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Is Asian Flushing Syndrome a Disadvantage in the Labor Market?*

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Abstract

A large fraction of people in East Asia are incapable of digesting alcohol because of a genetic deficiency of aldehyde dehydrogenase. In this study, we examine whether the genetic variation in alcohol tolerance contributes to inequality in the labor market. We conducted our original surveys in Japan, Taiwan, and Korea with about 2,000, 1,000, and 500 prime-age working men in each country, respectively. We measured the respondents' genetic degree of alcohol tolerance by a bio-marker test. The data reveal that alcohol-tolerant men consume more alcohol in all three countries, but their earnings and hours worked are not systematically different from their alcohol-intolerant counterparts. Our results suggest that there is no universal mechanism in which drinking, a cultural behavior, influences labor-market outcomes.

JEL Classification: C41; D12; I19
Keywords: Asian Flushing Syndrome; Drinking; Earnings; Hours Worked; Genetic Trait; Alcohol Patch Test

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1 Introduction

Alcohol plays a significant role in human life (Standage, 2006; Forsyth, 2018). As alcohol releases endorphins, pleasure hormones, it often helps people forget bad memories and become more cheerful. Also, meals become more flavorful with a glass of wine or a bottle of beer. Drinking is not usually an isolated individual activity but rather a social experience. People drink with friends and family to celebrate and also to grieve together. Therefore, we might expect that the influence of drinking can extend beyond the dinner table and reach the labor market. Drinking may smooth communication among coworkers or business partners; it can ease job stress and thus enhance productivity.

Not everyone can enjoy drinking alcohol, however. People are heterogeneous in their degree of alcohol tolerance, and alcohol is even toxic to some people (Heath and Martin, 1992; Heath et al., 1999; Schuckit et al., 2001b). The ability to digest alcohol is genetically determined to an extent, and such a genetic ability is not continuously distributed. There are three distinct types of the genetic trait (tolerant, sensitive, and intolerant), and one's type is constant over his or her lifespan (Eng et al., 2007; Matsuse et al., 2001; Li et al., 2009). When a person consumes alcohol, the liver decomposes it into acetaldehyde by alcohol dehydration (ADH) enzymes and further into acetic acid by acetaldehyde dehydrogenase (ALDH) enzymes. People with super-active ADH or inactive ALDH experience a high acetaldehyde concentration in their blood after alcohol intake. Since acetaldehyde is highly toxic, those who cannot decompose it effectively suffer a drunken sickness, such as headache, vomiting, and a hangover. Therefore, they are physiologically more limited than others in obtaining the benefits of drinking.

In this study, we examine whether the unequal distribution of the genetic trait of alcohol tolerance contributes to inequality in the labor market. To this end, we collected data from three East Asian countries: Japan, Taiwan and Korea. Researchers have established that the deficiency of alcohol digestive ability is pervasive among people in East Asia (Li et al., 2009). For this reason, the syndrome of facial flushing reaction to alcohol intake is

called "Asian flush." We conducted our original survey in Japan, Taiwan, and Korea with about 2,000, 1,000 and 500 prime-age working men in each country, respectively. The survey includes a bio-marker test, called the alcohol patch test, which measures respondents' genetic tolerance to alcohol (Muramatsu et al., 1989; Matsuse et al., 2001). According to the data we collected, about 50-60% of our respondents are of the alcohol-tolerant (AT) type, and thus the remaining 40-50% are of the alcohol-intolerant (AIT) type. This distribution is very close to that reported in a meta-analysis of medical studies based on genome analysis (Li et al., 2009).

To summarize our main findings, first, we find that AT men drink more often and more per episode than AIT men. The results are consistent across the three countries and robust to controlling for individual characteristics and parents' types of alcohol tolerance. A possible reason for the positive effect of the genetic ability to digest alcohol on drinking is the existence of a positive economic return to drinking. If drinking helps grease social relationships with those related to work or plays a role in improving productivity, those who can take advantage of their ability to drink should do so. To check whether the genetic trait indeed leads to an economic advantage, we compare earnings and hours worked between AT and AIT men. Unlike the effects on drinking behavior, we find few consistent findings across countries. While we find a bit of evidence that AT men earn more than AIT men in Korea, our findings robustly show that the genetic trait has no significant effect on labor-market outcomes in Japan and Taiwan. The effects for the latter two countries are not only statistically insignificant but also economically small or sometimes of the opposite sign. Therefore, our findings here suggest that there is no universal channel through which drinking influences labor-market outcomes that is common across countries.

Next, we examine subjective evaluations about the benefits and costs of drinking, mainly in two regards: benefits related to work and those related to health. We included a set of questions regarding the effects of drinking to learn about the channels of the positive effect of the ability to drink on labor-market outcomes. For example, we asked whether the

respondent agreed that drinking helps networking with other people. We also asked whether the respondent agreed that drinking is good for mitigating mental stress. Consistent with what we found for the effects on labor-market outcomes, we find that Koreans are more likely to believe that drinking is helpful for social networking than Japanese and Taiwanese men. This suggests that if there is any return to alcohol tolerance on labor-market outcomes, it is likely to be due to a business culture that emphasizes the needed to engage in business communication with alcohol, rather than a physiological mechanism that alcohol intake enhances labor productivity.

Our paper is associated mainly with the two strands of research. First, there has been a vast literature on the labor-market effects of drinking. Identifying the causal effect of drinking is a difficult task, because the quantity of drinking is not randomly assigned across individuals. Economic theory predicts that consumers chooses the optimal amount of alcohol consumption where the marginal utility equals the marginal cost. To date, many studies have attempted to resolve the endogeneity problem in various ways, from controlling for individual fixed effects, to twin studies, to instrumental variable estimation (Peters, 2004; Renna, 2008; Berger and Leigh, 1988; Zarkin et al., 1998; van Ours, 2004; Tekin, 2004; Soydemir and Bastida, 2006; Mullahy and Sindelar, 1993; Auld, 2005; Jones and Richmond, 2006; Dave and Kaestner, 2002).[1]

To be clear, we do not attempt to recover the causal impact of drinking on labor-market outcomes, because the genetic trait of alcohol tolerance could affect labor-market outcomes through the channels other than drinking behavior. The most serious identification threat is the intergenerational transmission of the genetic trait. Since the ability to digest alcohol is a genetic trait, one's ability should be correlated with parents' ability. Parents' drinking be-

[1]This question is related to the literature on health and business cycles. Drinking is one of the health behaviors studied intensively in the literature. The results are mixed. On one hand, people might drink less during recessions because of the income effect; they lack the financial resources to support drinking (Ruhm, 1995; Ettner, 1997; Freeman, 1999). On the other hand, drinking may increase during recessions, because the opportunity cost of leisure time is lower. During economic downturns, both the unemployed and employed may drink alcohol to ease their stress and emotional tension (Ruhm and Black, 2002; Tekin, 2004; Hill and Angel, 2005). Recent studies pay closer attention to the style of drinking; Dee (2001), Dávalos et al. (2012), and Bor et al. (2013) report an increase of binge drinking during recessions.

havior is correlated with family environments, which might have significant long-term effects on labor-market outcomes.[2] Thus, although our setting is reminiscent of the Mendelian randomization approach in epidemiology (Lawlor et al., 2008; Davey Smith and Hemani, 2014; von Hinke Kessler Scholder et al., 2011, 2014; von Hinke et al., 2016), we do not take this approach and instead, limit our attention to estimate the causal effect of the genetic trait on labor-market outcomes. Therefore, it is our major limitation that we cannot identify the mechanisms through which the genetic trait may affect economic outcomes. We believe, however, that this is still an important question from the perspective of fairness and discrimination, since the ability is as exogenous as gender and race that one cannot choose nor change.

Second, our paper is also related to the literature examining the influences of genetic characteristics on economic outcomes. We have found a growing body of evidence that many crucial determinants of labor-market outcomes are genetically inherited from antecedents. To name a few, physical appearance features, such as height, weight, and facial beauty, are by and large determined genetically. A number of studies have found that those characteristics affect not only labor-market outcomes, such as wage and earnings, but also academic achievements and social behaviors, such as crime (Persico et al., 2004; Hamermesh, 2011; Mocan and Tekin, 2010). Furthermore, using the classical twin study design, Cesarini et al. (2009) find that a substantial portion of individual variation in social preferences and risk aversion is genetically determined. There is a growing body of scientific evidence on the associations between genes and socioeconomic behaviors (Rietveld et al., 2013; Benjamin et al., 2012).

The remainder of the paper proceeds as follows: Section 2 introduces the metabolism of alcohol. Section 3 explains our data. In particular, we check the validity of the genetic information that we collected by the alcohol patch test. In Section 4, we present our empirical

[2]Addressing this concern, we asked respondents about their parents' types of alcohol tolerance and controlled for parents' types in our regression models. Still we believe that the exclusion restriction is unlikely to hold in our case. We explain our concern in detail in Appendix A.

model and results. We then discuss heterogeneous results for labor-market outcomes across three countries. Section 5 concludes.

2 Asian Flushing Syndrome

In this section, we introduce some background information on why a significant group of East Asians are incapable of digesting alcohol and show the syndrome of Asian flush. When a person drinks alcoholic beverages, the stomach and small intestine absorb ethyl alcohol, and the liver decomposes it into acetaldehyde by alcohol dehydration (ADH) enzymes. The critical gene that encodes the activity level of ADH enzyme is ADH1B. This gene is divided into inherited gene polymorphisms, whose types give rise to variations in the conversion efficiency of alcohol into acetaldehyde. While the polymorphism ADH1B*1 is the normal type, the polymorphism ADH1B*2 type leads to super-active ADH enzymes that result in a quick acetaldehyde buildup.

