The cross-effects of cigarette and betel nut consumption in Taiwan: have tax increases made a difference?


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This paper empirically identifies cross-price elasticities of betel nut and cigarette consumption in Taiwan based on the Central Bureau of Statistics demand model. It compares reduction of cigarette consumption as a result of the proposed Betel Nut Health Tax with reduction of betel nut consumption as a result of the Tobacco Health and Welfare Taxes levied in 2002 and 2006, in order to determine which tax is most effective. Results from a simulated comparative analysis indicate that the Betel Nut Health Tax reduces cigarette consumption to a much greater extent than the Tobacco Health and Welfare Taxes reduce betel nut consumption.

Keywords Tobacco consumption, betel nut consumption, cross-price elasticity, tobacco tax

KEY MESSAGES

- Cross-price elasticities for cigarettes and betel nuts in Taiwan were empirically estimated using the Central Bureau of Statistics demand model for time series data.
- The cross-effects on cigarette and betel nut consumption from tobacco taxes levied in 2002 and 2006 and a proposed tax on betel nuts were then investigated and simulated for policy analysis.
- Results indicate that the proposed tax on betel nuts will reduce cigarette consumption to a much greater extent than the tobacco taxes will reduce betel nut consumption.

Introduction

The chewing of betel nuts is a very old, widespread habit in Asian countries, particularly in South and Southeast Asia (Yang 2000; Gupta and Warnakulasuriya 2002; Warnakulasuriya et al. 2002; Winstock 2002; IARC 2004). Derived from the seeds of a palm tree (Areca) that grows in tropical regions of the South Pacific, Asia and East Africa, betel nuts rank fourth in worldwide popularity of central nervous system stimulants, behind only cigarettes, alcoholic beverages and coffee (Cawte 1985; Norton 1997). In fact, statistics indicate that between 10% and 20% of the global population consumes them (Raghavan and Baruah 1958; Marshall 1987).

Both the public and medical professionals have long considered cigarette smoking and betel nut chewing to be separate issues because they appear to be two distinctly different behaviours (Wen and Levy 2002). Research, however, is increasingly finding that the two habits are closely related. In a study conducted in Taiwan, Wen et al. (2005a) found that nearly 93% of the country’s betel nut users are also smokers. They also found that ~94% of those who consume both betel nuts and cigarettes either began smoking before using betel nuts or took up smoking and betel nut use simultaneously. Only 6% began chewing betel nuts before they started to smoke. Wen et al. (2005b) further found that...
people who consume both betel nuts and cigarettes are more likely to become heavy smokers than are smokers who do not use betel nuts. This strongly implies that betel nut use increases as smoking increases and that the relationship between the two substances is complementary.

In an effort to decrease consumption of both products, the government of Taiwan has levied taxes three times on domestic and imported cigarettes in the last three decades (1987, 2002, 2006). It has also proposed—but not yet enacted—a Betel Nut Health Tax. The ability of taxation to lower consumption rates of both substances depends largely on the complementary relationship between betel nut use and smoking. However, this relationship has not yet been verified through empirical research. To address this issue, we studied the cross-price elasticities of betel nut and cigarette consumption using the Central Bureau of Statistics (CBS) demand model. We also performed a simulated comparative analysis to determine whether cigarette reduction caused by the proposed Betel Nut Health Tax would be greater or less than betel nut reduction caused by the 2002 and 2006 Tobacco Health and Welfare Taxes.

**Tobacco consumption in Taiwan**

In a 2007 study, the Taiwan Bureau of Health Promotion found that ~1300 million people around the world smoked cigarettes in 2006; ~5 million of these, or 0.38% of all smokers, were Taiwanese (Bureau of Health Promotion 2007). Although this figure appears to be relatively small, it translates into the fact that 21.84% of all Taiwanese (39.56% of men and 4.12% of women) smoked cigarettes in 2006. Given the detrimental effects of smoking on longevity and life quality, such figures represent an enormous health burden. In fact, smoking-related health care and medical costs add up to approximately New Taiwan Dollar (NT$) 20 billion annually (Lin et al. 2002). Tsai et al. (2005) estimated that smoking reduced Taiwan’s GDP by US$1.032 billion (0.36%) in 2000.

In 1987, Taiwan took its first step to promote citizen health and lessen the economic burden of medical costs due to tobacco by levying the In-Kind Tax on cigarettes, which added NT$16 per pack. (On average, each pack contains 12 cigarettes.) After joining the World Trade Organization (WTO) in 2002, Taiwan imposed the Tobacco and Alcohol Tax, which added NT$11.8 to the price of each pack. It also levied a Tobacco Health and Welfare Tax of NT$5 per pack and earmarked the proceeds for tobacco control and other health-related services.

