Empirical Analysis of the National Treatment Obligation Under the WTO: The Case of Japanese *Shochu*

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Abstract

The national treatment obligation, along with the most favored nation obligation, is an important principle of non-discrimination adopted by the World Trade Organization. It requires that foreign products be treated no less favorably than national products. This paper empirically examines the 1996 WTO recommendation that a Japanese distilled alcoholic beverage, *shochu*, be classed as a “directly competitive or substitutable product” with regard to other distilled drinks, and thus that not taxing similarly be in violation of its national treatment obligation. Demand estimates obtained from a random-coefficient discrete-choice model reveal that a substitution pattern of *shochu* is far more complicated than that presumed by the WTO. Upon the WTO recommendation, Japan made all distilled alcoholic beverages be taxable at the same level. Our simulation analysis indicates that the tax revision, while it reduced the tax revenue, improved Japanese national welfare.

*Keywords*: National treatment obligation; WTO; Random-coefficient discrete-choice model; SS-NIP test;

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1 Introduction

The national treatment (NT) obligation, along with the most favored nation (MFN) obligation, is an important pillar supporting the principle of non-discrimination at the World Trade Organization (WTO). Whereas the MFN obligation requires equal treatment for goods from different nations, the NT obligation requires the treatment of imported goods, once they have cleared customs, to be no worse than that of domestically produced goods (See for example Jackson, 1997). The NT obligation was adopted as part of the undertaking by the WTO to prevent domestic tax and regulatory policies from being used as protectionist tools that would offset its efforts to reduce border restrictions to the flow of goods. The interpretation of the NT obligation is of critical importance to WTO members, because it has a profound impact on these countries’ freedom to formulate domestic policy.

A major interpretative issue with regard to the NT obligation is to determine whether imported and domestic products are “directly competitive or substitutable,” under the stipulation of Article III.2 of the General Agreement on Tariffs and Trade (GATT) of 1994 (Grossman, Horn, and Mavroidis, 2013). While the absence of a “directly competitive and substitutable” relationship between imported and domestically produced products precludes any possibility of protectionist measures contrast to the NT provision, it is interesting to note that case law has not clarified the interpretation of the terms. As Horn and Mavroidis (2004: 43) state, the WTO has no clear methodology to offer for the interpretation of the NT obligation, let alone for determining which products might be “directly competitive and substitutable.” To the best of our knowledge, this paper is the first to offer empirical evidence on the practical implementation of the NT obligation mentioned above in an application to Japanese alcoholic beverages.

In 1995, the EU, the US, and Canada requested consultations with Japan at the WTO, under the claim that a Japanese law taxed the locally produced alcoholic beverage shochu more favorably than several other import-dominated distilled alcoholic beverages (Japan—Tax on Alcoholic Beverages (WTO, 1996b), hereafter Japan—Tax). In November 1996, Japan accepted the WTO Appellate Body’s recommendation that the complainants’ claim be considered legitimate. To comply with the recommendation, Japan revised its Liquor Tax Law in 2000. An integral issue in this dispute was whether shochu and other distilled beverages were “directly competitive and substitutable” (DCS). In the dispute settlement process, the Appellate Body found that the decisive criterion in the determination of DCS is whether two products have common end-uses (inter alia) as shown by the elasticity of substitution (WTO, 1996b: 25). This empirical issue addressed by the WTO is highly relevant for the concept of market definition often employed in the fields of industrial organization and antitrust economics. Nevertheless, to our knowledge, the economics literature has devoted hardly any attention to this issue. Using the existing methods available in these fields, this
paper provides a practical implementation for us to assess how NT should be applied. To do so, we revisit the Japan–Tax dispute as an application, and evaluates ex-post whether the conclusion reached by the Panel makes sense; in other words, whether shochu and the other distilled beverages were in a DCS relationship with one another.

We first perform the test of small but significant and non-transitory increase in price (SSNIP) to determine whether shochu and other distilled beverages constitute a relevant market. The SSNIP test is a convenient method used by antitrust practitioners to identify the smallest market relevant to product competition. Our test reveals that, contrary to the WTO recommendation, shochu by itself forms a relevant market, independent of other beverages. Since the SSNIP test is known to be vulnerable to possible statistical biases arising from endogeneity and omitted variables, we proceed to estimate Japanese consumer demand for alcoholic beverages to examine the robustness of the result obtained in the SSNIP test. We estimate a random-coefficient discrete-choice model by using the method recently proposed by Dubé, Fox, and Su (2012). Controlling for possible endogeneity in price, a substitution pattern is found far more complicated than that inferred from the SSNIP test: the cross-price elasticities are asymmetric and statistically different from zero.

The NT obligation is often deemed to be in conflict with national sovereignty. In Japan–Tax, the NT obligation placed severe constraints on the Japanese government’s ability to freely determine domestic liquor tax rates. In response to the WTO recommendation, the Japanese government eventually imposed the same tax rates on all distilled alcoholic beverages sold domestically. We conduct simulation exercises based on the obtained demand estimates to assess whether and to what extent the tax revision improved welfare. The simulation results show that the liquor tax revision did increase social welfare of Japanese people. This is because the WTO recommendation corrected for the distortion arising from a higher tax on mostly imported liquor, whose demand is more price-elastic than a lower-taxed liquor, shochu, which is predominantly domestically produced during the study period.

The NT obligation has received notable academic attention. Horn (2006) offers the first formal analysis of the role of NT in bilateral trade agreements. He investigates the contractual incompleteness inherent in trade agreements over internal measures, and shows that if tariff agreements account for subsequent tax setting incentives, the NT obligation can improve welfare even when a first-best contract would call for discrimination against imported products. Saggi and Sara (2008) and Gulati and Roy (2008) point it out that when tariffs are exogenously fixed, NT may prevent a non-protectionist government from implementing welfare-maximizing policy and reduce social welfare. While the present paper does not share the analytical framework and motivations proposed by the above work, in that it does not deal with issues of incomplete contracts nor optimal taxation, this paper finds empirical evidence consistent with their theoretical claims that the NT obligation
enhanced domestic national welfare.

The rest of this paper is organized as follows. The next section (Section 2) provides an overview of Japan—Tax. A major issue in the dispute was whether shochu was DCS to other distilled alcoholic beverages. Section 2 provides a notion to define the Japanese distilled-beverage market using the SSNIP test often used in antitrust economics. To check the robustness of the findings of the test, Section 3 estimates a random-coefficient discrete-choice model of Japanese demand for alcoholic beverages in general. Using the estimation results, Section 4 assesses the extent to which the revised tax rates following the WTO recommendation had affected economic welfare of the domestic country. Section 5 provides concluding remarks.