In the Japanese and Korean populations, more than 90% of people have the ADH1B*2 gene (Eng et al., 2007). In the Taiwanese population, the share is around 70% (Li et al., 2007). Acetaldehyde is further converted into acetic acid by acetaldehyde dehydrogenase (ALDH). Among the types of ALDH, ALDH2 plays the most crucial role in the oxidation of acetaldehyde, and ALDH2 is divided into inherited gene polymorphisms. The polymorphism ALDH2*1 is the normal type, while ALDH2*2 encodes an inactive ALDH2 enzyme. The ALDH2 enzyme is less active among homozygotes ALDH2*2/*2 than among heterozygotes ALDH2*1/*2. ALDH2*2 is also referred to as ALDH2*504Lys, because the difference *2 type has the Lysine acid instead of the Glutamic acid at codon position 504. Around 45% of people have ALDH2*2 in Japan, and around 30% in Korea have it (Eng et al., 2007). According to Li et al. (2009); Chang et al. (2017), which are based on the geographic interpolation of independent studies, the number is around 40% in Japan, 40% in Taiwan, and 25% in Korea.

Since acetaldehyde is a toxic substance, it leads to a flushed face and other physical

symptoms, including headache, vomiting, and a hangover. Figure 1 shows the change of face color before and after the alcohol intake of an intolerant individual. Luczak et al. (2011) examine the interactive effects of ADH1B*2 and ALDH2*2 on the self-reported sensitivity to alcohol intake, using the sample of Asian-American college students of Chinese and Korean descent, and find that ALDH2*2 (inactive acetaldehyde dehydrogenase) plays a dominant role in the determination of sensitivity to alcohol intake. They further report that given the presence of ALDH2*2, the presence of ADH1B*2 (super-active alcohol dehydration) amplifies the reaction. Overall, according to existing medical literature, 30-45% of Japanese, Taiwanese, and Koreans are sensitive to alcohol intake because of a high concentration of acetaldehyde in the bloodstream after drinking.

Sensitivity to alcohol intake is specific to East Asians. People with the low-active or inactive types of ALDH virtually do not exist in European and African races (Li et al., 2009). Thus, a study that exploits the variation of ALDH types is best suited to the East Asian population. To highlight the significance of genetic variation, we compare our sample with that of von Hinke Kessler Scholder et al. (2014), which is the only study in the field of economics using the variation of ALDH types. They use the variation of ADH1B to examine the impact of maternal drinking during the pregnancy on child academic achievement. In their sample, about 5% of 4,201 British mothers are classified as the abnormal type that results in the excess buildup of acetaldehyde. The small size of the treatment group limits the generalizability of their findings. In contrast, in our sample, about 46% of 3,338 Japanese, Taiwanese, and Korean men have the abnormal ALDH2 type.

3 Data from the Three Countries

3.1 Survey and Alcohol Patch Test

The first requirement for our study is to collect individual-level data on the genetic trait of alcohol tolerance along with information on drinking behavior, labor-market outcomes, and

socioeconomic characteristics. Since no such data are available, we created and conducted an original survey. The most unusual feature of our survey is that it collects the genetic information about alcohol tolerance. Expensive genetic testing is necessary to know the specific ALDH gene polymorphism, but a simple and inexpensive bio-marker test, called the alcohol patch test, can identify low active and inactive types (Muramatsu et al., 1989; Matsuse et al., 2001). The alcohol patch test can be done by simply attaching a bandage-like patch soaked with ethanol to the inner side of the upper arm for 20-30 minutes. Then the test determines the degree of tolerance to alcohol based on the change in skin color in the area where the patch is removed. Figure 2 illustrates the test procedure.

In this study, we hired a survey company in each country. Through the company, we distributed the alcohol patch test to respondents and collected the results through the online survey. The online survey also collected information on the frequency and per-episode amount of drinking, attitudes toward drinking, employment status, earnings, hours worked, and basic socioeconomic characteristics.[3]

For Japan, we targeted working men between 25 and 59 years old who were living in Japan in March 2015. We employed stratified random sampling by age, educational background, annual income, region, industry, and employment type from about 210,000 people across the nation who had pre-registered as potential survey participants, such that the sample represents 25 to 59 years old working men in Japan. To the sample of respondents, we mailed the alcohol patch test, along with the identification number and instructions from the web-marketing company. We then conducted an online survey with the respondents and asked them to provide the results of the alcohol patch test and answer the questions (45 items) about socioeconomic characteristics, drinking behavior, and labor-market outcomes. By putting the identification number together with the alcohol patch test, we assured that respondents had implemented the test and let them answer the questions about the test

[3]For the purpose of our study, it is critical to collect information on drinking behavior accurately. We explain our survey questions in Section 4.2. In addition, we provide the English-translated full contents of the questionnaire in Online Appendix A.

results at hand. The original sample size is 2,068. We restricted the sample to those who worked in the last week of the survey, including the self-employed. Dropping those who did not work in the last week or failed to report their earnings reduced the size of the analysis sample to 1,894 (91.6%).

The surveys for Taiwan and Korea were implemented in the same way as we did for Japan. We hired a survey company in Korea and collected the data on 518 working men aged 25 to 59 in February 2017. While the Japanese sample is constructed as a nationally representative sample, the Korean sample is limited to Seoul and its vicinity because of a tight budget. In addition, we restricted respondents to men who worked in the last week of the survey from the beginning. The final sample size is smaller than that of Japan, 518. For Taiwan, we conducted the survey using a survey company and collected the data on 1,000 men aged 25 to 59 between March and June 2019. Like the Japanese sample, the Taiwanese sample is constructed as a nationally representative sample. As we did for the Japanese sample, we restricted the Taiwanese sample to men who worked in the last week of the survey, and the final sample size is reduced to 926 (92.6%).[4]

Since our respondents implemented the alcohol patch test by themselves and self-reported their results through the online survey, one may be concerned that they might misreport the results.[5] To address this concern, as well as to ensure the accuracy of the responses as much as possible, we asked three different questions about the patch test result. By asking multiple questions, we could cross-check the responses across questions. The three questions

[4]Since the Japanese and Taiwanese data included non-workers, we can check a potential sample selectivity bias due to restricting the sample to workers. In particular, for the purpose of our paper, it is important to know whether the sample is selected based on the genetic trait and its effects on labor-market outcomes. We ran a linear regression of the genetic trait on work participation and found no significant effect. The coefficient estimate for the AT type is 0.014 (p-value = 0.284) for Japan and 0.011 (p-value = 0.514) for Taiwan. In our sample, the work participation rate is 92% for Japan and 93% for Taiwan. These are close to the national statistics. The employment rate of men aged 25-54 of Japan in 2015 was 92% (Organisation for Economic Co-operation and Development, Employment Rate: Aged 25-54: Males for Japan [LREM25MAJPM156S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/LREM25MAJPM156S, July 15, 2020.) The employment rate calculated from the Taiwanese Manpower Utilization Survey 2018 is 86%.

[5]We discuss the potential bias arising due to measurement errors in the reported test results in the Appendix B.

are as follows; first, we directly asked respondents to report their "type" identified according to the instruction that is included in the package with the patch. The instruction explains how to read the result. Concretely, the instruction shows three colors (white, pink and red), so respondents can compare their skin color on the spot the patch was attached with each of three colors on the instruction. Each color corresponds to each type; white = NN type (tolerant), pink = ND type (sensitive) and red = DD type (intolerant). The patch test result should be one of the three in the color-type matching table, but some respondents cannot determine their results because their skin color is somewhere between any two colors on the instruction. Thus, in the survey, we gave them four choices, including the last choice "The result is indeterminate." The proportion of those with ambiguous results is 2.3% for Japan, 2.7% for Taiwan and 0.58% for Korea.

For those who could not determine their test result based on the color table, we utilized the response to another question to resolve the ambiguity. In that question, we asked, "Please describe the change of your skin color in terms of the 0 to 10 scale: 0 means "no change" and 10 means "certain change."[6] There is no missing response to this question by survey design, so we used the response to this question and imputed the ambiguous (indeterminate) type from the first question. To do that, for each country and for each type, we computed the average response to the last question. Then, for those with missing type, we imputed their type as the type with a computed average that was closest to their response. After imputation, every respondent belongs to one of the three types: tolerant, sensitive, or intolerant.[7]

Figure 3 shows the distribution of gene types by country. We find that the distribution we identified from the alcohol patch test roughly matches up with the distribution identified by

[6]We asked another similar question about the change of the skin color: "Which of the following best describes the color of the skin in the area where the patch has been removed?" For that question, each respondent selected one of the following answers: (i) the area where the patch has been removed clearly became red; (ii) the area where the patch has been removed became slightly red; (iii) the change is too little to tell whether any change actually occurred in the area where the patch has been removed, and (iv) no change in the color of the skin occurred.

[7]For more details about the imputation process, please see Appendix C.

more accurate genome sequencing analyses conducted by medical scientists. About 50-60% of respondents reported no change in skin color; the remaining reported a slight change or a significant change of the skin color turning to red. These numbers are consistent with the distribution of the ALDH2*2 gene type reported in the medical literature (Eng et al., 2007).

