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Tax Pass-through in the European Beer Market

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Abstract

We study the pass-through of indirect taxes on beer prices in the European Union (EU). Exploiting the variation of value added tax rates, beer excise tax rates, and beer prices in a panel of monthly data from 1996 to 2016 of all current 28 EU member states, we estimate the tax pass-through of specific beer excise taxes and ad valorem value added taxes, respectively. Ad valorem taxes are under-shifted at a rate of approximately 70%. Specific excise taxes are almost fully shifted to prices in the EU, but, in contrast to the empirical findings for the US, there is no evidence of over-shifting. Nevertheless, the difference between ad valorem and specific tax pass-through rates indicates that imperfect competition plays an important role in the European beer market.

Keywords: Tax incidence, Pass-through, VAT, Excise Taxes, EU.
JEL codes: H22, H23

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1 Introduction

All 28 Member States of the European Union levy specific excise taxes as well as value added taxes (VAT) on the consumption of beer. This parallels the practice in many other countries which also apply a mix of specific and ad valorem taxes on beer.[1] This commonly observed tax pattern can be attributed to the externalities and internalities associated with the consumption of alcoholic beverages, the relatively inelastic demand for beer, and the administrative ease of levying such taxes. The present analysis investigates the pass-through of specific excise taxes and of the VAT to beer prices in the 28 member states of the European Union. Figure 1 presents the beer price developments in the 28 member states since 1996, where, for clarity, these have been grouped into four different panels.

Our study provides several contributions. First, we provide evidence for pass-through rates for indirect taxes on beer in the EU. While there is substantial evidence for the pass-through rates of alcoholic beverages for the US, including beer, the European evidence is sparse and, where it exists, only relates to the level of individual member states. Moreover, Kenkel (2005), Shrestha and Markowitz (2016), and Young and Bielińska-Kwapisz (2002) have found a substantial degree of over-shifting of beer excise taxes in the US. This raises the question, whether such over-shifting is also present in the EU. Our results indicate that this is not the case, since we find that specific excise taxes on beer are almost fully shifted to beer prices in our sample.

Second, we analyze pass-through rates of specific excise taxes and of ad valorem taxes on beer prices. Under perfect competition, theory predicts that these rates should be equal. Considering the difference between these pass-through rates allows to assess whether imperfect competition considerations play a role in the beer market, and to shed light on the respective welfare effects of ad valorem and specific taxes. Our results show that ad valorem taxes (VAT) are substantially under-shifted to beer prices at a pass-through rate of approximately 70%. This suggests that, despite the absence of over-shifting, imperfect competition plays an important role in the European beer market, since such differential effects are not

[1] Some countries also levy ad valorem excise taxes either instead of, or in addition to, specific excise taxes, as well as an ad valorem tax such as the VAT or general sales taxes. In the European Union (EU) this is not the case. As laid down in the Council Directive 92/83/EEC all EU member states should tax beer using specific excise taxes only, and should refrain from ad valorem excise taxes.

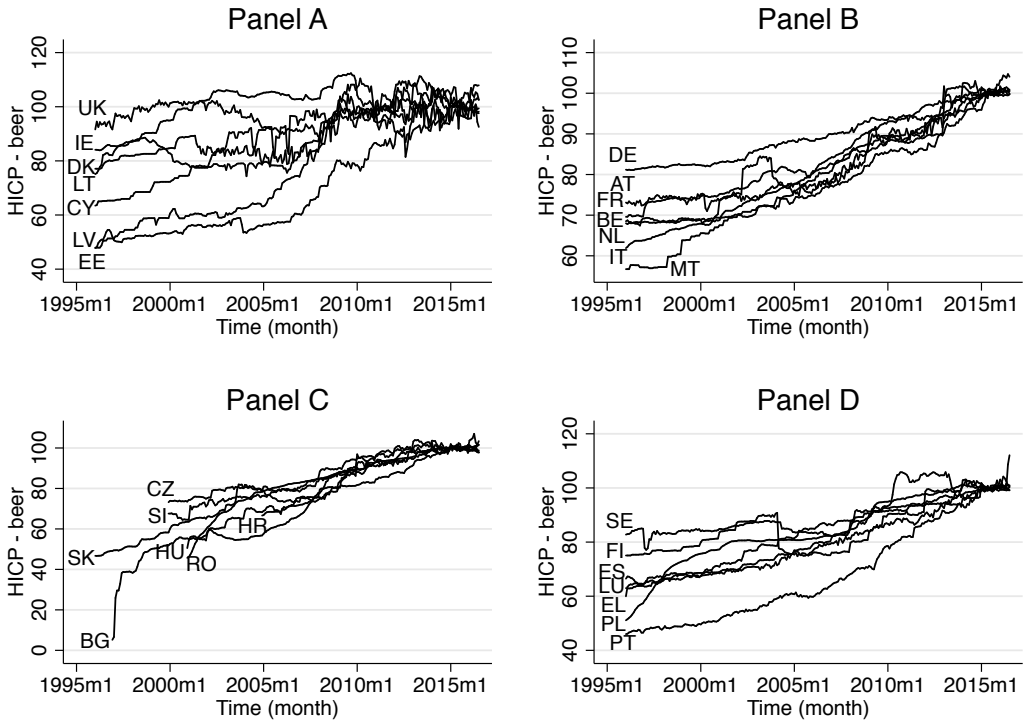


Figure 1: Development of harmonized indices of beer consumer prices at the European level (2015 = 100). *Source:* data is from Eurostat and figures by authors.

compatible with perfect competition from a theory perspective.

