CIGARETTE EXCISE TAXATION:
THE IMPACT OF TAX STRUCTURE ON PRICES, REVENUES, AND CIGARETTE SMOKING

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NBER Working Paper No. 16287
August 2010
JEL No. H2,I18

ABSTRACT

The main purpose of this study is to provide empirical evidence on the effects of the cigarette excise tax structure on three outcomes: cigarette prices, government revenues, and cigarette consumption. We composed cross-sectional time-series data for 21 EU countries from year 1998 to 2007 from various data resources. We provide strong evidence that the price gap between premium and low-priced brands is larger in countries with a greater share of ad valorem tax. A 10-percent raise in the share of ad valorem tax in total excise tax leads to about a 4 to 5 percent increase in the price gap, with a smaller impact in more concentrated markets. Our estimates confirm that greater instability of government tax revenues from cigarette excise taxes can be attributed to greater reliance on the ad valorem tax and such instability increases with the growth of manufacturers' market power. We also find that greater reliance on a specific tax has greater impact on cigarette smoking, but the impact diminishes with the growth of manufacturers' market power.

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I. Introduction

Tobacco taxes are the most cost effective tobacco control measure for promoting smoking cessation, preventing initiation, and reducing consumption.   More than 100 studies from industrialized countries produce consistent evidence that shows that the higher prices that result from increased tax lead to significant reductions in cigarette smoking.   Most of these studies produce estimates for the price elasticity of demand in the range from -0.25 to -0.50, implying that a 10% increase in the price of cigarettes will reduce overall cigarette consumption by between 2.5% and 5.0% (Chaloupka and Warner, 2000; Chaloupka et al., 2000).   A growing number of studies from low and middle income countries suggest that the same price increase will produce even larger reductions in consumption (Ross and Chaloupka, 2006).

Governments impose a variety of taxes on tobacco products, with excise taxes levied by most countries globally.   The two major excises are specific excise taxes (those imposed based on quantity or product characteristics) and ad valorem excise taxes (those imposed based on value). Worldwide, out of 167 countries for which data are available, 60 countries rely solely on specific taxation, 60 on ad valorem, and 48 of them use a combination of both (the majority of them being in Europe); 19 countries impose no excise tax on cigarettes (WHO, 2010).

Given the inelastic demand for tobacco products and the low share of taxes in retail prices in most countries, increases in tobacco taxes produce sustainable and higher revenues for the governments. However, the two types of excises can differentially affect

prices, revenues and the quality and variety of products available and, as a result, smoking behavior and its consequences (Sunley et al., 2000; WHO, 2010).   The choice between specific and ad valorem taxes depends on a government's priorities.

All European Union countries impose both specific and *ad valorem* excise taxes on cigarettes. According to the current European Union council directive (2002/10/CE), each member state should apply an overall minimum tax (specific tax + ad valorem tax) of EUR 64 per 1,000 cigarettes for cigarettes of the price category most in demand. Moreover, the minimum level of total tax should be 57% of retail price (inclusive of all taxes) for cigarettes of the price category most in demand.

While many factors affect the final price of cigarettes, the most important policy-related determinants of tobacco prices are taxes on tobacco products. Tobacco taxes provide significant revenue to governments with relatively low administrative costs making tobacco taxes appealing, especially during periods of budget shortfalls. Moreover, higher tobacco taxes are effective in reducing tobacco consumption and thereby improving public health. The ability to increase revenues and improve public health has made tobacco tax increases a popular policy lever to pull in recent decades.

However, a longstanding debate exists in Europe regarding the harmonization of cigarette taxes with southern European countries predominantly favoring ad valorem taxation and northern European countries predominantly favoring a more specific tax structure (Delipalla and O'Donnell, 2001; Antonanzas and Rodriguez, 2007). The different tax structures emerge primarily because each country has different fiscal policy

objectives with some countries focused more on economic goals and others motivated by public health and other objectives. The difference in preferred tax structure has hampered an agreement on harmonization of taxes among EU countries. Evidence on the impacts of these two types of taxes on cigarette prices, government revenue, and cigarette consumption will help inform the tax structure debate.

This paper attempts to inform policy makers on the impact of cigarette tax structure on the three aforementioned outcomes. We hypothesize that countries that rely more heavily on ad valorem taxes than specific taxes will have a greater variation in price between high- and low-priced brands. To the extent that a stronger reliance on ad valorem tax provides a price advantage to lower-priced domestic brands compared to more expensive international brands, countries that have a stake in manufacturing and distributing tobacco would likely prefer ad valorem taxes to specific taxes if one objective of these taxes is to favor domestic production. We also hypothesize that the cigarette tax structure will affect the variability of revenue streams over time with countries that have a greater reliance on ad valorem taxes having greater variability in revenue streams than countries that rely more heavily on specific taxes due to industry initiated price changes. Recent evidence from Spain supports this hypothesis. In 2006, Spain which relies heavily on ad valorem taxes, raised its tobacco tax and witnessed a fall in tobacco revenues. The unexpected fall in revenues was due to the tobacco producers reducing the price of their products (Antonanzas and Rodriguez, 2007). Finally, we hypothesize that the cigarette tax structure will have an impact on overall cigarette

consumption. Specifically, we hypothesize that overall cigarette consumption will be less affected by tax increases in countries that rely more heavily on ad valorem taxes than specific taxes. If as hypothesized above, countries that rely more heavily on ad valorem taxes will have a greater variation in price between high- and low-priced brands, then smokers in heavier ad valorem tax environments will have greater opportunities to switch down to lower-priced discount brands and thus decrease their overall consumption less than smokers in relatively lower ad valorem environments. This paper will test the above mentioned hypotheses using cross-sectional time-series data for twenty-one European Union (EU) countries for years 1998 to 2007.

II. Background

Much of the difference in behavioral effects between ad valorem and specific excise taxes arises because tobacco products are typically available in a wide range of quality grades. Thus taxes affect consumer decisions about quality and quantity. A higher tax may lead consumers to reduce both the quality and the quantity of the cigarettes consumed. The consumer's decision to lower quality in response to higher taxes is sometimes referred to as "quality shading". Because of quality shading, specific excise taxes are a more preferred tobacco control instrument than ad valorem taxes for the purposes of tobacco control.

If there are just high quality and low quality cigarettes, then the overall quantity, Q is the sum of low and high quality cigarettes:

$$Q = Q_1 + Q_2$$

If the same specific excise tax T is imposed on both high and low quality cigarettes, the total revenue collected is

$$\text{Tax Revenue} = T(Q_1 + Q_2)$$

Tax revenue depends on the total amount, high and low quality, purchased and not on the mix between high and low quality cigarettes. While changes in total quantity can affect revenue, with a uniform specific excise tax, quality shading has no effect on tax revenue when total quantity remains constant; this is not true for ad valorem taxes. Specific excise taxes also allow tobacco producers less scope to manipulate tax revenues by altering relative prices.

For an ad valorem tax, total amount collected is

$$\text{Tax Revenue} = t(P_1 Q_1 + P_2 Q_2) = t(P_1 Q_1 + P_2 (Q - Q_1))$$

Here, changes in the quality mix alters the amount of revenue, even if total quantity, Q, remains constant: A one unit increase in Q_1, holding Q constant, causes revenue to decline by $t(P_1 - P_2)$. If producers alter the mix of prices, P_1 and P_2 , causing quantities Q_1 and Q_2 to change, tax revenue can vary, even if total quantity remains unchanged. Our hypothesis that revenues will exhibit more variability with ad valorem taxes stems from this observation.