2 Historical Background and Preliminary Analysis

This section provides an overview of Japan—Tax, beginning with Section 2.1, which describes an overview of the WTO shochu dispute. A major issue in this dispute was whether shochu and other distilled beverages were “directly competitive and substitutable” (DCS) with each other. If they were, the complainant parties claimed, the wide gap between shochu taxes and other Japanese liquor taxes should have been unacceptable. The WTO Appellate Body concluded that shochu and the other distilled alcoholic beverages were DCS, and that the variable taxes violated the WTO rule. However, the Body did not offer any precise criteria for the determination of DCS. In Section 2.2, we suggest a simple approach corresponding closely to the procedure taken by an antitrust authority, assessing the impact of, say, a proposed merger between companies. Our analysis concludes that shochu constituted a relevant market on its own, implying that it and other beverages were not in a DCS relationship. To check the robustness of the result obtained in Section 2.2, we perform a demand analysis in the subsequent sections.

2.1 Overview of the WTO Dispute

On June 21, 1995, the EU requested consultations with Japan concerning the internal taxes levied by the Japanese government on certain alcoholic beverages pursuant to Japan’s Liquor Tax Law (WTO, 1995a). In the following month, the US (WTO, 1995b) and Canada (WTO, 1995c) joined the consultations. These three parties made essentially the same complaint: that Japan had acted inconsistently with Article III of GATT by applying higher tax rates to distilled alcoholic beverages, with the exception of Japanese shochu.

At the time of the consultations, Japan’s Liquor Tax Law classified alcoholic beverages into seven categories, four of which were classed as distilled alcohol and as a result come under the direct focus of this study; these are shochu, liqueurs, spirits, and whisky (considered as a category
of its own). The other three were brewed alcohol, including beer and cider; wine; and sake. 1 The liquor tax on distilled beverage was imposed according to quantity: in 1995, the tax rates, adjusted by alcohol content, ranged from 5,280 Japanese Yen (JPY) per 10 L on shochu to 24,558 JPY on whisky, as shown in Figure 1. 2 While the law made no explicit distinction between domestic and imported alcoholic beverages, the complainant parties said, that Japan unduly favored (domestic) shochu over other distilled beverages, the latter of which were disproportionately imported. Indeed import share of shochu accounted for a mere 3.4 percent of domestic consumption in 1994, whereas whisky and other spirits accounted for 22.5 and 27.5 percents respectively.

The complainants and Japan submitted quantitative evidence to a WTO Dispute Panel. The Japanese government cited statistics on the correlation between price and consumption trends for the previous twenty years. In contrast, the complainants based their argument on the reactions of a sample of 400 shochu drinkers to a series of different combinations of counterfactual price levels for shochu and spirits. While this evidence appears to be subject to either endogeneity in price or bias in sampling procedure, the Panel nevertheless ruled in favor of the complainants. The WTO Appellate Body subsequently concluded, in the final report on the matter in 1996, that shochu and the other distilled beverages were in a DCS relationship, and that Japan, by not taxing them at similar levels, was in violation of its obligation under Article III:2, second sentence, of the GATT (WTO, 1996b: 32). In response to the judgment of the Appellate Body, the Japanese government passed a new amendment to the Liquor Tax Law in October 2000, taxing shochu at the same rate as other distilled beverages, as shown in Figure 1.

During the settlement process, neither the WTO Panel nor the Appellate Body offered precise criteria as to how DCS should be determined. The Appellate Body in its report agreed with the Panel’s view about factors relevant to the criteria, such as cross-price elasticity, product characteristics, common end-uses, and tariff classifications (WTO, 1996b: 25). The Panel noted that it gave particular emphasis to some factors such as results from a consumer survey conducted by the complainants and facts concerning a past liquor tax reform in Japan (Paragraph 6.32 of WTO, 1996a). However, the Panel and the Appellate Body did not clarify what weight was to be given to each of the factors mentioned.

If we understand that the concept of DCS is intended to capture the degree to which an increase in the tax on a set of products benefits another set of products in terms of increased sales volume, the appropriate indicator for DCS must then be cross-price elasticity. In the subsequent sections of this paper, we present formal statistical methods to measure the degree of DCS between shochu and

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1 The category of sake includes sake compounds and mirin vinegar.

2 To be precise, two kinds of shochu are sold in Japan, depending on the degree of alcohol content. Shochu group A contains 36 percent alcohol or lower, and shochu group B has a higher alcohol content. Because of the limited availability of price data, we use the sales-weighted average of the two groups in this study.
other distilled beverages in *Japan–Tax*. We utilize publicly available data and attempt to address the econometric issues that emerge from this empirical application, which were not adequately handled in *Japan–Tax*. We believe that the statistical method proposed in the following sections will help us understand how to determine DCS, as stipulated in the NT obligation.

In Section 3, we apply a discrete choice model to directly estimate cross-price elasticity and assess the validity of the claim in that *shochu* and other distilled beverages are DCS toward each other. First, however, Section 2.2 presents a much simpler technique to assess DCS between *shochu* and other alcoholic beverages.

### 2.2 Preliminary Analysis of Market Definition

In evaluating the DCS relationship between multiple products, an adjudicating body essentially asks whether the products are in the same relevant market (i.e., whether the level at which the products are in the same market is the relevant level). If the products are determined to be in the same market, they must be highly substitutable for each other in the eyes of consumers. Otherwise, they are not deemed to be in direct competition. While the WTO has no clear approach to defining the relevant market, it is noted in the report that “under national antitrust [...] regimes, the extent to which products directly compete is measured by the elasticity of substitution” (Paragraph 6.31 of WTO, 1996a).

Before we estimate cross-price elasticity (in Section 3), this section proposes the SSNIP test to identify the smallest market relevant to the product competition of the products under consideration. To anticipate the result, the method finds that *shochu* constitutes an independent market of its own, and thus is not DCS to other distilled beverages. After presenting the results, we point out weakness of the test, which leads us to use another method to assess Japanese demand for alcoholic beverages, as will be seen in the next section.

The SSNIP test was introduced with the US Merger Guidelines of 1982, and has been widely used by competition authorities to define relevant markets in a variety of contexts. Starting with the narrowest possible market definition, if it is profitable for a hypothetical monopolist to increase the price(s) of product(s) in this candidate market by a small amount, say 5 percent, the candidate market is determined to be the relevant market. This is because the presence of a hypothetical profitable monopolist implies that the elasticity of substitution of products outside the candidate market is small. If, on the other hand, the increase in price is not profitable because consumers would substitute products outside the candidate market, the market definition must be extended to include the closest of these substitutes in order to ensure that any product exercising a competitive pressure on the product(s) in question is included in the market definition. Products are added to the candidate market until a five-percent price increase is profitable for a hypothetical monopolist.
owning all the products in the candidate market. The relevant market has then been found.

As Katz and Shapiro (2003) concisely explain, the effect of an SSNIP on a hypothetical monopolist’s profit depends on the percentage of unit sales that would be lost as a result of a price increase as well as on the prevailing profit margin earned on each unit sold. The price increase will be profitable, if the following inequality holds:

\[
\frac{\Delta q_{j,t}}{q_{j,t}} \frac{\Delta p_{j,t}}{p_{j,t}} > -\frac{1}{(\Delta p_{j,t}/p_{j,t}) + MU_{j,t}}
\]

where \(q_{j,t}, p_{j,t}\) and \(MU_{j,t}\) are respectively quantity demanded, price and markup for product \(j\) in year \(t\); and \(\Delta h_{j,t}\) is defined as \(h_{j,t} - h_{j,t-1}\), where \(h\) is either \(p\) or \(q\). We are interested in investigating whether or not shochu is DCS to other alcoholic beverages — in other words, whether Japanese shochu data satisfy eq. (1).

