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**Barać, Željana Aljinović; Burnać, Paško; Rogošić, Andrijana; Šodan, Slavko; Vuko, Tina**

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RESEARCH ARTICLE



# Cigarette price elasticity in Croatia – analysis of household budget surveys

Željana Aljinović Barać, Paško Burnać, Andrijana Rogošić, Slavko Šodan and Tina Vuko

Faculty of Economics, Business and Tourism; University of Split, Split Croatia

## ABSTRACT

This study estimates both conditional and unconditional cigarette price elasticity of quantity demanded in Croatia. Authors use Deaton's method, also known as the Almost Ideal Demand-System (AIDS), to obtain consistent estimates of the cigarette price elasticity on the sample of Croatian households. The data from household surveys (HBS) conducted in Croatia for three periods (2010, 2011 and 2014 year) is provided by the Croatian Bureau of Statistics (CBS). Estimated unconditional cigarette price elasticity is  $-1.38$  and estimated conditional price elasticity is  $-0.63$ . Simulation of the tax effects shows that rising specific excise tax for 10 percent would result in 2 percent decrease in cigarette consumption while total tax revenues would increase by 1.97 percent. This study provides evidence that the demanded quantity for cigarettes is responsive to their prices. Consequently, this implies that tobacco tax policy can be used as an efficient tool for reducing cigarette consumption in Croatia.

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Cigarette price; public policy; economics; taxation

## 1. Introduction

With more than one third (35%) of adult population declared as smokers in 2017 (Special Eurobarometer 458 Report, 2017), smoking prevalence in Croatia remains among the highest in Europe. More precisely, the survey conducted during 2014 and 2015 by the Croatian Institute of Public Health (Dečković-Vukres, Ivičević Uhernik, & Mihel, 2016) has indicated that: (1) 25.7 percent of the adult population are daily smokers; (2) the share of smokers is the highest in the age group from 25 to 44 years (38.9 percent) and among respondents who completed only high school education (36.4 percent); (3) smoking prevalence is higher in male (35.3 percent) than in female population (27.1 percent). Especially disturbing fact is that Croatia has 23 percent of daily smokers in the student population, which is the second highest proportion among all 35 European countries included in ESPAD survey (European Monitoring Centre for Drugs and Drug Addiction, 2015). The level of daily smoking among students in Croatia is approximately two times higher than the ESPAD average (12 percent).

Although various tobacco control measures have already been implemented, Croatia still has to put more effort to achieve better results in smoking cessation and tobacco consumption prevention (WHO, 2016). A large number of studies provide consistent

evidence that rising tobacco prices through increased tobacco taxes is one of the most effective ways of reducing tobacco consumption and its adverse health consequences (Chaloupka, Cummings, Morley, & Horan, 2002; Chaloupka, Peck, & Tauras et al., 2010; Chaloupka, Yurekli, & Fong, 2012). Generally, international research shows that 10 percent increase in cigarette price can reduce cigarette consumption by 4–8 percent, and that most countries fall into this range (Jha and Chaloupka, 2000). However, some countries can show different price elasticity because of specific cultural and social factors (Ross and Al-Sadat, 2007). For example, a recent study from Ireland (Kennedy, Pigott, & Walsh, 2015) shows that the estimated price elasticity of cigarette demand ranges from  $-1.6$  to  $-2.0$ , averaging at  $-1.8$ . Similarly, (Nguyen, Rosenqvist, & Pekurinen, 2012) conducted a comparative study for 11 EU countries (Austria, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom) and found that the long-run price elasticities of demand for cigarettes ranged from  $-0.21$  to  $-1.49$ , with the typical value close to  $-1.0$ . Yeh, Schafferer, Lee, Ho, and Hsieh (2017) study covering 28 EU countries (including Croatia) indicate that the price elasticity of cigarette ranges from  $-0.50$  to  $-1.23$ , and that low- and middle-income countries have a higher price elasticity. Studies estimating cigarettes price elasticity in Croatia are rare and provide mixed results. For example, Budak and Lovrinčević (2005) find that cigarette consumption in Croatia is price inelastic ( $-0.36$ ), whereas Aljinović Barać, Burnać, and Markota et al. (2018) using time series data find that long-run price elasticity ranges from  $-0.44$  to  $-0.61$ , and using HBS data (AIDS model with non-consumers included) find cigarette price elasticity to be as high as  $-1.07$ . Since above-mentioned studies provide mixed evidence on the elasticity of cigarette demand in Croatia, the aim of this study is to estimate price elasticities allowing for both inclusion and exclusion of households reporting zero consumption in order to provide additional evidence of cigarettes price elasticity.

