Tax Collision: The Effect of VAT and Excise Duties on the Retail Price of Unleaded Gasoline[1]

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Abstract

This paper researches the imposition of the Value Added Tax (VAT) on the excise-inclusive retail price of unleaded gasoline in the European Union countries. The issue of tax-on-tax arises when the excise duty is included into the VAT tax base. We analyse the tax burden shifting through the retail prices of gasoline in the context of tax collision between VAT and excise duty. The results show that VAT burden is over shifted toward the end-consumers through prices. Moreover, the tax interaction between VAT and the specific tax reduces the corrective effect of the excise duty imposed on the unleaded gasoline.

Keywords: *tax collision, tax burden shifting, excise duties, VAT*

JEL Classification: H22, H23, H29, H30

Introduction

The issue of the tax incidence and tax burden shifting represents an on-going debate in the taxation literature. Although the effects of direct and indirect taxation have been widely analysed, there are aspects of tax incidence that have been overlooked in the literature. There can be found an extensive theoretical approach to comparison and analysis of the pros and cons of ad valorem tax and ad unit taxes due to the relentless search for the optimal taxation. However, regardless the extensive theoretical analyses, the tendency to consider each type of tax individually, without taking into account the element of tax interaction stemming from the tax mix between Value Added Tax (VAT) and excise duties, prevails.

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In the EU countries, there are three types of excisable goods that are subject to a mix of ad valorem and ad unit taxes – tobacco products, alcoholic beverages and transport fuels. Due to the peculiar method of including the excise duty into the VAT tax base, the issue of tax-on-tax arises. Therefore, the interaction between ad valorem and ad unit tax resembles a tax collision that artificially increases the tax base of the VAT. The aim of the paper is to prove the existence of tax collision between VAT and excise duty as a result of the specific tax-on-tax issue. Henceforth, the paper aim to analyse the effect of tax collision between VAT and excise duty on tax burden shifting through prices in case of the regular unleaded gasoline in the EU. Di Giacomo, Piacenza and Turati (2012) and Di Giacomo et al. (2015) have analysed the excise duty pass-through and the ability of the specific tax based mechanisms to stabilize the price of transport fuels as a counter measure to rising crude oil prices. Even though the authors have researched the role of VAT and its interaction with excise duties on fuel prices their papers have not addressed explicitly the issue of tax collision implications on tax burden shifting. The issue of tax-on-tax imposition and the resulting tax collision requires a special attention, in order to identify the impact of ad valorem and ad unit taxes on excisable good prices in the context of tax mix. Therefore, our paper develops the works of Di Giacomo, Piacenza and Turati (2012); Di Giacomo et al. (2015) further by including the tax collision into the empirical analysis, which plays the role of an interaction term, as a new exogenous factor that influences tax burden shifting through the retail price of gasoline in the EU countries.

In the first section of this paper, we briefly review the theoretical background related to tax burden shifting and comparative theoretical analyses of ad valorem and ad unit taxes. We assess empirical studies that analysed the effect of indirect taxation on consumer's and seller's prices in case of the excisable goods. The second section of this paper investigates the specific issues of including the excise duty into the VAT tax base and the distinct tax effect of excise duty and VAT on the retail price. The third section of this paper describes the empirical methodology used to analyse the effect of VAT, excise duty and the tax collision (i.e., taken as interaction term) on the retail price of gasoline in the EU countries. The last section of this paper presents the discussion of results and the concluding remarks.

Literature Review

The current literature on tax burden shifting can be classified in five main categories. The first category focuses on theoretical approach regarding the tax burden shifting in three different market structures, such as perfect equilibrium, monopoly and oligopoly (Seligman, 1910; Kotlikoff and Summers, 1987; Fullerton

and Metcalf, 2002). The aforementioned authors underline that underline that over shifting will occur when consumer price increases by more than the tax rate change. The degree of tax shifting depends upon the price elasticity of demand and supply. In the case of elastic demand, the tax burden is under shifted; a large part of the burden is borne by the seller. Conversely, when the demand is highly inelastic, the consumer will bear most of the tax burden, and over shifting can appear.

The second category of theoretical literature reviewed is the comparison between ad valorem and ad unit tax burden shifting (Katz and Rosen, 1985; Seade, 1985; Delipalla and Keen, 1992; Keen, 1998; Myles, 1995; Schroder, 2004). The authors argue that in case of the perfect competition, there is no difference between the ad valorem and ad unit taxes, both levies rendering the same outcome with respect to the effect on final price or tax revenues. Keen (1998) notes that the distinction between ad valorem (i.e., as a portion of the good's price) and ad unit tax (a tax per unit/litre) creates a wedge between producer price and consumer price in a different manner. The ad valorem and ad unit taxes imposed on excisable goods bear two distinct effects: the multiplier effect and the upgrading effect. First, the excise duty, taken as a specific per unit tax, imposes the upgrading effect, in which any improvement in the quality of the product or increase in net-of-tax price is not reflected in the amount of tax paid. Second, the ad valorem tax (VAT or general sales tax) bears the multiplier effect. Because the tax is applied on the good's value, imposed as a proportion of the price, any improvement in the quality or increase of net-of-tax price (i.e., the seller price) is automatically reflected into the ad valorem amount.

The third category of reviewed theoretical literature is the evaluation of ad valorem taxes versus ad unit taxes in the specific settings of Bertrand and Cournout frameworks (Suits and Musgrave, 1953; Anderson et al., 2001; Delipalla and Keen, 2001; Grazzini, 2006). The literature concludes that the ad valorem tax is welfare superior to the ad unit tax in a symmetric Cournout oligopoly setting from a welfare and tax revenue maximization point of view. In comparison with Cournout settings, the literature finds that in the Bertrand framework, ad unit taxes are welfare superior to ad valorem taxes. In the monopoly case, ad valorem is found to be superior to the ad unit tax because ad valorem taxes leave tax revenues unchanged and increases the output.