As a result of these taxes, the price of domestic cigarettes rose from NT$23.97 to NT$30.57 in 2002, and the price of imported cigarettes rose from NT$43.02 to NT$54.86. On average, cigarette taxes rose to NT$16.8 per pack, which resulted in an additional business revenue tax of 5%.

In 2006, the government increased the Tobacco Health and Welfare Tax by another NT$5. As a result, the price of domestic cigarettes rose from NT$30.69 per pack in 2001 to NT$35.07 in 2002, and the price of imported cigarettes rose from NT$43.02 to NT$54.86. On average, cigarette taxes rose to NT$16.8 per pack, which resulted in an additional business revenue tax of 5%.

### Table 1: Comparison of cigarette retail prices and total excise taxes from 2001 to 2006

<table>
<thead>
<tr>
<th></th>
<th>Retail prices (NT$/pack)</th>
<th>Total excise tax (NT$/pack)</th>
<th>Change in retail price, 2001–02 and 2005–06 (%)</th>
<th>Change in total excise tax, 2001–02 and 2005–06 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001 Domestic</td>
<td>23.97</td>
<td>10–11</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>43.02</td>
<td>16.6</td>
<td>–</td>
</tr>
<tr>
<td>2002 Domestic</td>
<td>30.57</td>
<td>16.8</td>
<td>27.53</td>
<td>61.81–68</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>54.86</td>
<td>16.8</td>
<td>27.52</td>
</tr>
<tr>
<td>2005 Domestic</td>
<td>30.69</td>
<td>16.8</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>55.06</td>
<td>16.8</td>
<td>–</td>
</tr>
<tr>
<td>2006 Domestic</td>
<td>34.16</td>
<td>21.8</td>
<td>11.3</td>
<td>29.76</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>61.68</td>
<td>21.8</td>
<td>12.02</td>
</tr>
</tbody>
</table>

Despite these tax increases, however, the average price of cigarettes in Taiwan today is still significantly lower than in many other countries (Guindon et al. 2002; Tsai et al. 2002; Blecher and Van Walbeek 2009). In 2002, taxes accounted for 40% of the retail price of cigarettes in Taiwan, while they accounted for 66% or more of the price in higher-income countries—with the notable exception of the United States (Chaloupka et al. 2000). To put this in perspective, consider the following. If the price of a pack of domestic cigarettes were expressed in the amount of working time needed to earn an equivalent amount of money, it would take an Indian 77 min, an Indonesian 62 min, a Chinese 56 min, and a Taiwanese only 10 min to earn enough to buy a pack of cigarettes (Guindon et al. 2002).

Such low prices have consistently hindered Taiwan’s attempts to significantly reduce the number of smokers; by 2002,
Betel nut consumption in Taiwan

A nationwide survey taken by the Bureau of Health Promotion in 2002 found that 17% of Taiwanese men and 1.2% of Taiwanese women habitually chew betel nuts (Department of Health, Executive Yuan 2003). This consumption has had serious health consequences. Between 1998 and 2002, the incidence of oral cancer in Taiwan rose by an astounding 35.74%. Taiwan currently has the world’s highest incidence of oral cancer, and the disease now ranks fourth on the top ten list of the most common causes of cancer death among Taiwanese males. Since as many as 90% of oral cancer cases are linked to the consumption of betel nuts, the international medical community now believes they are carcinogenic (see Bureau of Health Promotion 2001, 2005).

In response to this epidemic, Taiwan’s Health Department has proposed levying the Betel Nut Health Tax. To estimate how high the tax should be in order to significantly reduce consumption, Lee (2004) used a quantitative model that drew on questionnaire data for central Taiwan as well as enrollee data from the Bureau of National Health Insurance. He found that a tax of NT$0.22 per betel nut would lead to a 2.82% decrease in betel nut consumption, a 0.125% decrease in medical costs and an increase of NT$8.449 billion in tax revenue. At present, however, the government has attached little urgency to this proposal.

In order to evaluate the potential effectiveness of the proposed Betel Nut Health Tax, this study conducts simulations that examine the cross-effects of both cigarette and betel nut taxes. Our study also assesses the effects on cigarette consumption of the NT$5 Tobacco Health and Welfare taxes levied in 2002 and 2006. It should be noted that the data we have used for betel nuts comes from domestically grown betel nuts alone. Even though Taiwan is a member of the WTO, its agricultural authorities have banned importation of betel nuts from other countries in order to protect domestic production. Although betel nuts smuggled in from China are available on the black market, the majority consumed in Taiwan are grown and produced locally.