The price elasticity in this study is estimated using one of the most popular (John, Chelwa, & Vulovic et al., 2019; Salti, Chaaban, Nakkash, & Alaouie, 2015) systems of demand equations – the Almost Ideal Demand System on data from HBS. In addition to the original AIDS model (Deaton & Muellbauer, 1980) that restricts analysis on tobacco consumers only (i.e., conditional elasticity), this study allows for both inclusion and exclusion of consumers reporting zero consumption. Allowing for zero consumption (i.e., unconditional elasticity) is particularly attractive for tax policy purposes, given that some households which do not consume tobacco now, may begin consumption later if and when prices decrease, income increases, etc. (John et al., 2019). Also, estimating both conditional and unconditional price elasticities using AIDS model provides an opportunity to compare obtained results with similar studies that considered only conditional tobacco demand (Chelwa & Walbeek, 2019; John, 2008; Vladislavljevic, Zubović, Đukić, & Jovanović, 2020), as well as with those that included all households in the analysis (John, 2005; Eozenou & Fishburn, 2009; Guindon, Nandi, & Chaloupka et al., 2011; Gligorić, Pepić, Petković, Ateljević, & Vukojević, 2020). To the best of the authors' knowledge, the only study that reports both conditional and unconditional price elasticities using Deaton's method on HBS data is (Mugosa, Cizmovic, Lakovic, & Popovic, 2020). Their results (for Montenegro) confirmed that conditional price elasticity based on HBS data is similar to price elasticity obtained using aggregate time series data on cigarette consumption (i.e.,  $-0.62$  vs  $-0.68$ ), while unconditional price elasticity is

estimated to be higher (i.e.,  $-0.80$ ). This study also extends previous research by estimating both conditional and unconditional estimates of cigarette price elasticity using HBS data, and provides additional evidence on cigarette price elasticity in Croatia that could be used as an effective evidence-based policy tool for reducing tobacco use in Croatia.

## 2. Methods

### 2.1. Model framework

This section briefly introduces the applied methodology of price elasticity estimation, while detailed exposition of the AIDS methodology can be found in Deaton and Muellbauer (1980). The methodology is based on the data from HBS. The individual household responses on cigarette expenditures and purchased quantities can be used to calculate so-called unit value of a good, which then can be used as a price proxy. However, while the unit value of a good depends on actual market prices, it cannot be used as direct substitute for prices as it also reflects consumers' quality choices and the measurement error in quantity (John, 2008). Exploiting the structure imposed by weak separability, Deaton has developed a method for estimating price elasticity using unit values that estimates and compensates for quality effects (Deaton, 1998; Deaton, 1997). Deaton's basic assumption is that all households in the same cluster have the same market price. However, market price is not observed by itself, but makes its presence felt through quantities purchased and their unit values, which are both observed. Clusters are typically small territory units such as municipalities or villages with dozens or so households living in the same place and surveyed over the same period. Within-cluster variations in purchases and unit values depend only on income and household characteristics while between-clusters variations in purchases are at least partly depended on between-clusters market price variations. Namely, spatial price-variation can be reasonably justified if markets are not perfectly integrated, for example because of high transport costs.

The estimation of the AIDS model consists of three stages. In the first stage, within-clusters variations are used to estimate budget share and unit value equations (Eqs. (1) and 2). The following equations connect the budget shares and unit values to household expenditures, household characteristics and the underlying prices of commodities:

$$w_{hc} = \alpha^0 + \beta^0 \ln x_{hc} + \gamma^0 \cdot z_{hc} + \theta^0 \ln p_c + f_c + u_{ch}^0 \quad (1)$$

$$\ln v_{hc} = \alpha^1 + \beta^1 \ln x_{hc} + \gamma^1 \cdot z_{hc} + \psi^1 \ln p_c + u_{hc}^1 \quad (2)$$

where indices  $h$  and  $c$  represent households and clusters respectively. The left-side variables in the model are  $w_{hc}$  – share of the household budget spent on cigarettes and  $v_{hc}$  – calculated unit values. The right-side variables of both equations are:  $x_{hc}$  – total expenditures of the household  $h$  in cluster  $c$ ,  $z_{hc}$  – other household characteristics,  $p_c$  – price of the cigarettes in cluster  $c$ ,  $f_c$  – cluster fixed-effect, while  $u_{ch}^0$  and  $u_{hc}^1$  represent the error term.