Finally, the third contribution of our study relates to our empirical strategy. We employ a panel of beer price indices and tax rates of the various EU member states in our analysis, treating these member states as a valid counterfactual for each other. Similar to incidence studies that have considered states or cities within the US, or within other countries, as a credible counterfactual for each other, see Evans, Ringel and Stech (1999), Besley and Rosen (1999) Harding, Leibtag and Lovenheim (2012), Shrestha and Markowitz (2016), Kopczuk et al. (2016), and Young and Bielińska-Kwapisz (2002), for example, we argue that this strategy can also be employed to estimate pass-through rates in Europe. This approach is in contrast with most of the existing empirical literature on European countries, where tax pass-through has typically been estimated exploiting the time variation of individual country data only. Carbonnier (2013) and Bonnet and Réquillart (2013) study the case of excise taxes and VAT reforms in France, for example, and Bergman and Hansen (2016) provide evidence of the excise tax pass-through using

Danish data only. Our identification strategy is instead based on the assumption that, at least since the implementation of European Single Market on January 1st, 1993, input and product markets have become substantially integrated across EU member states. Accordingly, beer price developments in member states where taxes remain constant can serve as a valid counterfactual for the development in another member state where taxes change at a particular point in time. We exploit the frequent changes in specific beer excises tax rates as well as in the VAT rate, which are decided independently at the level of each member state. Accordingly, we use a panel of member states' beer price indices and investigate how these are effected by changes in the specific excise tax rates and changes in the VAT rate, respectively. Our analysis indicates that beer prices in the various EU member states move closely together, and thus can be used as an appropriate counterfactual for each other.

Based on conceptual considerations laid out in Section 2, we develop two different estimation frameworks to explore the effects of specific excise taxes and value added taxes on beer prices and estimate the respective pass-through. This permits us to consider the differential impact of specific versus ad valorem taxes. Conceptually, in a competitive market the pass-through rate should be the same for ad valorem taxes, such as the VAT, and specific taxes, and the pass-through rate should be between zero and one. Theoretical approaches that allow for imperfect competition, however, point out the possibility of over-shifting of taxes to prices, see Fullerton and Metcalf (2002) and Weyl and Fabinger (2013). Moreover, these theoretical approaches provide a theoretical foundation for different pass-through rates of specific and ad valorem taxes, with the former ones being passed through to a larger extent. Finally, from a welfare perspective, ad valorem taxes Pareto-dominate specific excise taxes under imperfect competition, see Grazzini (2006), Denicolò and Matteuzzi (2000), Anderson, De Palma and Kreider (2001*a*) and Anderson, De Palma and Kreider (2001*b*), among others, for theoretical discussions. In a nutshell, for the same level of government revenues, prices are set at a lower level with ad valorem taxes implying higher consumer surplus.[2] Excise taxes may have an advantage, however, if the tax is thought to be corrective, and the

[2]Note that these theory findings can potentially be reversed, if firms have multiple products, see Hamilton (2009). Given that many consumption goods, including beer, are primarily sold via multi-product retailers, the difference between specific and ad valorem tax pass-through rates may be considered ambiguous a priori, and needs to be assessed empirically.

excise directly targets the externality, such as alcohol content for example, see also Bonnet and Réquillart (2013). Such considerations, are less important in the case of beer, however, since the alcohol content is closely related to the quantity of beer itself.

Our study relates to several strands of literature. The empirical analysis of indirect tax pass-through has been addressed by a number of studies over recent years, see Bergman and Hansen (2016) for a comprehensive overview. Two important reference points for our analysis are the contributions by Young and Bielińska-Kwapisz (2002) and Shrestha and Markowitz (2016) who both consider excise tax pass-through to beer prices in the US. Both studies find substantial over-shifting to prices. Shrestha and Markowitz (2016) conclude that a 10-cent increase in beer taxes translates into a 17 cents increase in the retail prices.

With European data, Benedek et al. (2015) have estimated the VAT pass-through for a group of commodities based on a panel of 17 selected EU member states over the period 1999 to 2013.[3] Their results imply different effects according to different types of the VAT rate. For the standard rate, the accumulated effect of the tax change shows full-shifting. However, they find the pass-through rates for the reduced rates as well as for reclassifications to be around 30% and 0%, respectively. We also use a panel approach but focus on the differences between specific and ad valorem taxes. In contrast to Benedek et al. (2015), we find that in our specific market, beer, where the standard rate applies, the VAT pass-through rate is substantially below unity.

Our analysis is organized as follows. In the next section we describe the conceptual framework and derive the equations to be estimated for the case of an ad valorem tax, i.e. the VAT, and a specific tax, respectively. In line with the practice in the European Union we do not allow for an additional ad valorem excise tax. In Section 3 we describe our data and carry out a descriptive analysis. We then provide our empirical approach and the estimation results in Section 4. Section 5 provides several robustness checks, and Section 6 concludes.

[3]Thus, they use a similar approach to our analytical framework. We build on this, but additionally provide evidence that such an approach is appropriate for the EU member states. Moreover, we focus on the pass-through of both, ad valorem and specific taxes, and we identify the difference between the pass-through rates.

2 The framework

In general, the consumer price of beer P is given by $P = (q(t,\tau) + t)(1+\tau)$, where t is the excise tax, τ indicates the value added tax rate, and $q = q(t,\tau)$ is the producer price, which itself is a function of both tax rates. Our conceptual approach takes this dependency into account, and also disentangles the role of the different taxes. To investigate the impact of tax changes on consumer prices, we rely on the approach introduced in Carbonnier (2013). This allows to derive the equations to be estimated in the case of VAT and specific excise taxes, respectively. We first consider the case of VAT.

2.1 Value added taxation

Define ϕ to be the consumer's share of burden for the ad valorem tax. It represents the ratio of the tax-inclusive price variations with respect to VAT changes to the consumer price variation for constant producer prices

$$\phi = \frac{\frac{\partial P}{\partial \tau}}{\frac{\partial P}{\partial \tau}\Big|_{q=const}} = \frac{\frac{\partial q}{\partial \tau}(1+\tau) + q + t}{q+t} = 1 + \frac{1+\tau}{q+t}\frac{\partial q}{\partial \tau}. \tag{1}$$

Full pass-through of the value added tax onto prices implies $\phi = 1$ and $\phi = 0$ represents no shifting. We define q^0 as the hypothetical producer price that would prevail without any taxes. Furthermore, two proxy parameters m and n are defined so that

$$P = (q^0 + mt)(1 + n\tau) \tag{2}$$

Since we do not observe these proxy variables n and m, we need to determine the relationship between them and the pass-through rate ϕ. From (2) we have $\frac{\partial P}{\partial \tau} = n(q^0 + mt)$. In addition, since $q = \frac{P}{1+\tau} - t$, computing the first derivative with respect to the tax variable τ, yields $\frac{\partial q}{\partial \tau} = \frac{\partial P}{\partial \tau}\left(\frac{1}{1+\tau}\right) - \frac{P}{(1+\tau)^2}$. Plugging these in (1), rearranging the relationship between ϕ and n, and applying $q + t = \frac{P}{1+\tau}$ and $q^0 + mt = \frac{P}{1+n\tau}$ generates

$$\phi = \left(\frac{P}{1+n\tau}\right)\frac{n(1+\tau)}{P} = \frac{n(1+\tau)}{1+n\tau}. \tag{3}$$

