

RESEARCH PAPER

Effect of cigarette tax increase on cigarette consumption in Taiwan

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Objectives: This study evaluates the effect of a 5 New Taiwan Dollar (NT\$5) Health and Welfare Tax increase on the consumption of domestic and imported cigarettes and cigars.

Methods: Using statistics published annually from 1971 through 2000, we set up a model based on the Central Bureau of Statistics (CBS) demand model to estimate price and expenditure elasticity coefficients of cigarettes and cigars.

Results: Our results showed that the price elasticity coefficients for domestic and imported cigarettes were -0.644 and -0.822 . The consumption of imported cigarettes was reduced by 7.51 packs per capita, and the consumption of domestic cigarettes was reduced by 15.21 packs per capita. Total per capita consumption of cigarettes was reduced by 22.72 packs (18%).

Conclusions: From the public health and financial perspectives, the increase in this excise tax on tobacco to the Taiwan government will have significant effect in reducing cigarette consumption; it will also generate additional tax revenues.

Since Taiwan entered the World Trade Organization (WTO) in 2002, its government has taken important steps to counter the effect of opening its tobacco market by trying to manage the sale of tobacco and control the hazards of its use. Traditionally, cigarette prices are lower in Taiwan than those in many other countries.^{1,2} Statistics on the purchasing power of cigarette customers in terms of worker's wages have shown that purchase of one pack of domestic cigarettes requires 77 minutes of work in India, 62 minutes in Indonesia, 56 minutes in China, and only 7–10 minutes of work in Taiwan.¹ Therefore, it stands to reason that as long as the price of domestic cigarettes stays comparatively low, there will be no financial reason for a significant reduction in the smoking rate in Taiwan's population. In fact, Taiwan had 4.5 million smokers (one out of three adults) in 2002.³ Health hazards inflicted by tobacco have cost the government about NT\$ 20 billion for medical expenses and brought about NT\$160 billion loss of gross domestic product (GDP) per year.⁴

In recent years, Taiwan has made major progress in tobacco control by taxation, the implementation and enforcement of clean air laws, restrictions on advertising by tobacco manufacturers, anti-smoking media campaigns, school education programmes, health warning labels, the implementation and enforcement of youth access laws, and taxation on cigarette products. The effects of some of these tobacco countermeasures in reducing tobacco consumption are obvious, while others are less certain. It is universally recognised that taxation on cigarette products has been very effective at reducing tobacco use.⁵ Numerous studies have confirmed that taxing cigarette sales helps reduce the consumption of cigarettes.^{6–9} Therefore, cigarette tax increases have become an important policy for tobacco consumption control.^{10–12} In 1999, Hsieh *et al*¹³ found that the price elasticity of demand for cigarettes in Taiwan to be -0.6 , which might suggest that the effect of increasing taxes

might reduce cigarette consumption more significantly in Taiwan than in other countries with lower price elasticities.

Before 1 January 2002, Taiwan's domestic cigarettes were supplied by a government run manufacturer, the Taiwan Tobacco and Wine Bureau. Domestic cigarettes were taxed at NT\$10–11 per pack.¹⁴ Before 2002, imported cigarettes, starting in 1987, were taxed at NT\$16.6 per pack. Also before 2002, both domestic and imported cigarettes were subject to an in-kind tax, called monopolistic profit, which constituted nearly 47% of retail price.⁵ After Taiwan entered the WTO in 2002, the new cigarette tax law enacted in Taiwan imposed a tobacco tax of NT\$11.8 per pack and an additional Health and Welfare tax, amounting to an additional NT\$5 per pack, which was to be earmarked for tobacco control and other health related services. Therefore, on an average, the excise taxes on a pack of 20 cigarettes came to NT\$16.8 per pack, resulting in an additional business revenue tax of 5%.