In our regression analysis, we combined the sensitive and intolerant types together into one type and have two types in the end: the alcohol-tolerant (AT) and alcohol-intolerant (AIT) type. We use the indicator variable for the AT type in our analysis and apply the The dichotomization because the reaction to alcohol intake is similar between homozygotes ALDH2*2/*2 and heterozygotes ALDH2*1/*2 types (Luczak et al., 2011). In other words, there are much smaller differences between the sensitive and intolerant types in terms of the genetic ability of digesting alcohol than their differences from the tolerant type.

Table 1 reports the descriptive statistics of individual characteristics by country. The share of AT men is 0.52 for Japan and Taiwan and a bit higher, 0.6, for Korea. The average age is similar across countries, 40-42. The share of the college-educated is 0.66 for Japan, which is similar to the national statistics, while it is higher for Taiwan and Korea, 0.85 and 0.92. In the latter two countries, high-educated workers are oversampled. In all three countries, marital status and parents' education are similar to each other. The share of the self-employed is 0.14 for Japan, 0.2 for Taiwan, and 0.28 for Korea. The average monthly earnings are the highest for Korea, 4,816 USD, while Japan and Taiwan are very similar, at about 4,200 USD. Hours worked are long in all three countries, on average, 45-48 hours per week.

3.2 Heritability of Alcohol Tolerance

Alcohol tolerance is a genetic trait inherited from parents. Since we want to examine the effect of the genetic trait on drinking behavior and labor-market outcomes, an obvious concern about identification is that there are confounding effects by parents' characteristics and family background. As AT is a genetic trait, AT men are more likely to have AT parents,

and the effect of one's own type can be confounded with those of parents' type and parents' behavior. To deal with this problem, we collected information about the alcohol tolerance of respondents' parents, based on the respondents' memory (parents' phenotype about alcohol tolerance).[8] Since the questions are asked retrospectively about parents during the respondents' adolescence, and since some respondents did not want to reveal information about their parents, there is a non-ignorable number of missing responses. In Japan, 8% of respondents did not report the mother's type and 3% did not report father's type. The missing data problem is more severe for Taiwan, where 19% did not report the mother's type and 12% the father's type. In the sample of Korea, however, only 1% did not report the mother's type and 2.3% the father's type. The results below should be taken cautiously because of missing data.

Table 2 tabulates the distribution of the AT type by the father's and the mother's types. We find that among Japanese men who responded that both parents were the AIT type, the share of the AT type is 0.26. In contrast, among those who responded that both parents were the AT type, the share of the AT type is much higher, 0.79. We find similar results for Taiwan and Korea. We find a statistically significant correlation between the respondent's own type and the father's type in all three countries. The partial correlation between the respondent's own and the mother's type, however, is not statistically significant in Taiwan and Korea. This is probably because the statistical power is low due to missing data for Taiwan and a small sample size for Korea. At least, the significant correlation with the father's type confirms that the types are genetically transmitted, as indicated in the medical literature (McClearn and Kakihana, 1981; Martin et al., 1985; Heath and Martin, 1992; Bierut et al., 1998; Heath et al., 1999; Prescott and Kendler, 1999; Schuckit et al., 2001a; Kendler et al., 2003; Mayfield et al., 2008).

We further examine the partial correlations of own gene type and background character-

[8]The exact question is "Which of the following best describes the alcohol tolerance of your father?" The possible responses are 1) His physical trait does not allow any drinking of alcohol, 2) His physical trait allows only a little alcohol drinking, 3) His physical trait allows alcohol drinking without any issue, or 4) Do not want to or cannot answer. The question was asked about the mother in the same way.

istics, including parental gene types. Specifically, we regress the indicator for the AT type on a set of parental types and missing value indicators, in addition to background characteristics. The results are reported in Table 3. We find that parental gene types are essential determinants of one's own gene type, which again confirms the heritability of the trait, as we found in Table 2.[9] It is notable that, conditional on parental gene types, none of demographic characteristics can explain respondents' own gene type, though they are jointly significant for Taiwan. This finding suggests that the gene type is independent of age, marital status, parental education, and own education.

In our main regression analysis, to address the above concern that we might capture the effect of parents' types rather than the respondent's own type, we control for parents' types (both the father's and the mother's) and also the indicators for missing parental types (one for the father and another for the mother). Therefore, we exploit arguably exogenous variation in one's genetic type conditional on parents' types.

4 Empirical Model and Results

4.1 Empirical Model

We estimate the effects of the genetic trait of alcohol tolerance on drinking behavior and labor-market outcomes. Assuming that one's gene type is random, conditional on a set of individual characteristics and parents' gene types, our estimation model is as simple as follows:

$$drink_i = \alpha\ tolerant_i + X_i\delta + u_i \tag{1}$$

and

[9]The results show that having missing values for parental types is positively correlated with one's own type. We do not know how to interpret the results, but one possibility is that tolerant parents drink too much and their children do not want to reveal that fact.

$$labor_i = \beta\ tolerant_i + X_i\zeta + v_i, \tag{2}$$

where the dependent variable in Equation (1), $drink_i$, is a measure of the drinking behavior of individual i, such as frequency and intensity of alcohol consumption.[10] The dependent variable in Equation (2), $labor_i$, is a measure of labor-market outcomes; we look at two measures: annual earnings in the previous year and hours worked in the last week. Since our sample consists of workers, we take the natural logarithm of both variables, so that one can infer the results for hourly wages. In both equations, the key explanatory variable is $tolerant_i$, which is the indicator variable that takes 1 if the person is classified as the AT type, and 0 otherwise.[11]

The vector, X_i, includes a constant, age, age squared, own education (2-year college or higher), parents' education, and parents' gene types. As mentioned before, a potential threat to causal identification arises from the fact that alcohol tolerance is inherited from parents; AT men are more likely to have AT parents, as also confirmed in our sample in Table 2. This raises a concern about omitted variable bias. The genetic type of alcohol tolerance and parental drinking behavior could be correlated, and parental drinking behavior may affect family environments. This correlation could bias our estimate, because early family environments affect labor-market outcomes (Brunello et al., 2017). To address this potential concern, we control for parents' gene types as additional controls.

The causal effects of the gene type on drinking and labor-market outcomes should be unbiasedly and consistently estimated if the conditional mean assumptions hold; $E(u_i|tolerant_i, X_i) = 0$ and $E(v_i|tolerant_i, X_i) = 0$. These assumptions should hold if the gene type is not systematically correlated with unobserved determinants of drinking or labor-market outcomes, conditional on X_i including parents' types. The lack of systematic differences in the observ-

[10] As we will explain in the next subsection, we look at 4 different measures of drinking behavior: 1) the number of days the respondent drinks in a typical week, 2) the average amount of alcohol intake in a typical week, 3) binge drinking, and 4) whether the respondent drinks or does not drink at all.

[11] One may be concerned that the genetic trait of alcohol tolerance should be measured with errors. Please see the Appendix B regarding potential bias due to measurement errors in the binary explanatory variable.

able characteristics of respondents between the AT and AIT types, conditional on parental types, reported in Table 3 supports that these assumptions are likely to hold.

4.2 Alcohol Tolerance and Drinking

In this subsection, we check whether the genetic trait of alcohol tolerance affects drinking behavior. It might be obvious that those who can tolerate alcohol drink more than those who cannot digest it, but we think that it is important to check this relationship. Although we do not attempt to estimate the causal effect of drinking on labor-market outcomes, if the genetic trait of alcohol tolerance affects both drinking and labor-market outcomes, drinking should be a major channel for the labor-market effect of the genetic trait. Thus it is necessary to check whether the genetic trait of alcohol tolerance affects drinking.

It is not easy to measure drinking behavior accurately. Therefore, in our surveys, we asked detailed questions about drinking in various ways, such as the usual drinking amount and drinking in the last week. Using the responses to the questions, we construct four variables representing drinking behavior: 1) the number of days the respondent drinks in a typical week, 2) the average amount of alcohol intake in a typical week, 3) binge drinking and 4) whether the respondent drinks or does not drink at all. As a measure of the quantity of drinking per occasion, we asked about the typical amount of drinking by each type of alcohol beverage, such as beer, sake, shochu, wine, whiskey, and other varieties; in total, there are 14 different kinds for Japan and 16 kinds for Taiwan. In contrast, in the case of Korea, to minimize the response burden, we asked questions about the two most common types, beer and soju. The responses are recorded in the unit of bottle or liter. We converted and aggregated the quantities into the pure ethanol amount, using the typical alcohol contents of each variety. To capture the intensity of drinking per episode, we use the indicator of whether the respondent drinks five glasses or more within two hours and refer to those who do so as "binge drinkers."[12] Finally, we examine the drinking decision at the extensive margin

[12]Many studies have found negative impacts of binge drinking on health. For example, Welch (2017) points out that binge drinking can induce potentially severe impairments in memory and executive function,

by the indicator variable of whether the respondent drinks at least once in a typical week.

We examine the differences in drinking behavior by the genetic type of alcohol tolerance that we identify from the alcohol patch test. Table 4 reports the average number of drinking incidents per week in the three countries. In Columns (1) and (2), for Japan, we find that AT men drink on 3.5 days per week, while AIT men drink on 1.8 days. We find similar results for Taiwan and Korea. The data show, however, that both AT and AIT men in Taiwan and Korea drink less often than Japanese men, and the differences between the gene types are smaller. One plausible reason is that respondents in Taiwan and Korea are more educated than those in Japan, as we oversampled the college-educated in the first two countries.