Equation (3) plays a key role in estimating VAT pass-through. Subsequently, defining the operator $\delta_i(\tau) = \tau_i - \tau_0$, where τ_i represents the VAT rate in period i

and τ_0 is the VAT rate in the base period, and applying it to the natural logarithm of equation (2) gives $lnP_i = ln(q_i^0 + mt_i) + ln\left(1 + n\tau_0 + n\tau_i - n\tau_0\right))$. Further rearranging yields

$$lnP_i = ln(1 + n\tau_0) + ln(q_i^0 + mt_i) + ln\left(1 + \frac{n\delta_i(\tau)}{1 + n\tau_0}\right). \tag{4}$$

Since $\frac{n\delta_i(\tau)}{1+n\tau_0}$ is small compared to one, the Taylor expansion of $ln\left(1 + \frac{n\delta_i(\tau)}{1+n\tau_0}\right)$ in equation (4) will be $\frac{n}{1+n\tau_0}\delta_i(\tau)$ so that

$$lnP_i = \underbrace{ln(1 + n\tau_0)}_{term1} + \underbrace{ln(q_i^0 + mt_i)}_{term2} + \underbrace{\frac{n}{1 + n\tau_0}\delta_i(\tau)}_{term3}. \tag{5}$$

This will be the baseline for our VAT pass-through estimations. *Term 1* in equation (5) stands for the constant terms while *term 2* includes determinants of producer prices including the excise tax rate. *Term 3* is the tax-shifting term and its coefficient will be used to derive the value added tax pass-through.

2.2 Excise Tax

Consider now the case of an excise tax. Starting again from $P = (q(t, \tau) + t)(1 + \tau)$, we define η as the consumer's share of burden from the excise tax

$$\eta = \frac{\frac{\partial P}{\partial t}}{\frac{\partial P}{\partial t}\Big|_{q=const}} = 1 + \frac{\partial q}{\partial t}. \tag{6}$$

In addition, it holds that $q = \frac{P}{1+\tau} - t$, so that $\frac{\partial q}{\partial t} = \frac{\frac{\partial P}{\partial t}}{1+\tau} - 1$. According to equation (2) and using our proxy variables m and n, the partial change of price with respect to the excise tax is $\frac{\partial P}{\partial t} = m(1 + n\tau)$. Combining these two first derivatives with equation (6) gives the relationship between our measure of excise tax pass-through and the proxy variables

$$\eta = \frac{m(1 + n\tau)}{1 + \tau}. \tag{7}$$

Subsequently, with t_0 changing to t_1, given equation (2), Δt can be written as $\Delta t = \frac{1}{m}\left(\frac{P_1 - P_0}{1+n\tau} - \Delta q\right)$. Further rearranging generates the relationship between an excise tax change and the corresponding price change between any subsequent periods.

$$\Delta P = \underbrace{m(1+n\tau)\Delta t}_{term1} + \underbrace{(1+n\tau)\Delta q}_{term2}. \tag{8}$$

This is the baseline for our estimation of the excise tax pass-through. In equation (8), *term 1* represents our tax shifting term and *term 2* stands for cost controls and value added taxes. The coefficient of *term 1* allows us to determine the excise tax pass-through.

3 Data and descriptive analysis

We employ a monthly dataset starting from Jan-1996 to July-2016 which is comprised of VAT standard rates, excise taxes related to beer, and indices of consumer beer prices (HICP thereafter) harmonized at the European level. Eurostat[4] is the main source for all our price series and it provides monthly data on a wide range of sub-HICPs as well as aggregated price indices. The set-up of these indices allows for comparisons and evaluations of consumer price changes across the EU. Aside from beer, two additional series of sub-HICPs related to transport and energy are included in our study as controls in our regressions to account for possible variations of the producer price. Table 1 provides summary statistics on our price indices as well as on tax rate changes.

The webpage of European Commission, section Taxation and Customs Union[5] offers detailed information on the evolution of VAT standard rates together with the respective dates of change for each member state. Excise tax data and the corresponding historical tables are retrieved from the same source. Dates of tax changes are partly exploited according to the historical tables of excise duties but, unfortunately, in many cases this information is not indicated in the table, especially during the 1990s. To overcome this issue and for being able to capture the correct month of change for each country, we additionally compiled this information from the *reform database* of the European Commission. For the few cases where neither of the two sources offer the required information, the start of the corresponding calendar year is considered as the time of the tax change. Finally, we re-scale all the excise tax rates so that these rates in each country

[4] `ec.europa.eu/eurostat`

[5] `ec.europa.eu/taxation_customs/business`

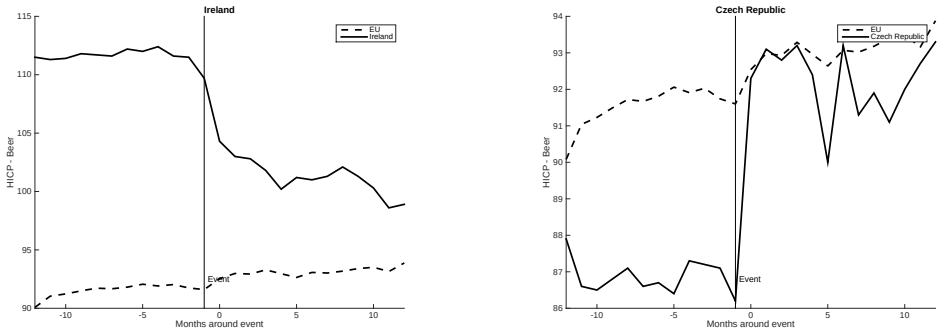
Table 1: Summary statistics and the number of tax rates

Variable	Mean	Std. Dev.	Min.	Max.	N
Beer(HICP)	83.393	14.559	5.2	112.4	6586
VAT rate	20.016	3.02	8	27	6843
Transport(HICP)	84.298	17.708	2.03	116.88	6881
Energy(HICP)	77.408	23.265	6.59	127.12	6557
Number of tax changes			**Increases**	**Decreases**	**Total**
VAT			50	13	63
Excise tax			116	11	127

Notes: The first panel of this table represents summary statistics of our sample corresponding to 28 countries of the European Union from *Jan-1996* to *July-2016*. Additionally, the second panel of this table points out information regarding tax rate changes within these countries in the time period of our study.

correspond to the price index of that country, see the Appendix 7.1 for details of this procedure.