An important determinant of the demand for one good versus another good is relative price, that is, the ratio P_2 / P_1, the price of high quality cigarettes relative to the price of low quality cigarettes. The effect on relative prices considered here is similar to effect

studied in the "shipping the good apples out" (Hummel and Skiba, 2004). Ad valorem

and specific excise taxes have very different effects on relative prices. If the same

specific excise tax T is imposed on high and low quality cigarettes, the relative price falls

and becomes

$$(P_2 + T)/(P_1 + T);$$

the relative price of high quality cigarettes has declined which offsets the tendency to

substitute lower quality cigarettes for higher quality cigarettes. By contrast, a uniform

ad valorem tax leaves relative price unchanged:

$$(P_2(1+t))/(P_1(1+t)) = P_2/P_1,$$

leading to more substitution away from high priced cigarettes than we would expect to

see with specific excise taxes. This observation supports the other two hypotheses

suggested in the introduction. First, there is greater price variation under ad valorem

taxes because specific excise taxes reduce relative prices. Second, consumption is lower

under specific excise tax regimes because quality shading is attenuated by the reduction

in relative prices, which does not occur with ad valorem taxes.

III. Empirical Specification

The goal of the empirical analysis is to obtain estimates of the effects of the cigarette

excise tax structure on cigarette prices, consumptions, supply and government revenues.

Specifically, we examine the effects of the tax structure on (a) two cigarette price

variables, annual average cigarette prices and the price gap between premium and

low-priced brands; (b) two government revenue variables, government revenues from

excise taxes and the stability of government revenues; (c) two cigarette consumption variables, cigarette consumptions per capita and the adult smoking prevalence; and (d) one cigarette supply variable, the total cigarette supply. The multivariate regression models we used to obtain these estimates are presented in the following sections.

Cigarette Prices

In this section, we illustrate the empirical specifications exploring the effects of the tax structure on annual average cigarette prices and the price gap between premium and low-priced brands.

$$price_{jt} = \alpha_j + \delta_t + X_{jt}\gamma + spc_{jt}\beta_1 + adv_{jt}\beta_2 + v_{jt} \quad (2.1)$$

In equation (2.1), the average cigarette price in Euros in country j year t ($price_{jt}$) depends on country fixed effects (α_j), year fixed effects (δ_t), and time-varying country-specific economic characteristics denoted by X_{jt}, such as measures of cigarette market concentration, real GDP per capita in Euros and unemployment rates. The two parameters of interest are those associated with specific excise tax rates (spc_{jt}) and *ad valorem* tax rates (adv_{jt}). We control for the time-varying country-specific economic characteristics because countries in our samples can differ substantially in these characteristics that may have significant impacts on cigarette prices and/or excise tax rates. Country and year fixed effects are included in most specifications so as to control for permanent differences in cigarette prices across these countries and time-varying factors that may affect cigarette prices. Equation (2.1) enables us to estimate the effects of absolute changes in excise tax rates on average cigarette prices.

In addition to exploring the impacts of absolute changes in excise tax rates, we also adopt an alternative specification to obtain estimates of influences from relative changes of the *ad valorem* tax on the price gap between premium and low-priced brands.

$$pricegap_{jt} = \hat{\alpha}_j + \hat{\delta}_t + X_{jt}\hat{\gamma} + advp_{jt}\hat{\beta} + \hat{v}_{jt} \quad (2.2)$$

In equation (2.2), the price gap between premium and low-priced brands in percentage in country *j* year *t* ($pricegap_{jt}$) is determined by the share of the *ad valorem* tax in the total excise tax ($advp_{jt}$). The share of the *ad valorem* tax suggests the relative importance of the *ad valorem* tax in the total excise tax. It is also a percentage measurement, which is obtained by dividing the *ad valorem* tax rates over the total excise tax in Euros.

Finally, to fully exploit different impacts of the tax structures on the cigarette price gap across various market concentrations, we further stretch the specification in equation (2.2) into the following,

$$pricegap_{jt} = \overline{\alpha}_j + \overline{\delta}_t + X_{jt}\overline{\gamma} + advp_{jt}\overline{\beta}_1 + (advp_{jt} * HHI_{jt})\overline{\beta}_2 + \overline{v}_{jt} \quad (2.3)$$

In equation (2.3), additional to the share of the *ad valorem* tax in the total excise tax ($advp_{jt}$), we also include the interaction terms of the share of the *ad valorem* tax with cigarette market concentrations ($advp_{jt} * HHI_{jt}$), which are measured by quartiles of the Herfindahl -Hirschman Index (HHI_{jt}). In this case, estimates of $\overline{\beta}_2$ are able to tell us how the effects of the tax structure on the price gap would be affected by cigarette manufactures' market powers.

Government Excise Tax Revenues

We also explore the effects of the tax structure on two measures of government

revenues from excise taxes. One is real government revenues in Euros and the other one

is the stability of government revenues, which is indicated by the difference in

government revenues between current and previous years.

$$govrev_{jt} = \alpha_j + \delta_t + X_{jt}\gamma + spc_{jt}\beta_1 + adv_{jt}\beta_2 + v_{jt} \quad (2.4)$$

Equation (2.4) presents the empirical model used for real government revenues

($govrev_{jt}$). β_1 and β_2 in equation (2.4) correspond to the estimated effects of specific and

ad valorem taxes on government revenues from cigarette excise taxes in Euros. In this

case, equation (2.4) is almost identical with equation (2.1) and the only exception is the

dependent variable, where government revenues ($govrev_{jt}$) are used instead of cigarette

prices ($pricegap_{jt}$).

The specification investigating the effect of the relative importance of the *ad valorem*

tax on the government revenue stability ($govrevdiff_{jt}$) is quite different from equation

(2.2). The assumption here is that increases in the relative importance of the *ad valorem*

tax might raise the instability of government revenues, as cigarette manufactures have

greater potential for abusive "transfer" pricing and cigarette consumers have greater

potential for "switching down" to cheaper brands in such circumstances.

However, one concern is that increases in excise tax rates themselves might also raise

the instability of government revenues, by increasing the differences in government

revenues between two consecutive years. But such effect of tax changes might be hard to

detect and thus undermine our estimates, if both *ad valorem* and specific excise taxes

increase by the same proportion. In other words, it is possible that the stability of government revenues might be affected by the changes in tax rates, while the share of the *ad valorem* tax in the total excise tax remains the same.

$$
\begin{aligned}
govrevdiff_{jt} &= \hat{\alpha}_j + \hat{\delta}_t + X_{jt}\hat{\gamma} + spcdiff_{jt}\hat{\pi}_1 + advdiff_{jt}\hat{\pi}_2 \\
&+ spc_{jt-1}\hat{\lambda}_1 + adv_{jt-1}\hat{\lambda}_2 + advp_{jt}\hat{\beta} + \hat{v}_{jt}
\end{aligned}
\tag{2.5}
$$

In order to address this concern, we include additional controls to the specification presented, changes in excise tax rates between current and previous years (*spcdiff$_{jt}$* and *advdiff$_{jt}$*) and excise tax rates in the previous year (*spc$_{jt-1}$* and *adv$_{jt-1}$*). Therefore, in equation (2.5), the government revenue stability not only depends on the relative importance of the *ad valorem* tax but also relies on the changes in tax rates and excise tax levels in the previous year, although the latter variables are not what we specifically focus on in this study.