Figure 2 shows quantity and price data for the distilled alcoholic beverages examined in this study. The price and quantity data of annual frequency are available from Annual Statistical Data on Liquor & Food Industries. The National Tax Agency of Japan collects the data of an alcoholic product at the moment that it leaves the factory. The ex-factory price and the corresponding quantity data are sorted by prefecture where the product is consumed, and they are then aggregated over a year. The data, which are publicly available, are traced back to the year of 1994 and forward to 2001, when the revision of the Liquor Tax Law had been completed. As mentioned above, following the practice often used in the antitrust field, we consider a five-percent price increase in this exercise (i.e., \(\Delta p_{j,t}/p_{j,t} = 0.05\) for all \(j\) and \(t\)). The aggregated national-level data prior to 1996 indicate that eq. (1) always holds for any values of \(MU_{j,t}\): the left-hand side of (1) takes the value of 11.24, whereas the right-hand side always takes a negative value. This observation would suggest that shochu constitutes a relevant market on its own, independent of other distilled beverages. This inference depends crucially on the observation made in Figure 2, in that price and quantity of shochu appear to move in the same direction: indeed, the unconditional correlation coefficient is 0.26. As originally noted by Trajtenberg (1990), this positive correlation may be due to the lack of control for endogeneity in the price variable. In the next section, we address the econometric issue in demand estimation.

3 Demand Model of Alcoholic Beverages

This section describes the estimation model we use to explain the Japanese alcoholic beverage market. In Section 3.1, we introduce a demand system derived from a random-utility discrete-choice model of consumer behavior. We do not observe individual purchasing behavior, but instead, aggregate across individual buyers to obtain the demand for an alcoholic product while still allowing
for heterogeneity across consumers. Section 3.2 addresses identification issues of this model, and Section 3.3 discusses the estimation results. The demand model and its estimates provide a basis for the analyses in Section 4, in which we assess the extent to which the revised tax rates following the WTO recommendation have affected economic welfare in Japan.

### 3.1 Discrete-Choice Model

This section describes a random-coefficient discrete choice model of alcoholic beverages in Japan. In any particular year, we take an individual of legal drinking age as the purchasing entity, where each individual has a unit demand for a bottle of alcoholic beverage on a daily basis. We denote the market size by $M_S$. Our lack of data on individual purchases does not allow us to distinguish between the decision to visit a store and the decision of how many of bottles to purchase. Since a bottle size varies, we standardize it at 750 mL. Each individual $i$ who is part of market $m$ is assumed to maximize the following indirect utility function at time $t$ by choosing alcoholic beverage $j$ among $J_t + 1$ alternatives, one of which is the option of not purchasing alcoholic beverages:

$$u_{i,j,m,t} = \beta_0 + \frac{\alpha}{y_{i,m,t}} p_{j,m,t} + x'_{j,m,t} \beta_{t,m,t} + \xi_{j,m,t} + \epsilon_{i,j,m,t}, \quad (2)$$

where $u_{i,j,m,t}$ is consumer $i$’s utility from consuming the alcoholic beverage $j$ in market $m$ at time $t$. The annual data have a regional dimension — we view each of Japan’s 47 prefectures to be an independent market in this paper. The income for consumer $i$ who purchases in market $m$ ($= 1, \ldots, M$) at time $t$ ($= 1, \ldots, T$) is denoted by $y_{i,m,t}$, and the price of a bottle of alcoholic beverage $j$ is denoted by $p_{j,m,t}$. Both variables are deflated by the overall CPI index to constant 2005 JPY. Note that $p_{j,m,t}$ is after tax; we will discuss in Section 4 how liquor taxes affect the price. The vector $x_{j,m,t}$ denotes alcoholic beverage $j$’s observed attributes, whose $k$-th component is denoted by $x_{j,k,m,t}$. We use in this vector the variables of normalized alcoholic content and a dummy variable that takes one if beverage $j$ is distilled and zero otherwise. Our data set contains both brewed and distilled alcoholic beverages, the former including beer (5), sake (15) and wine (13), and the latter liqueurs (12), shochu (25), spirits other than whisky (37) and whisky (40). Inside the parenthesis is the drink’s alcohol content (as percentage). The term $\alpha$ denotes consumer’s sensitivity to changes in real price and income, the parameter to be estimated. The utility function contains $\xi_{j,m,t}$, an unobserved (to an econometrician) product quality of alcoholic beverage $j$ with the property that

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3 The legal drinking age in Japan is twenty years old. We tested an alternative measure of market size to assess the population above 15 years old. The demand estimates reported in Section 3.3 are robust to the alternative definition.

4 The alternative assumption of either 500 mL or 1 L for the bottle size makes no qualitative difference to the results discussed here.

5 The market share for the outside option is on average 65 percent. In the study period, no entry nor exit of alcoholic beverage $j$ is observed; thus $J_t$ does not depend on $t$. 

8
In Section 3.2, we discuss an econometric endogeneity problem generated by $\xi_{j,m,t}$.

To enable richer substitution patterns, we follow the model of Berry, Levinsohn and Pakes (1999), allowing different consumers to have different intensities of preferences for different beverage characteristics, $x_{j,m,t}$. We rely on a random-coefficient utility specification and assume that individual preference intensity is represented by $\beta_{i,m,t}$, whose $k$-th component is denoted by $\beta_{i,k,m,t}$:

$$
\beta_{i,k,m,t} = \beta_k + \pi_k y_{i,m,t} + \nu_{i,k},
$$

where $\nu_{i,k}$ follows the normal distribution with mean zero and variance $\sigma_k$. Note that for each characteristic of $x_{j,k,m,t}$, consumer $i$’s taste varies with her income $y_{i,m,t}$ and a taste shock $\nu_{i,k}$.

While we lack data on individual consumer income, the income distribution at the market level is well approximated by the log-normal distribution, $dG_{m,t}(y)$, with the mean and variance of the distribution being obtained annually from Shinozaki (2007). Note that $y_{i,m,t}$ is the $(i, m, t)$-th component of $y$, and that the density $dG_{m,t}()$ is allowed to differ by year and market. We assume that the taste variable, $\nu_{i,k}$, is drawn from an i.i.d. standard normal distribution, and the parameters to be estimated, $\pi_k$ and $\sigma_k$, capture the variances in consumer tastes for characteristic $x_{j,k,m,t}$. Consumers with similar demographic attributes tend to have a similar product ranking, and thus similar substitution patterns. The inclusion of the random coefficients, $\beta_{i,m,t}$ in (2) allows for correlation between alcoholic beverage types with similar characteristics, and thus presumably for more realistic substitution patterns relative to the traditional logit model.