Before moving to our empirical analysis, we present some graphical evidence as a simple way to assess non-parametrically the effect of tax changes on beer prices. In general, tax changes may differ by type, i.e. excise versus VAT changes, by size, and by their direction. Similarly, price responses, in terms of their speed of adjustment and their size, can potentially vary across member states and across time. More generally, the graphs allow to compare the co-movement of prices in the member states where taxes were changed to the price development in the other member states to assess visually the validity of using the individual member states as a counterfactual for each other. The individual panels in Figures 2 and Figure 3 provide evidence for the evolution of prices in particular member states around various tax changes. Note that all the displayed events where selected such that no other event is present within the twelve month window around the event. Figure 2a represents the Irish case at the start of 2010, when both ad valorem and specific taxes decreased in the same period, while Figure 2b corresponds to tax rate increases (in the VAT and the excise tax) in the Czech Republic. According to Figure 2a, before the event takes place, the HICP of beer at the European level and the HICP of Ireland follow a similar trend until the price index drops from 109.7 to 104.3 due to a cut in both specific (from 19.87 to 15.71 Euros per hl/°alc) and ad valorem (from 21.5 to 21 percent) taxes. A somewhat similar event, even though in the opposite direction, occurred in the Czech Republic in the same



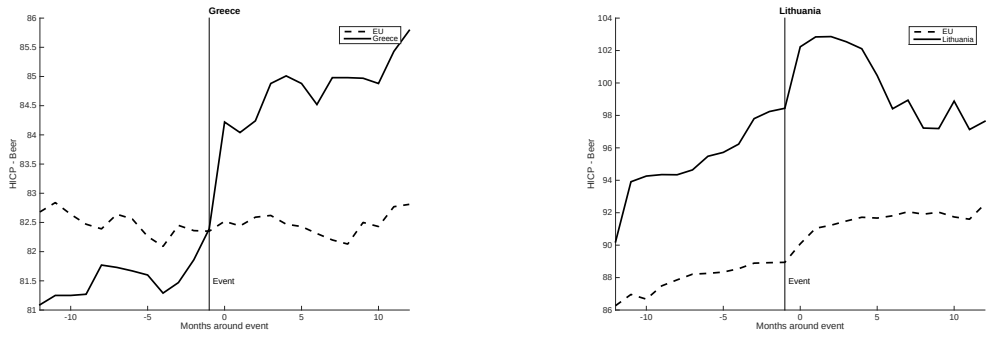
(a) Ireland **(b)** Czech Republic

Figure 2: HICP of Beer around the points of tax increase and tax cut.
Notes: Both events on this graph correspond to the same month (1 : 2010). Figure *a* indicates the case of excise tax and VAT cuts in Ireland without the presence of any other event through the window after and before the indicated event. Figure *b* follows the same method but is based on excise tax and VAT increases. *Source:* data is from Eurostat and figures by authors.

month which translates into a spike in the price index, changing from 86.2 to 92.3 while both specific (from 24 to 32 Koruna hl/°Plato) and ad valorem taxes (from 19 to 20 percent) increase.

Figure 3 compares two member states that experienced the same tax change event, however, at different points in time. Greece experienced a VAT reform in April 2005 which increased the standard rate from 18% to 19%. This affected the price index to increase by around 2 percent. Similarly, Lithuania increased the standard VAT rate in January 2009 from 18% to 19%. This was accompanied by an increase in the beer price index of around 4 percent.

Taking into account that individual country price indices tend to be more volatile than the EU average beer price index, the overall evidence provided suggests that beer prices move relatively closely together in the absence of tax changes, so that member states may be considered a reasonably good counterfactual for each other. This is also confirmed by the event study graphs we provide in Section 4.



(a) Greece **(b)** Lithuania

Figure 3: Different price responses.
Notes: Sub-figures *a* and *b* represent country cases of a one percent VAT rate increase in 4:2005 and 1:2009 in Greece and Lithuania, respectively. *Source:* data is from Eurostat and figures by the authors.

4 Empirical analysis and results

Based on equations (5) and (8) derived in Section 2, we estimate the VAT and excise tax pass-through on beer prices. However, before estimating equation (5) all our series are tested for the presence of a unit root to avoid spurious regressions. We apply the Im-Pesaran-Shin test, which is a procedure commonly applied for testing for non-stationarity in panels (Im, Pesaran and Shin (2003)). The test results (not reported, available on request) reflect that our dependent variable as well as the other price indices used as controls are highly persistent and non-stationary in levels. Therefore, we carry out the regression for the VAT pass-through in first differences. The estimated equation is

$$\Delta ln(P_{ci}) = \alpha_c + \alpha_i + \alpha_t + \beta \Delta ln X_{ci} + \sum_{j=-1}^{1} \beta_j \Delta_{c,i+j}(\tau) + \varepsilon_{ci}, \tag{9}$$

where i and c correspond to the month and member state, respectively. Moreover, α_c and α_i are country and time fixed effects, and α_t is a vector of dummies indicating changes in excise taxes. The set of controls, X_{ci}, comprises the indices of energy and transport cost and β and β_j are the coefficients to be estimated. Estimation of equation (9) provides a value for $\hat{\beta}_3 \equiv \sum_{j=-1}^{1} \hat{\beta}_j$, which is the coefficient of the tax-shifting term. We consider a single lead and a single lag here, since the complete effect of the tax change may not occur through the

same period.[6] What we are interested in, and defined earlier as the measure of value added tax pass-through in equation (1), is ϕ or the consumer's share of the burden for an ad valorem tax change. Based on (3), it holds that $\frac{\phi}{1+\tau_0} = \frac{n}{1+n\tau_0}$. Comparing this term to the coefficient of our tax-shifting term in (9) we have

$$\hat{\phi} = \hat{\beta}_3(1 + \bar{\tau_0}), \tag{10}$$

where $\bar{\tau_0}$ is computed as the average of the τ_0s in all member states, and $\hat{\beta}_3$ is generated from the estimations of equation (9). Finally, comparing equations (5) and (9), note that using the first differences is fully in line with our theoretical framework. For the first difference $\Delta_i \left[\frac{n}{1+n\tau_0}\delta_i(\tau)\right] = \frac{n}{1+n\tau_0}\left[\delta_i(\tau) - \delta_{i-1}(\tau)\right]$. Subtracting the tax rate τ_0 yields the new tax shifting term $\frac{n}{1+n\tau_0}\Delta_i(\tau)$.