The market price is not observed, so parameters  $\theta$  and  $\psi$  cannot be directly estimated from the Eqs. (1) and (2). However, it is assumed that the market prices do not vary within the cluster, so the remaining parameters can be consistently estimated by using

cluster deviation-from-the-mean approach. Thus, the effect of prices will be removed from the equations. In the second stage, between-clusters variations are used to estimate spatial price elasticities of quantity demanded. Finally, in the third stage the price and quality effects are disentangled relying on a weak separability assumption and symmetry restrictions are imposed in order to increase the precision of the parameter estimates (John, 2008).

It is also important to note that cigarette consumption is not only related to the changes in the prices of cigarettes (i.e., own-price elasticity), but also to the changes in prices of other goods, such as their potential complements or substitutes (i.e., cross-price elasticity). Considering that cigarettes consumption in Croatia accounts for more than 95 percent of overall annual tobacco volume sales (Aljinović Barać et al., 2018), other tobacco products are not included in the price elasticity estimation as substitutes. However, previous research has documented that alcohol and coffee drinking strongly stimulate smoking (Bjørngaard et al., 2017; Marshall, Epstein, & Green, 1980). Since coffee, coffeehouses and tobacco smoking have long tradition and specific social dimension in the Balkans as a part of the Ottoman legacy (Fotić, 2011), in this study coffee consumption is used to derive cross-price elasticity.

## 2.2. Sample and data description

Empirical part of the study is based on repeated cross-sectional survey data from Household Budget Survey. Access to the HBS data was provided in the Croatian Bureau of Statistics (CBS) safe room with excluded direct identifiers for individuals. The Survey is carried out on the random sample of private households and it is separately defined for each year. Until 2011, the Survey was conducted as an annual survey, and since then it was changed into a multiyear survey. Therefore, in this study the Survey data for years 2010, 2011 and 2014 are used. The Survey collects data on household consumption expenditures, socio-economic characteristics, housing conditions, availability of durables, etc. It is in line with the Eurostat's methodological recommendations and international standards and classifications. The structure of the household consumption expenditures follows the international classification COICOP (Classification of Individual Consumption by Purpose).

Before estimating AIDS model, it was necessary to define unit values and other variables used in the model from the Survey data at the household level. The unit values of cigarettes were calculated by dividing household expenditure on cigarettes with the number of cigarette packs purchased during the same period. The unit values are expressed in Croatian HRK per cigarette pack. Similarly, cigarette budget shares were calculated as a ratio of household expenditure on cigarettes and total expenditure for the observed period. The same procedure was used to calculate unit values and budget shares for coffee in order to estimate cross-price elasticity. All variables measured in monetary values were deflated to their real values from 2010, by using Consumer Price Index.

The mean unit value of cigarette (budget share for the whole sample, budget share for cigarette consumers) was 16.06 HRK (0.02, 0.05) in 2010, 16.87 HRK (0.02, 0.05) in 2011 and 21.30 HRK (0.01, 0.05) in 2014. The mean unit value of coffee (budget share) was 57.16 HRK (0.008) in 2010, 60.80 HRK (0.008) in 2011 and 60.27 HRK (0.008) in 2014, while the mean value of total households' expenditure was 91,409 HRK, 89,847 HRK and

**Table 1.** Descriptive statistics of other household characteristics.

| Variable          | Obs.  | Mean  | Std dev. | Min | Max |
|-------------------|-------|-------|----------|-----|-----|
| Household size    | 7,814 | 2.81  | 1.56     | 1   | 10  |
| Male ratio        | 7,814 | 0.44  | 0.28     | 0   | 1   |
| Adult ratio       | 7,814 | 0.92  | 0.17     | 0.2 | 1   |
| Mean education    | 7,814 | 11.52 | 2.21     | 0   | 20  |
| Maximum education | 7,814 | 12.20 | 2.38     | 0   | 20  |
| Household type    | 7,814 | 2.07  | 1.05     | 0   | 3   |