Let $\epsilon_{i,j,m,t}$ represent the idiosyncratic taste of consumer $i$ for product $j$ in market $m$ at time $t$, and follows the type-I extreme value. We assume that the mean utility from the outside option is normalized to zero. The distribution assumption yields the following closed-form probability of consumer $i$’s choosing product $j$:

$$
\begin{align*}
\pi_{i,j,m,t} &= \frac{\exp \left( \beta_0 + \frac{\alpha}{y_{i,m,t}} p_{j,m,t} + x'_{j,m,t} \beta_{i,m,t} + \xi_{j,m,t} \right)}{1 + \sum_t \exp \left( \beta_0 + \frac{\alpha}{y_{i,m,t}} p_{l,m,t} + x'_{l,m,t} \beta_{i,m,t} + \xi_{l,m,t} \right)}.
\end{align*}
$$

The market share of alcoholic beverage $j$, denoted by $s_{j,m,t}$, is obtained by

$$
\begin{align*}
s_{j,m,t} &= \int_y \int_\nu s_{i,j,m,t} dF(\nu)dG_{m,t}(y),
\end{align*}
$$

where $dF(\nu)$ represents the joint standard normal density of taste shocks, $\nu$, the $(i,k)$-th element of which is $\nu_{i,k}$, as introduced in (2). Note that the market share of the outside option, $s_{0,m,t}$, is obtained by $1 - \sum_j s_{j,m,t}$. We make the independence assumption in $dF(\nu)$ and $dG_{m,t}(y)$, and follow the estimation method detailed in Dubé, Fox and Su (2012) to form a generalized method of moment (GMM) estimator. The population moment condition is a product of $\xi_{j,m,t}$ and
instrumental variables introduced in the next section. While Berry, Levinsohn and Pakes (1995; BLP) proposes to numerically compute the market shares and $\delta_{j,m,t}$ by means of inversion, Dubé et al (2012) points out that the BLP method would generate numerical errors in calculating the nested fixed point. They instead propose to solve a mathematical program under the constraint that $s_{j,m,t}$ as obtained in (3) equals the observed market shares. In the next section, we discuss the instrumental variables used for the GMM objective function.

### 3.2 Instruments

We are concerned that the variable of price may be correlated with the error, $\xi_{j,m,t}$. It is likely that the observed characteristics do not capture all the important dimensions of the alcoholic beverages under study; indeed, $\xi_{j,m,t}$ is often interpreted as the unobserved quality error. If $\xi_{j,m,t}$ is correctly perceived by consumers and sellers in the market, this unobserved quality error is likely to be correlated with price: Better-quality products may induce higher willingness to pay, and sellers may be able to charge higher prices, perhaps due to higher marginal costs.

Traditionally, the cost variables excluded from $x_{j,m,t}$ are used as instruments in homogeneous-goods models, and this practice is still appropriate here. As an instrument of this sort, we employ liquor tax per bottle, standardized by alcohol content. The liquor tax is levied on producers before the product is shipped; thus, the tax is included in the price measure, and it is unlikely to be influenced by unobserved demand shocks.

In a product differentiation model, the costs of rival products are appropriate instruments. With market power in supply, the markup of each product depends on the costs of the other products. The liquor taxes on the other products are thus related to $p_{j,m,t}$, but since the liquor tax is assumed to be exogenous, they are still valid instruments. We include in the set of instruments the averaged liquor taxes for the distilled and brewed alcoholic beverages.

Information from the income distribution may also help identify the parameter, $\alpha$. We use as instruments the means and variances of the distribution by market and by year, from which we draw the sample of individuals in the estimation of (2). We also include in the set of instruments the interaction terms between the mean income levels and three exogenous variables, namely, alcohol content and liquor tax rate for each beverage and a dummy variable for distilled drinks.

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6For each combination of $m$ and $t$, we draw 20 individuals for $y_{i,m,t}$ from the distribution $dG_{m,t}(y)$, and another 1,000 draws of $\nu_{i,k,m,t}$ from $dF(\nu)$ for those consumers who have income of $y_{i,m,t}$. Doubling the number of draws make little changes to the estimation results discussed in the next section.

7To check the robustness of the sampling procedure regarding income distribution, we further disaggregate $G_{m,t}(y)$ by gender and use the data on the ratio of male and female workers by market and by year to estimate the model. The qualitative results discussed in the rest of the paper do not change under this alternative specification.
3.3 Demand Estimates

This section presents estimation results for the demand model discussed in the previous section. The dataset of annual frequency used covers the 1994–1995 period, during which the WTO conducted their investigation for Japan–Tax. We define the geographic market \( m \) as prefecture. In the demand estimation, we include data on brewed as well as distilled beverages, so that a consumer in the model has eight choices, including the outside option. By incorporating brewed beverages in our analysis, we hope that our estimates of cross-price elasticities below will be insusceptible to the assumption of an outside option. We describe the data sources in the Appendix.

Table 1 presents five estimation results. Models (1-A) and (1-B) are based on a standard logit model, in which we allow no heterogeneity in individual preferences. Estimates under (1-C), (1-D), and (1-E) are obtained from the random-coefficient discrete-choice model discussed in Section 3.1. Models (1-D) and (1-E) serve as the robustness check to the estimates obtained from (1-C). We thus first focus on the first three estimates (1-A) to (1-C), and will discuss (1-D) and (1-E) later in this section.

While (1-A) is estimated by the ordinary-least squares (OLS) method, (1-B) allows for endogeneity in the price coefficient. Remember that, as discussed in Section 3.1, heterogeneity across consumers is entered by the simulation draws from the two variables, \( y_{i,m,t} \) and \( \nu_{i,m,t} \) in the second and third terms in the right-hand side of eq. (2). Thus, the indirect utility function (2) of (1-A) and (1-B), the models which do not allow for individual heterogeneity, is reduced to the following equation:

\[
\quad u_{i,j,m,t} = \beta_{0}^{AB} + \alpha^{AB} p_{j,m,t} + x_{0}^{AB} \gamma_{j,m,t} + \xi_{j,m,t} + \epsilon_{i,j,m,t},
\]

where \( \beta_{0}^{AB} \), \( \alpha^{AB} \), and \( \gamma_{j,m,t}^{AB} \) are parameters to be estimated under models (1-A) and (1-B), and we assume the same distributional assumptions on \( \xi_{j,m,t}^{AB} \) and \( \epsilon_{i,j,m,t}^{AB} \), as those of \( \xi_{j,m,t} \) and \( \epsilon_{i,j,m,t} \) in eq. (2). The first-stage \( F \)-statistic for the explanatory power of the instruments conditional upon the included exogenous variables is 124.6, indicating that the instruments are not weak. The estimated price coefficients are found positive. The chi-squared statistic tests the validity of the instruments conditional on there being a set of valid instruments that just identify the model. This does not allow us to reject the orthogonality condition between some of the instruments and the error term.

The random-coefficient model (1-C) appears to fit the data moderately well. We calculate the goodness of fit measure, which summarizes the discrepancy between observed market shares and the shares predicted under the model in question. The goodness of fit is 0.84 for (1-C), and 0.19 for (1-B). This finding corroborates with the estimated correlation coefficient between observed and predicted market shares, which is 0.96 for (1-C) and 0.62 for (1-B).
We also examine out-of-sample predictions for the five years (1996–2001) after the period of estimation. Surprisingly, given the substantial changes in liquor tax rates over the period shown in Figure 1, model (1-C) explains the data well over this 5-year period, with a goodness of fit measure of 0.54, and does especially well in predicting market shares: the correlation coefficient between observed and predicted market shares is 0.94. This out-of-sample analysis provides additional evidence on the importance of incorporating preference heterogeneity when accounting for the data under study.