Similarly structured to equation (9), but directly based on (8), we estimate the following equation for the excise tax pass-through

$$\Delta P_{ci} = \alpha_c + \alpha_i + \alpha_\tau + \beta'\Delta X_{cij} + \sum_{j=-1}^{1} \beta'_j \Delta t_{c,i+j} + \varepsilon'_{ci}, \tag{11}$$

where α_c and α_i again represent country and time fixed effects, respectively. In addition, α_τ is a vector of dummy variables to capture the impact of VAT rate changes. Our other controls are the price indices of transport and energy in each member state in first differences and β' and β'_j are the coefficients to be estimated. Finally, $\hat{\beta}'_3 \equiv \sum_{j=-1}^{1} \hat{\beta}'_j$ is the coefficient of our tax-shifting term accounting for a single period of lead and lag. Given equation (7), the coefficient of Δt in term 1 corresponds to $\eta(1 + \tau)$, and therefore

$$\hat{\eta} = \frac{\hat{\beta}'_3}{1 + \bar{\tau}}. \tag{12}$$

This gives the value of the consumers' share of the excise tax excise burden, given the estimated value of $\hat{\beta}'_3$ and $\bar{\tau}$ as the average VAT rate across all periods and member states in our sample.

Subsequently, we extend our regressions (9) and (11) by including 12 periods of lead and lag for the tax change, turning our approach into an event study design, see Sandler and Sandler (2014) for an encompassing discussion. The inclusion of lead terms allows us to observe the existence of any pre-trends in our sample of

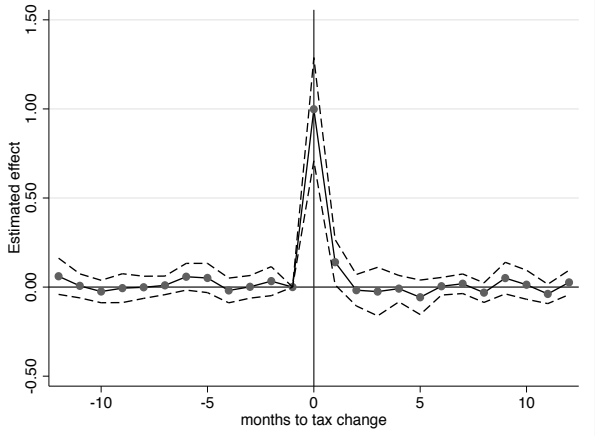
[6]Note that we discuss extensions to several leads and lags further below.

the EU member states before the occurrence of the tax changes. Since we consider two types of taxes in our study separately, the event study graphs in Figure 4 are also generated separately for each tax. In both of these graphs, the month before the event is defined as the reference period. In addition, all of the lead and lag terms are interacted with the magnitude of the corresponding tax change, following the suggested procedure by Sandler and Sandler (2014) for events with different treatment intensity.

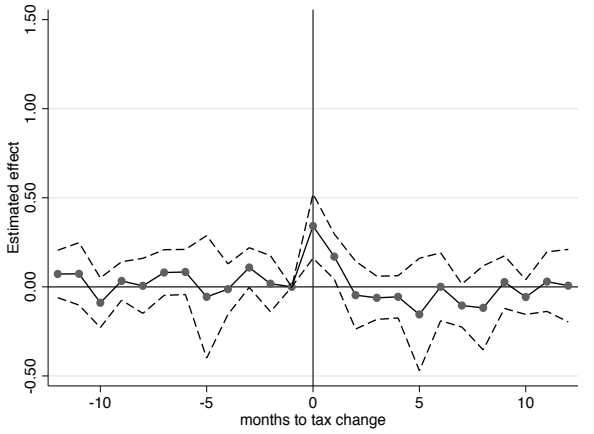
The event study graph shows that, for the case of excise tax changes, the effects are concentrated in the first two months in which the tax change is implemented. For VAT changes, which are substantially less frequent, the effects are also concentrated in these first two months, but, additionally, there seems to be some preceding price increases as well, which are marginally significant (the price change three month before the tax change, in particular). More generally, there is no sign of systematic differences more than four months before the tax events, indicating that EU member states may be considered a good counterfactual for each other.

Table 2 summarizes our results of estimating different forms of equation (9). In all regressions, the dependent variable corresponds to the first-differenced natural logarithm of beer HICP. Moreover, standard errors are clustered at the country level. As discussed in Section 2, and according to equation (10), our estimated value added tax pass-through $\hat{\phi}$ is computed according to the estimated coefficients of tax shifting term in (9), which are provided in the last row. Since our variables are first-differenced, we also consider an alternative version of (9) without country fixed effects. Columns 6 and 7 in Table 2 indicate the results corresponding to this approach.

The comparison of the contemporaneous VAT pass-through, in Columns 5 and 7 of Table 2, to the pass-through computed by including lead and lag terms, in Columns 4 and 6, again shows, in line with the event study evidence, that the full effect of a tax reform does not occur instantaneously. The total VAT pass-through rate, taking the previous, the following, and the month in which the tax change occurs into account, is approximately 70%. But the contemporaneous pass-through, according to Column 5, only implies a pass-through rate of around 40% to beer prices. Note that the value of $\bar{\tau}_0$ which is used in computing equation (10) is generated as the equally-weighted average of VAT in all the EU countries



(a) Event study - excise taxes



(b) Event study - VAT

Figure 4: Event study graphs.
Notes: graph (*a*) represents the result of an event study for excise tax by including 12 periods of lead and lag into equation (11). Graph (*b*) indicates the result of an event study for VAT with the same approach as excise tax based on equation (9). The dashed lines indicate 95% confidence intervals and the vertical lines in $t = 0$ show the month when the tax change occurs.
Source: authors' calculations.

in the first period, January 1996. The computed values of pass-through in this table indicate under-shifting of beer prices with respect to the value added tax changes in the EU.[7]

Table 3 presents the results of estimating different forms of equation (11) for the pass-through of excise taxes where the dependent variable is the beer

[7]This conclusion also holds if we add further leads and lags of the tax rate change to the regression in Column 4. More specifically, considering a 1 year time horizon around the month of the tax rate change (6 leads and 6 lags of the tax rate change) as well as considering a 2 year time horizon around the month of the tax rate change (12 leads and 12 lags of the tax rate change) result in a cumulative VAT pass-through rate of 0.51 and 0.44, respectively.