We hope that the results of this study will give the government of Taiwan, as well as the governments of other Southeast Asian countries, a useful reference with which to institute taxes on cigarettes and betel nuts as part of an overall health policy.
Methodology

Empirical specification

In simultaneously assessing the cross-impact of both the proposed Betel Nut Health Tax and the two Tobacco Health and Welfare Taxes on net consumption of cigarettes and betel nuts, we primarily used cross-price elasticity between betel nuts and cigarettes as the basis for our calculations. We believe it is appropriate to simultaneously estimate the price elasticity of cigarettes and betel nuts using a demand system since the two appear to be closely linked in consumers’ decision-making processes. Such an approach should yield a better estimate than single equations; it should also avoid the incorporation of residual-causing information and the resulting errors in estimation.

Past empirical studies of the price elasticity of cigarettes mostly obtained price elasticity values of $-0.5$ to $-1.05$ for cigarettes in mid-/low-income countries and $-0.25$ to $-0.5$ in high-income countries (Chaloupka et al. 2000). More recently, John (2008) studied different tobacco products in India and found that own-price elasticity estimates for bidis (an indigenous, hand-rolled tobacco preparation) ranged from $-0.4$ to $-0.9$. John also found that leaf tobacco elasticities are near to unity. This implies that smokers in mid-/low-income countries are more sensitive to increases in the price of cigarettes than are smokers in high-income countries. In the literature on the price elasticity of cigarettes in Taiwan, Hsieh et al. (1999) estimated that domestic cigarettes have a demand own-price elasticity of $-0.6$, while imported cigarettes have a demand own-price elasticity of $-1.1$. Lee et al. (2005) estimated that domestic cigarettes have an own-price elasticity of $-0.644$, while imported cigarettes have an own-price elasticity of $-0.822$.

In regard to betel nuts, Fu and Chen (1999) found that the price elasticity in Taiwan is $-0.37$ to $-0.64$. Chang and Ting (2005) used time series data for the period 1953–2001 to estimate the short-term price elasticity of betel nut as $-0.2$ and the long-term own-price elasticity as $-0.7621$.

To obtain statistical price elasticities for cigarette and betel nut consumption, a demand system model can be used. Duffy (1995) employed the Almost Ideal Demand System (AIDS) to evaluate the effect of advertising on alcoholic drinks and tobacco in the United Kingdom. Escario and Molina (2004) used an Addictive and Linear Almost Ideal Demand System (AL/AIDS) to obtain price elasticities in Spain by applying a time series on three types of tobacco. In a comparative study, Lee et al. (2005) found that the Central Bureau of Statistics (CBS) demand model (Keller and Van Driel 1985) outperforms other demand models for empirical cigarette elasticity. Therefore, this study applies the CBS demand model to describe differential changes in quantities share as a function of changes in total consumption using betel nuts and cigarettes that does not exhaust the total budget of an individual. The parameter $c_i$ denotes marginal budget share, while the parameter $s_{ij}$ measures the cross-substitution effects of a compensated change in the price of $j$ on the quantity of $i$. The theory of demand implies adding up, symmetry and homogeneity restrictions on the CBS parameters in equation (1). In particular, we have:

Adding-up:

$$\sum_{i=1}^{n} c_i = 0, \sum_{i=1}^{n} s_{ij} = 0, \sum_{i=1}^{n} l_i = 0, \sum_{i=1}^{n} a_{q0} = 0, \quad j = 1, 2, \ldots, n$$

(2)

Symmetry:

$$s_{ij} = s_{ji}, \quad i, j = 1, 2, \ldots, n$$

(3)

Homogeneity:

$$\sum_{j=1}^{n} s_{ij} = 0, \quad i = 1, 2, \ldots, n$$

(4)

Negativity:

$$\sum_{i,j=1}^{n} x_i \cdot s_{ij} \cdot x_j \leq 0, \quad x_i, x_j \neq \text{constant}$$

(5)

An important aspect of negativity is that the diagonal elements of the matrix of Slutsky coefficients must be non-positive and expressed as:

$$s_{ii} \leq 0, \quad i = 1, \ldots, n$$

(6)

Finally, the Marshallian own-price and expenditure elasticities, respectively $e_{ii}$ and $e_p$, can be derived from equation (1) as follows: $e_{ii} = (c_i / w_i + c_j) - w_i$ and $e_p = (c_j / w_i) + 1$. We calculated reductions in cigarette and betel nut consumption as a result of the 2006 Tobacco Health and Welfare Tax and the proposed Betel Nut Health Tax by multiplying price elasticity by the percentage of the price change.