The fourth category of theoretical literature reviewed is the approach towards the tax mix imposed on excisable goods and the issue of tax-on-tax when the excise duty is included into the VAT tax base (Carbonnier, 2014; Laffer, 2014). The fifth category of literature reviewed is represented by the empirical studies which analyse the tax burden shifting on three categories of excisable goods, such as tobacco, alcohol and transport fuels (Delipalla and O'Donnell, 2001;

Young and Bielinska-Kwapisz, 2002; Kenkel, 2005; Decicca, Kenkel and Liu, 2013; Bergman and Hansen, 2010; Chaloupka, Straif and Leon, 2010; Chouinard and Perloff, 2004; Alm, Sennoga and Skidmore, 2005; Nerudova and David, 2008; Marion and Muehlegger, 2011; Di Giacomo, Piacenza and Turati, 2012; Kopczuk et al., 2013; Jametti, Redonda and Sen, 2013; Di Giacomo et al., 2015). The main objective of these papers is to investigate the reaction of the consumer's and seller's prices of excisable goods to changes in tax terms. The findings regarding excise duties on alcohol and tobacco are relatively similar; the main conclusion converges to the fact that indirect taxes on alcohol and tobacco products tend to be fully shifted and, in some cases, particularly in case of the alcohol products, the retailers are prone to over-shift the tax burden. The findings regarding the excise duties on diesel and unleaded gasoline point more to the fact that indirect taxes on transport fuels tend to be fully shifted through prices toward end-consumers, and only in a few cases is the tax burden over shifted.

The Issues of Including Excise Duties into the Value Added Tax Base

The common practice in the EU countries, in the matter of imposing VAT on excisable goods such as alcohol, tobacco products and motor fuels is to include the excise duty into the VAT tax base. There is an additional tax incidence on the retail price, due to the artificially increased VAT by the size of the excise duty. Therefore, the issue of the tax-on-tax appears, as noted previously by Laffer (2014) and Henry et al. (2009). Consequently, when the government decides to increase the VAT or the excise duty, the pricing policy must accommodate this tax collision to compensate for the ad valorem and ad unit interaction. Therefore, when the government declares that the final consumers will pay *tx* excise duty for transport fuels, in reality, they pay $tx(1 + VAT)$ excise duty. In this case, the VAT extends beyond taxing the value added and increases the tax burden on consumers and producers alike.

Laffer (2014) considers that this tax interaction in the particular case of tobacco leads to a disproportional increase of price compared with ad valorem and ad unit tax-rate changes. In case of tobacco taxation, Laffer (2014) argues that the imposition of VAT on the excise duty-inclusive price, produces a non-linear relationship between the VAT tax rate increase and the final retail price. The author approaches the issue of tax collision in the particular case where ad valorem excise duty is included into the VAT base. Laffer (2014) underlines that any increase in non-proportional elements of the price such as production costs will have a larger impact on final price due to the tax multiplier. The VAT multiplier equation is as follows:

$$VAT_{multiplier} = \frac{1}{1 - VAT_{effective} - Excise_{effective}} \quad (1)$$

The difference between nominal and effective VAT, as Laffer (2014) argues, is the mark-up rate applied on the taxable value of the good or service before the VAT and the effective VAT is the percentage of the final consumer price. For example, when the VAT is 20% nominal value, the effective value of VAT = 20/120 = 16.67% of the consumer price. Due to the multiplier effect mentioned above, a 1 monetary unit increase in the pre-tax price will lead to a more than 1 monetary increase of the final price; thus, an over shifting of the tax burden can occur.

This rationale can be easily extended to other excisable goods, such as transport fuels. Taking into account that the excise duty imposed on unleaded gasoline is an ad unit and not an ad valorem excise duty (i.e., excise duty is a fixed charge per litre of fuel and not as percentage of pre-tax price of gasoline), the VAT multiplier equation proposed by Laffer (2014) needs to be adjusted. In this particular context, the VAT multiplier becomes the following:

$$VAT^{*}_{multiplier} = \frac{1}{1 - (1 * VAT_{nominal})} x \frac{Excise\,duty}{Excise\,duty - (Excise\,duty\ * VAT_{nominal})} \quad (2)$$

Since the VAT is imposed on excise duty inclusive price (i.e., which is a sum of production costs, transportation costs plus retailer mark-up and per unit excise duty), the increase of final price will be significantly affected by the tax multiplier. The first term on the right-hand side in Equation (2) is ad valorem tax on the value added, and the second term represents the tax-on-tax issue by including excise duty into the VAT base. For example, by excluding the excise duty from the VAT base the final price of gasoline decreases by at least one tenth.

The inclusion of excise duty into the VAT base in case unleaded gasoline represents a fixed cost that the fuel retailers take as given and must incorporate into their pricing policy because they have no control on its size. The tax policy on unleaded gasoline is strictly an exogenous factor that cannot be influenced by the retailers, assuming that they are law-abiding taxpayers. Because the tax burden represents more than 50% of the retail price of unleaded gasoline in the European Union countries, the tax policy significantly affects the final price by influencing fixed costs and profit margins. By decomposing the retail gasoline price, it can be observed that the inclusion of excise duty into the VAT base leads to a twofold increase of VAT revenues. Therefore, it is important to analyse how this particular case of tax collision affects the seller and consumer price of motor fuels.

The Equation (2) represents a clear example of how the tax burden of gasoline excise duty could be over shifted, considering that gasoline bears specific features of necessity in which the final consumer behaviour is significantly different from the consumption of other excisable goods such as tobacco and alcohol. Therefore, the price elasticity of demand for gasoline according to Dahl (2012) and Havranek and Kokes (2015) is considered relatively inelastic, ranging between –0.14 and –0.3. This finding implies that the demand for fuels, at least in the short-term, will not significantly shift downward as a response to price increases. According to Seade (1985), the tax burden shifting is most likely to occur when the transaction agents (seller or buyer) are not responsive to price changes. Consequently, the tax burden is shifted fully or potentially over shifted toward the less elastic agent. Over shifting might occur for various reasons, such as demand inelasticity, fuel-retailer market power or quality improvement of the excisable good or as a compensatory measure for decreased demand in the future.

Data and Methodology

This paper follows the methodological approach of Kenkel (2005), Marion and Muehlegger (2011) and Jametti, Redonda and Sen (2013), in which a reduced form model is estimated by regressing the tax-inclusive price of unleaded gasoline to its main exogenous determinants. Regressing the tax-inclusive retail price of gasoline to the tax rates (e.g., excise duties and VAT), the obtained coefficient represents the share of the tax burden that is borne by the final consumers. We expect the tax burden associated with gasoline to be over shifted toward end consumers through prices. One explanation for our expectations is the fact that a new tax rate increase will diminish demand in the long term by increasing prices; consequently, retailers will increase the price by more than the tax rate to compensate for future losses due to lower demand. Another explanation for tax burden over shifting is due to the tax-on-tax imposition, in which by including the excise duty into VAT tax base, the tax burden is increased artificially due to tax collision.