Similarly, to explore potential diverse impacts of the tax structures on the stability of government revenues by various market concentrations, the variable of interest, the share of the *ad valorem* tax, is interacted with quartiles of the Herfindahl -Hirschman Index. This specification is illustrated in equation (2.6).

$$
\begin{aligned}
govrevdiff_{jt} &= \overline{\alpha}_j + \overline{\delta}_t + X_{jt}\overline{\gamma} + spcdiff_{jt}\overline{\pi}_1 + advdiff_{jt}\overline{\pi}_2 \\
&+ spc_{jt-1}\overline{\lambda}_1 + adv_{jt-1}\overline{\lambda}_2 + advp_{jt}\overline{\beta}_1 + (advp_{jt}*HHI_{jt})\overline{\beta}_2 + \hat{v}_{jt}
\end{aligned}
\tag{2.6}
$$

Cigarette Consumptions and Supply

This section demonstrates the specifications examining the impacts of the tax structure on both cigarette consumption and supply, as these specifications are particularly similar and the only differences are the dependent variables. The dependent variables involved in these specifications include cigarette consumption per capita, the adult smoking prevalence and the total cigarette supply.

$$cigcon_{jt} / smkpre_{jt} / cigpro_{jt} = \alpha_j + \delta_t + X_{jt}\gamma + spc_{jt}\beta_1 + adv_{jt}\beta_2 + v_{jt} \quad (2.7)$$

Equation (2.7) presents the basic specifications adopted for cigarette consumptions and supply. In this empirical model, the cigarette consumption per capita ($cigcon_{jt}$), the adult smoking prevalence ($smkpre_{jt}$) or the total cigarette supply ($cigpro_{jt}$) in country j year t is determined by specific tax rates (spc_{jt}) and *ad valorem* tax rates (adv_{jt}), in addition to other factors.

Then we take a step further, to investigate the impacts of specific (spc_{jt}) and *ad valorem* tax rates (adv_{jt}) on cigarette consumption per capita ($cigcon_{jt}$), the adult smoking prevalence ($smkpre_{jt}$) and the total cigarette supply ($cigpro_{jt}$) by market concentration. Similar as in equations (2.3) and (2.6), the variables of interest are interacted with measures of market concentration. But this time, instead of being interacted with the share of *ad valorem* tax, quartiles of the Herfindahl -Hirschman Index are interacted with specific and *ad valorem* tax rates. A more detailed empirical model is specified in equation (2.8).

$$cigcon_{jt} / smkpre_{jt} / cigpro_{jt} = \overline{\alpha}_j + \overline{\delta}_t + X_{jt}\overline{\gamma} +$$
$$spc_{jt}\overline{\beta}_1 + (spc_{jt} * HHI_{jt})\overline{\lambda}_1 + adv_{jt}\overline{\beta}_2 + (adv_{jt} * HHI_{jt})\overline{\lambda}_2 + \overline{v}_{jt} \quad (2.8)$$

IV. Data and Measures

In this section, a detailed description of data resources involved and variables constructed for the purpose of the study are presented. The primary sample for the empirical analysis was consisted of observations in 21 European Union (EU) countries from 1998 to 2007. These data were obtained from various sources.[1] Cigarette tax structures and government revenues from cigarette excise taxes came from the European Commission. Measures of cigarette prices were obtained from the Economist Intelligence Unit (EIU) and the Tobacco Merchants Association (TMA). Data for cigarette consumptions and supply came from the ERC Group PLC. Data for country-specific economic conditions were obtained from the World Economic Outlook published by the International Monetary Fund (WEO/IMF), and data for market shares of major cigarette manufacturers of each corresponding EU country came from the TMA. All the monetary measures in local currencies or U.S. dollars were transformed into Euros in real terms by using exchange rates and average consumer price indices obtained from the WEO/IMF. Detailed summary statistics are presented in the next section.

Cigarette Tax Structure

The information on cigarette excise tax structure of these 21 EU countries from 1998 to 2007 came from the Excise Duty Tables (EDT), which are constructed by the

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[1] These 21 countries include Austria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and United Kingdom.

European Commission.[2] These tables were updated at different months of every year. In each table, the specific excise tax per 1,000 pieces of cigarettes in Euros, the *ad valorem* excise tax as the percent of the tax inclusive retail selling price (TIRSP) per 1000 pieces of cigarettes from the most popular price category (MPPC), and the TIRSP per 1000 pieces of cigarettes from the MPPC were reported. Since the exact dates of implementing tax regulation changes were unavailable, we generated the annual average specific and *ad valorem* excise taxes in Euros for each country in real terms. To measure the relative importance of the *ad valorem* tax in the total excise tax of cigarettes, we also constructed the variable, the share of the *ad valorem* tax in the total excise tax. This variable was obtained by dividing the *ad valorem* tax in Euros by the total excise tax, which is the sum of both Specific and *ad valorem* taxes in Euros (i.e. not including VAT).[3]

Cigarette Prices

In this study, we adopted two measures of cigarette prices: annual average prices and the price gap between premium and low-priced brands. The former variable came from the World Cigarette Guide produced by the TMA, in which the annual average cigarette prices in U.S. dollars and in the national currency were reported. Using the exchange rates and the average consumer price index obtained from the WEO/IMF, we generated

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[2] For Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia, the tax structure data only became available after 2003.
[3] Ad valorem tax rates from the EDT were based on the tax inclusive retail selling price (TIRSP) for 1000 pieces of cigarettes from the most popular price category. Therefore the ad valorem tax in Euros was obtained by multiplying the tax rates with the TIRSP of the cigarettes from the most popular price category.

the real annual average retail price of a pack of 20 cigarettes in Euros for each

corresponding EU country from 1998-2007.

In order to explore the effects of the tax structure on the gap in cigarette prices

between high- and low-priced cigarette brands, the variable, the cigarette price gap, was

constructed by using cigarette prices of the Marlboro brand (or equivalent) and local

brands reported by the EIU. The EIU collected these prices information twice a year at

one or more cities in these 21 EU countries.[4] In each survey, the EIU collected cigarette

prices from three survey locations according to their survey intensity, low, middle and

high. All the cigarette prices were reported in local currency units. In this case, we

constructed the semi-annual average prices of the Marlboro brand (or equivalent) and

local cigarette brands in local currency units for each country. These price measures were

obtained as the average prices of three locations within the city if only one city had been

surveyed in the country, or obtained as population weighted average prices if more than

one city of the country had been included in the survey.

We argue that the price of the Marlboro brand (or equivalent brands) is a reasonable

proxy for that of premium brands, while the price of local brands is also a plausible

substitute for that of the low-priced brands.[5] The price gap was obtained by taking price

differences between the Marlboro (or equivalent) brand and the local brands and then

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[4] From 1998 to 2003, the survey took place in March and September, while the survey was updated in June and December from 2004 to 2007.
[5] Among over 97% of our final samples, the prices of Marlboro or equivalent brands are higher or equal to those of local brands. Among about 86% of our final samples, the prices of Marlboro or equivalent brands are higher than those of local brands.

dividing the price difference by the prices of local brands. Therefore the measure of the

price gap was in percentage measurement, rather than in any monetary units.

Government Revenues from Cigarette Excise Tax

Government revenues from the cigarette excise tax of these 21 EU countries also

came from the EDT tables, which were available from 1998-2007.[6,7] Specifically, we

derived two revenue variables, real government revenues from the cigarette excise tax in

Euros and the differences in government revenues between two consecutive years. The

former one was constructed by using government revenues from the cigarette tax in Euros

and the average consumer price index of each corresponding EU country obtained from

the WEO/IMF, while the latter one was obtained by dividing the differences in

government revenues between current and previous years over the government revenue

from the cigarettes excise tax in previous year. So the difference in government revenues

between two consecutive years was also in percentage terms instead of monetary units.