In this study, the CBS model constrained by homogeneity and symmetry conditions was implemented with Zellner’s Seemingly Unrelated Regression (SUR) procedure using the Time Series Processor (TSP) package version 4.2B. Since the adding-up condition renders the system perturbation covariance matrix singular, estimation must take place after deletion of the cigarette share equation, with estimates of the coefficients of the dropped equation retrieved from the adding-up constraints.

Data

An analysis of the relationship between price and consumption of cigarettes and betel nuts is essential. Therefore, this study uses aggregate time series data for the period 1971–2007 to analyse consumer demand for betel nuts, as well as for domestic and imported cigarettes. Data on annual cigarette sales were obtained from the Taiwan Tobacco and Wine Monopoly Bureau (1971–2000) and the National Treasury Agency (2001–07). Because we could not obtain real statistics on market sales of betel nuts, we calculated betel nut consumption using betel nut production data for the period 1971–07. These data were mainly obtained from the Republic of China Agricultural Statistics Yearbook (Council of Agriculture 2004a).

Annual consumption per capita of cigarettes (betel nuts) was calculated by dividing the total annual cigarette (betel nut) consumption among the population of adults 15 years of age or older. Cigarette consumption figures consisted of both domestic and imported cigarettes. Cigarette and betel nut expenditures were classified as expenditures on domestic cigarettes, imported
Table 2  Estimated price and expenditure elasticity values

<table>
<thead>
<tr>
<th>Equation</th>
<th>Budget share</th>
<th>Expenditure</th>
<th>Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Betel nuts</td>
</tr>
<tr>
<td>Betel nuts</td>
<td>0.322</td>
<td>0.599** (2.817)</td>
<td>-0.384** (-4.144)</td>
</tr>
<tr>
<td>Domestic cigarettes</td>
<td>0.359</td>
<td>0.778** (5.967)</td>
<td>-0.131** (-2.328)</td>
</tr>
<tr>
<td>Imported cigarettes</td>
<td>0.318</td>
<td>1.655** (14.702)</td>
<td>-0.473** (-9.699)</td>
</tr>
</tbody>
</table>

Notes: 1  ratios are shown in parentheses. The coefficient \( ij \) is the effect of an increase in the price of \( i \) on the quantity of \( j \).

** Marshallian own-price elasticities.

<table>
<thead>
<tr>
<th>betel nuts</th>
<th>Domestic cigarettes</th>
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</tr>
</tbody>
</table>

**Results**

Elasticity of betel nut and cigarette demand

Elasticity coefficients are often very useful analytical tools for economic policy. Table 2 shows estimated expenditure and price elasticity coefficients computed from mean consumer budget shares between 1987 and 2007. Expenditure elasticity of demand is a measure of the responsiveness of demand to changes in expenditure on a blanket of similar goods. It reflects changes in quantity purchased and is also sensitive to changes in consumer expenditure. We use this measure as a proxy for income. The expenditure comes from a bundle of similar goods segregated by other goods.

In our study, if the percentage change in the quantity demanded for cigarettes is greater than the percentage change in consumer expenditure, the demand is expenditure elastic, or responsive to changes in consumer expenditure. In other words, a 1% change in expenditure for cigarettes induces a change in quantity demanded for cigarettes of > 1%. Additionally, if the percentage change in the quantity demanded for cigarettes is less than the percentage change in consumer expenditure for cigarettes, the demand is interpreted as being expenditure inelastic, or not responsive to changes in consumer expenditure. This means that a 1% change in expenditure for cigarettes induces a change in quantity demanded of < 1%. The higher the expenditure elasticity of cigarettes, the more sensitive consumer demand for cigarettes is to expenditure changes.

The estimated expenditure elasticity coefficients for betel nuts, domestic cigarettes and imported cigarettes are 0.599, 0.778 and 1.655, respectively. Expenditure elasticity for imported cigarettes exceeds unity, while that for betel nuts and domestic cigarettes is less than unity. These results indicate that when total betel nut and domestic cigarette demands are considered together, they dominate imported cigarette demand to a much greater extent than when betel nut and domestic cigarette demands are considered individually.