The retail price of the transport fuels is a function of costs and tax terms:

$$P_{retail\ gasoline} = f(Crude\,oil,\ Excise\,duty,\ VAT,\ \epsilon) \tag{3}$$

The main determinants of the retail price of unleaded gasoline are the cost of crude oil (*Crude oil*), the indirect taxation – excise duty (*Excise duty*) applied as ad unit tax per litre, the ad valorem tax (VAT) applied in percentage on the price,

and ϵ is the error term representing other exogenous factors that influence the price of motor fuels.

The calculation of the retail price of unleaded gasoline in the analysed 23 EU countries have the particular tax-on-tax issue in which the VAT is applied on the excise-inclusive retail price:

$$P_{retail\,(g)} = \left(net\ price + Excise\,duty \right) * VAT \tag{4}$$

The $net\ price$ encapsulates the price of crude oil and other costs related to insurance and freight (CIF). This method of imposing VAT on excisable goods such as gasoline raises the issue of tax collision between consumption tax (VAT) and the corrective tax (Excise duty). Therefore, our innovation in empirically analysing the effect of tax terms on the retail price of fuels is to introduce another term into the regression equation – the tax collision between VAT and Excise duty, which plays the role of the interaction term. The regression equation to be estimated is the following:

$$\begin{aligned} &Priceg_{i,t} = \\ &\beta_0 + \beta_1 \left(Excise_{i,t} \right) + \beta_2 \left(VAT_{i.t} \right) + \beta_3 \left(Crudeoil_t \right) + \beta_4 \left(taxcollision_{i,t} \right) + \gamma + \epsilon \end{aligned} \tag{5}$$

Where $Priceg_{i,t}$ = the average weekly tax-inclusive retail price of unleaded gasoline in Euro cents per litre in country *i* at time *t*, $Excise_{i,t}$ = the excise duty expressed in Euro cents per litre in country *i* at time *t*, $VAT_{i.t}$ = the effective ad valorem tax applied on excise-inclusive retail price of gasoline in country *i* at time *t* expressed in percent, $Crude_{i.t}$ = is the price of crude oil expressed in Euro cents per litre in country *i* at time *t*, and $taxcollision_{i,t} = Excise_{i,t} * VAT_{i.t}$ representing the interaction term between excise duty and VAT applied on fuel price; γ represents the country fixed effects and ϵ the error term. It is also necessary to mention the limitations of the study, which represent the lack of data. This fact prevented us to include other variables possibly influencing the retail price of gasoline as for example market power, market concentration and marginal costs of fuel retailers.

A special attention should be devoted to the interaction term in multiplicative models. According to Brambor, Clark and Golder (2006), when an interaction term is introduced into a multiple variable regression the constitutive elements of the interaction term do not present the overall effect but only the conditional effect on dependent variable. Thus, when the interaction term between excise duty and VAT is introduced in Equation (5), the obtained coefficient β_1 presents the conditional effect on tax-inclusive price of gasoline when VAT is present. Brambor, Clark and Golder (2006) underlines that the interpretation of conditional effects from interaction terms should be done using the following formula:

$$\frac{\Delta Priceg}{\Delta Excise} = \beta_1 + \beta_4 \overline{VAT} \tag{6}$$

We choose the mean sample value of VAT in order to calculate the conditional effect of excise duty on the price of gasoline. Interpreting only the coefficient β_1 without using the formula showed in Equation (7), VAT is assumed to equal 0 or constant. Even if case of VAT = 0 is possible, this interpretation is not useful in our case, where VAT is present and is assumed to have a significant impact on the gasoline tax-inclusive price. The introduction of the tax collision (as interaction term) is a method to analyse how the tax interaction between excise duty and VAT affect the retail price, given that the VAT is applied on the excise-inclusive retail price. Hence, the re-calculated coefficient of excise duty using Equation (7), captures the conditional impact of excise duty on the price of gasoline when VAT is assumed to be $\overline{VAT}$. Because the VAT imposed on unleaded gasoline price is changed between 2005 – 2014 in the analysed EU countries, we can also estimate the conditional effect of VAT on the price of gasoline using the mean of excise duty:

$$\frac{\Delta Priceg}{\Delta VAT} = \beta_2 + \beta_4 \overline{Excise} \tag{7}$$

The panel data analysis is based on data provided by European Commission Oil Bulletin that include weekly data on the average retail price of unleaded gasoline and the package of indirect taxation applied to this commodity. The data for crude oil prices are based on Spot Price Europe Brent provided by the US Energy Information Administration (US EIA). Our empirical analysis is based on 23 European Union countries, Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Germany, Greece, Finland, France, Hungary, Ireland, Italy, Luxembourg, Malta, the Netherlands, Poland, Portugal, Spain, Slovenia, Slovakia, Sweden and the United Kingdom, for the period 2005 – 2014. The available raw data obtained from the aforementioned sources has been processed in order to set all variables at the same level. Consequently, the crude oil price data obtained from US EIA in US dollars per barrel was transformed into EUR per litre. The tax-inclusive price of unleaded gasoline was inflation adjusted using the Eurostat data regarding Harmonized Consumer Price Index (HCPI) where the baseline year was 2005 (i.e. 2005 = 100). Another measure undertaken in this empirical analysis consist into dividing the analysed panel data into three groups of the EU countries: the Western EU which contains data for Austria, Belgium, Denmark, Germany, France, Finland, Ireland, Luxembourg, the Netherlands, Sweden and the United Kingdom; the Southern EU which contains data for Cyprus, Greece, Italy, Portugal, Malta and Spain; the Eastern EU which contains

data for the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia and Slovenia. The purpose of dividing the panel data analysis into three groups is due to the differences between the EU countries economic development and market structure. However, between the three groups of countries analysed there is a common tax policy, where the excise duty is included into the VAT tax base. As an additional measure to capture systematic differences in the tax policy on gasoline and the gasoline price variations across the EU countries the country fixed effects term was introduced into the model.