Table 2: VAT pass-through in the European Union

	(1) $\Delta ln(P)$	(2) $\Delta ln(P)$	(3) $\Delta ln(P)$	(4) $\Delta ln(P)$	(5) $\Delta ln(P)$	(6) $\Delta ln(P)$	(7) $\Delta ln(P)$
ΔVAT	0.380***	0.338***	0.341***	0.344***	0.344***	0.347***	0.348***
	(0.102)	(0.0891)	(0.0865)	(0.0887)	(0.0888)	(0.0878)	(0.0880)
ΔVAT_{-1}	0.130*	0.132*	0.162**	0.164**	no	0.163**	no
	(0.0716)	(0.0709)	(0.0611)	(0.0605)		(0.0600)	
ΔVAT_{+1}	0.0204	0.0509	0.0789	0.0798	no	0.0807	no
	(0.0577)	(0.0553)	(0.0617)	(0.0610)		(0.0600)	
cost controls				yes	yes	yes	yes
excise tax dummies			yes	yes	yes	yes	yes
time f.e.		yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes	no	no
adj. R^2	0.001	0.013	0.192	0.192	0.190	0.192	0.190
$\hat{\phi}_{EU}$	0.631	0.620	0.693	0.700	0.409	0.703	0.414

Notes: Robust standard errors in parentheses which are clustered at the member state level. In all regressions, dependent variable corresponds to the first-differenced beer HICP in logs. ϕ is our measure of tax pass-through and reflects the consumer's share of burden for ad valorem tax and is computed according to $\phi = \hat{\beta}_3(1 + \bar{\tau}_0)$ with $\bar{\tau}_0 = 19.12\%$. Cost controls are the price indices of transport and energy. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

HICP in first differences. The standard errors are again clustered at the member state level. Based on equation (12) our measure of excise tax pass-through $\hat{\eta}$ is computed according to the estimated coefficients of tax shifting term in (11), which are indicated in the last row. Similar to the case of value added taxes, we allow for a period of lead and lag of the tax change since the effect may not occur instantaneously. Moreover, since our variables are in first differences, an alternative structure is considered for equation (11), where country fixed effects are eliminated from the model. The corresponding results are indicated in Columns 6 and 7 of Table 3.

The comparison of the contemporaneous excise tax pass-through, in Columns 5 and 7 of Table 3, to the pass-through computed by including lead and lag terms in Columns 4 and 6, again shows that the effect of a tax reform does not only occur instantaneously. Namely, a one unit of increase in the excise tax rate, according

Table 3: Excise tax pass-through across the European Union

	(1) ΔP	(2) ΔP	(3) ΔP	(4) ΔP	(5) ΔP	(6) ΔP	(7) ΔP
ΔExcise	0.977***	0.941***	0.930***	0.933***	0.931***	0.931***	0.930***
	(0.135)	(0.122)	(0.121)	(0.122)	(0.122)	(0.122)	(0.122)
ΔExcise_{-1}	0.128**	0.124*	0.121*	0.122*	no	0.121*	no
	(0.0608)	(0.0600)	(0.0602)	(0.0602)		(0.0589)	
ΔExcise_{+1}	0.00474	0.0133	0.00997	0.0115	no	0.0109	no
	(0.0162)	(0.0136)	(0.0117)	(0.0121)		(0.0121)	
cost controls				yes	yes	yes	yes
VAT dummies			yes	yes	yes	yes	yes
time f.e.		yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes	no	no
adj. R^2	0.136	0.158	0.164	0.164	0.161	0.164	0.161
$\hat{\eta}_{EU}$	0.925	0.899	0.885	0.889	0.776	0.887	0.775

Notes: Robust standard errors in parentheses which are clustered at the member state level. In all regressions, dependent variable corresponds to the first-differenced beer HICP. $\hat{\eta}$ is our measure of tax pass-through and reflects the consumer's share of burden for excise tax and is computed according to $\hat{\eta} = \frac{\hat{\beta_3}'}{1+\bar{\tau}}$ with $\bar{\tau} = 20.016\%$. Cost controls correspond to the price indices of transport and energy.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

to Column 4, increases prices by around 90 percent while the contemporaneous pass-through according to Column 5, implies around 77 percent increase in beer prices[8]. Please note that $\bar{\tau}$ in this case is the average of the value added tax across all periods and all the countries. Given the values of η_{EU} under different specifications in Table 3, the excise tax is almost fully-shifted to the prices.

5 Robustness checks

To assess the robustness of our results we carry out several additional checks. These alternative estimates concern the inclusion of further controls as well as

[8]The inclusion of further terms of lead and lag of up to 6 and 12 in the regression corresponding to Column 4, does not alter this conclusion as doing so results in a cumulative excise tax pass-through of 0.86 and 1.06, respectively.

Table 4: Robustness check for VAT pass-through

	(1) $\Delta ln(P)$	(2) $\Delta ln(P)$	(3) $\Delta ln(P)$	(4) $\Delta ln(P)$	(5) $\Delta ln(P)$	(6) $\Delta ln(P)$
ΔVAT	0.344***	0.345***	0.298**	0.297**	0.300*	0.304**
	(0.0919)	(0.0922)	(0.128)	(0.128)	(0.144)	(0.144)
ΔVAT_{-1}	0.143*	no	0.208*	no	0.0551	no
	(0.0739)		(0.118)		(0.0984)	
ΔVAT_{+1}	0.0796	no	0.0519	no	-0.0836	no
	(0.0620)		(0.0949)		(0.0649)	
cost controls	yes	yes	yes	yes	yes	yes
excise tax dummies	yes	yes	yes	yes	yes	yes
time f.e.	yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes	yes
adj. R^2	0.192	0.192	0.186	0.184	0.220	0.220
$\hat{\phi}$	0.674	0.410	0.658	0.350	0.322	0.361

Notes: Robust standard errors in parentheses which are clustered at the member state level. In all regressions, dependent variable corresponds to the first-differenced beer HICP in logs. ϕ is our measure of tax pass-through and reflects the consumer's share of burden for ad valorem tax and is computed according to $\hat{\phi} = \hat{\beta}_3(1 + \bar{\tau}_0)$ with $\bar{\tau}_0$ equal to 19.12% for regressions 1 and 2, 17.95% for regressions 3 and 4, and 18.84% for regressions 5 and 6. Cost controls correspond to the price indices of transport and energy. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

restrictions of our sample. The first approach aims at minimizing potential omitted variable bias, the second addresses potential concerns about the validity of using the EU member states as a counterfactual for each other. In particular, market integration may not have been very close between certain member states, so that price developments may have been rather different in individual member states due to market fragmentation even in the absence of tax changes.