The second row of Panel A in Table 4 presents the average pure alcohol intake by the gene type of alcohol tolerance. Again we find that for Japan, AIT men consume about 17.8 milliliter (ml) of pure alcohol per day, while AT men intake 37.7 ml (in the case of beer, the alcohol content is 5%, so the average amount of alcohol intake for AT men corresponds to about 700 ml, i.e., two regular cans of beer). We also find similar results among Taiwanese and Koreans, but with a lesser amount in terms of the level. For Taiwan, AIT men drink 4.2 ml, while their AT counterparts drink 10.5 ml. For Korea, AIT men drink 15.4 ml and AT men drink 26.2 ml .[13]

The third row of Table 4 presents the share of binge drinkers, who drink five glasses or more within two hours, in each country by the gene type of alcohol tolerance.[14] The results show that binge drinkers are more prevalent among AT men in all three countries. This finding is consistent with the well-known fact that those with ALDH2*2, and thus those who are intolerant of alcohol consumption, drink less and consequently are protected from alcohol abuse (Dasgupta, 2017).

and Okoro et al. (2004) reveals that it can also induce mental distress, including stress reactions, depression, and emotional problems. Wechsler et al. (1994) find that binge drinkers are likely to have various behavioral problems. Later, we will check whether excluding binge drinkers affects our regression results.

[13]According to statistics from the Ministry of Health and Welfare of Korea (2018), beer and soju account for 86.7% of total alcohol consumption. If we impute total alcohol consumption for our sample based on the average share of beer and soju, alcohol consumption is 17.7 for AIT men and 30.2 for AT men.

[14]The National Institute on Alcohol Abuse and Alcoholism in the US uses this definition of binge drinking for males.

Lastly, the fourth row of Table 4 presents the share of "drinkers," those who drink any alcohol in a typical week. The results are similar as before; AT men are more likely to drink alcohol than AIT men. One intriguing finding is that the share of drinkers is much higher in Korea than in Japan or Taiwan. It is notable that the share of drinkers is 82% even among AIT men. In fact, we find that the share of binge drinkers is also much higher in Korea compared to Japan and Taiwan. About 90% of Korean AT men are binge drinkers and the share is 75% even for AIT men. The results are in stark contrast with those in Japan and Taiwan, where the share of binge drinkers is 28% in Japan and 35% in Taiwan even among AT men.[15]

We attempt to confirm the results from unconditional mean comparison by the regression analysis after controlling for individual characteristics and, more importantly, parents' alcohol tolerance. Table 5 presents the results of alcohol drinking behaviors on the indicator for the AT type, controlling for age, age squared, married, never-married, college or post-graduate degree holdings, parents' education (college or higher), and parents' alcohol tolerance types (and their missing value indicators). The results show that the regression-adjusted gaps in drinking behavior between the AT and AIT types are very similar to the unconditional gaps reported in the previous table.

In sum, the gene type identified from the alcohol patch test is a strong predictor of drinking behaviors in all three countries. One possible reason for why AT men drink significantly more than AIT men is the presence of a positive economic return to drinking.[16] In the next section, we examine the effect of the genetic trait on labor-market outcomes.

[15]The results here imply that the culture of drinking is very different across countries, especially between Korea and the other two countries. We compare the drinking cultures of Taiwan and Korea in Appendix D. We find that, compared to Taiwanese, Koreans are more likely to feel social pressure to drink and engage in excessive drinking.

[16]The genetic trait may affect lifetime outcomes through various channels. One possible channel is that the genetic trait affects the age at first drink, and this may significantly affect subsequent behavior and outcomes. For Taiwan and Korea, we added a new question asking the age at first drink. We checked if the genetic ability to drink initiates drinking earlier. The earlier men start drinking, the more outcomes the genetic trait could affect. For example, if those with a higher ability to drink alcohol are more likely to start drinking, for example, when they are students, the genetic ability may affect schooling and academic achievement. The results show that AT men in Taiwan start drinking a little bit earlier by 0.8 year (p-value = 0.02), while there is no significant effect for Korea (the point estimate is 0.04 and p-value = 0.79).

4.3 Alcohol Tolerance and Labor-Market Outcomes

We now examine whether the genetic trait of alcohol tolerance affects labor-market outcomes. Specifically, we look at monthly earnings and the number of hours worked in the last week.[17] Table 6 presents the regression results of labor-market outcomes on the genetic type for the three countries. Columns (1) and (2) present the results for Japan, earnings and hours, respectively. The results show that AT men earn 3.4% *less* per month and work 3.1% less per week. The finding of a negative effect of alcohol tolerance on earnings is not consistent with the hypothesis that there is a positive return to drinking and that being able to tolerate alcohol is an advantage in the labor market. Both estimates for earnings and hours are not statistically significant. Columns (3) and (4) show the results for Taiwan. We also find no statistically significant effect on earnings or hours.

In contrast, for Korea, we find that AT men earn more than AIT men. Although the estimate is marginally significant at the 10% level, the effect is rather large, 11.5%, amounting to almost one third of the college earnings premium.[18] We also find that AT men work shorter hours than AIT men, but the difference is not statistically significant. One possible explanation is that there is a positive return to the genetic trait in Korea but no relevant advantage in Japan and Taiwan. We try to substantiate this conjecture by looking at cross-country differences in beliefs about the benefits and costs of drinking in Section 4.5.

Regarding the lack of statistical significance in the results for Japan and Taiwan, one may be concerned about poor measurement of monthly earnings or weekly hours. We think, however, that this is unlikely to be true. If the measurement errors in the dependent variable had been really severe, we would have had imprecise estimates for the other variables in the regression model. Note that our regression model includes the standard variables in the

[17]For Japan and Taiwan, we asked for annual earnings in the previous year, including bonus payments. For Korea, we directly asked for monthly earnings. But earnings are reported in intervals for Korea, so we converted them to a continuous measure by using the midpoint of each interval. For the top interval, we imposed the average interval range and calculated the midpoint. We checked the results from using categorical values in the raw data and found that the results are consistent.

[18]Earnings are recorded in intervals for Korea. Thus we checked the robustness of the results by using categorical dependent variable models, such as ordered Probit or Logit, and found that the results hardly changed. The results are available upon request.

Mincer wage equation, such as education, age, and age squared. But in Table 6, for earnings, we find statistically significant estimates for these variables in all three countries. As our further defense against the argument of measurement error, in Appendix E, we present the estimates for the same variables in the standard Mincerian wage equation, such as age, age squared, and education (the indicator for 2-year college or higher) based on our data set and the nationally representative data set. We confirm that the estimates from our survey data are quite consistent with the estimates from nationally representative data. The results at least partially relieve our concern about measurement error.[19]

4.4 Robustness Checks

We conduct four robustness checks, and Table 7 summarizes the results. First, we restrict our sample to wage workers. As seen in Table 1, 14-28% of respondents in our sample are self-employed. Earnings are more systematically determined for wage workers, while earnings of the self-employed are more influenced by macroeconomic conditions, such as business cycles. Therefore, if the genetic ability of digesting alcohol affects labor-market outcomes through any specific mechanism, such an effect can be more easily detected among wage workers. In Panel A, we find that the results are similar to what we found for all workers. For earnings, AT men earn less in Japan and more in Taiwan, but both estimates are insignificant. For Korea, AT men earn more by 7.1%, but the finding is not statistically significant, perhaps because of the small sample size. Across the three countries, we do not find any significant effect on hours worked.

Second, in Panel B, we exclude heavy drinkers. A major channel of the effect of the genetic trait on labor-market outcomes should be drinking. As some previous studies have pointed out, the effect of drinking can be nonlinear (inverted U-shaped), mainly due to the negative effect from heavy drinkers (van Ours, 2004; Tekin, 2004). This can explain the insignificant effect for Japan and Taiwan: AT men are generally advantaged in the labor

[19]We also discuss potential bias due to measurement errors in our measurement of the genetic trait in Appendix B.

market, but they are also more likely to be heavy drinkers and end up with lower earnings. To check this possibility, we exclude those who drink more 100 ml per day (in terms of beer, almost 6 cans as the daily average). The results in Panel B show that the genetic trait of alcohol tolerance still has no significant effect on labor-market outcomes in Japan and Taiwan. But the effect becomes larger and statistically significant for Korea, which means that the previous estimates are underestimated because of heavy drinkers with lower earnings.

In Panel C, we check the robustness of our results by additionally controlling for job characteristics. Specifically, we control for the following variables: the indicator for the self-employed(Shane et al., 2010; Brandstätter, 2011; Caliendo et al., 2014), the indicator for jobs requiring interpersonal skills, and two indicators for firm size (three groups in each country).[20] Note that job characteristics might be the consequences of the genetic trait, because people sort themselves into jobs based on their skills, including the ability to drink. Thus, by controlling for job characteristics, we conduct a kind of mediation analysis. We find, however, that the results do not change much. This means that especially for Korea, the effect of the genetic trait could occur in some channels other than job characteristics.

Lastly, we restrict the sample to relatively younger workers. This subsample analysis also checks if the effect of the genetic ability to drink matters differently over age. It seems reasonable to assume that the innate ability should matter more for younger workers as they extend their social network and develop their career. Here we focus on workers younger than 50 years old. It turns out that the results in Panel D are not different from our main results. We find again no effect for Japan. The estimate for Japan is even negative. For Taiwan, the estimate is close to zero. It is possible that older cohorts might have a positive economic return to drinking in Taiwan. For Korea, the estimate is positive but not significant.