After the three groups of panel data analysis were established, the data was tested for stationarity using three different unit root tests: the Levin-Lin-Chu test (Levin, Lin and Chu, 2003), the Harris-Tzavalis test (Harris and Tzavalis, 1999) and Im-Pesaran-Shin test (Im, Pesaran and Shin, 2003). In case of the first two groups of countries, the Western EU and the Southern EU all variables from Equation (5) prepared for regression estimation have unit root. Therefore, we decided to transform the variables into the natural logarithms and take first differences. The benefits of log transformation lead to eliminating the outliers and also decreasing the skewed distributions of continuous variables. The outcome estimates of a logarithm transformed dependent and independent variable regression can be interpreted as elasticities. Moreover, in order to interpret the effect of independent variables at unit level we will report the log-transformed estimates, calculating the exponential of the obtained coefficients. In the particular case of third group of EU countries analyse, namely the Eastern EU, when testing the stationarity of the data the real price of gasoline rejected the null hypothesis of unit root while the independent variables have a unit root. Thus we decided to take only the first differences of all variables analysed for the Eastern EU group of countries.

The newly transformed dependent and independent variables for the three groups were re-tested using the Liu-Lin-Chu test, the Harris-Tzavalis test and Im-Pesaran-Shin test and the results obtained were able to reject the null hypothesis of unit root for all variables used. Before running our model we test the panel data for the presence of heteroscedasticity and serial correlation. The occurrence of heteroscedasticity shows that the variability of dependent variable is unequal across values of an explanatory variable that is used to predict it. Even if the OLS estimates are not biased in the presence of heteroscedasticity, the estimation is not efficient because it tends to underestimate the true variance and covariance. Standard errors and t-values tend to be biased and we cannot rely on the confidence intervals if there is heteroscedasticity. The presence of serial correlation in panel data analysis points towards the several shortcomings of the chosen model. Autocorrelation can appear due to the omitted variables or measurement errors. As in the case of heteroscedasticity, serial correlation does not produce biased estimates

but reports biased standard errors and could lead to less efficient results. Therefore we use the latest test in STATA for serial correlation in panel data analysis, namely Wooldridge test recommended by Drukker (2003). If serial correlation is identified and also traces of heteroscedasticity are present then Baltagi (2008) and Wooldridge (2010) recommend clustering at the panel data level in order to obtain consistent estimates of standard errors. This method eliminates the issues of cross-sectional heteroscedasticity and within-panel (serial) correlation.

In order to choose between fixed-effects model and random-effects estimation of our regression equation, we perform the Hausman test (Hausman, 1978) to compare which of the two is more appropriate for our empirical analysis.

The main assumption of this empirical analysis considers that the role of excise duty on gasoline is to decrease the consumption of fossil fuels and thus internalize the negative externalities of burning the harmful transport fuel. We expect that the exogenous tax variables (i.e. excise duty and VAT) would have a positive impact on the real price of unleaded gasoline. Also, the control exogenous variable – the price of crude oil is expected to have a positive impact on the price of gasoline. However, the expectations regarding the tax collision between excise duty and VAT and their impact of the real price of gasoline are bound to speculation. Taking into consideration the tax-on-tax situation, which doubles the size of the VAT multiplier, we expect that the tax burden of fuel taxation will be over shifted towards the end consumers. Moreover, it is important to analyse how the artificially increased VAT tax base affects the retail price of fuels.

Results

In Table 1, the pre-estimation test show that we cannot reject the null hypothesis of no heteroscedasticity according to the Likelihood-ratio test and no autocorrelation in panel data according to the Wooldridge test for the Western group of EU countries. In this case we need to cluster at panel data level in order to report robust standard errors. Moreover, as shown in Table 1, we were unable to reject the null hypothesis of Hausman test, which shows that both, random and fixed-effects are appropriate for our estimation.

Similar with the Western group of EU countries, the pre-estimation tests in Table 2 show that we cannot reject the null hypothesis of no heteroscedasticity according to the Likelihood-ration test and no autocorrelation in panel data according to the Wooldridge test for the Southern group of EU countries. In this case we need to cluster at panel data level in order to report robust standard errors. Moreover, as shown in Table 2, we were unable to reject the null hypothesis of Hausman test, which shows that both, random and fixed-effects are appropriate for our estimation.

T a b l e 1

The Pre-estimation Tests Regarding Heteroscedasticity, Serial Correlation and Hausman Test for the Western Group of EU Countries

Pre-estimation tests	
Model without the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(10) = 358.73 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 10) = 136.161 Prob > F = 0.0000
Hausman test *Ho: difference in coefficients not systematic*	chi2(3) = 0.02 Prob > chi2 = 0.9995
Model with the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(10) = 360.64 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 10) = 135.467 Prob > F = 0.0000
Hausman test: *Ho: difference in coefficients not systematic*	chi2(4) = 0.04 Prob > chi2 = 0.9990

Note. The pre-estimation tests included in Table 1 control if heteroscedasticity and serial correlation is present. The Hausman test is verifying if random-effects is preferred to fixed-effects model.

Source: Author calculations.

T a b l e 2

The Pre-estimation Tests Regarding Heteroscedasticity, Serial Correlation and Hausman Test for the Southern Group of EU Countries

Pre-estimation tests	
Model without the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(5) = 220.09 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 5) = 64.567 Prob > F = 0.0005
Hausman test *Ho: difference in coefficients not systematic*	chi2(3) = 0.25 Prob>chi2 = 0.9684
Model with the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(5) = 213.22 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 5) = 62.175 Prob > F = 0.0005
Hausman test*:* *Ho: difference in coefficients not systematic*	chi2(4) = 0.34 Prob > chi2 = 0.9869

Note. The pre-estimation tests included in Table 1 control if heteroscedasticity and serial correlation is present. The Hausman test is verifying if random-effects is preferred to fixed-effects model.

Source: Author calculations.

In Table 3, the pre-estimation test show that we cannot reject the null hypothesis of no heteroscedasticity according to the Likelihood-ration test and no autocorrelation in panel data according to the Wooldridge test for the Eastern group of EU countries. In this case we need to cluster at panel data level in order to report robust standard errors.

Moreover, as shown in Table 3, we were unable to reject the null hypothesis of Hausman test, which shows that both, random and fixed-effects are appropriate for our estimation.

