)	-0.503	-0.140	-0.233 (0.153)	-0.534	0.068
N	1394		486			1394					486	
<i>Females</i>												
Alcohol use												
Former drinker	-0.739** (0.295)	-1.318	-0.159	-0.851** (0.462)	-1.757	0.055	-0.270*** (0.080)	-0.427	-0.113	-0.122 (0.126)	-0.369	0.124
Constant	-0.311 (0.352)	-1.002	0.380	0.353 (0.641)	-0.904	1.611	-0.249*** (0.092)	-0.430	-0.069	-0.055 (0.147)	-0.343	0.233
Abstainer												
Heavy drinker	-1.515*** (0.406)	-2.311	-0.718	-1.043* (0.558)	-2.139	0.053	-0.378*** (0.104)	-0.581	-0.175	-0.112 (0.120)	-0.349	0.124
N	1911		715			1911					715	

MZ, monozygotic; DZ, dizygotic. Heteroscedasticity-robust standard errors are in parenthesis. Reference category: moderate drinkers. \*\*\*, \*\*, \* Statistically significant at least at the 1%, 5% and 10% levels, respectively.

be that alcohol consumption has been at much higher level for men particularly among the older age cohorts. Former drinkers have generally weaker labor market outcomes even in the relatively small sample of MZs.

### 3.2. Robustness checks

*3.2.1. Additional covariates.* The raw data suggest (cf. Figures 1 and 2) that most of the differences between former drinkers, constant abstainers, moderate drinkers and heavy drinkers may have already been present in 1990. Despite twin differencing, such differences between the groups suggest that omitted variable bias may be relevant. The baseline models did not include controls because many of the potential explanatory variables may not be predetermined. We therefore evaluate the robustness of our baseline results to the addition of various controls. We account for education, health-related controls and past experiences of adverse shocks. These variables may contribute to labor market outcomes and be correlated with alcohol consumption. We use within twin-pair variation in these variables to explore the robustness of our within twin estimations.

Education is measured in years, based on the highest completed education level. We add education as a control, as there is a link between labor market success and alcohol use on the one hand, and alcohol use and labor market success on the other (Latvala *et al.*, 2011). The health-related controls include the number of chronic diseases and smoking. The number of chronic diseases (as measured in the 1975 survey) is used to account for pre-existing health endowment. These diseases include, among others, emphysema, chronic obstructive pulmonary disease, high blood pressure, angina pectoris, peptic ulcer, diabetes and gout. Smoking is measured using pack-years in 1990. It captures lifetime consumption of cigarettes. We add smoking behavior as a control, because there is evidence that alcohol consumption and cigarette consumption are jointly determined (Van Ours, 2004). We also include a stressful life events (SLE) index that is a weighted sum of 11 negative life shocks selected from the 17 Holmes and Rahe items (Riese *et al.*, 2013), taken from the 1990 twin survey. Adverse life shocks may cause one twin to consume alcohol and also contribute to his or her weaker labor market attachment and lower earnings.

The results that account for the controls are shown in Table VII. While not reported in detail, education obtains a positive coefficient ( $\beta = 0.06$ , 95% CI: 0.02 to 0.09), and the number of diseases obtains a negative coefficient ( $\beta = -0.07$ , 95% CI:  $-0.13$  to  $-0.02$ ) when long-term earnings are used as the outcome variable. These findings indicate that educational attainment and pre-existing health endowment are important predictors of lifetime labor market success. The SLE index has a negative relationship with labor market attachment. The results for alcohol consumption remain largely unchanged. The only exception is the coefficient of heavy drinkers that, while still negative, is no longer statistically significant at the conventional level in a model that uses employment as the outcome variable. Being a former drinker seems to be negatively associated with earnings ( $\beta = -0.21$ , 95% CI:  $-0.42$  to  $0.002$ ) and labor market attachment ( $\beta = -0.93$ , 95% CI:  $-1.71$  to  $-0.15$ ).