[20]The variable for interpersonal skills is based on the response to the question of "How important are interpersonal skills for your job?" and the variable is one if the response is "Strongly agree.". Firm size is measured by the number of coworkers. For each country, we divide all respondents into three quantile groups and control for two indicators; medium- and large-sized firms.

4.5 Perceived Benefits of Drinking: Differences across Countries

In this subsection, we examine whether the heterogeneous results on the return to alcohol tolerance across the three countries are consistent with cross-country cultural differences regarding perceptions about alcohol drinking. The underlying hypothesis is that drinking as a social activity should have different cultural meanings across different countries.

In our survey, we asked a series of questions about the potential benefits and costs of drinking. Specifically, we asked about potential channels in which drinking might directly affect labor-market outcomes. We also asked about indirect channels through which drinking could enhance productivity via its effects on physical or mental health. All the questions are formatted in the same way. If the respondent thinks there is no effect of drinking on a particular channel, then he can skip the question (for Japan and Taiwan) and choose "None" (for Korea). There are 8 potential channels in the survey and among them, the following four are directly related to work performance: whether drinking helps social networking, communication with coworkers, or superiors or facilitating business negotiation, and whether drinking is a waste of time and interfering with work.[21] The first three are positive channels through which drinking may increase work performance, while the last is a negative channel. In addition, we asked four more questions about the potential effects of drinking on physical and mental health. These questions were asked in the same way as the first four; whether drinking is good for physical health, bad for physical health, good for mental health, and bad for mental health. We asked about physical health and mental health and asked for each twice in the positive way and in the negative way. Also, we constructed additional indicators for those who believe drinking is neither good nor bad for their physical or mental health. That is, they do not believe that drinking affects labor-market outcomes via health. Lastly, we asked a separate question about whether the respondent believes that drinking plays a role of mitigating stress or depression. While the first eight questions were asked regarding the relationships between drinking and work performance, the last question was asked about

[21] There are 9 questions in Japan and Taiwan, because the questions about communication with coworkers and that with superiors are asked separately.

the effect of drinking in general.[22]

Figure 4 shows the share of respondents who agreed with each question by country. We find that, in all three countries, the majority of respondents think that drinking helps social networking with others. Also, more than 40% agree that drinking makes it easier to communicate with coworkers or supervisors. For both questions, we find that the share of those with a positive view on drinking is higher in Korea than in the other two countries. The differences between Korea and the other two countries are also found in the next two questions: whether drinking helps business negotiations and whether drinking is a waste of time. Only 17% and 33% of Japanese and Taiwanese respondents think that it helps business negotiation, while 71% of Koreans think so. Not many respondents think that drinking is a waste of time or interferes with their work. Somewhat ironically, we find that Koreans who tend to state that drinking has a positive social role are more likely to hold a negative view of drinking than Japanese or Taiwanese.

Next, regarding the effect of drinking on health, we find that a small share of respondents (less than 10% in all three countries) think that drinking improves their physical health. In contrast, about 20% of Japanese and Taiwanese respondents, respectively, believe that drinking has negative physical effects, but surprisingly, nearly 80% of Koreans think so. This is somewhat consistent with the negative view of Koreans that drinking is a waste of time and interferes with their work. This compares with the finding that about 70% of Japanese and Taiwanese respondents think drinking is neither good nor bad for physical health. In contrast to physical health, more respondents think that drinking is beneficial for mental health. About 40-50% of respondents think that drinking is good for mental health. However, similar to physical health, Koreans think drinking is bad for mental health, while more of Japanese and Taiwanese believe it is neither good nor bad. Lastly, about one third of respondents in three countries think that drinking can mitigate mental stress and anxiety in general.

[22]Online Appendix A presents the English-translated questionnaires from the three countries. We present the results from all the questions about attitudes toward drinking, rather than cherry picking the results.

Overall, our three-country comparison reveals that attitudes in Korea differ from those in Japan and Taiwan. Koreans think that drinking helps their business and social relationships in their workplace, but at the same time, they also believe that drinking is a waste of time and bad for health. That is, it seems that there is a positive return to drinking in the labor market, while it is costly in terms of time and health.[23] In other words, drinking is an investment for job-specific human capital. For Japanese and Taiwanese, in contrast, drinking is instead regarded as a form of consumption according to individual preferences.

5 Conclusion

In this study, we estimated the causal impact of alcohol tolerance on drinking behavior and labor-market outcomes, exploiting heterogeneity in the genetic trait of alcohol tolerance among East Asians. We conducted our original surveys covering about 2,000, 1,000, and 500 prime-age men in Japan, Taiwan, and Korea, respectively. Our data show that those men who are genetically tolerant to alcohol tend to drink more in terms of both frequency and intensity of drinking. The results are consistent across all three countries. We failed, however, to find any systematic evidence that the genetic trait of alcohol tolerance affects labor-market outcomes across three countries. While alcohol-tolerant men earn more than alcohol-intolerant men in Korea, we do not find any significant effect for Japan and Taiwan. The results imply the absence of a common physiological mechanism through which alcohol tolerance affects labor-market outcomes across the three countries. It is universally true that not everyone enjoys drinking and that the preference is determined genetically to an extent. Whether the genetic ability to digest alcohol is used as an advantage in the labor market, however, should differ across cultures and institutions. Implementing a similar estimation based on the genome data matched with administrative earnings records in East Asia is an agenda for future research.

[23]The results also imply that the positive return to alcohol tolerance on labor-market outcomes is likely to be due to a business culture that emphasizes business communication with alcohol, rather than a physiological mechanism that alcohol intake enhances labor productivity.

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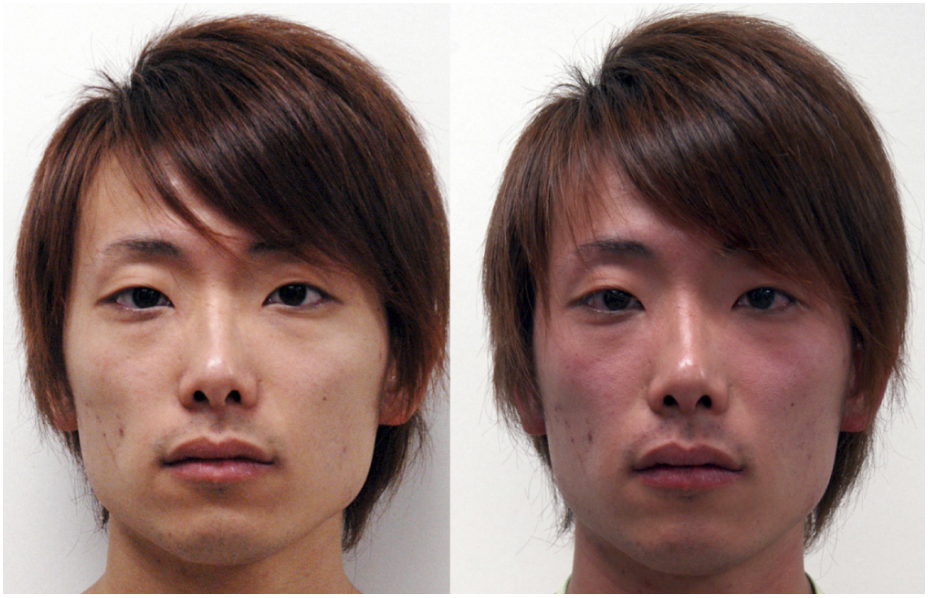
Figure 1: Asian Flushing Syndrome

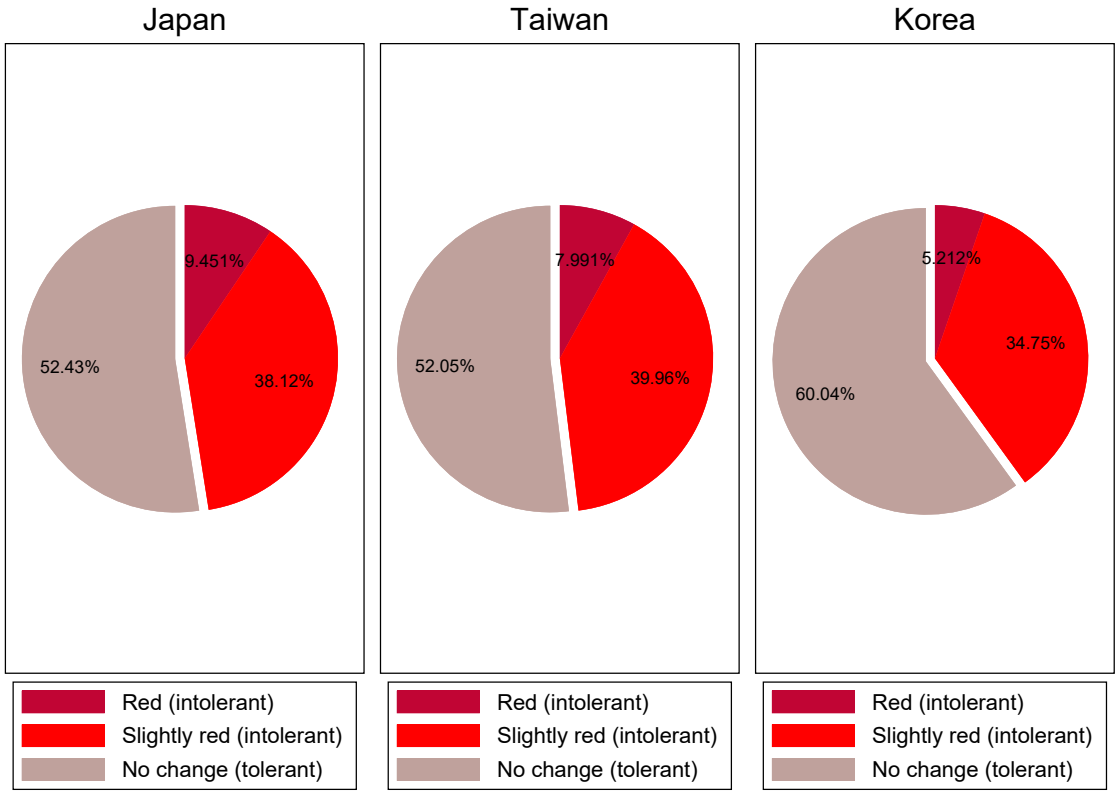


Note: Brooks PJ, Enoch M-A, Goldman D, Li T-K, Yokoyama A (2009) The Alcohol Flushing Response: An Unrecognized Risk Factor for Esophageal Cancer from Alcohol Consumption. PLoS Med 6(3): e1000050. doi:10.1371/journal.pmed.1000050.