T a b l e 3

The Pre-estimation Tests Regarding Heteroscedasticity, Serial Correlation and Hausman Test for the Eastern Group of EU Countries

Pre-estimation tests	
Model without the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(7) = 178.37 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 7) = 135.147 Prob > F = 0.0000
Hausman test *Ho: difference in coefficients not systematic*	chi2(3) = 0.04 Prob > chi2 = 0.9991
Model with the interaction term	
Likelihood-ratio test *(Assumption: nonhet nested in hetero)*	LR chi2(7) = 157.19 Prob > chi2 = 0.0000
Wooldridge test *for autocorrelation in panel data* *H0: no first-order autocorrelation*	F(1, 7) = 134.270 Prob > F = 0.0000
Hausman test *Ho: difference in coefficients not systematic*	chi2(4) = 0.01 Prob > chi2 = 0.9998

Note. The pre-estimation tests included in Table 1 control if heteroscedasticity and serial correlation is present. The Hausman test is verifying if random-effects is preferred to fixed-effects model.

Source: Author calculations.

The regression analysis was estimated in two different models, without and with the interaction term included into the model. According to the Hausman test, each model was estimated in two variants, where the first variant excludes the country fixed effect and the second variant includes the country fixed effect. Both variants of our model, Variant A and Variant B report robust standard errors. The reason of reporting the robust standard errors using the method suggested by Cameron, Gelbach and Miller (2011) is to test the robustness of the regression outcome by taking into account possible serial correlation between the countries included in each analysed group; hence the standard errors were clustered by country level. In the Table 4, the first set of results are reported for the model without the interaction term between the excise duty and the VAT imposed on the inflation adjusted retail price of unleaded gasoline in the Western EU group of countries. The obtained coefficients for both variants do not present any modifications. The sign and the impact of the excise duty and the price of crude oil are positive as expected. It is important to specify that the results presented in Table 4 are the log-transformed coefficients by calculating the exponential. The VAT, considered as an exogenous tax variable has no statistical significant effect on the price of gasoline in this particular model. Since the coefficients

are transformed using the exponentials, the interpretation can be done at the unit level. Hence, one monetary unit increase of the excise duty in the Western EU group of countries would lead to a 1.075 monetary units increase of the retail price of gasoline. In this case the tax burden is over shifted towards the final consumers.

Table 4

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Western EU Countries (OLS Regression without the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	1.075*** (0.0194)	1.075*** (0.0194)
Crude oil	1.077*** (0.00675)	1.077*** (0.00675)
VAT	1.001 (0.0266)	1.001 (0.0266)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	5 709	5 709

Note: Standard errors in parentheses, level of significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations.

Source: Authors calculations.

When estimating the second model, where the interaction term is introduced, we notice a significant change of the results. The estimates presented in Table 5 are transformed calculating the exponential of the initial results. The estimation procedure follows the same methodology as in Table 4. The variant A presents the results obtained without the country fixed effects and robust standard errors. The Variant B presents the results obtained including the country fixed effects term and cluster the standard errors at the country level. Using the Variant B estimates, the results confirm our expectation of positive sign of exogenous independent variables.

However, the interpretation of the impact of excise duty and VAT on the real price of gasoline is done using formula described in Equations (6) and (7). It can be interpreted that the effect of one monetary unit increase of excise duty would lead to an 0.63 monetary units increase in the retail price of gasoline only in the case where VA = 0. When we assume that VAT = $\overline{VAT}$ then the coefficient of excise duty increases from 0.63 to 0.75 using the formula from Equation (6). In case of VAT, the conditional effect on the retail price of gasoline in the Western EU group of countries increases from 0.842 to 1.253. This means that and 1% increase of VAT would lead to 1.253% increase of the retail price of gasoline when the excise duty is included into the VAT tax base.

T a b l e 5

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Western EU Countries (OLS Regression with the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	0.630* (0.123)	0.630* (0.123)
Crude oil	1.077*** (0.0102)	1.077*** (0.0102)
VAT	0.842** (0.0536)	0.842* (0.0539)
Tax collision	0.720** (0.0884)	0.720* (0.0888)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	5 709	5 709

Note: Standard errors in parentheses, level of significance:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations.

Source: Authors calculations.

The difference between the results obtained in Table 4 and Table 5 are evident. Excluding the interaction term and assuming there is no tax collision between the excise duty and the VAT imposed on the gasoline price, the excise duty tax burden will be over shifted towards the final consumer. When we consider that there is a tax collision between the indirect taxes imposed on the gasoline price, the obtained results change radically. The obtained estimates show that the inclusion of excise duty into the VAT tax base leads to under shifting of excise duty tax burden and to an over shifting of VAT tax burden in the Western EU group of countries. The impact of control variable in the form of the price of crude oil is positive as expected.

In Table 6 the results for Southern EU group of countries are presented, calculating the exponentials of the initial estimates. Following the same procedure we estimate the impact of exogenous tax variables and the price of crude oil as control variable without including the tax collision term. The results confirm our expectation of positive impact of excise duty and the price of crude oil on the tax-inclusive price of gasoline. The effect of VAT on the retail price of gasoline in Southern EU is similar with the Western EU group of countries. The research revealed that VAT is not statistically significant when the interaction term is excluded from the regression analysis. In case of excise duty, based on the results, it can be concluded that one monetary unit increase of this tax would lead in average to a 1.101 monetary units increase in the retail price of gasoline. Hence, the excise duty tax burden is over shifted.

In Table 7 we include the tax collision into the regression, in order to capture the impact of including the excise duty into the VAT tax base. The results obtained

change substantially compared with Table 6. The interpretation of the coefficients for excise duty and VAT is done using the formula from Equations (6) and (7), taking into account that these represent conditional effects. Hence, one monetary unit increase of excise duty would lead to 0.801 monetary units increase into the retail price of gasoline, when VAT = 0.

T a b l e 6

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Southern EU Countries (OLS Regression without the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	1.101*** (0.0188)	1.101*** (0.0701)
Crude oil	1.027*** (0.00728)	1.027** (0.00878)
VAT	0.978 (0.0230)	0.978 (0.0155)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	5 709	5 709

Note: Standard errors in parentheses, level of significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations.

Source: Authors calculations.

T a b l e 7

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Southern EU Countries (OLS Regression with the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	0.811*** (0.0357)	0.810*** (0.0370)
Crude oil	1.028*** (0.00723)	1.028** (0.00876)
VAT	0.830*** (0.0265)	0.830*** (0.0308)
Tax collision	0.745*** (0.0292)	0.744*** (0.0447)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	5 709	5 709

Note: Standard errors in parentheses, level of significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations.

Source: Authors calculations.