**Notes:**

Adult ratio is calculated as a proportion of household members older than 14 years in household. Mean education represents mean years of schooling for all members at household level. Maximum education represents years of schooling of household member with the highest level of education. Household type is defined according the labor market activity. The labor market activity of the household members is ranked in the following order (i.e., from “maximum” to “minimum” activity): (1) employed, (2) self-employed, (3) pensioner, and (4) unemployed. If any member of the household is employed, then the household is labelled as “employed”. If there are no employees, in the household, but there are self-employed, the household type is “self-employed”. If there are no employees or self-employed, but there is a pensioner in the household, the household is marked as “pensioner”, and finally if the adult household members are all unemployed the household is labelled as “unemployed”.

97,161 HRK, respectively. Calculated unit values are similar to actual average cigarette prices in Croatia for each year (Aljinović Barać et al., 2018). Also, to deal with potential outliers during the data cleaning process, the highest and the lowest values of the actual cigarettes prices per pack were compared to the reported minimum and maximum unit values. This is important because data collected may have erroneously entries such as unacceptably high or low values (for example, in the sample the highest reported unit value was 208.51 HRK, while the lowest reported unit value was 3.97 HRK). In order to approach the lower and the upper bounds of actual cigarette prices, the top and the bottom one percent of calculated unit values of cigarettes were trimmed. Descriptive statistics for other household characteristics is given in Table 1.

Detailed descriptive statistics for all variables included in the model is also reported for the subsample of households that purchase cigarettes (Table 2). Beside the total expenditure variable ( $x_{hc}$ ), all other household characteristics are represented with the vector  $z_{hc}$  in Eqs. (1) and (2).

The households that reported cigarette consumption have an average male ratio around 50 percent and approximately 90 percent adult members. From the mean and maximum years of education (11.8 and 12.54) it can be concluded that household members on average have secondary level of education. Majority of analyzed households (70 percent) are from Continental Croatia. Finally, there are approximately 69 percent households with at least one person employed and 4 percent households with at least one person self-employed. Households without employed or self-employed members and having at least one pensioner make about 22 percent, while households with only unemployed members make around 5 percent.

### 3. Results

In the first stage of the AIDS model, within-cluster regressions of unit values and budget shares are used to estimate Eqs. (1) and (2). Clusters are defined as combination of municipality and year. Accordingly, using the whole sample of 7,825 households 652

**Table 2.** Descriptive statistics for the subsample of households that purchase cigarettes.

|                             | Obs.  | Mean  | Std dev. | Min  | Max   |
|-----------------------------|-------|-------|----------|------|-------|
| Unit Value, Cigarettes (ln) | 2,406 | 2.84  | 0.20     | 2.07 | 3.66  |
| Budget share, Cigarettes    | 2,406 | 0.05  | 0.04     | 0.00 | 0.49  |
| Total expenditure (ln)      | 2,406 | 11.47 | 0.48     | 9.07 | 12.76 |
| Household size (ln)         | 2,406 | 1.06  | 0.52     | 0    | 2.30  |
| Male ratio                  | 2,406 | 0.51  | 0.24     | 0    | 1     |
| Adult ratio                 | 2,406 | 0.89  | 0.18     | 0.2  | 1     |
| Mean education              | 2,406 | 11.80 | 1.54     | 0    | 18    |
| Maximum education           | 2,406 | 12.54 | 1.66     | 0    | 20    |
| Continental Croatia         | 2,406 | 0.69  | 0.46     | 0    | 1     |
| Household type – Employed   | 2,406 | 0.69  | 0.46     | 0    | 1     |
| Self-employed               | 2,406 | 0.04  | 0.20     | 0    | 1     |
| Pensioners                  | 2,406 | 0.22  | 0.41     | 0    | 1     |
| Unemployed                  | 2,406 | 0.05  | 0.22     | 0    | 1     |

Note: Expenditure variable and unit values of cigarettes are deflated to 2010 values.  
Variables definitions are presented in Table 1.

clusters were generated with an average of 12 households. Also, 11 observations were excluded for clusters that had less than 2 households, which is a necessary condition to estimate the Deaton's model (John et al., 2019). In this stage, information on household demand, income, and the unit value is used to estimate the quality effect, while other household characteristics are controlled for. The estimates are presented in Table 3.