Cigarette Consumption and Supply

The cigarette consumption and supply information used in this study were obtained

from the World Cigarette Report 2005 presented by ERC Group PLC.[8] From the report,

we obtained domestic cigarette production, the amount of cigarette imports and exports of

each corresponding EU country, as well as total cigarette consumption, the cigarette

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[6] For Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia, the tax revenue information only became available after 2003.
[7] The EDT tables published in sequential years might update the government revenue from cigarettes in previous issues. In this case, we always adopted the latest update.
[8] This information was obtained from the part of Europe and the part of Central and Eastern Europe in the Report.

consumption per capita, and the adult smoking prevalence from 1998-2004. Specifically, the adult smoking prevalence was based on the population aged 15 and above. Based on the information of domestic cigarette production, the amount of cigarette imports and exports, we constructed the variable, the total cigarette supply, which was obtained by summing up the domestic production and cigarette imports and subtracting exports.

Market Share Information of Cigarette Manufacturers

From the World Cigarette Guide, we also obtained the information on market shares of cigarette manufacturers of each corresponding EU country from 1998 to 2007. Based on the market share information, we constructed the Herfindahl-Hirschman Index (HHI) so as to control for the potential influence of the market structure on cigarette prices and/or the excise tax structure.[9] The HHI is a commonly accepted measure of market concentration, which is the sum of the squares of the market shares of each individual manufacturer (each cigarette manufacturer in our case). The HHI increases either as the number of the cigarette manufacturers in the market decreases or as the disparity in sizes between those manufacturers increases. Therefore a higher HHI indicates a higher concentrated (less competitive) market. We also generated a dichotomous variable for the missing HHI, which equals one if twenty percent or more of the total market share had not been claimed by any manufacturers in a country. In addition, five HHI indicators were constructed as an alternative measure of the market concentration to account for the

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[9] During the study period 1998-2007, some of EU countries had state-owned tobacco manufacturers (e.g. Italy, Portugal, Austria). However it is not clear whether the market-structure in these countries was monopoly or not. Consequently, the HHI captures the market concentration- competitive to monopolistic- structure.

non-linear effects of the HHI on cigarette related dependent variables. They represented the first quartile (the least concentrated quartile of the market) of the HHI, the second quartile, the third quartile, the fourth quartile (the most concentrated quartile of the market), and the missing category of the HHI.

Country-Specific Economic Conditions

Data for economic conditions of these countries came from the WEO/IMF. From the database, we acquired the GDP per capita in U.S. dollars, unemployment rates, and the average consumer price index from 1998 to 2007 for these 21 EU countries.[10] Again, the GDP per capita in U.S. dollars were converted into real GDP per capita in Euros by using the exchange rates and the average consumer price index of each corresponding EU country.

V. Results

In this section, we present our major findings from the empirical analysis. These findings are reported in three parts according to the three hypotheses discussed above. In the first part, we examine how the cigarette tax structure, specifically the balance between *ad valorem* and specific excise taxes, affect annual average cigarette prices and the price gap between premium and low-priced brands. In the second part, we discuss how the cigarette tax structure affects government revenues from the excise tax and the stability of

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[10] Unemployment rates during this time period were not available for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia.

the government revenue. In the last part, we present the estimates of the effect of the tax structure on cigarette smoking.

The Tax structure and Cigarette Prices

This section discusses the empirical findings on the effects of the tax structure on annual average cigarette prices and the price gap between premium and low-priced brands. In general, the estimates suggest that the greater reliance on the *ad valorem* excise tax leads to lower average cigarette prices and larger price gaps between premium and low-priced cigarette brands. In addition, these impacts from the tax structure are smaller in more concentrated (less competitive) markets. All these findings are consistent with our hypotheses discussed above. The estimates reported in this section are based on the annual average prices from the TMA and the cigarette price gaps obtained from the EIU.

Table 1 presents summary statistics of the final sample used for the average price analysis, which suggests that the real annual average prices of these EU countries were around 4.5 Euros during our sampling period. Table 2 demonstrates summary statistics of the final sample used for the price gap analysis. On average, the cigarette price of premium brands was about 20 percent higher than that of low-priced brands. In both cases, final samples indicate that EU countries generally rely more on the ad valorem cigarette excise tax, rather than the specific tax. In addition, the market of the cigarette industry in these EU countries was highly concentrated, with an average HHI of 3,200,

which is much higher than the HHI threshold used in the U.S. Department of Justice's

definition of a highly concentrated marketplace.[11]

Table 1: Summary Statistics of Annual Average Cigarette Prices Samples

Variables	Mean	Std. Dev.
Real Annual Average Prices in Euros	4.48	2.65
Real Specific Excise Tax in Euros (1,000 pieces)*	54.87	217.28
Real *ad valorem* Excise Tax in Euros (1,000 pieces)*	261.94	3,179.97
Real GDP per Capita in Euros	28,077.85	12,413.99
Average Consumer Price Index	110.10	21.29
Country Population (in millions)	50.07	24.72
Unemployment Rates**	8.01	2.66
Herfindahl-Hirschman Index	3,181.83	1,732.65
Herfindahl-Hirschman Index Missing Indicator	0.13	0.33
n=168		

Notes: Population weighted summary statistics are reported in the table, data are from 1997 to 2008. * The cigarette tax structure information is not available from 1997-2002 for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia. ** Unemployment rates are not available for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia during this time period.

Table 2: Summary Statistics of Cigarette Price Gap Samples

Variables	Mean	Std. Dev.
Cigarette Price Gap in Percentage	19.06	20.11
Specific Tax as % of Total Excise Tax*	35.77	26.43
ad valorem Tax as % of Total Excise Tax*	64.23	26.43
Real GDP per Capita in Euros	27,547.92	11,624.04
Average Consumer Price Index	109.09	20.29
Country Population (in millions)	50.78	24.23
Unemployment Rates**	8.08	2.69
Herfindahl-Hirschman Index	3,264.51	1,666.77
Herfindahl-Hirschman Index Missing Indicator	0.10	0.30
n=281		

Notes: Population weighted summary statistics are reported in the table, data are from 1998 to 2007. * The cigarette tax structure information is not available from 1997-2002 for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia. ** Unemployment rates are not available for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia during this time period.

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[11] According to the U.S. Department of Justice, markets in which the HHI is between 1000 and 1800 points are considered to be moderately concentrated, and those in which the HHI is in excess of 1800 points are considered to be concentrated. Also available at: http://www.usdoj.gov/atr/public/testimony/hhi.htm

The primary estimates of the effects of the tax structure on average cigarette prices are reported in table 3a and table 3b. In both tables, the estimates in columns 1 and 2 were obtained with the control of unemployment rates, while the results in columns 3 and 4 were estimated without the control of unemployment rates. Since unemployment rates were always unavailable for 7 EU countries in our sample (Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia), excluding the control of unemployment rates leads to a larger number of observations as indicated in columns 3 and 4. The linear specification of the HHI and the HHI missing indicator were adopted in regression analyses reported in columns 1 and 3, while we relaxed the linear restriction of the HHI in regression analyses reported in columns 2 and 4, in which the HHI was measured by five dichotomous variables, one for each quartile of the HHI and another indicator for the missing category. The real GDP per capita and country fixed effects were always included in all regressions. However, year fixed effects were only included in regression analyses presented in Table 3a.

The estimates in Table 3a suggest that the average price of a pack of 20 cigarettes would increase for about 0.015-0.02 Euros if the real specific excise tax per 1,000 cigarettes increased by 1 Euro and the real *ad valorem* fell by 1 Euro. That is to say, the average price of cigarettes would move at about the same pace as the changes in specific excise tax. On the other hand, the estimates also suggest that the increases in the real *ad valorem* tax might lead to lower average prices. These estimates are consistent with the

hypothesis that increases in the *ad valorem* tax are more likely to lead to "transfer" pricing.

