Tax Policy Changes and Market Prices

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I dedicate this work to my father, who wished to read my thesis.

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Abbreviations

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BTM	Business Tax Multiplier
CAPM	Capital Asset Pricing Model
CDC	Centers for Disease Control and Prevention
EC	European Commission
ECONFIN	The Economic and Financial Affairs Council
EEC	European Economic Community
EU	European Union
FRED	Federal Reserve Economic Data
FSE	Frankfurt Stock Exchange
HICP	Harmonized Index of Consumer Prices
HICP-CT	Harmonized Index of Consumer Prices at Constant Tax Rates
LBT	Local Business Tax
NAICS	North American Industry Classification System
OECD	Organisation for Economic Co-operation and Development
VAT	Value Added Tax

Chapter 1

Introduction

1.1 Motivation and review

The incidence of tax changes has long been a principal concern of public economists and policy makers. The interest, broadly considered, stems from the fact that tax policy changes, similar to other cost shocks, affect the economy's existing equilibrium and can potentially change market price ratios, factor rewards and the distribution of economic welfare (Kotlikoff and Summers (1987)).

This thesis provides empirical evidence for the impacts of tax changes onto market prices from different angles: pass-through of consumption taxes, stock market share price responses in light of corporate tax reforms, and finally how cross-country consumption tax differences translate into production inefficiency and affect relative producer price ratios between final consumption and intermediate sectors.

One of the seminal principles in public finance is tax incidence equivalence, which states that the burden of a unit tax is not dependent on who actually pays the tax, sellers or buyers, and the relative tax burden will solely depend on the relative elasticities of supply and demand (Ruffle (2005) and Morone, Morone and Nemore (2017)). Considering the fact that the actual burden of taxes is not necessarily born by whom they are levied upon, economic incidence varies from statutory incidence as

changes in taxes can result in behavioral responses and correspondingly changes in equilibrium prices.

Neoclassical economic theory allows for such behavioral reactions of individuals as if they would fully internalize the respective effects of tax policy changes (Harberger (1962)). One key principle of this theory is that preferences are consistent over time and solely affected by the reward one could earn. Moreover, based on this framework, behaviors are not impacted by the external environment and how decisions are made.

Limitations of this approach have been argued by several studies. For instance, Biswas et al. (1993) and Krishna et al. (2002) discuss that the way prices are communicated to individuals might systematically impact their reactions to changes, which then deviate from those expected based on the neoclassical theory results, that indicate individual's responses to price changes should not depend on how prices are framed.

The underlying idea of price-framing has well been discussed in the incidence studies related to tax salience, which distinguishes between the tax-inclusive and tax-exclusive prices. Chetty, Looney and Kroft (2009) showed that consumers are not fully aware of the tax burden. By conducting a field experiment in a grocery store, they indicated that those products whose both prices, inclusive and exclusive of the sales tax, are shown on the shelves to customers will have a lower demand in comparison to the control group, whose tax-exclusive prices are presented to customers. This suggests that the behavior of individuals can indeed be affected with the external environment by showing that individuals can better perceive the burden of taxes when they are more salient.

A long strand of literature has been developed to study the impacts of tax changes onto market prices both from a theoretical and an empirical perspective. See Fullerton and Metcalf (2002*b*) for an overview. This paper categorizes theoretical incidence studies based on different approaches of partial versus general equilibrium towards tax incidence

and distinct groups of tax payers.

Legislative changes occur all the time and with the advancement of econometric methods and their applications over the last decades as well as a better data availability, they create a suitable laboratory to view tax incidence from different empirical angles. For instance, see Doyle Jr and Samphantharak (2008) for an assessment of changes in sales taxes onto US gas prices, Luo and Tang (2014) study the incidence of carbon tax changes onto the market, among many other examples.