First, based on Figure 4, we observe that for both taxes, it typically takes two months for the pass-through to take place. This raises concerns about omitted variable bias in our benchmark estimates, where we only control for those country-months, where a tax change of the other indirect tax occurs. We therefore re-estimate equations (9) and (11) with the given structure but also dummy out the period after the tax change in the respective other tax. The results are

Table 5: Robustness check for excise tax pass-through

	(1) ΔP	(2) ΔP	(3) ΔP	(4) ΔP	(5) ΔP	(6) ΔP
ΔExcise	0.931***	0.930***	1.034***	1.032***	1.029***	1.028***
	(0.122)	(0.122)	(0.142)	(0.143)	(0.169)	(0.171)
ΔExcise_{-1}	0.120*	no	0.122	no	0.144	no
	(0.0618)		(0.0856)		(0.0854)	
ΔExcise_{+1}	0.0113	no	0.0287	no	0.0265	no
	(0.0121)		(0.0203)		(0.0279)	
cost controls	yes	yes	yes	yes	yes	yes
excise tax dummies	yes	yes	yes	yes	yes	yes
time f.e.	yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes	yes
adj. R^2	0.163	0.161	0.155	0.153	0.193	0.190
$\hat{\eta}$	0.89	0.78	1.00	0.86	1.00	0.87

Notes: Robust standard errors in parentheses which are clustered at the member state level. In all regressions, dependent variable corresponds to the first-differenced beer HICP. η is our measure of tax pass-through and reflects the consumer's share of burden for excise tax and is computed according to $\hat{\eta} = \frac{\hat{\beta_3}'}{1+\bar{\tau}}$ with $\bar{\tau}$ equal to 20.016% for regressions 1 and 2, 19.03% for regression 3 and 4, and 19.38% for regressions 5 and 6. Cost controls correspond to the price indices of transport and energy.
$^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

provided in Columns 1 and 2 of Table 4 for the VAT pass-through, and in the same columns of Table 5 for the excise tax pass-through. The results are very similar to the benchmark estimates in all cases.

Second, in the baseline model we estimated the tax pass-through employing data from all 28 EU member states. Some of these member states may not be sufficiently integrated with each other to serve as an appropriate counterfactual for each other. Therefore, we change our sample to the current Eurozone countries, where economies are arguably more integrated than those of the entire EU, and re-estimate tax pass-through using equation (9) for VAT and equation (11) for excise taxes. The results are provided in Columns 3 and 4 of Table 4 and Table 5, respectively. Pass-through rates drop very slightly for the VAT, and increase

very slightly for specific excise taxes, increasing the difference between the two pass-through rates.

Finally, in a further step, we additionally restrict our sample of the Eurozone countries by only including those periods in which the Euro had already been adopted as the national currency in the respective member state. This check should address concerns about incomplete exchange rate pass-through in the period before the adoption of the Euro. Moreover, Greece is also not included in this sample, given the low degree of integration of this member state with the rest of the Eurozone. We display the corresponding results in Columns 5 and 6 of Table 4 and Table 5, respectively. The VAT pass-through is even lower in this case, and the pass-through of specific excise taxes is again slightly higher than in the benchmark. To sum up, all additional estimates point at the robustness of our results.

6 Summary and conclusion

We investigate beer price responses to changes in specific beer excise taxes and value added taxes in the EU. Exploiting the tax and price variation in a panel of the 28 EU member states we first explore graphically and using event study designs whether the individual member states can serve as a valid counterfactual for each other. The approach thus emulates the research design that has been used to estimate pass-through rates in the US. Accounting for cost controls, time and country fixed effects as well as for changes in the respective other indirect tax, we find that the ad valorem VAT is less than fully shifted to beer prices at a pass-through rate of approximately 70%. Using a similar approach for the case of excise taxes, we estimate that these are almost fully shifted to beer prices. Thus, while the pass-through rate is substantially larger than for ad valorem taxes, we do not find evidence of over-shifting. This can be contrasted to the US beer market where excise taxes are substantially over-shifted to prices. The results, both for VAT and excise taxes, are found to be robust under different specifications.

Our findings of differential pass-through rates of specific and ad valorem taxes indicate that imperfect competition plays an important role in the European beer market. From a policy perspective, relying more heavily on ad valorem taxes may therefore be able to generate substantial welfare gains. Welfare could be

increased by a policy that replaced specific excise taxes by ad valorem taxes such that consumption levels remain unchanged. This should raise higher tax revenues without reducing consumer surplus and without compromising public health concerns and other negative externalities originating from alcohol consumption.

References

Anderson, Simon P, Andre De Palma and Brent Kreider. 2001*a*. "The efficiency of indirect taxes under imperfect competition." *Journal of Public Economics* 81(2):231–251.

Anderson, Simon P, Andre De Palma and Brent Kreider. 2001*b*. "Tax incidence in differentiated product oligopoly." *Journal of Public Economics* 81(2):173–192.

Benedek, Dora, Ruud A De Mooij, Michael Keen and Philippe Wingender. 2015. "Estimating VAT Pass Through.".

Bergman, U Michael and Niels Lynggård Hansen. 2016. "Excise Tax Pass-Through and Menu Costs: The Danish Evidence.".

Besley, Timothy J and Harvey S Rosen. 1999. "Sales taxes and prices: An empirical analysis." *National Tax Journal* 52(2):157.