Since the enactment of the new cigarette tax, the prices of domestic cigarettes and imported cigarettes have risen from NT\$25.1 and NT\$44.1 in 2001 to NT\$35.1 and NT\$50.4 in 2002.¹⁵ The growth in sales of domestic and imported cigarettes prices increased by 40% and 14% from 2001 to 2002. As can be seen in table 1, which describes cigarette taxes and prices before and after 2002, the cigarette tax increases brought about retail price increases that not only included the tax increase themselves but also included increases the companies almost invisibly added to cigarettes at the time same time.* The average cigarette tax accounted for 40% of the retail price in 2002. This 40% proportion, however, is still lower than 66% or more found in some higher income countries (with the notable exception of the USA).¹⁰ Consequently, cigarette prices in Taiwan are well below those of many other countries. The anti-smoking groups advocate the cigarette price increase was the most effective way of persuading smokers to quit and in discouraging people from experimenting. Meanwhile, since the health insurance system continues to incur heavy losses due to medical expenses for tobacco related illnesses, the

*When cigarette taxes are increased, cigarette companies also raise their prices to obtain the maximum profits from current, addicted smokers to help them offset the future losses due to tax induced reductions in cigarette consumption.¹⁵

Abbreviations: CBS, Central Bureau of Statistics; GDP, gross domestic product; TTWMB, Taiwan Tobacco and Wine Monopoly Bureau; WTO, World Trade Organization

Table 1 Comparison of cigarette retail prices and total excise tax before and after 2002

	Retail prices (NT\$/pack)	Total excise tax (NT\$/pack)	Change in retail price, 2001–2002 (%)	Change in total excise tax, 2001–2002 (%)
Before 2002				
Domestic cigarette	25.1	10–11		
Imported cigarette	44.1	16.6		
After 2002				
Domestic cigarette	35.1	16.8	40	53–68
Imported cigarette	50.4	16.8	14	1.2

Source: Shi and Hsieh (1999); Lee and Ye (2004).

government is being pressed to increase the current Health and Welfare Tax on tobacco.

How much of an increase would effectively bring about a decrease in tobacco consumption is not known. To help answer this question, we evaluate the effect of the 2002 tax on cigarette consumption and the further increasing taxes on cigarette consumption by estimating cigarette price elasticities.

METHODS

Literature on tax effects

A tax change can lead to smaller, commensurate, or greater increases in the retail price of the taxed commodities. In response to cigarette taxation, cigarette prices have been found to increase slightly more than the amount of tax increase alone in some countries.¹⁶ In fact, some recent studies have found that prices in Taiwan and South Africa increased by much more than the amount of the increased tax alone.^{17, 18} Therefore, to understand the effect of tax increases on cigarette consumption, we need to know two things: (1) the extent to which the tax increase results which depends both on the share of tax in price and on the industry pricing behaviour; and (2) the relation between price changes and consumption changes, or price elasticity of demand.

Economists have used estimates of price elasticity of demand, defined as the percentage change in consumption resulting from a 1% price increase, to measure the effect of change in cigarette price on changes in cigarette consumption. Overall, price elasticity for cigarette falls within the relatively wide range from -0.14 to -1.23, but most fall within a narrower range, from -0.3 to -0.5. Price elasticity has also been found to be about twice as great in less developed countries.^{19, 20}

Using secondary data collected by the Taiwan Wine and Tobacco Bureau, Hsieh *et al*¹³ calculated the price elasticity of demand for cigarettes to be -0.6 in Taiwan. Using individual data taken from a Year 2000 national face-to-face interview survey specifically designed to evaluate the effect of added tax, Tsai *et al*² obtained a price elasticity of -0.3. With that estimated price elasticity of -0.3, they calculated that total cigarette consumption would be reduced to 1.86 billion packs after the tax increase. Total revenue after Health and Welfare Tax was calculated to be \$NT9.3 billion.

Although higher taxes reduce the consumption or sales of cigarettes, cigarette tax revenues increase because the loss in revenues resulting from lower sales is more than offset by gains brought about by the increase in the tax rate. Policymakers in tobacco control and in the tax revenue departments will find that as long as the price elasticity of demand for cigarettes is less than -1, total sales revenue

increases when price increases,³ but that is not the same as total tax revenue.