Figure 2: Alcohol Patch Test

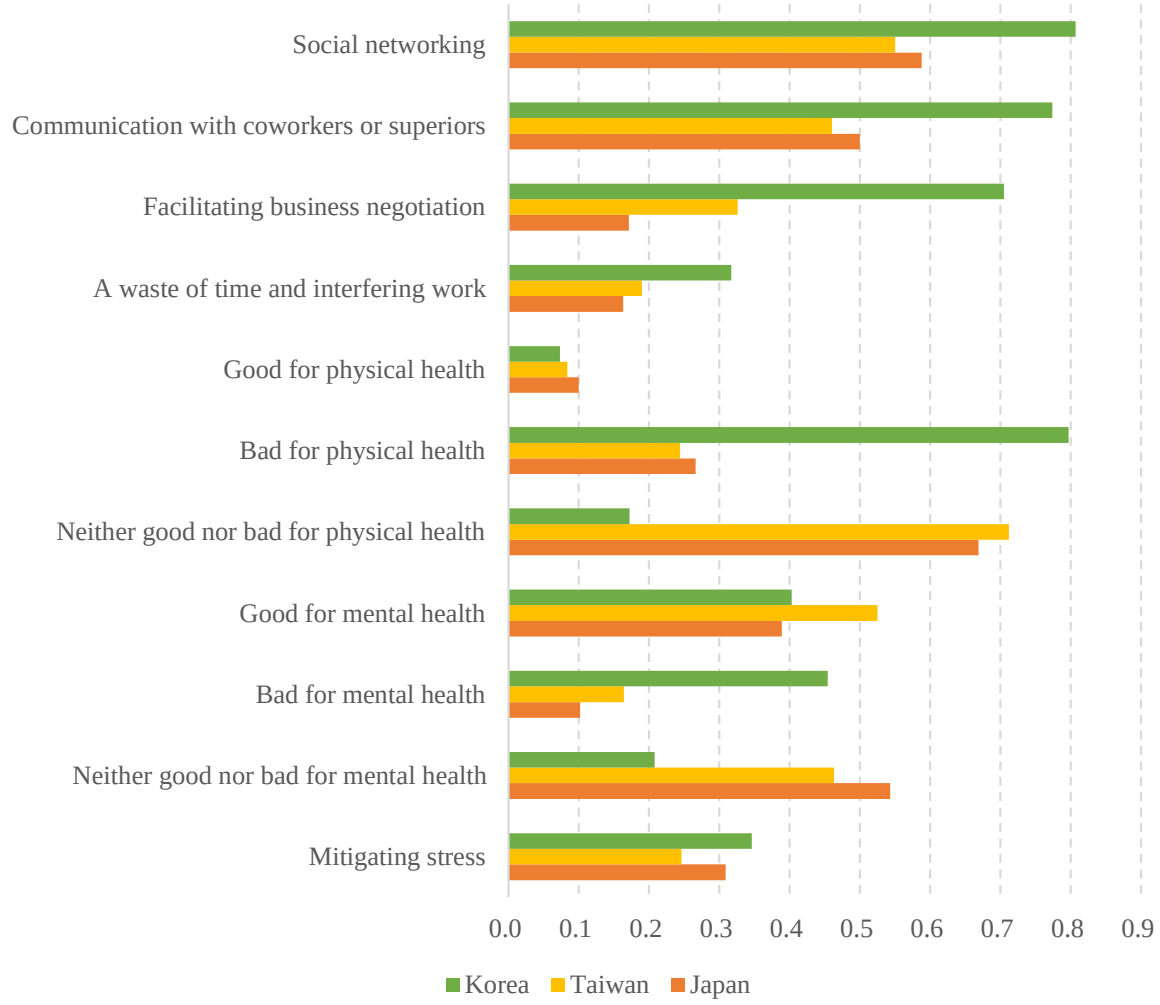
Note: Picture provided by Life Care Giken Inc. Left panel: the alcohol patch with color scale. Middle panel: the patch adhered to the skin. Right panel: change of the skin color after peeling off the patch. http://lifecare-giken.co.jp/goods/index3.html accessed on July 18, 2020.

Figure 3: The Distribution of Skin Colors after the Alcohol Patch Test



Note: The graph is based on the results of the alcohol patch test.

Figure 4: Perceived Benefits of Drinking



Note: Fraction of respondents who agree with the statement regarding the effect of drinking alcohol.

Table 1: Descriptive Statistics

	(1) Japan	(2) Taiwan	(3) Korea
AT type (alcohol tolerant)	0.52	0.52	0.60
	(0.50)	(0.50)	(0.49)
Age	42.3	41.9	40.2
	(9.4)	(9.7)	(9.1)
College education	0.66	0.85	0.92
	(0.48)	(0.35)	(0.28)
Married	0.61	0.62	0.57
	(0.49)	(0.49)	(0.50)
Never married	0.34	0.32	0.41
	(0.47)	(0.47)	(0.49)
Father college	0.31	0.26	0.37
	(0.46)	(0.44)	(0.48)
Mother college	0.20	0.15	0.19
	(0.40)	(0.36)	(0.40)
Self-employed	0.14	0.20	0.28
	(0.35)	(0.40)	(0.45)
Monthly earnings	4,204	4,211	4,816
	(2,462)	(2,473)	(3,346)
Weekly hours worked	46.1	47.5	44.5
	(13.0)	(12.2)	(20.0)
Observations	1,894	926	518

Note: Standard deviations are in parentheses. For marital status, the excluded group is that of the divorced, widowed, or separated. Monthly earnings are converted to PPP USD. College education includes 2-year college. Our collected data oversampled higher-educated and higher-earning men for Taiwan and Korea. The percentage of college-educated workers is 43% from the Taiwanese Manpower Utilization Survey 2018 and 66% from the Korean CPS data 2017.

Table 2: The Distribution of Alcohol Tolerance Type by Parents' Types

	Japan N = 1,894		Taiwan N = 926		Korea N = 518	
	Mother		Mother		Mother	
Father	Intolerant	Tolerant	Intolerant	Tolerant	Intolerant	Tolerant
Intolerant	0.26	0.40	0.36	0.37	0.44	0.50
	(461)	(189)	(172)	(93)	(177)	(28)
Tolerant	0.55	0.79	0.56	0.67	0.69	0.73
	(598)	(463)	(189)	(267)	(247)	(51)
Chi-square test for independence						
with the father's type	100.79		15.22		19.59	
	p<0.01		p<0.01		p<0.01	
with the mother's type	12.65		0.03		0.10	
	p<0.01		p=0.86		p=0.75	
Father's type missing	3.30%		12.20%		2.32%	
	(63)		(113)		(12)	
Mother's type missing	8.08%		18.57%		0.97%	
	(153)		(172)		(5)	

Note: The upper panel presents the fraction of AT-type respondents. The number of observations is in parentheses. The observations with missing parental types are excluded. The middle panel presents the results from the Chi-square test for independence between the respondent's own type and each parent's type. The bottom panel presents the percentage of missing values for parents' type and the number of missing observations in parentheses.

Table 3: Determinants of the Genetic Type of Alcohol Tolerance

	(1)	(2)	(3)	(4)	(5)	(6)
	Japan		Taiwan		Korea	
Tolerant father	0.323	0.323	0.253	0.257	0.244	0.236
	(0.023)	(0.023)	(0.036)	(0.036)	(0.044)	(0.045)
Tolerant mother	0.215	0.215	0.071	0.063	0.053	0.036
	(0.023)	(0.023)	(0.036)	(0.036)	(0.057)	(0.057)
Father type missing	0.267	0.268	0.052	0.056	0.247	0.246
	(0.065)	(0.065)	(0.062)	(0.062)	(0.133)	(0.143)
Mother type missing	0.133	0.134	0.081	0.076	0.313	0.354
	(0.043)	(0.043)	(0.051)	(0.050)	(0.056)	(0.087)
Age		0.005		-0.017		0.019
		(0.011)		(0.017)		(0.023)
Age squared/100		-0.005		0.013		-0.029
		(0.013)		(0.019)		(0.027)
Married		-0.070		0.000		-0.066
		(0.049)		(0.065)		(0.122)
Never married		-0.057		-0.014		-0.040
		(0.052)		(0.070)		(0.129)
College educated		-0.005		-0.031		0.145
		(0.023)		(0.048)		(0.082)
Father college		0.034		-0.023		0.026
		(0.027)		(0.043)		(0.053)
Mother college		0.024		0.052		-0.060
		(0.033)		(0.054)		(0.065)
Constant	0.235	0.166	0.329	0.815	0.442	0.079
	(0.018)	(0.233)	(0.031)	(0.345)	(0.036)	(0.477)
Observations	1,894	1,894	926	926	518	518
R-squared	0.155	0.158	0.066	0.079	0.068	0.089

Note: Heteroskedasticity robust standard errors are in parentheses. Explanatory variables include age, age squared, married, never married, college educated, father's college, and mother's college.