Estimated coefficients from the unit value equation suggest following conclusions. First, the coefficient of total expenditure shows that the expenditure elasticity of quality is 0.10. This implies that a doubling of the household total expenditure would increase the average price paid for cigarettes by approximately 10 percent. Since, unit values account for both variation in relation to quantity of cigarettes consumed and in relation to quality of consumed cigarettes (i.e., switching to a different brand), consumers might either consume less cigarettes (reduction in quantity) or consume lower quality cigarettes (quality shading). The significant and positive coefficient of total expenditure (in natural log) provides an evidence of quality shading. This means that the use of AIDS model is

**Table 3.** Estimates from unit value and budget share regressions.

| Variables                 | Unit Value     |         | Cigarettes Budget |         | Cigarettes Budget Share – |         |
|---------------------------|----------------|---------|-------------------|---------|---------------------------|---------|
|                           | (per pack, ln) |         | Share             |         | Consumers                 |         |
| Total expenditure (ln)    | 0.095***       | (0.011) | –0.040            | (0.001) | –1.868***                 | (0.003) |
| Household size (ln)       | –0.035***      | (0.010) | –0.002            | (0.001) | –1.034***                 | (0.003) |
| Male ratio                | –0.019         | (0.015) | 1.734***          | (0.002) | 1.409***                  | (0.004) |
| Adult ratio               | –0.001         | (0.024) | 0.553*            | (0.003) | 1.004*                    | (0.006) |
| Mean education            | –0.000         | (0.004) | 0.055             | (0.000) | –0.043                    | (0.001) |
| Maximum education         | 0.006*         | (0.004) | –0.062            | (0.000) | –0.069                    | (0.001) |
| Continental Croatia       | 0 (omitted)    |         | 0 (omitted)       |         | 0 (omitted)               |         |
| Household type – Employed | Omitted        |         | Omitted           |         | Omitted                   |         |
| Self-employed             | –0.027         | (0.021) | –0.183            | (0.002) | –0.417                    | (0.005) |
| Pensioners                | –0.024**       | (0.010) | –0.690***         | (0.001) | –0.067                    | (0.003) |
| Unemployed                | –0.002         | (0.018) | 0.849***          | (0.002) | 1.091**                   | (0.004) |
| Cluster dummies           | F(565, 1831)   |         | F(651, 7144)      |         | F(568, 1887)              |         |
|                           | 3.465***       |         | 1.286***          |         | 1.473***                  |         |
| Constant                  | 1.731***       | (0.116) | 0.012             | (0.013) | 0.276***                  | (0.029) |
| Observations              | 2,406          |         | 7,805             |         | 2,465                     |         |
| R-squared                 | 0.57           |         | 0.14              |         | 0.40                      |         |

Notes: \* Indicates significance at the 10% level; \*\* indicates significance at 5% level; \*\*\* indicates significance at 1% level.  
Variables definitions are presented in Table 1. Coefficients in the budget share regressions are multiplied by 100 for the reporting convenience. SEs are in parentheses.



necessary in order to obtain an unbiased estimate of cigarette price elasticity (John et al., 2019). Second, household size, education and household type also have significant effect on unit value. The negative coefficient on the household size suggests that an increase in household size has a similar effect as reduction in total expenditure. In other words, an increase in household size significantly decreases the average price paid by the household. The positive sign on maximum education implies that households with more educated members purchase cigarettes with higher unit value. Households with pensioners and without employed or self-employed members pay lower prices for cigarettes on average, which suggests that these types of households spend more on lower quality cigarettes. Finally, cluster fixed effects are statistically significant showing that both spatial and time variation are pronounced.

The results from the budget share equation based on consumers who report non zero cigarette consumption indicate that households with higher levels of expenditure and larger households spend smaller budget share on cigarettes. Additionally, budget share spent on cigarettes is larger in households with higher proportion of men, adults and in households with all unemployed members. Finally, cluster fixed effects are significant and come from both spatial and time variation, similar as in the unit value regression.