Table VII. Within MZ-regressions on alcohol consumption and long-term labor market outcomes with additional control/mediator variables

	Employment				Log(earnings)			
	Twin differences: MZ				Twin differences: MZ			
	$\beta$		95% CI		$\beta$	95% CI		
Alcohol use								
Former drinker	-0.930**	(0.397)	-1.708	-0.151	-0.207*	(0.106)	-0.415	0.002
Constant abstainer	0.545	(0.544)	-0.522	1.611	-0.066	(0.135)	-0.330	0.199
Heavy drinker	-0.747	(0.484)	-1.697	0.203	-0.170*	(0.100)	-0.367	0.026
Additional controls included	Yes				Yes			
N	1201				1201			

MZ, monozygotic. Heteroscedasticity-robust standard errors are in parenthesis. Reference category: moderate drinkers.

\*\*\*, \*\*, \* Statistically significant at least at the 1%, 5% and 10% levels, respectively. Additional controls are education years, number of diseases (in 1975), smoking and stressful life events index.

Being a heavy drinker is also negatively associated with earnings at the 10% level ( $\beta = -0.17$ , 95% CI:  $-0.37$  to  $0.03$ ). While our earlier qualitative conclusions were supported, these results have to be treated with some caution, because educational attainment, smoking and SLE index are not likely to be completely predetermined (i.e. they are potentially 'bad' controls, because past drinking, as measured in 1975 and 1981, may affect them).

*3.2.2. Alternative measures for alcohol consumption.* We constructed three alternative measures for alcohol consumption and used them to re-estimate the MZ twin-differenced models for average employment months and earnings. The results are shown in Table VIII. First, following Aalto and Seppä (2002), we used alternative thresholds for heavy drinking. In a survey study, Sillanaukee *et al.* (1992) examined the views of general practitioners about how they advise their patients about the maximum and yet appropriate levels of alcohol consumption. The mean levels were 15.5 drinks per week for men and 11 for women. These levels are about two-thirds of the standard Finnish threshold values for heavy drinking that we have used so far. Because one drink unit corresponds 12 g of pure alcohol, we can use these numbers to construct alternative thresholds for heavy drinking. Using 186 g per week for men and 132 g for women as the threshold levels, we found that our main findings are supported. The only exception is that the coefficient for heavy drinkers is statistically insignificant when employment is used as the response variable.

Second, we considered binge drinking, because it is a common form of alcohol misuse and because it has been documented to cause significant negative health effects (Wen *et al.*, 2012). Binge drinkers appear to have weaker labor market attachment later in life even when the relatively small sample of MZs is used ( $\beta = -0.80$ , 95% CI:  $-1.32$  to  $-0.28$ ). Thus, those who are binge drinkers have, on average over the 20-year period, 0.8 fewer employment months each year. They also have approx. 10% lower earnings compared with non-binge drinkers.

Third, we added binge drinking to the regression models together with our categorical alcohol consumption measures. The results for former drinkers remain intact. However, the coefficients for heavy drinkers are statistically insignificant when both employment and earnings are used as the response variable. These results show that the negative labor market effects of heavy drinking are most likely related to binge drinking behavior. Binge drinking itself remains negatively associated with labor market attachment ( $\beta = -0.75$ , 95% CI:  $-1.74$  to  $-0.19$ ).

Table VIII. Within MZ-regressions on alcohol consumption and long-term labor market outcomes using different alcohol measures: bivariate regressions