Table 4: Mean Differences in Drinking and Labor-Market Outcomes by Alcohol Tolerance

	(1)	(2)	(3)	(4)	(5)	(6)
	Japan		Taiwan		Korea	
	AT	AIT	AT	AIT	AT	AIT
A. Drinking behavior						
Drink incidents per week	3.52	1.81	0.94	0.67	1.94	1.56
	(2.60)	(2.27)	(1.49)	(1.27)	(1.41)	(1.24)
Alcohol consumption per day	37.7	17.8	10.5	4.2	26.2	15.4
	(54.3)	(48.2)	(29.9)	(13.0)	(26.1)	(19.3)
Binge drinking	0.28	0.10	0.35	0.19	0.90	0.75
	(0.45)	(0.29)	(0.48)	(0.40)	(0.30)	(0.43)
Drinker	0.84	0.58	0.44	0.34	0.91	0.82
	(0.37)	(0.49)	(0.50)	(0.48)	(0.29)	(0.38)
B. Labor-market outcomes						
Earnings	4244.4	4158.6	4124.3	4305.6	4815.4	4817.5
	(2552.7)	(2357.8)	(2144.1)	(2786.2)	(3194.2)	(3569.2)
Hours worked	45.80	46.34	47.84	47.14	44.32	44.87
	(13.44)	(12.53)	(12.32)	(11.97)	(19.98)	(20.07)
N =	993	901	482	444	311	207

Note: Standard deviations are in parentheses.

Table 5: Effects of Alcohol Tolerance on Drinking

	(1) Drinking incidents	(2) Alcohol intake	(3) Binge drinking	(4) Drinker
A. Japan				
AT	1.581	16.997	0.170	0.228
	(0.119)	(2.642)	(0.019)	(0.022)
Mean among AIT	1.81	17.83	0.10	0.58
Observations	1,894	1,894	1,894	1,894
R-squared	0.168	0.057	0.072	0.103
B. Taiwan				
AT	0.221	6.130	0.137	0.086
	(0.092)	(1.662)	(0.030)	(0.033)
Mean among AIT	0.67	4.23	0.19	0.34
Observations	926	926	926	926
R-squared	0.084	0.081	0.056	0.039
C. Korea				
AT	0.335	9.722	0.118	0.072
	(0.126)	(2.120)	(0.035)	(0.032)
Mean among AIT	1.56	15.35	0.75	0.82
Observations	518	518	518	518
R-squared	0.060	0.087	0.078	0.038

Note: Heteroskedasticity robust standard errors are in parentheses. Explanatory variables include age, age squared, married, never married, college educated, father's college, and mother's college.

Table 6: Effects of Alcohol Tolerance on Earnings and Work Hours

	(1)	(2)	(3)	(4)	(5)	(6)
	Japan		Taiwan		Korea	
	Earnings	Hours	Earnings	Hours	Earnings	Hours
AT	-0.034	-0.031	0.020	0.004	0.115	-0.027
	(0.043)	(0.019)	(0.031)	(0.020)	(0.061)	(0.083)
College	0.235	0.047	0.390	-0.045	0.376	0.135
	(0.039)	(0.020)	(0.046)	(0.039)	(0.145)	(0.192)
Age	0.104	0.027	0.089	0.020	0.195	0.130
	(0.020)	(0.010)	(0.015)	(0.010)	(0.039)	(0.056)
Age squared/100	-0.106	-0.032	-0.090	-0.029	-0.203	-0.152
	(0.023)	(0.011)	(0.017)	(0.012)	(0.046)	(0.064)
Observations	1,894	1,894	926	926	518	518
R-squared	0.166	0.029	0.209	0.026	0.349	0.103

Note: Heteroskedasticity robust standard errors are in parentheses. Explanatory variables include age, age squared, married, never married, college educated, father's college, and mother's college.

Table 7: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)
	Japan		Taiwan		Korea	
	Earnings	Hours	Earnings	Hours	Earnings	Hours
A. Wage workers	-0.007	-0.035	0.039	0.007	0.071	-0.036
	(0.039)	(0.019)	(0.032)	(0.021)	(0.046)	(0.053)
Observations	1,626	1,626	740	740	372	372
R-squared	0.218	0.029	0.209	0.033	0.262	0.039
B. No heavy drinkers	-0.044	-0.030	0.020	0.005	0.121	-0.025
	(0.044)	(0.020)	(0.031)	(0.020)	(0.061)	(0.083)
Observations	1,768	1,768	916	916	511	511
R-squared	0.173	0.028	0.208	0.024	0.351	0.105
C. Job characteristics	-0.037	-0.035	0.018	0.006	0.106	-0.031
	(0.042)	(0.019)	(0.030)	(0.020)	(0.057)	(0.079)
Observations	1,889	1,889	912	912	518	518
R-squared	0.221	0.048	0.257	0.033	0.429	0.215
D. Younger than 50	-0.014	-0.025	0.004	-0.004	0.086	-0.074
	(0.049)	(0.024)	(0.034)	(0.020)	(0.068)	(0.097)
Observations	1,391	1,391	673	673	416	416
R-squared	0.170	0.033	0.200	0.031	0.370	0.132

Note: Heteroskedasticity robust standard errors are in parentheses. Explanatory variables include age, age squared, married, never married, college educated, father's college, and mother's college.

A Potential Violation of the Exclusion Restriction

This section explains why we did not implement the instrumental variable estimation using bio-marker as the IV. For the estimand of the IV estimator to be the local average treatment effect, the independence of the IV, the exclusion restriction, the non-zero effect of IV on treatment, and the monotonicity assumptions should hold (von Hinke et al., 2016). Among these four assumptions, we doubt that the exclusion restriction is unlikely to hold. Let us denote Y as the labor-market outcome, X as the binary indicator for alcohol consumption, and Z as the binary indicator for alcohol tolerance. With these notations, the exclusion restrictions are $Y_i(X_i = 0, Z_i = 0) = Y_i(X_i = 0, Z_i = 1)$ and $Y_i(X_i = 1, Z_i = 0) = Y_i(X_i = 1, Z_i = 1)$. We doubt that the latter assumption is violated, because the potential labor-market outcome with alcohol consumption for individual i may well be different depending on whether he is intolerant or tolerant. Without the exclusion restriction, the estimated IV estimate does not render a useful interpretation.

B Bias from Measurement Error in the Binary Explanatory Variable

Pischke (2007) illustrates the OLS bias due to the measurement error of the binary explanatory variable.

$$Y_i = \alpha + \beta D_i + u_i, \tag{3}$$

where D_i is the binary variable that is not observed. Instead, researchers observed a misclassified binary indicator $\tilde{D}_i$. The conditional expectations of Y_i on the observed binary explanatory variables are:

$$\begin{aligned} E(Y_i|\tilde{D}_i = 1) &= \alpha + \beta P(D_i = 1|\tilde{D}_i = 1) & (4)\\ E(Y_i|\tilde{D}_i = 0) &= \alpha + \beta P(D_i = 1|\tilde{D}_i = 0) & (5) \end{aligned}$$

The OLS estimator is the sample analogue of the difference between these two, and thus the probability limit of the OLS estimator is:

$$\text{plim}\hat{\beta} = \beta[P(D_i = 1|\tilde{D}_i = 1) - P(D_i = 1|\tilde{D}_i = 0)]. \tag{6}$$

Let $q_1 = P(\tilde{D}_i = 1|D_i = 1)$, $q_0 = P(\tilde{D}_i = 1|D_i = 0)$, $\pi = P(D_i = 1)$ and $\hat{\pi} = N^{-1}\sum_i \tilde{D}_i$. The $\text{plim}\hat{\pi} = \pi q_1 + (1 - \pi)q_0$. By Bayes' rule,

$$\begin{aligned} P(D_i = 1|\tilde{D}_i = 1) &= \frac{P(\tilde{D}_i = 1|D_i = 1)P(D_i = 1)}{P(\tilde{D}_i = 1)} = \frac{q_1\pi}{\hat{\pi}}, & (7)\\ P(D_i = 1|\tilde{D}_i = 0) &= \frac{P(\tilde{D}_i = 0|D_i = 1)P(D_i = 1)}{P(\tilde{D}_i = 0)} = \frac{(1 - q_1)\pi}{1 - \hat{\pi}}. & (8) \end{aligned}$$

Substituting these expressions into (6), we obtain

$$\begin{aligned}
\text{plim}\hat{\beta} &= \beta\left[\frac{q_1\pi}{\hat{\pi}} - \frac{(1-q_1)\pi}{1-\hat{\pi}}\right] \\
&= \beta\frac{(1-\hat{\pi})\pi q_1 - \hat{\pi}\pi(1-q_1)}{\hat{\pi}(1-\hat{\pi})} \\
&= \beta\frac{\pi[(1-\hat{\pi})q_1 - \hat{\pi}(1-q_1)]}{\hat{\pi}(1-\hat{\pi})} \\
&= \beta\frac{\pi(q_1-\hat{\pi})}{\hat{\pi}(1-\hat{\pi})}. \qquad (9)
\end{aligned}$$

The OLS estimator is consistent if $\hat{\pi} = \pi$ and $q_1 = 1$. Our estimate of $\hat{\pi}$ is 0.48 for Japan, 0.48 for Taiwan, and 0.40 for Korea, as reported in Figure 3. These estimates are roughly consistent with the figures reported in the literature on the distribution of ALDH2 types (Eng et al., 2007; Li et al., 2009). Thus the degree of attenuation bias depends on $q_1 = P(\tilde{D}_i = 1|D_i = 1)$, the probability that AIT men are tested to be AIT. Muramatsu et al. (1989) identifies the ALDH2 type based on a Polymerase Chain Reaction (PCR) analysis and relates it with the result of the alcohol patch test. Among 113 adult subjects who have deficient ALDH2, 92% were positive in the alcohol patch test. Matsuse et al. (2001) reports that among 64 subjects who are identified to have deficient ALDH2 based on a PCR analysis, all of them were positive in the alcohol patch test.[24] These studies suggest that q_1 is close to 1. In the end, we believe that the effect of attenuation bias on our result is not significant.