Using the information in Table 3, own- and cross-price elasticity are obtained from the second and the third stage of the AIDS estimation procedure. In the third stage, weak separability assumption is used to disentangle the price and the quality effects estimated from the second stage. Table 4 presents both symmetry restricted and unrestricted estimates of price elasticities. Symmetry restricted estimates increase the precision of the parameters (John, 2008) and guarantee that the estimates satisfy unique substitution-complementary patterns (Deaton, 1997), ruling out the possibility that cigarettes are substitute of coffee when coffee is a complement of cigarettes.

Results indicate that conditional own-price elasticity is  $-0.63$  meaning that a 10 percent increase in cigarette price will lead to 6.3 percent decrease in quantity of cigarettes demanded. Estimated conditional tobacco price elasticities for similar studies using Deaton's methodology range from  $-0.3$  for Uganda (Chelwa & Walbeek, 2019) to  $-0.9$  for India (John, 2008). Furthermore, estimated conditional cigarette price elasticity is similar to the estimated price elasticity for Croatia using a time-series analysis of aggregate consumption data (Aljinović Barać et al., 2018). Conditional elasticity is based on the assumption that households with zero consumption are not purchasing cigarettes because cigarettes don't give them any utility, no matter what the price is (John, 2008).

**Table 4.** Own- and cross- price elasticities.

|  | Whole sample   |       |         | Consumers     |       |         |
|--|----------------|-------|---------|---------------|-------|---------|
|  | Elast. Coeff.  | SE    | t-value | Elast. Coeff. | SE    | t-value |
| <b>Symmetry restricted estimates</b>   |                |       |         |               |       |         |
| Cigarettes (own- price elasticity)     | $-1.378^{***}$ | 0.326 | -4.227  | $-0.634^{**}$ | 0.254 | -2.496  |
| Coffee (cross- price elasticity)       | $-0.629$       | 0.608 | -1.035  | $-0.223$      | 1.127 | -0.198  |
| <b>Symmetry unrestricted estimates</b> |                |       |         |               |       |         |
| Cigarettes (own- price elasticity)     | $-1.339^{***}$ | 0.337 | -3.970  | $-0.619^{**}$ | 0.265 | 2.336   |
| Coffee (cross- price elasticity)       | $-1.753^{***}$ | 0.243 | -7.214  | $-0.625^{**}$ | 0.253 | -2.470  |

Notes: \*\* indicates significance at 5% level; \*\*\* indicates significance at 1% level. SEs are calculated via bootstrap procedure by making 1000 draws from the second stage data.

Unconditional elasticity of quantity demanded is  $-1.38$ , and remains also high ( $-1.07$ ) when outliers are included in the analysis (Aljinović Barać et al., 2018). However, large magnitude of difference in conditional and unconditional elasticity estimates suggests that some households who reported zero consumption at this price would report positive consumption if the price reduced. For example, this would imply that if cigarette prices decrease by 10%, then quantity of cigarettes demanded by present smokers would increase in 6%, while the overall quantity demanded would increase in 14%. The relatively high unconditional elasticity of quantity demanded could be related to the short time frame of the analysis (i.e., only three years), which covered the process of Croatia joining EU. During that period some major changes in tobacco taxation policy had happened that led to significant increase in cigarette prices (Aljinović Barać et al., 2018). Nevertheless, the obtained result falls within the range of unconditional cigarette price elasticities for comparable studies using Deaton's methodology (from  $-0.5$  for Vietnam (Eozenou & Fishburn, 2009) to  $-1.4$  for Bosnia and Herzegovina (Gligorić et al., 2020). The symmetry-unrestricted estimates provide similar results. Cross-price elasticity is negative and statistically significant only for symmetry-unrestricted estimates indicating complementary pattern between cigarettes and coffee. However, symmetry-restricted estimate are not significant.

Finally, estimated values of the coefficients of  $\ln X$  from Eqs. (1) and (2) are used to calculate the total expenditure elasticity by rearranging these equations after taking a log and the first derivate (Deaton, 1997). Estimated total expenditure elasticity is positive and it takes value of 0.88, meaning that a 10 percent increase in total expenditure would lead to an 8.8 percent increase in cigarettes consumption. For the sample of households reporting non-zero consumption, the estimated total expenditure elasticity is also positive and it takes value of 0.56. The estimates of expenditure elasticities are in the line with the similar studies ranging from 0.2 to 2.4. (John et al., 2019).