Estimated price elasticity coefficients for betel nuts, domestic cigarettes and imported cigarettes are -0.384, -0.609 and -0.824, respectively. This means that imports are more sensitive to price changes than either betel nuts or domestic cigarettes. Betel nuts are relatively price-inelastic compared with the price elasticity of both domestic cigarettes (-0.609) and imported cigarettes (-0.824). The price elasticity coefficient for betel nuts, at -0.384, is smaller than in studies by Fu and Chen (1999) and Chang and Ting (2005). This implies that betel nuts are much less elastic when using time series data from the supply side of betel nuts. (It is not surprising that people who chew betel nuts are not very sensitive to price changes due to their heavy addiction to such substances.)

The estimated price elasticity coefficients for domestic cigarettes and imported cigarettes, at -0.609 and -0.824, respectively, are similar to those of Lee et al. (2005). Cross-price elasticities suggest the nature of the relationship between the two products and indicate whether they are mutually substitutive or complementary. In this case, they imply that betel nuts and cigarettes are complementary because cross-price elasticities for betel nuts and cigarettes are negative. Taking betel nuts as an example, a respective cross-price elasticity of -0.131 for imported cigarettes implies that demand for betel nuts is less sensitive to changes than the own-prices of imported cigarettes.

These figures indicate that increases of 10% in the prices of domestic and imported cigarettes will cause decreases of 0.82% and 1.31%, respectively, in the demand for betel nuts. Furthermore, demand for imported cigarettes is more sensitive to changes in the price of betel nuts (-0.473) than is demand for domestic cigarettes (-0.131). This suggests that a change in the price of betel nuts does not affect the consumption of imported cigarettes and may cause only a minor change in demand for domestic cigarettes.
Effects of cigarette taxes on cigarette and betel nut consumption

This study used cigarette and betel nut consumption information for 2001 and 2005 to analyse the effect on cigarette and betel nut consumption of the price increases resulting from the Tobacco Health and Welfare Taxes levied in 2002 and 2006. In 2001, each pack of cigarettes was subject to a tobacco tax of NT$11.8. Average annual per capita consumption of imported cigarettes was 66.14 packs, and average consumption of domestic cigarettes was 64.18 packs. This yielded an annual per capita total of 130.32 packs. After the Tobacco Health and Welfare Tax added an additional tax of NT$5 in 2002, excise taxes averaged NT$16.8 per pack. The cigarette market responded to this change by quickly raising the price of imported and domestic cigarettes to an average of NT$54.86 and 30.57 per pack, respectively.

Our study found that the own-price elasticities of domestic and imported cigarettes were −0.609 and −0.824, respectively. These price elasticity estimates indicate that per capita consumption of imported cigarettes will fall by 22.67% as a result of the price increases, while consumption of domestic cigarettes should fall by 16.62% (see Table 3). This is equivalent to a total drop in cigarette consumption of 445.86 million packs.

In 2001, average per capita betel nut consumption in Taiwan was 9.303 kg. The cross-price elasticities of betel nuts relative to domestic and imported cigarettes are −0.082 and −0.131, respectively, which implies that total betel nut consumption will fall by 9.77 million kg (5.86%) as a result of the 2002 price increases on both imported and domestic cigarettes.

In 2006, the price per pack of cigarettes rose again as the result of an additional NT$5 Health and Welfare Tax. This implies that average per capita cigarette consumption should fall by a total of 8.77%, which is equivalent to a total reduction of 189.89 million packs for the population 15 years of age or older. The total tax increase of NT$10 resulting from the 2002 and 2006 Health and Welfare Taxes implies that imported and domestic cigarette consumption should fall by 32.57% and 23.5%, respectively. These assumptions were proved essentially correct by a 2008 National Treasury report that found consumption of imported and domestic cigarettes fell during this period by 28.63% and 20.39%, respectively. Thus, these figures approximate the results predicted by our model.

Our study found that the own-price elasticities of domestic and imported cigarettes were −0.609 and −0.824, respectively. These price elasticity estimates indicate that per capita consumption of imported cigarettes will fall by 22.67% as a result of the price increases, while consumption of domestic cigarettes should fall by 16.62% (see Table 3). This is equivalent to a total drop in cigarette consumption of 445.86 million packs.