Table 3a: The Effect of the Tax Structure on Average Cigarette Prices (I)

	TMA Annual Average Prices			
COEFFICIENT	(1)	(2)	(3)	(4)
Real Specific Tax	0.012	0.023	0.019	0.021
	(0.021)	(0.020)	(0.019)	(0.015)
Real *ad valorem* Tax	-0.001	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	135	135	168	168
R-squared	0.96	0.97	0.96	0.97

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 3b: The Effect of the Tax Structure on Average Cigarette Prices (II)

	TMA Annual Average Prices			
COEFFICIENT	(1)	(2)	(3)	(4)
Real Specific Tax	0.030*	0.037**	0.030*	0.034**
	(0.015)	(0.014)	(0.015)	(0.013)
Real ad valorem Tax	-0.002*	-0.002**	-0.002*	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Year Fixed Effects	No	No	No	No
Observations	135	135	168	168
R-squared	0.95	0.96	0.96	0.96

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 4: The Effect of the Tax Structure on the Cigarette Price Gap (I)

Price Differences between Premium and Low-Price Brands				
COEFFICIENT	(1)	(2)	(3)	(4)
ad valorem Tax as % of Total Excise Tax	0.701*	0.536	0.262	0.389
	(0.347)	(0.308)	(0.275)	(0.268)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Observations	247	247	281	281
R-squared	0.92	0.92	0.86	0.86

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 5: The Effect of the Tax Structure on the Cigarette Price Gap (II)

Price Differences between Premium and Low-Price Brands		
COEFFICIENT	(1)	(2)
ad valorem Tax as % of Total Excise Tax	1.312	0.394
	(1.527)	(0.279)
ad valorem Tax as % of Total Excise Tax *hhic2	-0.782	-0.064
	(1.473)	(0.241)
ad valorem Tax as % of Total Excise Tax *hhic3	-1.081	-0.032
	(1.485)	(0.270)
ad valorem Tax as % of Total Excise Tax *hhic4	-0.927	0.071
	(1.431)	(0.262)
ad valorem Tax as % of Total Excise Tax *hhic5	-0.900	-0.251
	(1.461)	(0.280)
Unemployment Rates	Yes	No
HHI Indicators	Yes	Yes
Observations	247	281
R-squared	0.93	0.87

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per

capita, year and country fixed effects. Hhic1 (the omitted category) represents the first quartile of the HHI (the least concentrated market), hhic2, hhic3, and hhic4 are second, third and fourth (the most concentrated market) quartile respectively, and hhic5 denotes the HHI missing category. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

The estimates in Table 3a are consistent across all specifications, though they are not statistically significant. One possible reason for the insignificance is that the year fixed effects caught up all the variation in tax changes. Therefore, for the estimates in Table 3b, we left out the control of year fixed effects. The estimates in Table 3b are fairly consistent with the results in Table 3a and they are all statistically significant. Again, the evidence in Table 3b confirms that higher specific excise tax increases average cigarette price, while a higher *ad valorem* tax as a share of the total tax leads to a lower average price.

Table 4 presents the estimates of the effects of the tax structure on the price gap between the premium and low-priced cigarette brands. The four specifications in this table are very similar to those in Table 3a, and the only difference is the key independent variable, the share of the *ad valorem* tax in the total excise tax was used in this case, instead of specific and *ad valorem* taxes in Euros in Table 3a. This means that we are assuming that the specific excise tax falls when the *ad valorem* tax increases so that the total excise tax remains constant. The results in Table 4 provide consistent evidence that greater reliance on the *ad valorem* excise tax leads to a larger price gap between the premium and low-priced cigarette brands and this result is consistent with the conclusions of previous literature. Specifically, one percentage point increase in the share of *ad*

valorem tax would raise the price gap by 0.3-0.7 percentage points. This estimate implies that a 10-percent raise in the share of *ad valorem* tax leads to about a 4 to 5 percents increase in the price gap, on average.

To further explore the impact of tax structure on the price gap, we included interaction terms of the share of *ad valorem* tax and indicators of the market concentration, the HHI categories. The results are reported in Table 5. The hypothesis here is that manufacturers in more concentrated (less competitive) markets might benefit from their monopoly power on cigarette pricing, and thus their prices are less likely to be affected by the increase in the *ad valorem* tax. The results in Table 5 provide consistent evidence to support this hypothesis. Recall that the first quartile of the HHI (hhic1, which is the omitted group in Table 5) represents the most competitive (least concentrated) market and the fourth quartile of the HHI (hhic4) represents the most concentrated market. Table 5 undoubtedly indicates that the impact of the growth in the share of *ad valorem* tax on the price gap was much smaller in more concentrated markets, suggesting that the manufacturers in these markets have the market power to maintain the prices.

The Tax structure and Government Excise Tax Revenues

This section explores the effect of the tax structure on government revenues from cigarette consumption (other than VAT) and the stability of this revenue. Given the evidence presented in the previous section that the higher specific cigarette excise tax as a share of the total excise tax raises average prices and the higher *ad valorem* tax as a share

of the total excise leads to a lower average price, it is reasonable to make the hypotheses that, (a) the higher specific tax share would lead to higher government revenues from cigarettes, while the higher *ad valorem* tax share might cause a reduction as more smokers switch down to less expensive cigarettes that generate less tax revenues; (b) as a result, a country relying more on an *ad valorem* excise tax might experience larger variations in government tax revenues from cigarettes as revenues are more subject to industry-initiated price changes; (c) when the country has a concentrated cigarette market, the variations in the government revenue might be even greater given the greater market power of cigarette companies. The evidence presented in this section provides supporting evidence for these hypotheses. In addition, the estimates presented in this section are consistent with the conclusion in the previous section. The findings presented in this section are based on the revenue information provided by the EDT.

The summary statistics of the final sample used for the investigation are reported in Table 6. It indicates that the real annual government tax revenue from the cigarette excise tax was about 7 billion, on average, in these 21 EU countries during this time period and it increased by about 6 percent per year.

Table 6: Summary Statistics of Government Revenue Samples

Variables	Mean	Std. Dev.
Real Government Revenues from Cigarette Tax in Euros (in millions)	7,049.23	4,015.91
Difference in Government Revenues between Current and Previous Years (in percentage)	6.17	22.34
Real Specific Excise Tax in Euros (1,000 pieces)*	56.57	220.94
Real *ad valorem* Excise Tax in Euros (1,000 pieces)*	270.96	3,236.05
Specific Tax as % of Total Excise Tax*	35.92	26.74

ad valorem Tax as % of Total Excise Tax*	64.08	26.74
Real GDP per Capita in Euros	28,929.93	11,749.70
Average Consumer Price Index	107.74	13.76
Country Population (in millions)	50.98	24.60
Unemployment Rates**	8.01	2.66
Herfindahl-Hirschman Index	3,184.17	1,743.51
Herfindahl-Hirschman Index Missing Indicator	0.13	0.34
n=159		

Notes: Population weighted summary statistics are reported in the table, data are from 1998 to 2007. * The cigarette tax structure information is not available from 1997-2002 for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia. ** Unemployment rates are not available for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia during this time period.