#### 4. The effect of cigarette taxation on consumption and government revenues

The effects of price changes through taxation can be estimated with simple prediction model based on following assumptions (John, 2008): (1) there are no substitution effects due to price change; (2) change in price is equivalent to the change in tax; (3) there is no increase in illicit trade as a result of increased taxes. For example, annual consumption of cigarettes in Croatia in 2017 was estimated to 309,329,614 cigarette packs and the weighted average price of a pack of cigarettes was 23.80 HRK (3.19 EUR). Specific excise was 26 percent of average retail price, ad valorem excise 34 percent and VAT 20 percent of retail price. Table 5 shows the changes in cigarette consumption and government revenue as a result of changes in excise tax.

In the first scenario, assuming that in the next year Croatian GDP will increase by 2.8 percent and cigarette prices will stay unchanged, it can be expected (using unconditional price elasticity) that cigarette consumption as well as tax revenues will increase by 2.46 percent. In the second scenario, according to the model estimations (using unconditional price elasticity) if a specific excise increases by 10 percent and GDP grow remains 2.8 percent, this would lead to 2.00 percent decrease in cigarette consumption but the total tax revenues would increase by 1.97 percent (total excise revenues growth of

**Table 5.** Changes in consumption and government revenue from changes in taxes.

| Scenario | Conditional price elasticity |                    | Unconditional price elasticity |                    |
|----------|------------------------------|--------------------|--------------------------------|--------------------|
|          | Cigarettes consumption       | Government revenue | Cigarettes consumption         | Government revenue |
| I*       | 1.57%                        | 1.57%              | 2.46%                          | 2.46%              |
| II**     | −0.47%                       | 3.56%              | −2.01%                         | 1.97%              |

Notes:

Assumptions: cigarette consumption 309,329,614 packs; conditional price and income elasticity −0.63 and 0.56; unconditional price and income elasticity −1.38 and 0.88; real GDP growth 2.8%.

\*Scenario I: do nothing, only income effect.

\*\* Scenario II: increase cigarette prices via specific excise (10% increase).

2.24 percent and VAT revenues growth of 1.18 percent). The results of the simulation for conditional price elasticity also indicate that tobacco taxes have the potential to increase revenue while reducing consumption at the same time.

## 5. Discussion and conclusion

To the best of authors' knowledge, there are only several studies using Deaton's methodology to estimate the price elasticities of cigarettes and tobacco. Price elasticity estimates from these studies vary considerably, and the most range from − 0.2 to − 1.4 (Chavez, 2016; Chelwa & Walbeek, 2019; Chen & Xing, 2011; Eozenou & Fishburn, 2009; Gligorić et al., 2020; John, 2005, 2008; Mugosa et al., 2020; Salti et al., 2015; Vladislavljevic et al., 2020). However, it should be noted that some of these studies considered all households in the budget share regression, some considered only households with positive purchases, and some were not explicit about this matter. Also, previous research shows (Mugosa et al., 2020) that conditional price elasticity using AIDS model and price elasticity estimates obtained using aggregate consumption data are similar, while unconditional price elasticity using AIDS model tend to be higher. In order to provide more comprehensive and comparable results of cigarette price elasticity for Croatia, this paper extended (Aljinović Barać et al., 2018) research and presented estimates of both unconditional and conditional price elasticities in Croatia using AIDS model on HBS data. The results clearly show that the demanded quantity for cigarettes in Croatia is responsive to price changes and that the price policy can be efficient instrument in reducing smoking prevalence. This is important since the prevalence of smoking in Croatia is rather high, especially among adolescents and young adults.

Despite valuable research contributions and practical implications, this study still has several limitations. First, the price elasticity is estimated only for cigarettes and not for any other tobacco products. Second, this study uses data on household level, while it would be more relevant to use individual level data. Thirdly, data time-frame in the analysis was limited to only three years (2010, 2011 and 2014) while it would be more useful to have recent data, especially for policy purposes. Finally, given the high prevalence of smoking in the student population, future research could estimate the factors associated with young tobacco consumers and the possibilities to prevent or reduce youth smoking.

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