The mean of the coefficient in the alcohol content variable is estimated to be negative and statistically significant. The estimated standard deviation of the same coefficient implies that consumer preference regarding alcohol content is indeed diverse. The estimates also indicate that consumers with higher income tends to prefer beverages with lower alcohol content. However, none of the coefficients in the distillation dummy variable are statistically significant. This finding may indicate that the average consumer is indifferent to whether the alcoholic beverage in question is distilled or brewed. This observation has a bearing on the substitution pattern discussed below in this Section.

The price coefficient is negative and statistically different from zero. Using the obtained price estimate from model (1-C), we present in Table 2 estimated own- and cross-price elasticities for all the seven types of beverage under study. The \((l, n)\) element in the elasticities matrix indicates the elasticity of \(n\) with respect to a change in the price of \(l\). While the logit model restricts all elasticities in a particular row of the matrix to the same value, a random-coefficient model allows these elasticities to differ with differences in the price sensitivity between different types of consumers purchasing various alcoholic beverages. The table indicates that the demand for distilled beverages is inelastic, lying in the range from —0.50 for whisky to —0.10 for shochu. A beverage with a higher alcohol content (e.g., whisky) tends to have a higher own-price elasticity because of the estimated random coefficient for alcohol content and price; a consumer with a lower value of income \(y_{i,m,t}\) has on average both a larger coefficient of alcohol content and a larger (in absolute value) coefficient of price. This indicates that the consumers preferring beverages with a higher alcohol content tend to be more price sensitive.

A closer look at the table shows also that demand for beer, the value of which is —0.09, is less elastic than demand for the distilled beverages. These findings are similar to those found in previous literature. Fogarty (2010), for example, reviews actual, reported individual-country own-price elasticity estimates, concluding that the demand for alcoholic beverages is price-inelastic and finds little support for the idea that demand for alcoholic beverages (except wine) varies fundamentally across most countries. Cook and Moore (1999), and Chaloupka, Grossman, and Saffer (2002) also report that the demand for beer is the least elastic among these alcoholic beverages, which
corroborates with our estimates presented in Table 2.

Cross-price elasticities among distilled beverages are statistically different from zero, but appear to be economically insignificant. The estimated random coefficient for alcohol content indicate that individual consumers had different tastes regarding the amount of alcohol in their drinks. Indeed, Table 2 shows that, although the values are small, cross-price elasticity for beverages with similar alcohol content is larger than for beverages with widely divergent alcohol content. While market-level aggregated data do not allow us to infer the underlying reasons for these small cross-price elasticities, they may be due to persistent consumer habits regarding the purchase of alcoholic beverages. Indeed, Fogarty (2010) reports that consumers respond to price discounting by engaging in inventory behavior, rather than substituting different alcoholic beverages.

To check the robustness of the (1-C) estimates, we perform two additional estimation exercises. One exercise is to relax the assumption that Japan’s 47 prefectures are an independent market. In particular, one may be concerned as to whether the prefectures in Tokyo metropolitan areas are an independent market. In response to the concern, we exclude the four prefectures in Tokyo metropolitan areas (namely, Chiba, Kanagawa, Saitama, and Tokyo) from the original data, and estimate the same specification of (1-C). The results shown under (1-D) in Table 1 indicate that the estimates are similar to those found in (1-C), and also generate qualitatively the same simulation results as those obtained by using the (1-C) estimates. The other exercise is to allow the demand error to have autocorrelation. This exercise intends to incorporate a feature of habitual persistence. To do so, we assume \( \xi_{j,m,t} = \rho \xi_{j,m,t-1} + e_{i,j,m,t} \) and estimate the same model as (1-C). The results are under (1-E). While the obtained price estimate is no longer statistically significant, the estimates under (1-E) produce qualitatively similar demand elasticities and resulting welfare implications that will be discussed in the next section.

The estimated substitution pattern, being statistically significant (although economically insignificant), seems to support the claims of the complainants in Japan–Tax: all distilled beverages were DCS. The Panel and the Appellate Body agreed with the complainants, and as a result, the Japanese government revised its Liquor Tax Law to tax all distilled beverages at the same rates. However, because the estimated own- and cross-price elasticities are asymmetric, it is not clear as to the welfare consequence of the tax revision following the WTO recommendation. We evaluate this issue in the next section.

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8 We thank a referee for encouraging us to do these exercises.
9 We alternatively consolidated the four prefectures in Tokyo metropolitan areas into one observation by taking the average of them, and estimated the random-coefficient discrete-choice model. We again found that the estimates are similar to those under (1-C). The results were available from the authors upon request.
10 Alternatively, in a preliminary exercise, we estimated the model by including the past consumption volume in a set of the explanatory variables. Unfortunately, we could not obtain a reasonable estimate of the price coefficient, perhaps due to an insufficient control of endogeneity in the past consumption variable.
4 Evaluating Japan’s Liquor Taxes

While NT serves as a device that blunts the use of internal instruments as tools of protectionism, it may also prevent a non-protectionist government from implementing a welfare-maximizing policy when imported and domestic products are differentiated. With regard to the Japanese Liquor Tax Law under study, the NT obligation constrained the Japanese government from freely determining domestic liquor taxes; in conformity with the WTO’s recommendation, the government reformed the Law in 2000 to tax all distilled alcoholic beverages at the same rate. As shown in Figure 1, the revised tax rates on whisky were more than 50 percent lower than the previous rates, and those on *shochu* and liqueurs increased respectively by 93 and 21 percent.

Based on the model and estimates reported in the previous sections, this section measures the impact of the tax revision on economic welfare. Below, we begin with a definition of social surplus based on the demand model presented in Section 3.1, and then examine the pass-through of the liquor tax rates. It is reasonable to assume that the social welfare is the sum of three elements: consumer surplus, $CS_t$; producer surplus, $PS_t$; and tax revenues, $TR_t$. All three of them are a function of $r_t$, a vector of the liquor tax rates at the end of period $t$. Note that, as shown in Figure 1, liquor tax rates differ by beverage type but are uniform across markets. The consumer surplus can be represented as follows:

$$CS_t = \sum_m MS_{m,t} \int_y \int_y \ln \left(1 + \frac{\sum_i V_{i,t,m,t}}{y_{i,m,t}}\right) dF(v) dG_{m,t}(y),$$  

(4)

where

$$V_{i,j,t,m} \equiv \exp \left[ \beta_0 + \frac{\alpha}{y_{i,m,t}} p_{j,m,t}(r_t) + \lambda_{j,m,t} \right].$$

Remember that $MS_{m,t}$ is the market size at market $m$ in year $t$. The price of product $j$ is now a function of $r_t$, while the relationship between $p_{j,m,t}$ and $r_t$ depends on the degree of “pass-through”, which is determined by supply and demand conditions. For example, if the market is perfectly competitive and marginal cost is constant, the pass-through is complete; whereas if the elasticity of demand is perfectly elastic, no pass-through is present.