	Employment months				Log(earnings)			
	Twin differences: MZ				Twin differences: MZ			
	$\beta$		95% CI		$\beta$		95% CI	
(1) Alcohol use with lower thresholds								
Former drinker	-0.935**	(0.395)	-1.701	-0.160	-0.199*	(0.107)	-0.409	0.011
Constant abstainer	0.647	(0.551)	-0.433	1.727	-0.063	(0.132)	-0.322	0.197
Heavy drinker	-0.531	(0.341)	-1.200	0.137	-0.179***	(0.067)	-0.311	-0.048
(2) Binge drinker	-0.802***	(0.266)	-1.324	-0.281	-0.096*	(0.058)	-0.209	0.017
(3) Alcohol use and binge drinking in the same model								
Former drinker	-0.961**	(0.395)	-1.735	-0.186	-0.200*	(0.107)	-0.411	0.010
Constant abstainer	0.638	(0.551)	-0.433	1.718	-0.058	(0.134)	-0.320	0.204
Heavy drinker	-0.683	(0.484)	-1.632	0.266	-0.165	(0.101)	-0.363	0.033
Binge drinker	-0.752***	(0.267)	-1.276	-0.227	-0.085	(0.055)	-0.193	0.024
N	1201				1201			

MZ, monozygotic. Heteroscedasticity-robust standard errors are in parenthesis.

\*\*\*, \*\*, \* Statistically significant at least at the 1%, 5% and 10% levels, respectively.

*3.2.3. Alternative income measure.* As a further robustness test, we considered an alternative measure for lifetime earnings. To this end, we calculated a measure for lifetime income as the logarithm of the average of annual taxable income over the period of 1990–2009. This measure is broader than earnings as it also includes capital income (dividends and capital gains) and income transfers and social security benefits, such as unemployment and parental leave benefits. When the response variable was lifetime income, our result for former drinkers remains intact, although the (absolute) size of the coefficient was slightly smaller. Being a former drinker is associated with 15% lower lifetime income in the combined DZ/MZ sample ( $\beta = -0.148$ ,  $p = 0.020$ , 95% CI:  $-0.274$  to  $-0.023$ ). The corresponding estimate for earnings is  $-28\%$  (Table V). The coefficients for heavy drinkers became statistically insignificant. These findings are *not* a sign of sensitivity of our results, as there is an obvious explanation for them. Income transfers and social security benefits may protect former and heavy drinkers from the adverse labor market consequences of alcohol consumption. Moreover, capital income is not similarly affected by, for example, poorer health that excessive alcohol consumption may cause. There is also earlier evidence that shows that the effect of risky behavior in the form of smoking on the taxable income is smaller (as compared with earnings; see Böckerman *et al.*, 2015). These patterns are consistent with the view that the social safety net of the (Finnish) welfare state protects people from the adverse impacts of exogenous shocks and from people's own harmful choices.

*3.2.4. Sign error.* Finally, inspired by the recent work of Gelman and Carlin (2014), we considered the risk of making a sign error ('Type S error') or exaggerating the effect size ('Type M error'). The intuition of Type S error is that it measures the probability that our estimate has the incorrect sign, *given* that it is found to be statistically significant. Type M error, in turn, refers to the factor by which the effect could in expectation be overestimated, given that it is statistically significant; for a more detailed discussion, see Gelman and Carlin (2014).

To evaluate these errors, we have to hypothesize a true effect size. It seems that there is no such prior information for the long-term employment or earnings effects. We therefore straightforwardly consider the possibility that the true effect size is 25% smaller in absolute value than what our preferred point estimates suggest: Using the regressions for employment months and the estimate (and its standard error) for the former drinkers from the twin-differenced DZ–MZ model (of Table V), we find that Type S error is far less than 0.01. Thus, it seems that the probability that our estimate has the incorrect sign, *given* that it is statistically significant, is negligible. We also find that Type M error for the same point estimate is 1.19. This indicates that, in expectation, the estimated effect is  $\sim 1.2$  times too high, given that it is found to be statistically significant and what we hypothesized about the true effect size. When the response variable is earnings and the estimate and its standard error for the former drinkers is taken from the estimated twin-differenced MZ model (of Table V), these numbers are  $< 0.01$  and 1.85, respectively. Even in this smaller sample, these numbers seem satisfactory if they are compared with what Gelman and Carlin (2014) considered problematic.