The empirical model

Price elasticities can be obtained statistically with the demand model for cigarettes. Taiwan cigarette product demand can be described using the Central Bureau of Statistics (CBS; Keller and Van Driel²¹) demand model, which, in a comparative study of several demand systems, Lee and Ye¹⁵ found to perform best. The CBS demand model describes the differential change in the quantity share as a function of changes in total tobacco expenditure and prices†:

$$\omega_{it}(d \log q_{it} - d \log Q_t) = c_i d \log Q_t + \sum_j s_{ij} d \log p_{jt} \quad (1)$$

where q_{it} and p_{it} are the quantity and the price of i th good in period t , w_{it} is the budget share of i th good in period t , and $d \log Q_t = \sum w_{it} d \log q_{it}$ is Divisia quantity index. The c_i parameters i denote the marginal budget shares. The s_{ij} parameters measure the cross substitution effects of a compensated change in the price of j on the quantity of i . The theory of demand implies the following restriction on the CBS parameters in (1). In particular, we have:

$$\text{adding up: } \sum_{i=1} c_i = 0, \quad \sum_{i=1} s_{ij} = 0, \quad j = 1, 2, \dots, n \quad (2)$$

$$\text{symmetry: } s_{ij} = s_{ji} \quad i, j = 1, 2, \dots, n \quad (3)$$

$$\text{homogeneity: } \sum_{j=1} s_{ij} = 0 \quad i = 1, 2, \dots, n \quad (4)$$

$$\text{negativity: } \sum_{i=1} \sum_{j=1} x_i s_{ij} x_j \leq 0 \quad x_i, x_j \neq \text{constant} \quad (5)$$

An important aspect of negativity is that the diagonal elements of the matrix of Slutsky coefficients must be non-positive.

$$s_{ii} \leq 0 \quad i = 1, \dots, n \quad (6)$$

Finally, the Marshallian own-price and expenditure elasticities, ϵ_{ii} and η_i , respectively, can be derived from equation 1 as: $\epsilon_{ii} = s_{ii}/w_i + c_i - w_i$ and $\eta_i = c_i/w_i + 1$. Using the price elasticity times the percentage of the price change, we calculated potential reductions in cigarette consumption.

Data

An analysis of the relations between price and consumption of cigarettes was essential. We used aggregate time series data obtained from the period of 1971 through 2000 to analyse customer demand. Data of the annual cigarette sales in Taiwan from 1971 to 2000 is reported by Taiwan Tobacco and Wine Monopoly Bureau (TTWMB) in the Taiwan Tobacco and Wine Statistical Yearbook.²² The cigarette consumption was calculated by the annual number of packs of cigarettes or number of cigars sold per capita to users 15 years old or over. Annual per capita cigarette consumption by users 15 years old or older was calculated by dividing total annual quantities by end year population of adults 15 years old or older. Cigarette consumption quantities were grouped

† In this model, a choice has been made to include the expenditure variable directly, rather than income. The reason that expenditure variable in model performs relatively well in terms of explanatory power.

according to: domestic cigarettes (DC; after deducting exports), imported cigarettes (IC), and cigars (CG; both domestic and imported cigars). The total tobacco expenditures were grouped according to domestic cigarettes, imported cigarettes, and cigars. The year end data on adults over 15 years old or older used in this study has been reported by the Ministry of the Interior of the Republic of China, published in the *Statistical Yearbook of Interior*.²³

In the above mentioned reports, the price of domestic cigarettes price is the average retail price per pack weighted by the quantity of each brand of domestic cigarette sold on the Taiwan market. The price of imported cigarettes is derived by dividing the total sales income of imported cigarettes by total sales quantity of consumed imported cigarettes. Cigar price is the average retail price per piece weighted by the market sale quantity for each brand of domestic and imported cigars sold. Domestic cigar production ceased in 1989. Because the imported cigarettes and cigar prices in the above reports are wholesale prices, the prices do not reflect actual retail circumstances. Thus, for our purposes, we used a 10% mark up as retailer profits to calculate imported cigarettes and cigars retail prices. The 10% mark up for imported cigarettes price is based on information from cigarette vendors;¹⁵ the 10% mark up of cigars is based on the price gap between the price paid by the public and the price the TTWMB charged the retailers.²² Data on all prices and total tobacco expenditures were then deflated based on the consumer price index (1996).

Statistics

In this study, the CBS model with homogeneity and symmetry imposed was used by the Zellner's seemingly unrelated regression (SUR) procedure, with the time series processor package (TSP), version 4.2B. Since the adding-up condition renders the covariance matrix of a system's disturbance singular, it is necessary for an estimation to take place after the deletion of the cigars share equation, with estimates of the coefficients of the dropped equation being retrieved from the adding up constraints. Annual data for the period 1971–2000 were also used as part of the materials in this study.