However, if we take the mean value of VAT (i.e. following the Equation (9)), then one monetary unit increase of excise duty would lead to 0.93 monetary units increase of the retail price of gasoline. Comparing the results for excise duty between Table 6 and Table 7, the inclusion of interaction term between excise

duty and VAT decreases the effect of excise duty on the retail price of gasoline. When the tax collision is excluded from the estimation, the excise duty estimate shows that the tax burden is over shifted towards the end consumer. Including the tax collision in the regression the excise duty tax burden is under shifted, where a share of the burden is borne also by the gasoline retailer.

Taking into consideration that VAT is changed periodically in the Southern EU group of countries between 2005 – 2014 we calculate the conditional effect of VAT on the retail price using the formula from Equation (7). In the hypothetical case where Excise equals zero, a 1% increase of VAT would lead to 0.830% increase in the retail price of gasoline. When assuming the sample mean value of excise duty, a 1% increase of VAT would lead to 1.173% increase in the retail price of gasoline. Consequently, the conditional effect of VAT reveals that the VAT tax burden is over shifted towards the end consumer. The effect of the crude oil price is positive as expected, where one monetary unit increase in the crude oil price leads to an 1.028 monetary units increase in the tax-inclusive price of gasoline.

Comparing the results obtained in Table 6 and Table 7, it can be observed that the tax collision between excise duty and VAT plays an important role in the tax burden shifting from gasoline retailer to the final consumer. There can be identified a similarity between Southern EU and Western EU group of countries, where the inclusion of excise duty into the VAT tax base leads to under shifting of excise duty tax burden.

In Table 8 the results for Eastern EU group of countries are presented. In this table we run the regression without including the tax collision term between the excise duty and the VAT. The results show that one monetary unit increase in the excise duty would lead to 1.307 monetary units increase in the retail price of gasoline. The results for the Eastern EU are similar with the results obtained for Western EU and Southern EU group of countries, where the excise duty tax burden is over shifted. The price of crude oil has a positive effect as expected and the VAT has no statistical significant effect on the retail price of gasoline.

When the tax collision term is introduced into the model, the results change substantially, as shown in Table 9. Following the same procedure, we calculate the conditional effects of excise duty and VAT on the price of gasoline using Equations (6) and (7). Assuming that VAT equals zero, one monetary unit increase in the excise duty would lead to a 3.562 monetary units decrease of the retail price of gasoline. When we assume the sample mean value of the VAT, then one monetary unit increase of excise duty would lead to 1.62 monetary units increase into the retail price of gasoline. Moreover, since the VAT is also changed in the Eastern EU group of countries between 2005 – 2014 we calculate the

conditional effect of VAT using the formula from the Equation (10). Assuming that Excise equals zero, then a 1% increase into the VAT would lead to 11.94% decrease of the retail price of gasoline. When we consider the mean value of the Excise duty, a 1% increase in the VAT would lead to 0.285% decrease of the retail price of gasoline.

T a b l e 8

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Eastern EU Countries (OLS Regression without the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	1.307* (0.448)	1.307*** (0.0432)
Crude oil	0.112*** (0.0186)	0.112*** (0.0186)
VAT	–0.128 (0.150)	–0.126 (0.151)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	4 152	4 152

Note: Standard errors in parentheses, level of significance:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations.

Source: Authors calculations.

T a b l e 9

The Impact of Indirect Taxation and Crude Oil on the Retail Price of Unleaded Gasoline in the Eastern EU Countries (OLS Regression with the interaction term)

Independent Variables	**Dependent variable**: Priceg	
	Variant A	Variant B
Excise	–3.562*** (1.001)	–3.562*** (1.001)
Crude oil	0.110*** (0.0165)	0.110*** (0.0166)
VAT	–11.94*** (2.271)	–11.94*** (2.384)
Tax collision	27.95*** (5.527)	27.95*** (5.547)
Country fixed effect	NO	YES
Robust Standard Errors	YES	YES
N	4 152	4 152

Note: Standard errors in parentheses, level of significance:* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; N – number of observations. *Source*: Authors calculations.

The results obtained from estimating the model with and without the interaction term differ substantially. However, the results obtained for Eastern EU group of countries are opposite to the Western EU and Southern EU group. The excise duty is over shifted in both models and the VAT tax burden is under shifted. The impact of the crude oil price on the retail price of gasoline is positive as expected.

Discussion of Results

The aim of this paper was to analyse the tax burden shifting of VAT and excise duty through the retail price of gasoline in the particular context of the tax-on-tax situation that occurs in the case of excisable goods in the EU countries. Based on the already existent research, we develop the topic further by employing tax collision between VAT and excise duty as a new exogenous variable, in order to estimate the conditional effect of each indirect tax on the retail price of gasoline. We consider that an extensive approach is necessary when analysing the effect of tax terms on the retail price of gasoline to capture the real reactions of pricing policy to exogenous factors.

The results show that the tax burden resulting from a mix of ad valorem and ad unit taxes imposed on an excisable commodity, such as gasoline, tend to be borne more by the final consumer than by the seller. The excise duty burden is close to fully shifted toward consumers, whereas a small share of the tax burden is borne by the retailer. The VAT tax burden is over shifted toward end-consumers in Western EU and Southern EU group of countries and under shifted in the Eastern EU. It is important to underline that the estimates obtained for the Western EU and Southern EU group of countries, in case of VAT conditional effect on the gasoline retail price confirms the theoretical assumptions made in Section 3. Namely, if the retailer increases the net-of-tax price by one monetary unit (due to quality improvements or increase in profit margin) the consumer price must increase by more than 1 monetary unit due to VAT multiplier effect. This price reaction to tax factors could be described as an advantageous one when it occurs for tobacco products and alcoholic beverages. Asymmetric price reaction to tax increases is beneficial in the case of tobacco and alcohol because it decreases the demand for such goods and reduces the negative externalities associated with them. However over shifting of the tax burden in the case of gasoline retail price leads to several implications for consumer welfare. Considering the fact that transport fuels are necessities, in which the price elasticity of demand is relatively inelastic, the tax burden over shift increases the regressivity of indirect taxes. The results of our research show that further development of the research can be done through considering tax-on-tax issues and tax collision between ad valorem and ad unit taxes when analysing the indirect tax regressivity.

The results obtained by including the tax collision, constructed as an interaction term decreases the impact of corrective levies such as excise duties on gasoline. The tax collision that results from imposing a mix of VAT and excise duty on excisable goods increases significantly the deadweight loss of taxation. Thus, this tax-on-tax term imposes an additional cost on the retailer, reducing its profit margin and the level of output.