To obtain a sense of the degree of pass-through in our study, we assessed the supply-side behavior of the Japanese liquor market. With a lack of data on individual suppliers, we have no knowledge of either their production costs or their ownership structure. Under the assumption that each supplier sells one type of product $j$, a solution to the profit maximization problem for product $j (=1, ..., J)$
is given by:

\[
\begin{pmatrix}
p_{1,1} \\
p_{2,1} \\
\vdots \\
p_{M,T}
\end{pmatrix} -
\begin{pmatrix}
r_{1,1} \\
r_{2,1} \\
\vdots \\
r_{M,T}
\end{pmatrix} =
\begin{pmatrix}
mc_{1,1} \\
mc_{2,1} \\
\vdots \\
mc_{M,T}
\end{pmatrix} -
\Theta
\begin{pmatrix}
\Delta^{-1}_{1,1} & \cdots & \cdots & 0 \\
\vdots & \ddots & \ddots & \vdots \\
0 & \cdots & \cdots & \Delta^{-1}_{M,T}
\end{pmatrix}
\begin{pmatrix}
s_{1,1} \\
n_{2,1} \\
\vdots \\
sm_{M,T}
\end{pmatrix},
\tag{5}
\]

or

\[p - r = mc - \Theta B(p) s,
\]

where \(p, r, mc, \) and \(s\) denote vectors of prices, marginal costs, liquor tax rates, and market shares, respectively. Note that \(A\) (\(A\) is one of \(p, mc, r,\) or \(s\)) is a vector of \(\left(A_{1,1}', A_{2,1}', \ldots, A_{M,T}'\right)\), where \(A_{m,t} = (A_{1,m,t}, A_{2,m,t}, \ldots, A_{J,m,t})'\). Remember that \(r_{m,t} = r_t, \forall m\) and that \(s_{m,t}\) is presented as a fraction of the total number of consumers who are of legal drinking age. The matrix \(B(p)\) is defined as \(\text{diag} \left(\Delta^{-1}_{1,1}, \Delta^{-1}_{2,1}, \ldots, \Delta^{-1}_{M,T}\right)\), where \(\Delta_{m,t}\) is a \(J\) by \(J\) matrix with \((j,l)\) element \(\frac{\partial \theta_{j,l}^m}{\partial p_{j,m,t}}\). Eq. (5) implies that price, \(p\), consists of three elements: tax, \(r\), marginal cost, \(mc\), and markup, represented by the second term on the right-hand side of the equation. The last element depends on the degree of competitiveness in the market, denoted by a \(J \times 1\) vector, \(\theta_{m,t} = (\theta_{1,m,t}, \theta_{2,m,t}, \ldots, \theta_{J,m,t})'\). The diagonal matrix \(\Theta\) is defined as \(\text{diag} \left(\theta_{1,1}, \theta_{2,1}, \ldots, \theta_{M,T}\right)\). Conduct parameter \(\theta_{m,t}\) takes a value from 0 (where the market is perfectly competitive) to 1 (where the market is monopolistic). Note that, conditional on product \(j\), we assume that the value of \(\theta_{j,m,t}\) is the same for all \(m\) and \(t\) (i.e., \(\theta_{j,m,t} = \theta_{j, \forall m, t}\)), and thus \(\theta_j\) is an estimate of our interest here.

Each element of \(B\) is calculated from the probability formula defined in eq. (3). Note that the cross derivatives differ, depending on the distribution of consumer attributes \(\nu_{i,k}\) and \(y_{i,m,t}\). Each component of \(B\) can be computed by the demand estimates. The marginal cost of producing beverage \(j\) for market \(m\) in year \(t\) is denoted by \(mc_{j,m,t}\). Since no data are available on product-level marginal cost, we substitute \(mc\) with the matrix of year- and product-dummies, \(D\), with a vector of parameters, \(\gamma\), to be estimated. Thus, using the data and obtained demand estimates presented in Table 1, we estimate the following system of equations in 1994 and 1995:

\[p - r = D'\gamma - \Theta \hat{B}s + e.
\]

Note that \(\hat{B}\) is the cross derivative acquired from the demand estimates under model (1-C), and \(e\) is a vector of the error term. Because \(\hat{B}s\) is a function of \(p\), we apply a 2SLS estimation to the above equation using as instruments the interaction terms between the product dummies and the variables associated with the income distribution introduced in Section 3.2. As shown in Table 3, none of the conduct parameters, \(\theta_j\), are estimated to be statistically different from zero,
implying that the market is reasonably approximated by a model assuming perfect competition. This result is robust to the inclusion of the market-specific dummy variable in $D$ (under 3-B), or to the expansion of the product categories to incorporate brewed alcoholic beverages (under 3-C).

Combining this finding with the fact that many producers exist in each market, it may be reasonable to assume that the liquor tax on product $j$ has complete pass-through on $p_j$. The demand estimates obtained in Section 3 enable us to assess the extent to which the quantities demanded respond to the changes in $r_t$. The tax revenues, $TR_t$, are thus calculated as the inner product of $r_t$ and $\sum MS_{m,t}S_{m,t}$.

The effect of the liquor tax revision on welfare is evaluated by the difference between welfare in 1995 (before the revision) and welfare in a counterfactual simulation in which the tax rates in 2000 (after the revision) were applied in 1995. We employ the demand estimates under (1-C) in Table 1 to calculate the consumer surplus using eq. (4). Social surplus is the sum of consumer surplus and tax revenues under the competitive market inferred from the above exercise.

The first row of Table 4, (4-A), shows the simulation results of consumer surplus and tax revenues under the tax rates after the revision. The next row shows the estimates of the effects of the revision on economic surplus. The revision increased the consumer surplus by an annual amount of 34.37 billion JPY, or the equivalent of 310 million USD. This is the net effect of the positive effect of 114.98 billion JPY from the decrease in tax on whisky and the negative effect of 80.61 billion JPY from the increase in taxes on shochu and liqueurs. The effect on the consumer surplus of a change in tax depends on the market size, the amount of tax change, and own-price elasticities. The market size of whisky is no larger than those for shochu and liqueurs, as shown in Figure 2. On the other hand, the change in tax rates along with the demand elasticity is greater for whisky than those for shochu and liqueurs; the tax on whisky decreased by 14,200 JPY, and the taxes on shochu and liqueurs increased by 4,800 JPY and 1,800 JPY respectively (see Figure 1). The estimated own-price elasticity is -0.50 for whisky, -0.10 for shochu, and -0.16 for liqueurs (Table 2). Because of the larger tax change and price sensitivity of whisky, the effect on consumer surplus of the tax reduction for whisky outweighs that of the tax increase for shochu and liqueurs.