RESULTS

The coefficients estimated by the CBS model with homogeneity and symmetry constraints are shown in table 2. Except for cigars, all expenditure and price coefficients were significant at the 5% level. Root mean square errors, expressed in percentages and system R^2 , were used to assess goodness-of-fit. These errors were less than 1% in each demand equation, and the system R^2 value was 0.819 (table 2), indicating that the model performed very well. The Durbin-Watson statistic showed no evidence of autocorrelation, indicating that that CBS model was acceptable.

Elasticity of cigarette demand

One of the most interesting economic coefficients for policy analysis has been an elasticity coefficient. Table 3 presents the estimated expenditure and price elasticity coefficients, at the mean values and customer budget shares. The estimated expenditure elasticity coefficients for domestic and imported cigarettes, calculated at sample means, were 0.689 and 2.401, respectively. These estimates imply that a 10% increase in total tobacco expenditures would bring about a 6.89% and 24.01% increase in the sales of domestic and imported cigarettes.

As the total market expanded, the demand for each category of cigarettes was expected to increase proportionally. However, while the expenditure elasticity for the imported cigarettes exceeded unity, those for domestic cigarette and

cigars fell below unity. These results suggested that an expansion of the total cigarettes demand favoured the imported cigarettes much more than the domestic demand, a finding that was also reported by Hsieh *et al.*¹⁴ A plausible explanation for this difference is that consumers perceive imported cigarettes as having better quality and as being goods that consumers would aspire to use, with the demand for them fuelled by advertising images and messages. Since imported cigarettes seem to maintain great potential in the Taiwan market in this manner, the government wants to try and protect the market share of domestic cigarettes, which a complete ban on all advertising and promotion might help.

The estimated price elasticity coefficients for domestic and imported cigarettes, calculated at sample means, were -0.644 and -0.822 , respectively. These estimates imply that a 10% increase in domestic and imported cigarette price would cause a 6.44% decrease in domestic cigarette and 8.22% decrease in imported cigarette consumption. The imported cigarettes appear to be more sensitive to price changes than the domestic cigarettes.

Effects of cigarette tax on cigarette consumption and tax revenues

This study uses 2001 cigarette price and consumption information to analyse the effect of a 2002 NT\$5 Health and Welfare Tax on cigarette consumption and government tax revenue. In 2001, the Taiwan average consumption of imported cigarettes and domestic cigarettes was 67.22 packs per capita and 59.3 packs per capita, respectively, totalling 126.52 packs per capita. After 2002, when Taiwan entered the WTO and the new tax law imposed NT\$11.8 tobacco tax per pack plus an additional Health and Welfare tax of NT\$5, excise taxes on a pack of 20 cigarettes averaged NT\$16.8. The cigarette market responded by raising the prices for imported cigarettes and domestic cigarettes to NT\$50.4 per pack and NT\$35.1 per pack, which amounted to a NT\$6 increase for imported cigarettes and NT\$10 increase for domestic cigarettes. Results from our study showed that the price elasticity of imported cigarettes was -0.822 , and -0.644 for the domestic cigarettes (table 3).

With a price increase of NT\$6 for imported cigarettes and NT\$10 for domestic cigarettes, the price elasticity estimates imply that consumption of imported cigarettes would be reduced by 7.51 packs per capita and consumption of domestic cigarettes would be reduced by 15.21 packs. In other words, these reductions would amount to a total reduction of 22.72 packs per capita, 402 million packs of cigarettes, an 18% per capita decrease in cigarette consumption. Compared with 2001 figures, cigarette consumption would be reduced to 1.836 billion packs and the government tax revenue would be increased to NT\$30.849 billion. In fact, 2002 National Treasury statistics reported the sales of 1.74 billion packs. Based on this figure we calculated that total tax revenue to be NT\$29.1 billion in 2002. This figure approximates the results of our model prediction.

Comparing the tax revenue of NT\$22.3 billion before the enactment of the new tax, we found that the NT\$5 increase in cigarette tax brought in an extra NT\$8.6 billion tax revenue.