Table 7: The Effect of the Tax Structure on Government Revenue

COEFFICIENT	Government Revenues in Euros, Real Term			
	(1)	(2)	(3)	(4)
Real Specific Tax	39.871	39.875	25.116	26.528
	(65.217)	(63.216)	(53.591)	(52.152)
Real *ad valorem* Tax	-2.698	-2.696	-1.703	-1.797
	(4.411)	(4.277)	(3.625)	(3.529)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Observations	134	134	159	159
R-squared	0.96	0.96	0.96	0.96

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 7 presents the estimates on how changes in the specific and *ad valorem* excise taxes affect government revenues from the cigarette excise tax in Euros. Estimates from different specifications are quite consistent, suggesting that increases in the specific tax would raise government revenues, while increases in the *ad valorem* tax might reduce the

revenue. Specifically, a one-Euro increase in the specific excise tax per 1,000 cigarettes would raise government revenues by 25-40 million. In other words, on average, a 20% increase in the specific excise tax (about 11 Euros) would raise government revenues from cigarette consumptions by 4%-6%. In contrast, a one-Euro increase in the *ad valorem* excise tax per 1,000 cigarettes would reduce government revenues by 2-2.5 million. That is to say, on average, a 20% increase in the *ad valorem* excise tax (about 54 Euros) would reduce government revenues from cigarette consumption by 1.5%-2%, though none of these estimates are statistically significant.

The rest of the section focuses on the effect of the tax structure on the stability of government revenues and the cigarette tax structure here is represented by the share of the *ad valorem* tax in the total excise tax. The empirical estimates are reported in Tables 8a, 8b and 9.[12]

Table 8a: The Effect of the Tax Structure on Government Revenue Stability (I)

Differences in Government Revenues between Current and Previous Years				
COEFFICIENT	(1)	(2)	(3)	(4)
ad valorem Tax as % of Total Excise Tax	2.916	2.604*	2.741	2.519
	(1.815)	(1.395)	(1.801)	(1.427)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Changes in Tax	Yes	Yes	Yes	Yes
Tax level in Previous Year	No	No	No	No
Observations	120	120	138	138
R-squared	0.32	0.36	0.34	0.38

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[12] Because of the availability of the exchange rates, additional controls of indicators of tax changes and excise tax levels in the previous year are only available from 1999-2007. Therefore, the number of observations in Tables 8a, 8b and 9 declines, compared to Table 7.

Table 8b: The Effect of the Tax Structure on Government Revenue Stability (II)

Differences in Government Revenues between Current and Previous Years				
COEFFICIENT	(1)	(2)	(3)	(4)
ad valorem Tax as % of Total Excise Tax	2.696**	2.378**	2.595	2.209**
	(1.141)	(0.809)	(1.491)	(0.949)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Changes in Tax	Yes	Yes	Yes	Yes
Tax level in Previous Year	Yes	Yes	Yes	Yes
Observations	120	120	138	138
R-squared	0.35	0.39	0.37	0.41

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

One concern here is that if *ad valorem* and specific excise taxes increase by the same proportion (in this case, the share of the *ad valorem* tax in the total excise tax would not change much), the increase in the excise tax itself would raise the difference in the government revenue between two consecutive years. In order to address this concern, we included additional controls in the regressions, indicators of tax changes and excise tax levels in the previous year. Specifically, the estimates reported in Table 8a were obtained

with the additional controls of tax change indicators, while estimates presented in Table 8b and Table 9 were obtained with all these additional controls, both tax changing indicators and baseline tax levels.

The results in Table 8a and Table 8b are consistent with our hypothesis. The positive association between the importance of the *ad valorem* tax in the total excise tax and the variability of government revenues provides strong evidence that the greater reliance on the ad valorem tax would lead to greater variations in government revenues from cigarette consumptions. In most of the specifications, these estimated coefficients are statistically significant. Specifically, if the share of the *ad valorem* tax in the total excise tax rose by one percentage point, the variability of the tax revenue would increase by roughly 2.5 percentage points, which corresponds to a 40% change in revenue variation.

Similar to what we did in Table 5, we include interaction terms of the share of the *ad valorem* tax and the HHI indicators so as to further explore the heterogeneous effects of tax structures on the stability of government revenues across different market concentrations. These results are presented in Table 9. Recalling that the omitted HHI indicator, hhic1, represents the quartile of the most competitive markets and the fourth indicator, hhic4, stands for the quartile of the most concentrated markets, the positive coefficients on the interaction terms suggest that such impacts of tax structures on the government revenue stability are much stronger in more concentrated markets. These estimates also imply that cigarette manufacturers with stronger monopoly power would have greater ability in manipulating cigarette prices. More importantly, this conclusion is

consistent with our hypothesis and the estimates in the previous section, though the estimates in Table 9 are not statistically significant. Considering the magnitudes of the estimates are quite large, one possible reason for insignificant estimates is the sample size.

Table 9: The Effect of the Tax Structure on Government Revenue Stability (III)

Differences in Government Revenues between Current and Previous Years				
COEFFICIENT	(1)	(2)	(3)	(4)
ad valorem Tax as % of Total Excise Tax	1.240	1.917	1.993	1.827
	(2.094)	(1.247)	(1.771)	(1.004)
ad valorem Tax as % of Total Excise Tax *hhic2	1.355	-0.176	0.337	-0.172
	(3.042)	(0.135)	(1.686)	(0.109)
ad valorem Tax as % of Total Excise Tax *hhic3	2.566	0.953	1.471	0.849
	(3.066)	(0.755)	(1.273)	(0.761)
ad valorem Tax as % of Total Excise Tax *hhic4	1.238	0.223	0.315	0.162
	(3.035)	(0.256)	(1.644)	(0.211)
ad valorem Tax as % of Total Excise Tax *hhic5	1.652	0.128	0.715	0.203
	(3.120)	(0.083)	(1.651)	(0.191)
Unemployment Rates	Yes	No	Yes	No
HHI Indicators	Yes	Yes	Yes	Yes
Changes in Tax	Yes	Yes	Yes	Yes
Tax level in Previous Year	No	No	Yes	Yes
Observations	120	138	120	138
R-squared	0.46	0.46	0.46	0.47

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. Hhic1 (the omitted category) represents the first quartile of the HHI (the least concentrated market), hhic2, hhic3, and hhic4 are second, third and fourth (the most concentrated market) quartile respectively, and hhic5 denotes the HHI missing category. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

The Tax structure and Cigarette Smoking

This section examines how the cigarette tax structure affects cigarette consumption and the total supply. Specifically, we empirically test our hypothesis that changes in cigarette consumption and/or the total cigarette supply would be smaller under a change in the *ad valorem* excise tax than under a change of the same magnitude in the specific excise tax. The underlying rational is that (a) cigarette consumers might have greater possibility to "switch down" to low-priced brands when facing the increase of the *ad valorem* excise tax, as these brands are less affected by such tax changes; (b) cigarette manufacturers have greater potential to "manipulate" market prices when facing the increase of the *ad valorem* excise tax so as to minimize the impact of the tax increase and (c) the evidence in previous sections of this chapter suggests that this is particularly true for those firms with monopoly power in the market. Table 10 presents the summary statistics of the final sample used for the empirical investigation, in which the cigarette consumption and supply data were obtained from the World Cigarette Report 2005 of the ERC Group PLC.

Table 10: Summary Statistics of Cigarette Consumption and Supply

Variables	Mean	Std. Dev.
Cigarette Consumption Per Capita	1,534.30	491.25
Adult Smoking Prevalence (Ages 15+) [†]	11.90	5.48
Total Cigarette Supply (in millions) [†]	83,016.33	41,263.46
Real Specific Excise Tax in Euros (1,000 pieces)*	58.21	245.93
Real *ad valorem* Excise Tax in Euros (1,000 pieces)*	320.75	3,617.21
Real GDP per Capita in Euros	25,543.12	10,018.57
Average Consumer Price Index	106.46	16.53
Country Population (in millions)	50.69	24.56
Unemployment Rates**	8.19	2.81
Herfindahl-Hirschman Index	3,448.34	1,587.57

Herfindahl-Hirschman Index Missing Indicator	0.06	0.24
n=126		

Notes: Population weighted summary statistics are reported in the table, data are from 1998 to 2005. * The cigarette tax structure information is not available from 1997-2002 for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia. ** Unemployment rates are not available for Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, and Slovenia during this time period. † The variable has some missing values.