The specific case of indirect tax mix and the peculiar tax-on-tax imposition, when excise duty is included into the VAT tax base, has detrimental implications for environmentally related excise duties imposed on unleaded gasoline. Assuming that the objective of excise duties on transport fuels is to mimic an environmental tax to reduce negative externalities from pollution, there is a question of the costs that these corrective taxes impose. According to the Pigovian principle, the corrective tax should be equal to the social costs that arise from pollution. In the case of tax mixes such as the one analysed in this paper, the tax collision between ad valorem (consumption tax) and ad unit tax (corrective tax) due to the tax-on-tax issue could artificially increase or decrease the size of the corrective levy and therefore renders a non-linear relationship between a VAT tax rate increase and the final retail price, as underlined by Laffer (2014). Moreover, our results show that the Pigovian principle is violated due to the tax collision; the excise duty burden is under shifted. This reaction of retail price to excise duty increase is breaching the polluter's pay principle, in which the consumer of gasoline should support the full cost of harming the environment. The methodology and the results of our paper can be used in the future by governments to simulate the effect of excise duty and VAT increases on the retail price of transport fuels when the state is pursuing a pollution abatement policy.

Conclusion

The research paper addresses the issue of tax-on-tax imposition on the excisable goods, such as unleaded gasoline in the EU countries. The aim of the paper is to further develop the works of Di Giacomo, Piacenza and Turati (2012); Di Giacomo et al. (2015), by researching the phenomenon of tax collision between ad valorem and ad unit taxes and their implications on tax burden shifting which was not taken into account by aforementioned authors. The contribution of our paper to current research lies in analysing the effect of VAT and excise duty on the retail price of gasoline when considering the tax collision. Taking into account the particularities of including the excise duty into the VAT tax base, we consider necessary to investigate the tax burden shifting in the context of tax collision. Before estimating the effect of tax terms on the retail price of gasoline itself, we determine that the VAT and excise duty collide due to the multiplier effect of the ad valorem tax. Consequently, the tax collision leads to an artificially increased VAT tax base. This newly devised exogenous factor, which influences the retail price of gasoline, is employed as an interaction term in the OLS multiple variable regression. Another development of extant research consists in analysing two separate models with and without the tax collision term, which

plays the role of interaction term between the excise duty and the VAT imposed on the retail price of gasoline. Also we divide the panel data analysis in three EU groups of countries, taking into account the market structure and economic development differences.

Estimating the first model, without the interaction term, we found that the excise duty tax burden tends to be over shifted towards the end consumer in all three groups of countries analysed. The results obtained from the second model estimation change radically when the tax collision term is introduced into the regression. Hence, the conditional effect of the excise duty, which depends on the sample mean value of the VAT, shows that the tax burden is under shifted of this corrective levy in the Western EU and the Southern EU group of countries. It can be concluded that the inclusion of excise duty into the VAT tax base decreases the impact of excise duty on the retail price of gasoline, thus violates the Polluter's Pay principle. The conditional effect of VAT on the retail price of gasoline, when the mean value of excise duty is assumed, shows that the VAT tax burden is over shifted towards the end consumers in in the Western EU and the Southern EU group of countries. The results for Eastern EU group of countries show an opposite trend in tax burden shifting of excise duty and VAT for gasoline compared with previous two EU groups. In Eastern EU group, the excise duty tax burden appears to be over shifted in both models, with and without the tax collision and the VAT tax burden is under shifted. It is important to notice that the inclusion of tax collision term into the second model for the Eastern EU shows that the inclusion of excise duty in the VAT tax base leads to an increase of tax burden over shifting of the excise duty. This result confirms the impact of tax-on-tax procedure of imposing the VAT on the retail price of gasoline discussed in Section 3.

In conclusion, we found that the tax collision between excise duty and VAT plays a different role in Western and Southern EU countries compared with the Eastern EU countries. The results obtained show that the excise duty is shared between the retailers and final consumers in the first two groups of analysed countries and is over shifted in Eastern EU countries. Opposite effect is observed in case of VAT, where the ad valorem tax burden is over shifted in the Western and Southern EU countries and under shifted in the Eastern EU member states.

The main assumption of this paper considers that the role of excise duty on gasoline is to decrease the consumption of fossil fuels and thus internalize the negative externalities of burning the harmful transport fuel. Based on the results of the research, we may conclude that the core finding shows that tax collision between the VAT and excise duty tends to violate the Polluter's Pay Principle, where the final consumer of gasoline is paying less than the external costs of

consuming gasoline in the Western and Southern EU countries and the final consumer is paying more than the external costs associated with gasoline consumption in the Eastern EU countries.

References

ALM, J. – SENNOGA, E. – SKIDMORE, M. (2005): Perfect Competition, Spatial Competition, and Tax Incidence in the Retail Gasoline Market. [Research Paper, No. 06-01.] Atlanta, GA: Andrew Young School.

ANDERSON, S. P. – DE PALMA, A. – KREIDER, B. (2001): The Efficiency of Indirect Taxes under Imperfect Competition. Journal of Public Economics, *81*, No. 1, pp. 231 – 251.

BALTAGI, B. (2008): Econometric Analysis of Panel Data. Chichester: John Wiley & Sons. ISBN 10 0-470-01456-3.

BERGMAN, U. M. – HANSEN, N. L. (2010): Are Excise Taxes on Beverages Fully Passed Through to Prices? [Working Paper, No. 4.] Copenhagen: University of Copenhagen.

BRAMBOR, T. – CLARK, W. R. – GOLDER, M. (2006): Understanding Interaction Models: Improving Empirical Analyses. Political Analysis, *14*, No. 1, pp. 63 – 82.

CAMERON, A. C. – GELBACH, J. B. – MILLER, D. L. (2011): Robust Inference with Multiway Clustering. Journal of Business & Economic Statistics, *29*, No. 2, pp. 238 – 249.

CARBONNIER, C. (2014): The Incidence of Non-linear Price-dependent Consumption Taxes. Journal of Public Economics, *118*, No. 1, pp. 111 – 119.

CHALOUPKA, F. J. – STRAIF, K. – LEON, M. E. (2010): Effectiveness of Tax and Price Policies in Tobacco Control. Tobacco Control, *20*, No. 3, pp. 235 – 238.