This NT\$5 tax has been enforced for more than two years, and a significant reduction in cigarette consumption has been shown to date. The cigarette taxes accounted for 40% of the retail price in 2002. Although 40% sounds high, this proportion is still rather low when, as mentioned earlier, comparing it with the 66% or more of the retail price going for cigarettes prices in high income countries (with the notable exception of the USA). Consequently, cigarette prices in Taiwan are well below those of many high income countries, who have seen significant reductions in cigarette

Table 2 Estimated elasticity coefficients of cigarette consumption using the CBS model with homogeneity and symmetry restrictions imposed

Equation	Total tobacco expenditure	Price			Summary statistics	
		Domestic cigarettes	Imported cigarettes	Cigars	RMSE (%)	Durbin-Watson
Domestic cigarettes	-0.25384 (-13.332)*	-0.06617 (-3.027)*	0.06816 (3.027)*	-0.00198 (-1.072)	1.02	1.847
Imported cigarettes	0.25360 (13.121)*	0.06816 (3.027)*	-0.07024 (-3.080)*	0.00207 (1.333)	1.04	1.759
Cigars	0.00023 (0.165)	-0.00198 (-1.072)	0.00207 (1.333)	-0.00009 (-0.114)	-	-
System $R^2=0.819$						

Notes: RMSE (root mean square error) = $\left(\frac{1}{T} \sum_{t=1}^T (\varepsilon_{it}^s - \varepsilon_{it}^a)^2\right)^{1/2}$ where ε_{it}^s and ε_{it}^a are the values of the simulated and actual errors in the t^{th} observation of the i^{th} equation.
 System $R^2 = 1 - \frac{1}{1 + 2*(LL_u - LL_b)*1/T*(N - 1)}$ where LL_u is log likelihood of the unrestricted model, LL_b is log likelihood of the base model, T is the number of observations, and N is the number of equations in the system.
 Note: t ratios are shown in parentheses.
 *Significant at 5% levels.

consumption. This certainly imposes a pressure on the government to implement another tax increase in the existing Health and Welfare Tax.

Inter-party negotiations at the Legislative Yuan reached a consensus to make amendments to the Tobacco and Liquor Tax Law to raise the health tax levied on cigarettes from NT\$5 to NT\$8 per pack, a rise of NT\$3 per pack. The tobacco industry is likely to pass on this tax increase as a price increase to consumers. A price rise of NT\$3 per pack in cigarette would cause a consumption reduction of 2.86 and 2.19 packs per capita in domestic and imported cigarette, respectively, and a reduction of 5.05 packs per capita, totalling 90 million packs, 5.21% per capita, in cigarette consumption. Cigarette consumption would be reduced to 1.6456 billion packs (based on a population count of 2002), and the government tax revenue would be NT\$32.564 billion, including the Health and Welfare Tax of NT\$13.2 billion. We estimate that with a Health and Welfare Tax increase from NT\$5 to NT\$8 per pack, there would be a NT\$5 billion increase in revenue from the Health and Welfare Tax. Table 4 provides estimates of the effects of tobacco excise tax increase on cigarette consumption and cigarette tax revenues.

Implications of tax increases

Our study shows cigarette price elasticity estimate to be less than one, meaning that although the tax will have some effect in reducing cigarette consumption, it will also generate additional tax revenues. The enactment of tobacco control policy, hopefully with continuing price increases, is expected to have significant effect in reducing cigarette consumption, making cigarettes less affordable to juveniles. With regards to government revenues, provided that the tax increases are proportionately larger than the resulting reduction in cigarette consumption, cigarette tax revenues will rise, which can help reduce current National Health Insurance deficits and possibly reduce the damage and death caused by smoking related diseases. This should be convincing enough

Table 3 Estimated values of price and expenditure elasticities†

Equation	Budget share	Elasticities	
		Expenditure	Price
Domestic cigarettes	0.817	0.689 (29.579)*	-0.644 (-17.083)*
Imported cigarettes	0.181	2.401 (22.487)*	-0.822 (-6.774)*
Cigars	0.002	1.116 (1.583)	-0.047 (-0.120)

Note: t ratios are shown in parentheses.
 *Significant at 5% levels.
 †Marshallian own price elasticities.

for the government to decide to continue using cigarette tax increases to control tobacco.