C Imputation of the Alcohol Patch Test Results

In this appendix, we explain how we imputed the missing values of the alcohol test result when the respondent reported that his result was ambiguous and could not be determined according to the color-type matching table given in the instruction. As explained in the text, we asked three questions about the patch test result and used two in our analysis, because the information from the other question is by and large redundant. The main question (Q1) asks for the result based on the color-type matching table. If a respondent reports one of three options, NN (tolerant), ND (sensitive), or DD (intolerant), then we assign the reported option as the respondent's type.

If the respondent could not determine his type in this first question, we utilize the next question (Q2). In the second question, we asked, "Please describe the change of your skin color in terms of a 0 to 10 scale: 0 means "no change" and 10 means "certain change." There is no missing response to this question by survey design, so we use the response to this question to impute the missing value for the first question.

First, we compute the mean score from the 0-to-10 scale question for each type for those whose types are determined by the first question. The following table presents the means and standard deviations of the scores from Q2 by country and by the response to Q1. The

[24] Tsutaya et al. (1999) questions the validity of the alcohol patch test to detect the ALDH2 2/2 (intolerant) type from the ALDH2 1/1 and ALDH2 1/2 (tolerant and sensitive) types, but our goal here is to detect the AIT type (ALDH2 2/2 and ALDH2 1/2 grouped together) from the AT type (ALDH2 1/1). Thus the goal of the study is different.

table shows that those who could not determine their type are close to the tolerant type. Their average score is between the averages of the sensitive and the tolerant types and lean toward the latter.

Table C1: Average Score of Skin Color Change by Response to Q1

	(1) Intolerant	(2) Sensitive	(3) Tolerant	(4) Ambiguous
Japan	8.7	6.0	0.6	2.0
	(1.0)	(1.8)	(1.2)	(1.8)
Taiwan	6.7	4.7	1.1	1.1
	(3.3)	(2.4)	(1.8)	(1.4)
Korea	8.7	5.6	0.9	2.0
	(1.3)	(1.4)	(1.2)	(2.6)

Note: Standard deviations are in parentheses. In Q2, the skin color change is scored using the 0 to 10 scale; 0 means "no change" and 10 means "certain change."

For those whose type is ambiguous in Q1, we impute their type by the type with the computed average that is closest to their response to Q2. For example, if a respondent in Japan reported "ambiguous" in Q1 and scored 1 for his skin color in Q2, then we assign "tolerant" as his type. After this process of imputation, every respondent belongs to one of the three types: tolerant, sensitive, or intolerant.

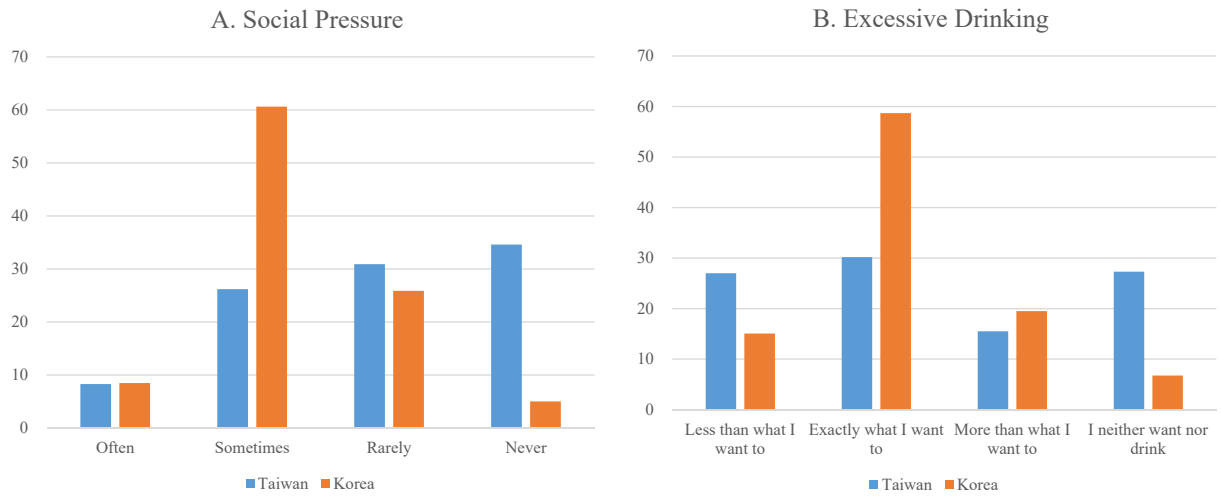
D Drinking Culture

Even though three countries are quite similar in various aspects, their drinking culture is quite different from each other. For Taiwan and Korea, we added two questions about social pressure on drinking. The first question is "Are you sometimes pressured by others or surrounding mood to drink more than you wanted to?" The response is one of the following: 1) Often, 2) Sometimes, 3) Rarely or 4) Never. The second question is "How do you compare the amount of your usual drinking to the amount that you want to drink?" The response is 1) Less than what I want to, 2) Exactly what I want to, 3) More than what I want to, or 4) I neither want nor drink. The following tables present the results.

We find that the results are different between Taiwan and Korea. Regarding social pressure to drink in Figure A, about 60% of Koreans said they are sometimes pressured to drink by others or social mood, while only 25% of Taiwanese reported so. In addition,, 35% of Taiwanese said they are never pressured, but the corresponding share for Koreans is only 5%.

Figure B shows that 59% of Koreans said that they usually drink exactly what they want to drink, while 30% of Taiwanese said so. It is interesting to find that Taiwanese are also more likely to drink less than what they would like. Lastly, it is notable that 27% of Taiwanese said they neither drink nor want to drink.

Figure 5: Peer pressure in drinking



E Validation Check for Measurement of Earnings

As a validation check for our measurement of earnings, we estimate a simple Mincerian wage equation and compare the results from our collected data with those estimated using nationally-representative data. The validation data are from the Basic Survey of Wage Structure 2014 for Japan, the Manpower Utilization Survey 2018 for Taiwan, and the Current Population Survey August Supplement 2017 for Korea. All three data sets are nationally representative and used for calculating the official national labor statistics. For this check, we restricted the data to match them to the sample we used in the paper as much as possible. We restricted the sample to working men aged 25 to 59. There are differences, however. Our sample includes the self-employed, but the validation sample does not. So here we restrict our sample to wage workers only. For Taiwan, we restricted the sample to wage workers working more than 35 hours per week. For Korea, we restricted it to those residing in urban areas.

The results in Table E1 show that the Mincerian equation estimates from our collected data are overall similar to those from the validation data. The results for Japan are remarkably similar. And the mean and median earnings are almost same between the two datasets. Also, for Taiwan and Korea, the regression results are similar between our sample and the validation data. But we find that the mean and median earnings in our sample are higher than those from the nationally representative data. This means that our samples for Taiwan and Korea overrepresent high-earnings workers.

Table E1: Validation of Earnings Data: Mincerian Equation for Wage Workers

	(1)	(2)	(3)	(4)	(5)	(6)
	Japan (2014)		Taiwan (2018)		Korea (2017)	
	Our sample	BSWS	Our sample	MUS	Our sample	CPS
College	0.307	0.266	0.410	0.314	0.242	0.336
	(0.037)	(0.021)	(0.048)	(0.007)	(0.101)	(0.012)
Age	0.109	0.079	0.090	0.065	0.144	0.113
	(0.019)	(0.002)	(0.016)	(0.003)	(0.025)	(0.006)
Age squared/100	-0.099	-0.074	-0.088	-0.064	-0.148	-0.115
	(0.022)	(0.002)	(0.019)	(0.004)	(0.030)	(0.007)
Mean earnings	4,345	4,469	4,040	2,945	4,797	3,257
Median earnings	4,071	4,024	3,519	2,627	4,116	3,024
Observations	1,626	545,418	740	9,841	372	9,006
R-squared	0.142	0.206	0.175	0.213	0.194	0.178

Note: The dependent variable is the natural logarithm of monthly earnings (PPP USD). The specification used in the paper controls for family characteristics. But not all the validation data have family variables, so we use the simplest specification. The validation data are from the Basic Survey of Wage Structure 2014 for Japan, the Manpower Utilization Survey 2018 for Taiwan, and the Current Population Survey August Supplement 2017 for Korea. Robust standard errors are in parentheses.