#### 4. DISCUSSION

This paper used twin data linked to register-based individual information to examine the long-term relationship between alcohol consumption and lifetime labor market outcomes. Our results show that former drinkers and heavy drinkers both have almost 20% lower earnings compared with moderate drinkers. Former drinkers also work approx. 1 month less each year over the 20-year observation period. These negative associations remained statistically significant when the shared environmental and genetic factors were controlled for. Because many of the differences examined may have been present already at the beginning of our observation window, we estimated models with additional controls. The negative associations for the former drinkers were also robust to the use of various covariates, such as education, pre-existing health endowment and smoking. We also find that binge drinking, a popular form of alcohol misuse, is negatively associated with subsequent employment months and may in fact be the reason why heavy drinking is associated with subsequent adverse labor market outcomes.

We examined the labor market consequences of alcohol consumption in the Finnish context. As in many other countries, alcohol consumption has severe negative health consequences (including morbidity and mortality) in Finland. Alcohol-related mortality increased by 16% among men and by 31% among women over the period 2004–2005 after a large reduction in the price of alcohol in 2004 (Herttua *et al.*, 2008). As a result, alcohol killed more Finns aged 15–64 years than cardiovascular disease or cancer did in 2005 (Statistics Finland, 2006). Our findings complete these prior findings by showing how alcohol use is associated with long-term labor market outcomes. We are inclined to think that these findings of ours generalize to other developed European countries.

There are some issues that have to be taken into account when interpreting our estimates. First, if heavy drinking increases considerably the probability of dying and/or attrition in our observation window, the estimates for heavy drinkers could be downward biased. However, this bias should be relatively minor in our context, because it takes a long time before serious alcohol-related diseases appear. In addition, for an individual not to be included in our analyses, it would have required that he or she was not employed and/or earned anything over the period 1990–2009 that constitutes the prime working age. The earlier analyses of the Finnish twin data (that we use) have also generally not found significant non-random selection (Kaprio, 2013).<sup>7</sup>

Second, we are not able to account for the fact that people may change their drinking status after 1990. Some heavy drinkers may become former drinkers or moderate drinkers over time. For example, employment of heavy drinkers may start to increase towards the end of our observation period because some of them quit drinking.

Third, we stress that our analysis of twin data does not completely rule out non-causal explanations for the negative association between alcohol consumption and labor market outcomes later in life. For example, a confounding psychological factor may induce one twin to consume alcohol. This unmeasured characteristic may also be significantly related to labor market success. This means that both alcohol consumption and long-term labor market outcomes may be driven by it.

Fourth, it is possible that there are significant peer effects in alcohol consumption at twin-pair level. There are earlier empirical studies that have used twin data to study peer effects (e.g. Harden *et al.*, 2008). These studies use information on siblings' best friends and their behavior. Unfortunately, the twin data that we use do not have such information on peers' alcohol consumption. We can, however, conclude that the negative associations between being a former drinker or a heavy drinker and the long-term labor market outcomes are *not* caused by the shared environmental and genetic factors.

We conclude by noting that to establish the exact conditions under which alcohol consumption is rational and whether consumers of addictive goods behave rationally or not is difficult (Cawley and Ruhm, 2011). There is arguably less scope for heavy alcohol consumption to be based on rational reasoning (with stable preferences), if alcohol consumption is associated both with significant out-of-pocket consumption costs and negative physical and mental health effects. Our findings suggest that former drinkers suffer non-negligible indirect monetary costs in terms of lost labor market earnings. Whether consumers are capable of taking into account the impact of their current alcohol consumption on their future labor market attachment and earnings capacity—and that such impact persists even after they quit drinking—is an open question.

#### ACKNOWLEDGEMENTS

This research has been financially supported by the Jenny and Antti Wihuri Foundation. We would like to thank Jaakko Kaprio for comments and access to the twin data. We are also grateful to two anonymous referees and Jutta Viinikainen for valuable comments that have greatly improved the paper.

#### CONFLICT OF INTEREST

The authors have no conflict of interest.

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<sup>7</sup>There is earlier evidence from other countries that alcohol use is not significantly associated with attrition in panel data (Cunradi *et al.*, 2005).

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