DISCUSSION

The main purpose of this study was to evaluate the effect of a tax increase on reduction of cigarette consumption by estimating cigarette price elasticity. Our model showed that, under the influence of the 2002 NT\$5 Health and Welfare cigarette tax, total per capita consumption of cigarettes was reduced by 22.72 packs (18%), meaning that the tax will have significant effect in reducing cigarette consumption; it will also generate additional tax revenues. As long as the tax hikes are substantially increased, the tax will discourage non-smokers from starting and serve as an economic restraint on youth that will reduce their ability to afford cigarettes.

Furthermore, if there were another increase in the Tobacco Health and Welfare tax—for example, from NT\$5/pack to NT\$8/pack—this would mean a further 2.86 and 2.19 packs decrease in domestic and imported cigarette consumption, approximately 5.05 pack per capita reduction or a total reduction of 90 million packs. Cigarette consumption would be further reduced to 1.6456 billion packs, with a revenue of tobacco excise taxes of NT\$32.564 billion, including the tobacco Health and Welfare tax of NT\$13.2 billion. We estimate that the further rise of tobacco Health and Welfare tax from NT\$5 to NT\$8 would lead to another NT\$5 billion increase in revenues from the Tobacco Health and Welfare Tax.

Our price elasticity estimation of tobacco customer demand found the price elasticity of the imported cigarettes to be higher than that of the domestic cigarettes, indicating that smokers are more responsive, or elastic, to price changes in imported cigarettes. If the percentage price hike for imported cigarettes is the same as that for domestic cigarettes,

Table 4 Effects of tobacco excise tax increase on cigarette consumption and cigarette tax revenues

	Total tobacco excise tax (NT\$)	Change in cigarette consumption (million packs)	Change in cigarette consumption (%)	Change in cigarette tax revenues (billion NT\$)
Additional Health and Welfare tax of NT\$5	16.8	-402	-18	8.6
Additional Health and Welfare tax of NT\$8	19.8	-90	-5.21	5

What this paper adds

Cigarette prices in Taiwan are considerably lower than those in many other Asian countries. Even a modest tax increase has resulted in a significant reduction in cigarette consumption, with price elasticity between -0.644 and -0.822 , for domestic and foreign cigarettes, respectively. Raising cigarette tax from the current 40% of retail price to two thirds or higher would be a highly effective tool in tobacco control, with the added benefit of substantially increasing the revenue.

imported cigarettes would undergo a greater reduction in consumption than domestic cigarettes. Currently, however, regardless of whether the cigarettes are domestic or imported, the Tobacco Health and Welfare Tax is NT\$250 for every thousand cigarettes. In other words, this tax is based on volume only. In the future, if there is another hike of NT\$3/pack Health and Welfare Tax levied on both domestic and imported cigarettes, this cost will be passed on to the customers and the percentage price rise in domestic cigarettes will be relatively higher, and there will be larger reductions in consumption of domestic cigarettes. If the Tobacco Health and Welfare tax could be levied based on retail prices, the retail price of imported cigarettes would be raised, making them less affordable and bringing about a greater reduction in their consumption.

As for the allocation of funds from the Tobacco Health and Welfare tax, 70% could be used as a reserve fund for the National Health Insurance system, while 30% could be put towards tobacco hazard prevention, and social welfare for local central governments. Proper use of the revenue from tobacco taxes not only promotes social justice but also provides another resource for the current funding shortage in the National Health Insurance system.

The effect of a new Taiwan cigarette tax scheme on reducing the cigarette consumption may be limited or reduced if the size of the tax hike is not large enough, if the initial price of cigarettes are low, if many legislators are supported by the tobacco lobby and therefore any proposal to increase tax will likely be strongly opposed in the legislative process, or if there is an increase in illegal smuggling either from mainland China or through sea routes from elsewhere in southeast Asia. Therefore policymakers should wisely allocate the tax revenue to maximise the effects of cigarette taxation on larger reductions in tobacco use and greater health benefits. Higher taxes alone will not solve all the problems. Finally, our findings should be considered with some reservation, as estimating price elasticity by the time series data from legal cigarettes mistakenly identifies any switching to smuggled cigarettes as a fall in consumption; consequently the estimated price elasticity overestimates the response of smokers to the price increase, and the actual impact on consumption. Further studies attempting to estimate price elasticity might want to use cross sectional data from the Health Interview Survey when trying to estimate the effect of cigarette tax on cigarette consumption and when comparing the difference of cigarette price elasticity according to various smoker characteristics.

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