CHOUINARD, H. – PERLOFF, J. M. (2004): Incidence of Federal and State Gasoline Taxes. Economics Letters, *83*, No. 1, pp. 55 – 60.

DAHL, C. A. (2012): Measuring Global Gasoline and Diesel Price and Income Elasticities. Energy Policy, *41*, No. 1, pp. 2 – 13.

DECICCA, P. – KENKEL, D. – LIU, F. (2013): Who Pays Cigarette Taxes? The Impact of Consumer Price Search. Review of Economics and Statistics, *95*, No. 2, pp. 516 – 529.

DELIPALLA, S. – KEEN, M. (1992): The Comparison between Ad Valorem and Specific Taxation under Imperfect Competition. Journal of Public Economics, *49*, No. 3, pp. 351 – 367.

DELIPALLA, S. – O'DONNELL, O. (2001): Estimating Tax Incidence, Market Power and Market Conduct: The European Cigarette Industry. International Journal of Industrial Organization, *19*, No. 6, pp. 885 – 908.

DI GIACOMO, M. – PIACENZA, M. – SCERVINI, F. – TURATI, G. (2015): Should We Resurrect 'TIPP Flottante' if Oil Price Booms Again? Specific Taxes as Fuel Consumer Price Stabilizers. Energy Economics, *51*, No. 1, pp. 544 – 552.

DI GIACOMO, M. – PIACENZA, M. – TURATI, G. (2012): Are "Flexible" Taxation Mechanisms Effective in Stabilizing Fuel Prices? An Evaluation Considering Wholesale Fuel Markets. Energy Economics, *34*, No. 4, pp. 1176 – 1186.

DRUKKER, D. M. (2003): Testing for Serial Correlation in Linear Panel-data Models. Stata Journal, *3*, No. 2, pp. 168 – 177.

FULLERTON, D. – METCALF, G. E. (2002): Tax Incidence. [Working Paper, No. 8829] Cambridge, MA: National Bureau of Economic Research.

GRAZZINI, L. (2006): A Note on Ad Valorem and per Unit Taxation in an Oligopoly Model. Journal of Economics, *89*, No. 1, pp. 59 – 74.

HARRIS, R. D. – TZAVALIS, E. (1999): Inference for Unit Roots in Dynamic Panels where the Time Dimension is Fixed. Journal of Econometrics, *91*, No. 2, pp. 201 – 226.

HAUSMAN, J. A. (1978); Specification Tests in Econometrics. Econometrica: Journal of the Econometric Society, *1*, No. 1, pp. 1251 – 1271.

HAVRANEK, T. – KOKES, O. (2015): Income Elasticity of Gasoline Demand: A Meta-analysis. Energy Economics, *47*, No. 1, pp. 77 – 86.
HENRY, K. – HARMER, J. – PIGGOTT, J. – RIDOUT, H. – SMITH, G. (2009): Australia's future tax system. Canberra: Commonwealth Treasury.
IM, K. S. – PESARAN, M. H. – SHIN, Y. (2003): Testing for Unit Roots in Heterogeneous Panels. Journal of Econometrics, *115*, No. 1, pp. 53 – 74.
JAMETTI, M. – REDONDA, A. – SEN, A. (2013): The Power to Pass on Taxes: A Test for Tax Shifting Based on Observables. [Working Paper Series, No. 4265.] Munich: CESifo.
KATZ, M. – ROSEN, H. S. (1985): Tax Analysis in an Oligopoly Model. Public Finance Quarterly, *13*, No. 1, pp. 3 – 19.
KEEN, M. (1998): The Balance between Specific and Ad Valorem Taxation. Fiscal Studies, *19*, No. 1, pp. 1 – 37.
KENKEL, D. S. (2005): Are Alcohol Tax Hikes Fully Passed Through to Prices? Evidence from Alaska. The American Economic Review, *95*, No. 2, pp. 273 – 277.
KOPCZUK, W. – MARION, J. – MUEHLEGGER, E. – SLEMROD, J. (2013): Do the Laws of Tax Incidence Hold? Point of Collection and the Pass-through of State Diesel Taxes. [Working Paper, No. w19410.] Cambridge, MA: National Bureau of Economic Research.
KOTLIKOFF, L. J. – SUMMERS, L. H. (1987): Tax Incidence. In: AUERBACH, A. J. and FELDSTEIN, M. (ed.): The Handbook of Public Economics. Amsterdam: North Holland Publishing, pp. 1043 – 1092.
LAFFER, A. B. (2014): Handbook of Tobacco Taxation: Theory and Practice. San Francisco, CA: Laffer Center. ISBN-13 978-1-934276-15-0.
LEVIN, A. – LIN, C. F. – CHU, C. S. J. (2002): Unit Root Tests in Panel Data: Asymptotic and Finite-sample Properties. Journal of Econometrics, *108*, No. 1, pp. 1 – 24.
MARION, J. – MUEHLEGGER, E. (2011): Fuel Tax Incidence and Supply Conditions. Journal of Public Economics, *95*, No. 9, pp. 1202 – 1212.
MYLES, G. D. (1995): Public Economics. Cambridge: Cambridge University Press. ISBN 9780521497695.
NERUDOVÁ, D. – DAVID, P. (2008): VAT in the Frame of Providing Management Services to the Subsidiary in the Selected EU Member States. Agricultural Economics, *54*, No. 1. pp. 333 – 342.
SCHRÖDER, P. J. (2004): The Comparison between Ad Valorem and Unit Taxes under Monopolistic Competition. Journal of Economics, *83*, No. 3, pp. 281 – 292.
SEADE, J. (1985): Profitable Cost Increases and the Shifting of Taxation: Equilibrium Response of Markets in Oligopoly. [Working Paper, No. 260.] Coventry, UK: University of Warwick, Department of Economics.
SELIGMAN, E. R. A. (1910): The Shifting and Incidence of Taxation. New York: The Columbia University Press.
SUITS, D. B. – MUSGRAVE, R. A. (1953): Ad Valorem and Unit Taxes Compared. The Quarterly Journal of Economics, *67*, No. 4, pp. 598 – 604.
WOOLDRIDGE, J. M. (2010): Econometric Analysis of Cross Section and Panel Data. Massachusetts: MIT Press. ISBN 9780262232586.
YOUNG, D. J. – BIELIŃSKA-KWAPISZ, A. (2002): Alcohol Taxes and Beverage Prices. National Tax Journal, *55*, No. 1, pp. 57 – 73.