Unlike other samples, the data on consumption and supply were only available from 1998 to 2005. We have two measures of cigarette consumptions. One is on the intensive margin, the cigarette consumption per capita, and the other one is on the extensive margin, the adult smoking prevalence. The total supply was obtained by summing up the domestic production and cigarette imports and subtracting exports. As indicated in Table 10, the average cigarette consumption per capita in these EU countries was about 1,500 pieces per year during this time period, which corresponded to 4 cigarettes a day. The adult smoking prevalence, which is defined as the smoking prevalence among the population aged 15 or above, was around 12 percent. The annual average cigarette supply among these EU countries was roughly 83,000 million pieces per year, equivalent to 230 million per day.

Table 11 presents primary estimates of the effect of the tax structure on the consumption per capita, the intensive margin of cigarette consumption. The estimates are robust across different specifications and all of them are highly significant at 1 percent level. These results suggest that the annual cigarette consumption per capita would decline by 7-8 pieces, if the real specific excise tax per 1,000 pieces rose by 1 Euro. That

is to say, a 10-Euro increase (a 17% increase) in the specific tax would reduce cigarette consumption by about 5%. On the other hand, the annual cigarette consumption per capita would rise by about one half cigarette, if the real *ad valorem* excise tax per 1,000 pieces rose by 1 Euro. The increase in the consumption associated with *ad valorem* tax

Table 11: The Effect of the Tax Structure on Cigarette Consumption (I)

	Cigarette Consumption Per Capita			
COEFFICIENT	(1)	(2)	(3)	(4)
Real Specific Tax	-6.855***	-6.996***	-7.210***	-8.138***
	(1.398)	(1.274)	(1.282)	(1.541)
Real *ad valorem* Tax	0.463***	0.471***	0.487***	0.548***
	(0.094)	(0.086)	(0.086)	(0.104)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Observations	107	107	126	126
R-squared	0.98	0.98	0.98	0.98

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 12: The Effect of the Tax Structure on Cigarette Consumption (II)

	Cigarette Consumption Per Capita	
COEFFICIENT	(1)	(2)
Real Specific Tax	-71.845***	-65.612**
	(19.577)	(18.952)
Real Specific Tax *hhic2	69.973***	61.862**
	(19.361)	(17.915)
Real Specific Tax *hhic3	71.207***	63.603***
	(18.768)	(17.474)
Real Specific Tax *hhic4	58.922**	53.483**
	(20.950)	(19.383)
Real Specific Tax *hhic5	70.165***	60.142**
	(19.706)	(17.667)

Real *ad valorem* Tax	4.853***	4.431**
	(1.322)	(1.280)
Real *ad valorem* Tax *hhic2	-9.149***	-6.891***
	(2.514)	(1.642)
Real *ad valorem* Tax *hhic3	-10.028***	-8.665***
	(2.221)	(2.087)
Real *ad valorem* Tax *hhic4	-24.190***	-15.170***
	(2.394)	(2.251)
Real *ad valorem* Tax *hhic5	-19.578***	-18.069***
	(3.784)	(4.312)
Unemployment Rates	Yes	No
HHI Indicators	Yes	Yes
Observations	107	126
R-squared	0.99	0.99

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. Hhic1 (the omitted category) represents the first quartile of the HHI (the least concentrated market), hhic2, hhic3, and hhic4 are second, third and fourth (the most concentrated market) quartile respectively, and hhic5 denotes the HHI missing category. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

increase might be because smokers have to consume more cigarettes in order to achieve the same satisfaction, when they "switch down" to low-priced brands. However, the magnitudes of these estimates are very small. A similar 10-Euro increase in the *ad valorem* tax would only raise the cigarette consumption by 0.3%.

Further, Table 12 explores the heterogeneous effects of the tax structure on the cigarette consumption per capita across different market concentrations. Again, the estimates are statistically significant and robust across different specifications. In the most competitive market, the increase in the specific excise tax has the strongest impact on the cigarette consumption. Specifically, one Euro increase in the specific tax of 1,000 pieces would reduce the consumption per capita by 5%. However, such impacts on the

consumption diminish with the increase of the market concentration. This phenomenon is consistent with the idea that the burden of a tax increase will be increasingly shared by cigarette manufacturers in more concentrated markets. Another potential explanation is that the cigarette manufacturers in more concentrated markets might be willing to invest more in other mediators, rather than price alone, to moderate the negative impact of tax increases on sales, for example spending more on advertisement.

Similarly, the effect of the *ad valorem* tax on the cigarette consumption we found in Table 11 is more pronounced in the most competitive market and declines in more concentrated markets. Actually, in more concentrated markets, increases in the *ad valorem* tax would reduce cigarette consumption at the intensive margin. For example, in the most concentrated markets (the last quartile of the HHI), cigarette consumption per capita would fall by 0.5-1%, if the ad valorem tax per 1,000 pieces increased by 1 Euro. These estimates are consistent with our previous finding that the price gap between premium and low-priced brands is much smaller in more concentrated markets, which implies that consumers have limited choices in their "switching down" responses.

Table 13: The Effect of the Tax Structure on Smoking Prevalence (I)

Adult Smoking Prevalence				
COEFFICIENT	(1)	(2)	(3)	(4)
Real Specific Tax	0.004	0.004	0.002	0.001
	(0.002)	(0.003)	(0.005)	(0.004)
Real *ad valorem* Tax	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes

Observations	88	88	100	100
R-squared	1.00	1.00	1.00	1.00

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

The estimated effects of the tax structure on adult smoking prevalence are reported in Tables 13 and 14. In both tables, the magnitude of these estimated coefficients is tiny and all of them are insignificant. The potential reasons might be associated with the facts that the sample size is too small and the changes in tax rates during this time period are not large enough to generate substantial changes in the smoking prevalence.

Table 14: The Effect of the Tax Structure on Smoking Prevalence (II)

	Adult Smoking Prevalence	
COEFFICIENT	(1)	(2)
Real Specific Tax	0.003	0.013
	(0.050)	(0.042)
Real Specific Tax *hhic2	0.009	-0.008
	(0.057)	(0.041)
Real Specific Tax *hhic3	0.008	-0.008
	(0.056)	(0.041)
Real Specific Tax *hhic4	-0.005	-0.013
	(0.055)	(0.046)
Real Specific Tax *hhic5	0.011	-0.009
	(0.059)	(0.040)
Real *ad valorem* Tax	-0.000	-0.001
	(0.003)	(0.003)
Real *ad valorem* Tax *hhic2	-0.008	-0.003
	(0.020)	(0.006)
Real *ad valorem* Tax *hhic3	-0.012	-0.007
	(0.017)	(0.005)
Real *ad valorem* Tax *hhic4	-0.031	-0.023
	(0.023)	(0.018)
Real *ad valorem* Tax *hhic5	-0.022	-0.014

	(0.019)	(0.008)
Unemployment Rates	Yes	No
HHI Indicators	Yes	Yes
Observations	88	100
R-squared	1.00	1.00

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. Hhic1 (the omitted category) represents the first quartile of the HHI (the least concentrated market), hhic2, hhic3, and hhic4 are second, third and fourth (the most concentrated market) quartile respectively, and hhic5 denotes the HHI missing category. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Table 15: The Effect of the Tax Structure on Cigarette Supply (I)