The liquor tax revision decreased tax revenues by the annual amount of 24.91 billion JPY, or

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11 According to UN Comtrade Database, Japan’s imports account for 7.4 percent of the world’s total import volume of distilled beverages in 1995.
12 We tested an alternative assumption on the supply side that the market is monopolistic, that is, $\theta_j$ takes one, which implies incomplete pass-through. The qualitative results discussed in this section do not change under this alternative assumption.
13 We use the averaged 2005 exchange rate of JPY 110.8 to the USD.
14 The effect of the decrease in tax on whisky is evaluated by the difference between the tax system in 1995 (before the revision) and the system in which the tax rates of beverages other than whisky are the pre-revision rates and the rate of whisky is the post-revision rate. Furthermore, by comparing the latter with the tax system in 2001 (after the revision), we can evaluate the effect of the increase in taxes on shochu and liqueurs.
15 The 1995 market sizes are 192,000 KL for whisky, 666,000 KL for shochu, and 223,000 KL for liqueurs, respectively.
the equivalent of 225 million USD; the increase in tax revenue from *shochu* and liqueurs was overwhelmed by the decrease from whisky. Overall, since our estimates indicate that the market is well described by perfect competition, the tax revision increased the social surplus by 9.46 billion JPY (85 million USD). This finding thus implies that the revision moved the liquor tax structure close to the optimal. In implementing the WTO recommendation, the Japanese government appears to have partially corrected for prior distortion in the consumption of whisky, but introduced new distortion in the consumption of *shochu* and other liquors. This new distortion came into being primarily because the WTO recommendation that the tax rates on all distilled beverages, including *shochu*, should be the same. This recommendations was made on the basis of the Appellate Body’s finding that *shochu* was in a DCS relationship with other distilled alcoholic beverages. The estimated demand elasticities in Table 2 imply that the substitution pattern of distilled alcoholic beverages is far more complicated than that suggested by DCS. Our calculation indicate that should the rates be optimally set, the domestic social surplus would be enhanced more than what the WTO recommended.

5 Conclusion

While the NT obligation is a pillar supporting the WTO’s non-discrimination principle, it has been neglected in the literature relative to the attention given the MFN obligation. This paper has provided the first empirical study on the role of the NT obligation, using the case of *Japan–Tax*, in which the Panel and Appellate Body were confronted with a Japanese law taxing the locally produced alcoholic beverage *shochu* more lightly than distilled drinks dominated by import brands. Though Japan argued that *shochu* was not in a DCS relationship with the distilled beverages, the Panel and Appellate Body found that all products concerned were DCS with all others.

This paper employed a random-coefficient discrete-choice model to assess purchasing behavior of alcoholic beverages by Japanese consumers and identified an asymmetric structure in the estimated cross-price elasticities. This paper then found that the optimal tax rates differ substantially across beverage types. This finding runs counter to the WTO recommendation that *shochu* is in a DCS relationship to other distilled beverages, and thus needs to be taxed similarly to them. This result highlights that although NT is meant to outlaw protectionist use of domestic instruments, it may also hinder a welfare-maximizing policy when imported and domestic products are differentiated and their price elasticities are not uniform.

This paper also found that while the policy adopted as a result of the WTO recommendation was not the best one from a social-welfare point of view, it improved the social surplus. Because distilled alcoholic beverages with larger import shares and higher pre-revision tax rates (e.g., whisky) had a higher own-price elasticity and a lower optimal tax rate than those of domestically produced
beverage (shochu), the revision to tax uniformly among them moved the tax differences close to optimal. However, this paper also revealed that under the constraint that all distilled alcoholic beverages are taxed at the same rate, the Japanese government chose the much higher level of uniform tax rates than the level that maximized the social surplus. This result highlights a limitation of the NT obligation, namely that the decision over the level of the common tax will be made unilaterally by the importing country.

The empirical method and policy implication used in this paper may also apply to the MFN obligation, the other pillar of the WTO’s non-discrimination principle. The MFN obligation prohibits discrimination between “like products” originating from different countries. Discrimination can lead to wasteful trade diversion in the absence of the MFN obligation: the most efficient products might not have equal access to foreign markets because of discriminatory trade preferences in favor of less efficient products from other countries. While persuasive at a general level, the practical implementation of the MFN obligation requires that a clear definition and methodology be employed to determine “like products” (e.g., see Jackson, 1997 and Choi, 2003). For example, in order to determine whether there exists a like product relationship in the MFN context, Choi (2003) recommends a market-based analysis to obtain information on demand substitutability between products.

Data Appendix

Estimating the demand model described in Section 3 requires data on price, quantity, and alcohol content by beverage type and by prefecture, which were obtained from Annual Statistical Data on Liquor & Food Industries in the period from 1994 to 2001. The data are originally collected by the National Tax Agency of Japan at the moment when the product is shipped from the factory. The ex-factory price and the corresponding quantity data are then sorted by prefecture of consumption. Therefore, alcoholic beverage consumption of Izakaya, for example, is included in the data at the prefecture level. We consider each prefecture to be an independent market. Data on alcohol content of distilled and brewed beverages is available from the National Tax Agency’s Annual Statistics Report. The estimation also uses data on income distribution obtained from the Basic Survey on Wage Structure. Information on the mean of the distribution is annually available for each market. It is also broken down by gender, available from the Ministry of Health, Labor and Welfare. Information on the variances of the distribution is reported in Shinozaki (2007).
References


### Table 1

**Demand Estimates**

<table>
<thead>
<tr>
<th>Variables / Statistics</th>
<th>(1-A) OLS</th>
<th>(1-B) 2SLS</th>
<th>(1-C) Random coefficient (w/o Tokyo areas)</th>
<th>(1-D) Random coefficient</th>
<th>(1-E) Random coefficient (w/ AR (1) process)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_i$</td>
<td>0.15c</td>
<td>0.08</td>
<td>1.37a</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>$p_i / y_i$</td>
<td></td>
<td></td>
<td></td>
<td>-1.26b</td>
<td>0.62</td>
</tr>
<tr>
<td>Alcohol content</td>
<td></td>
<td></td>
<td></td>
<td>-1.50b</td>
<td>0.56</td>
</tr>
<tr>
<td>Mean ($\beta_1$)</td>
<td>-7.28a</td>
<td>0.63</td>
<td>-13.00b</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Standard deviation ($\sigma_1$)</td>
<td>29.38a</td>
<td>7.00</td>
<td>30.60a</td>
<td>7.33</td>
<td></td>
</tr>
<tr>
<td>Interaction with $y_i$ ($\pi_1$)</td>
<td>-3.18b</td>
<td>1.32</td>
<td>-5.35b</td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td>Distillation dummy</td>
<td></td>
<td></td>
<td></td>
<td>-0.75a</td>
<td>0.13</td>
</tr>
<tr>
<td>Mean ($\beta_2$)</td>
<td>-0.32c</td>
<td>0.18</td>
<td></td>
<td>-1.71</td>
<td>2.42</td>
</tr>
<tr>
<td>Standard deviation ($\sigma_2$)</td>
<td>2.28a</td>
<td>0.50</td>
<td>2.59a</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>Interaction with $y_i$ ($\pi_2$)</td>
<td>0.27</td>
<td>0.40</td>
<td>0.24</td>
<td>0.65</td>
<td></td>
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<tr>
<td>Constant</td>
<td>-2.18a</td>
<td>0.11</td>
<td>-2.43a</td>
<td>0.12</td>
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</tr>
<tr>
<td>AR (1)</td>
<td></td>
<td></td>
<td></td>
<td>2.59a</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.92a</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.28a</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.98a</td>
<td>0.01</td>
</tr>
</tbody>
</table>

| Number of observations | 658       | 658       | 658                                     | 602                      | 329                                       |
| First-stage F statistics (d.f.) | 124.6 * (9, 646) | 124.6 * (9, 646) | 124.6 * (9, 646) | 124.6 * (9, 646) |
| Chi-square statistics (d.f.) | 12.08 (8) | 9.02 * (4) | 10.99 * (4) | 6.52 (4) |
| Goodness of fit         | 0.26      | 0.19      | 0.84                                    | 0.79                     | 0.88                                      |