Bonnet, Céline and Vincent Réquillart. 2013. "Tax incidence with strategic firms in the soft drink market." *Journal of Public Economics* 106:77–88.

Carbonnier, Clément. 2013. "Pass-through of Per Unit and ad Valorem Consumption Taxes: Evidence from Alcoholic Beverages in France." *The BE Journal of Economic Analysis & Policy* 13(2):837–863.

Denicolò, Vincenzo and Massimo Matteuzzi. 2000. "Specific and ad valorem taxation in asymmetric Cournot oligopolies." *International Tax and Public Finance* 7(3):335–342.

European Commission, EUROSTAT. 2011. "Harmonized Indices of Consumer Prices at Constant Tax Rates Reference Methodology.".

Evans, William N, Jeanne S Ringel and Diana Stech. 1999. "Tobacco taxes and public policy to discourage smoking." *Tax policy and the economy* 13:1–55.

Fullerton, Don and Gilbert E Metcalf. 2002. "Tax incidence." *Handbook of public economics* 4:1787–1872.

Grazzini, Lisa. 2006. "A note on ad valorem and per unit taxation in an oligopoly model." *Journal of Economics* 89(1):59–74.

Hamilton, Stephen F. 2009. "Excise taxes with multiproduct transactions." *The American Economic Review* 99(1):458–471.

Harding, Matthew, Ephraim Leibtag and Michael F Lovenheim. 2012. "The heterogeneous geographic and socioeconomic incidence of cigarette taxes: Evidence from Nielsen Homescan Data." *American Economic Journal: Economic Policy* 4(4):169–198.

Im, Kyung So, M Hashem Pesaran and Yongcheol Shin. 2003. "Testing for unit roots in heterogeneous panels." *Journal of econometrics* 115(1):53–74.

Kenkel, Donald S. 2005. "Are alcohol tax hikes fully passed through to prices? Evidence from Alaska." *The American economic review* 95(2):273–277.

Kopczuk, Wojciech, Justin Marion, Erich Muehlegger, Joel Slemrod et al. 2016. "Does tax-collection invariance hold? evasion and the pass-through of state diesel taxes." *American Economic Journal: Economic Policy* 8(2):251–86.

Sandler, Danielle H and Ryan Sandler. 2014. "Multiple event studies in public finance and labor economics: A simulation study with applications." *Journal of Economic and Social Measurement* 39(1, 2):31–57.

Shrestha, Vinish and Sara Markowitz. 2016. "The Pass-Through of Beer Taxes to Prices: Evidence from State and Federal Tax Changes." *Economic Inquiry* 54(4):1946–1962.

Weyl, E Glen and Michal Fabinger. 2013. "Pass-through as an economic tool: Principles of incidence under imperfect competition." *Journal of Political Economy* 121(3):528–583.

Young, Douglas J and Agnieszka Bielińska-Kwapisz. 2002. "Alcohol taxes and beverage prices." *National Tax Journal* pp. 57–73.

7 Appendix

7.1 Re-scaling of the excise tax rates

As reported by Eurostat, member states compute the harmonized indices of consumer prices separately and according to their national consumption. Therefore, the structure of the underlying consumption basket in the reference period can potentially be different across various member states. To assess the pass-through of excise taxes on the respective price indices thus requires to relate the taxes to the quantities in the consumption baskets underlying each index. Furthermore, beer excise taxes are imposed on a specific quantity. According to article 3 of directive 92/83/EEC[9], the excise duties on beer can be levied per hectoliter/degrees Plato or per hectoliter/degrees of actual alcoholic strength by volume, in each member state. Thus, an additional concern stems from varying units of measure of the excise tax rate in different countries.

To address these issues, we make use of the so-called harmonized index of consumer prices at constant tax rates (HICP-CT thereafter) which are available for most of the member states from 2005 on. The difference between the HICP and the HICP-CT is as follows. For each country HICP-CT is computed for hypothetical fixed tax rates under the assumption of a one-to-one pass-through while the HICP allows for the actual tax variations in each period. Therefore, the difference among the two indices captures the extent to which price changes correspond to a particular value of excise tax changes assuming instantaneous and full pass-through in each country (European Commission (2011)).

In the periods with a single excise tax change, looking at differences between the values of HICP and HICP-CT with an identical reference year (2015 = 100) relative to the value of effective tax change can be used to achieve our objective. Consider a period in which t_0 changes to t_1, based on the definition of HICP-CT, $P_1 = (q_1^0 + m\Delta t + mt_0)(1 + n\tau_1)$ and $P_1^{ct} = (q_1^0 + mt_0)(1 + n\tau_1)$ we have $P_1 - P_1^{ct} = m\Delta t(1 + n\tau_1)$. Rearranging and multiplying both sides by $\frac{1}{(1+\tau_1)\Delta t}$ gives

$$\frac{P_1 - P_1^{ct}}{(1 + \tau_1)\Delta t} = \frac{m(1 + n\tau_1)}{1 + \tau_1} = \eta. \tag{13}$$

The term on the right hand side, according to equation (12) corresponds to the

[9] "Council Directive 92/83/EEC of 19 October 1992 on the harmonization of the structures of excise duties on alcohol and alcoholic beverages"

pass-through of excise tax (η). The underlying assumption of HICP-CT is full and instantaneous pass-through and therefore $\eta = 1$, which means $\frac{P_1 - P_1^{ct}}{(1+\tau_1)\Delta t} = 1$ should hold. Computing this ratio for all the countries and for all those periods where the difference between HICP and HICP-CT is induced based on a single excise tax change reveals that for none of them the ratio $\frac{P_1 - P_1^{ct}}{(1+\tau_1)\Delta t}$ equals one. This implies that our set of excise tax rates should be re-scaled and we use this ratio for this purpose.

The term $\frac{P_1 - P_1^{ct}}{(1+\tau_1)\Delta t}$ in a period with an excise tax change (Δt) and a fixed value of VAT rate (τ_1), captures the relationship between the variations of excise tax (measured either by hecto liter per degree alcohol or hecto liter degree Plato) and the price index which can be used as a weight in each country to re-scale the excise tax rates and prepare them for estimations, using harmonized index of consumer prices.

Finally, note that, for all periods in which a member state had already adopted the Euro as the national currency, all excise tax rates were converted into pre-existing national currencies using the irrevocably fixed conversion rates to assure consistency across time.