COEFFICIENT	Total Cigarette Supply (Production + Imports - Exports)			
	(1)	(2)	(3)	(4)
Real Specific Tax	-598.553*	-532.785	-677.158**	-689.195**
	(283.141)	(288.738)	(252.636)	(241.302)
Real *ad valorem* Tax	40.303*	35.921	45.596**	46.445**
	(19.097)	(19.488)	(17.047)	(16.289)
Unemployment Rates	Yes	Yes	No	No
HHI + HHI Missing Indicator	Yes	No	Yes	No
HHI Indicators	No	Yes	No	Yes
Observations	91	91	102	102
R-squared	0.97	0.98	0.98	0.98

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

Tables 15 and 16 demonstrate the effects of the tax structure on the total cigarette supply. These estimates are consistent both internally and externally. Internally, the estimates are robust across different specifications, while externally, the results presented in these two tables are consistent with the findings in cigarette consumption. Specifically, increases in the specific excise tax would also reduce total cigarette supply, while the *ad valorem* tax increase might lead to a slight increase in the supply. For example, the estimates in Table 15 indicate that the total supply would fall by 7% in general if the specific tax per 1,000 pieces increased by 10 Euros, while a 10-Euro increase in the *ad valorem* tax would raise the supply by 0.5%. In both cases, the estimated effect is very analogous to our findings in cigarette consumptions. More importantly, Table 16 also suggests that the effect of tax increases disappear as the degree of market concentration increases. Again the results are consistent with our findings in the consumption in

magnitude. In the most competitive markets (the first quartile of the HHI), one Euro

increase in the specific tax per 1,000 pieces would reduce the total supply by 5% and a

same increase in the a*d valorem* tax would increase the supply by about 0.3%.

Table 16: The Effect of the Tax Structure on Cigarette Supply (II)

Total Cigarette Supply (Domestic Production + Imports - Exports)		
COEFFICIENT	(1)	(2)
Real Specific Tax	-4,211.856**	-3,712.677**
	(1,162.348)	(1,208.391)
Real Specific Tax *hhic2	3,871.975**	3,168.270**
	(1,228.248)	(1,240.577)
Real Specific Tax *hhic3	3,997.072**	3,283.024**
	(1,218.787)	(1,223.332)
Real Specific Tax *hhic4	3,782.351**	3,327.439**
	(1,295.324)	(1,266.974)
Real Specific Tax *hhic5	3,731.409**	2,983.934*
	(1,258.010)	(1,235.337)
Real *ad valorem* Tax	284.503**	250.709**
	(78.515)	(81.639)
Real *ad valorem* Tax *hhic2	-808.237	-414.033
	(658.362)	(290.363)
Real *ad valorem* Tax *hhic3	-284.145	51.633
	(547.281)	(161.345)
Real *ad valorem* Tax *hhic4	-621.655	-456.857
	(398.294)	(244.641)
Real *ad valorem* Tax *hhic5	-1,085.119	-654.750
	(635.932)	(404.613)
Unemployment Rates	Yes	No
HHI Indicators	Yes	Yes
Observations	91	102
R-squared	0.99	0.99

Notes: Standard errors assuming that observations are not independent within year are reported in parentheses. All models are estimated using country population as analytical weights. All models also include controls of real GDP per capita, year and country fixed effects. Hhic1 (the omitted category) represents the first quartile of the HHI (the least concentrated market), hhic2, hhic3, and hhic4 are second, third and fourth (the most concentrated market) quartile respectively, and hhic5 denotes the HHI missing category. *** p-value<0.01, ** 0.01<p-value<0.05, *0.05<p-value<0.10.

VI. Conclusions

The main purpose of this study is to provide empirical evidence to policy makers on the effects of the cigarette excise tax structure on three outcomes: cigarette prices, government revenues, and cigarette consumption. Specifically, we examined three hypotheses in this study, (a) countries that have greater reliance on *ad valorem* taxes would have a larger price gap between premium and low-priced brands; (b) countries with greater reliance on *ad valorem* taxes would experience greater variability in government revenue streams than countries that rely more heavily on specific taxes, and finally (c) cigarette consumption would be less affected by an increase in an *ad valorem* excise tax than by a comparable increase in a specific excise tax. In addition, we also explored these hypotheses by market concentrations of cigarette industries, as manufacturers with strong market power might have substantial influence on the efficacy of the tax policy.

Empirically, we composed cross-sectional time-series data for 21 EU countries from 1998 to 2007 from various data sources. Our results are robust across different specifications and consistent with our hypotheses. We provide strong evidence that the price gap between premium and low-priced brands is larger in countries with a greater share of *ad valorem* tax. A 10-percent raise in the share of *ad valorem* tax leads to about a 4 to 5 percent increase in the price gap, with a smaller impact change in more concentrated markets. Our estimates confirm that greater instability of government tax revenues from cigarette excise taxes can be attributed to greater reliance on the *ad*

valorem tax and such instability rises with the growth of manufacturers' market power.

We also find that greater reliance on a specific tax has greater impact on cigarette

smoking, but the impact diminishes with the growth of manufacturers' market power.

In sum, we conclude that the specific excise tax on cigarettes, compared to the *ad*

valorem tax, is a more efficient policy device to achieve fiscal policy, as well as public

health objectives. The specific excise tax, however, is more likely to be affected by

inflation. So regular or automatic adjustment might be necessary. As manufacturers'

market power and cigarette consumers' behavior responses play an important role on the

efficacy of the regulation, a balanced tax structure on all tobacco products and

complementary policies to reduce price manipulation would greatly facilitate the

procedure.

References:

Antoñanzas, F. and Rodríguez, R. (2007) Tobacco Policies in the European Union: Need for State and Continental Harmonisation? *European Journal of Health Economics* 8(4): 301-4.

Delipalla, S. and O'Donnell, O. (2001) Estimating Tax Incidence, Market Power and Market Conduct: the European Cigarette Industry. *International Journal of Industrial Organization* 19: 885–908.

Chaloupka, F.J. and Warner, K.E. (2000) The Economics of Smoking. In: *Handbook of Health Economics*, edited by A.J, Culyer and J.P. Newhouse. Amsterdam, the Netherlands: Elsevier Science, 1539-1627.

Chaloupka, F.J., Hu T-W., Warner, K.E., et al. (2000) The Taxation of Tobacco Products. In: Jha, P. and Chaloupka, F.J. eds.   Tobacco Control in Developing Countries.   Oxford: Oxford University Press. 237-72.

Ezzati, M and Lopez, A. (2003) Estimates of Global Mortality Attributable to Smoking in 2000.   Lancet 362: 847-52.

Hummels D., Skiba A., (2004) Shipping the Good Apples Out? An Empirical Conformation of the Alchian-Allen Conjecture. *Journal of Political Economy*, 2004, 112 (6), page 1384-1402

Jha, P, Chaloupka, F.J., Moore, J.A., et al. (2006) Tobacco Addiction.   In: Jamison D., Alleyne G.A., Bremen J.E., et al., eds.   Disease Control Priorities in Developing countries, 2nd edition. New York: Oxford University Press, 2006: 869-95.

Ross H, Chaloupka FJ. (2006) Economic policies for tobacco control in developing countries.   Salud Publica Mex. 2006;48 Suppl 1:S113-20.

Sunley, Emil M., Ayda Yurekli, and Frank Chaloupka. (2000) The Design, Administration, and Potential Revenue of Tobacco Excises: A Guide for Developing and Transition Countries. In: Jha, P. and Chaloupka, F.J. eds.   Tobacco Control in Developing Countries.   Oxford: Oxford University Press: 409-426.

WHO (2010), Technical Manual on Tobacco Tax Administration. World Health Organization, Geneva.