Table 3 Effects of the tobacco (betel nut) health tax surcharge on cigarette (betel nut) consumption

<table>
<thead>
<tr>
<th>Tax scenarios</th>
<th>Effect on</th>
<th>Change in price (%)</th>
<th>Change in consumption (%)</th>
<th>Change in consumption (million packs/million kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Tobacco Health and Welfare Tax of NT$5 in 2002</td>
<td>Domestic cigarettes</td>
<td>27.53</td>
<td>−16.62</td>
<td>−185.35</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>27.52</td>
<td>−22.67</td>
<td>−260.51</td>
</tr>
<tr>
<td></td>
<td>Betel nuts</td>
<td>−</td>
<td>−5.86</td>
<td>−9.77</td>
</tr>
<tr>
<td>Additional Tobacco Health and Welfare Tax of NT$5 in 2006</td>
<td>Domestic cigarettes</td>
<td>11.3</td>
<td>−6.88</td>
<td>−59.48</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>12.02</td>
<td>−9.9</td>
<td>−130.41</td>
</tr>
<tr>
<td></td>
<td>Betel nuts</td>
<td>−</td>
<td>−2.5</td>
<td>−3.49</td>
</tr>
<tr>
<td>Proposed Betel Nut Health Tax of NT$50.93 per kg</td>
<td>Domestic cigarettes</td>
<td>−</td>
<td>−2.66</td>
<td>−22.23</td>
</tr>
<tr>
<td></td>
<td>Imported cigarettes</td>
<td>−</td>
<td>−9.61</td>
<td>−119.29</td>
</tr>
<tr>
<td></td>
<td>Betel nuts</td>
<td>20.33</td>
<td>−7.8</td>
<td>−11.04</td>
</tr>
</tbody>
</table>

Discussion

The results of this study indicate that betel nuts and cigarettes do have a complementary relationship because the cross-price elasticity is significant only in the case of a betel nut price increase. The estimated cross-price elasticities for betel nuts and cigarettes imply that adoption of the Betel Nut Health Tax as a policy tool for controlling betel nut use will indeed reduce betel nut consumption; and it will be even more effective at curbing cigarette consumption.

Because this study lacked comprehensive and reliable data for betel nut consumption and retail prices, we were forced to infer betel nut consumption and price information from supply-side data. The possibility remains that the inferred consumption data do not truly reflect consumer demand in the presence of biases. As a result, future research must establish actual betel nut consumption and retail price databases using a personal survey.

It should be noted that the majority of people who consume betel nuts belong to the lower income ranges; therefore, the
additional—and regressive—Betel Nut Health Tax could lead to greater inequity in income distribution. For this reason, the funds that result from the proposed tax should not only be used to fill the financial gap in national health insurance, but they should also be earmarked for prevention programmes and the research and development of medical treatment. This will help to lower social inequities, diminish the effects of the regressive taxation and help to abate taxation obstruction.

When developing policies for betel nut taxation practice, we suggest that public health authorities focus on wholesalers. Our reasons are four-fold. First, the government can track the number of wholesalers and their whereabouts with relative ease, so levying a tax at this level would be efficient. Second, wholesalers constitute the largest beneficiaries in the betel nut industry. Therefore, levying a betel nut health insurance surcharge on them would be relatively fair and less subject to dispute. Third, wholesalers can easily transfer the health insurance surcharge directly to consumers. Therefore, levying a tax at the wholesale level can readily achieve the health policy goal of reducing betel nut intake. Finally, revenue from the surcharge could be transferred directly to the national health insurance safety reserve or be used to defray betel nut control measures. Such a surcharge could effectively compensate for the additional costs to the health insurance system caused by betel nut use and provide more funding for betel nut control efforts.

**Conclusion**

In 2009, Taiwan increased the Tobacco Health and Welfare Tax again by NT$10 per pack of cigarettes. This tax increase should reduce average per capita cigarette consumption by 16.77 packs, or 14.47%; a total reduction of 320.86 million packs for the population 15 years of age or older. It should also lead to an increase in tax revenue of NT$18.96 billion, which will help to cover the health insurance system’s current financial shortfall.

If the government were to levy a betel nut tax of NT$50.93 per kilogram, we project that average per capita consumption of imported and domestic cigarettes would fall by 8.46%. If the 2009 Tobacco Health and Welfare Tax and the Betel Nut Health Tax were levied simultaneously, total cigarette consumption could be reduced by 20.84%. Therefore, we strongly support this recommendation for policy consideration. We also suggest that research comprising more comprehensive simulations be conducted in the future to explore different taxation scenarios. This will enable policy makers to consider the partial complementary relationship that exists between cigarette and betel nuts when evaluating the real and comprehensive impacts of taxation on health and welfare.

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