Notes: Model (1-D) uses the data that exclude Tokyo metropolitan areas (namely, Chiba, Kanagawa, Saitama, and Tokyo) from the original data set. (1-E) allows the demand error to possess the first-order autocorrelation (AR(1)). The chi-square statistic is for a test of overidentifying restrictions. The superscripts, a, b, and c indicate significance at the 99-, 95-, and 90-percent confidence levels, respectively.
Table 2
Own- and Cross-Price Elasticities

<table>
<thead>
<tr>
<th>Distilled</th>
<th>Alcohol content (%)</th>
<th>Average price (1,000 JY)</th>
<th>Average market share (%)</th>
<th>Shochu</th>
<th>Liqueurs</th>
<th>Spirits</th>
<th>Whisky</th>
<th>Beer</th>
<th>Wine</th>
<th>Sake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shochu</td>
<td>25</td>
<td>0.545</td>
<td>2.52</td>
<td>-0.102</td>
<td>0.027</td>
<td>0.087</td>
<td>0.057</td>
<td>0.003</td>
<td>0.012</td>
<td>0.016</td>
</tr>
<tr>
<td>Liqueurs</td>
<td>12</td>
<td>0.755</td>
<td>0.67</td>
<td>0.012</td>
<td>-0.157</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Spirits</td>
<td>37</td>
<td>0.813</td>
<td>0.10</td>
<td>0.006</td>
<td>-0.341</td>
<td>0.020</td>
<td>0.0004</td>
<td>0.001</td>
<td>0.011</td>
<td>0.015</td>
</tr>
<tr>
<td>Whisky</td>
<td>40</td>
<td>2.654</td>
<td>0.67</td>
<td>0.088</td>
<td>0.003</td>
<td>0.462</td>
<td>-0.501</td>
<td>0.005</td>
<td>0.009</td>
<td>0.015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brewed</th>
<th>Alcohol content (%)</th>
<th>Average price (1,000 JY)</th>
<th>Average market share (%)</th>
<th>Shochu</th>
<th>Liqueurs</th>
<th>Spirits</th>
<th>Whisky</th>
<th>Beer</th>
<th>Wine</th>
<th>Sake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer</td>
<td>5</td>
<td>0.400</td>
<td>25.34</td>
<td>0.017</td>
<td>0.024</td>
<td>0.005</td>
<td>0.003</td>
<td>-0.090</td>
<td>0.060</td>
<td>0.054</td>
</tr>
<tr>
<td>Wine</td>
<td>13</td>
<td>1.050</td>
<td>0.47</td>
<td>0.004</td>
<td>0.002</td>
<td>0.003</td>
<td>0.002</td>
<td>0.003</td>
<td>-0.400</td>
<td>0.012</td>
</tr>
<tr>
<td>Sake</td>
<td>15</td>
<td>0.717</td>
<td>5.42</td>
<td>0.048</td>
<td>0.017</td>
<td>0.047</td>
<td>0.034</td>
<td>0.020</td>
<td>0.091</td>
<td>-0.175</td>
</tr>
</tbody>
</table>

Notes: The (l, n) element in the table shows the elasticity of product n with respect to the price change of product l, averaged over the study period. A number in the parenthesis represents the 95-percent confidence interval of the elasticity value.
<table>
<thead>
<tr>
<th>Dummy variables:</th>
<th>(3-A)</th>
<th>(3-B)</th>
<th>(3-C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Year</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
</tbody>
</table>

| First-stage $F$ statistics (d.f.) | 22.89 * (16, 355) | 34.11 * (16, 309) | 11.52 * (28, 622) |
| Chi-square statistics (d.f.)     | 41.49 * (12)      | 37.61 * (12)      | 50.76 * (21)      |
| $R^2$                             | 0.98              | 0.98              | 0.98              |
| Number of observations           | 376               | 376               | 658               |

Notes: A number in the bracket is the standard error of the estimate. The first-stage $F$-statistic provides the average explanatory power of the instruments, conditional on exogenous variables. The chi-square statistic is for a test of overidentifying restrictions. The superscripts, a, indicates significance at the respective 99-percent confidence levels.
### Table 4
Welfare Analysis on Liquor Tax Revision

<table>
<thead>
<tr>
<th></th>
<th>Consumer surplus (4-A)</th>
<th>Tax revenues (4-B)</th>
<th>Total: (4-A) + (4-B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before the Revision (4-A)</strong></td>
<td>128,515</td>
<td>2,005</td>
<td>130,521</td>
</tr>
<tr>
<td></td>
<td>( 51,598 , 389,010 )</td>
<td>-</td>
<td>( 53,603 , 391,010 )</td>
</tr>
<tr>
<td><strong>After the Revision (4-B)</strong></td>
<td>128,550</td>
<td>1,980</td>
<td>130,530</td>
</tr>
<tr>
<td></td>
<td>( 51,636 , 389,040 )</td>
<td>( 1,978 , 1,983 )</td>
<td>( 53,618 , 391,010 )</td>
</tr>
<tr>
<td><strong>Difference: (4-B) - (4-A)</strong></td>
<td>34.37</td>
<td>-24.91</td>
<td>9.46</td>
</tr>
<tr>
<td></td>
<td>( 29.03 , 39.64 )</td>
<td>( -27.13 , -22.49 )</td>
<td>( 1.84 , 17.16 )</td>
</tr>
<tr>
<td><strong>Decompositions:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax decrease on whisky</td>
<td>114.98</td>
<td>-105.45</td>
<td>9.53</td>
</tr>
<tr>
<td></td>
<td>( 110.93 , 118.96 )</td>
<td>( -109.03 , -102.01)</td>
<td>( 1.90 , 16.99 )</td>
</tr>
<tr>
<td>Tax increase on shochu and liqueurs</td>
<td>-80.61</td>
<td>80.54</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>( -81.91 , -79.40 )</td>
<td>( 79.43 , 81.87 )</td>
<td>( -0.33 , 0.18 )</td>
</tr>
</tbody>
</table>

(In billion JPY per year)

Note: A number in the parenthesis represents the 95-percent confidence interval.
Figure 1
Liquor Tax Rates

Thousand JPY
Figure 2
Prices and Quantities of Distilled Alcohol

Note: Each panel presents the sum of quantities and the sales-weighted average of prices by year over all markets in Japan.