Most of these studies are conducted based on a before-and-after analysis by exploiting the behavior of treatment versus control group over time. Sandler and Sandler (2014) argue how event studies have migrated from the finance literature into applied microeconomics and provide an overview on how methods such as Differences-in-Differences can be used to measure the average effect of an event on an outcome variable (Also see Goodman-Bacon (2018) and Agrawal and Hoyt (2018) for several use cases and methodological insights).

Studies included in this dissertation assess the effects of tax policy changes/differences onto prices, from different perspectives. The rest of this chapter summarizes the main findings of these papers and discusses the implications of each. Chapter 2, focuses on the topic of sin taxation and examines how changes in sales taxes (both ad valorem and excise) affect consumer prices and the market, in general. Chapter 3, takes an asset price approach and assesses the impacts of a corporate tax reform on the German stock market. Chapter 4, uses a more aggregate view towards prices and price changes and investigates whether differences in consumption taxes among EU-member states and, as a result, producer price ratios, cause distortions in the vertical structure of the economy.

1.2 Chapters and main findings

1.2.1 Tax Pass-through in the European Beer Market

How does changes in consumption taxes affect consumer prices? A key area of studies in tax incidence has been focused on the topic of sin taxation, which mainly considers the corrective role of taxes on goods whose consumption is associated with externalities, such as adverse health effects. Over the past years, the importance of consumption taxes for policy makers has considerably increased since this still remains as one of the major reasons of death[1]. The effectiveness of consumption taxes, however, depend on a number of factors and it is important to figure out how the actual burden is distributed between consumers and producers.

I compare the pass-through of specific beer excise taxes and ad valorem value added taxes (VAT) in a cross-country study using a panel of monthly data from 1996 to 2016 of all current 28 EU member states. As oppose to several empirical studies providing evidence on tax pass-through, which only exploit time variation within a specific country (see Carbonnier (2013) and Bonnet and Réquillart (2013) that study the case of excise taxes and VAT reforms in France, Bergman and Hansen (2016) provide evidence of the excise tax pass-through using Danish data, and Benzarti et al. (2017) discuss the Finish case of VAT changes, among others), my large sample of countries allows considering the general validity of the results.

I find that VAT is under-shifted at a rate of approximately 70% while 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. The difference between the two tax pass-through rates points towards the importance of imperfect competition in the European

[1] According to reports by Centers for Disease Control and Prevention (CDC), alcohol consumption and related diseases remain as the third most prevalent causes of death in the US.

beer market.

In addition, we differentiate between the pass-through of tax increases and decreases and show that excise tax increases are passed through faster and at a higher rate than excise tax decreases. The results, however, are mixed in case of VATs, as the coefficients are not statistically significant in tax decreases, which might have to do with the low number tax decreases than increases.

1.2.2 Does capital bear the burden of local corporate taxes? Evidence from the 2008 tax reform in Germany

This study takes an asset price approach to analyze the incidence of local corporate taxes. I build on several strands of literature which study the share price responses to policy changes (see for instance, Summers (1985), Cutler (1988) Lang and Shackelford (2000), Knight (2006), and Ohrn and Seegert (2019), among others). The key idea of the asset price approach maintains that the tax incidence corresponding to a tax change should be immediately reflected in asset prices once the decision to change the tax occurs.

Since the seminal work of Fama et al. (1969) on the stock price adjustments following new information, various studies have been developed to assess the impacts of *events* onto the stock market. From a methodological perspective, most of these studies employ abnormal returns, which are measured in form of residuals/prediction errors according to a benchmark model of normal returns, such as the market model (Binder (1998)). At a later stage, these market clean returns are used in a regression against dummy variables, which characterize the event timing, to parameterize the effect of an event. Over the years, the framework for market model has been developed based on the CAPM, which only takes the effect of market premium into consideration, to 3-4 factor models that also

account for other market characteristics (Fama and French (1993) and Carhart (1997)).

I consider the corporate tax act of 2008 and define the event as when public announcements on legislations made it clear that the reform will pass. The key to my identification strategy is to exploit differences of local business tax rate (LBT thereafter) across different German municipalities, which has elements defined either at the federal or municipal levels. While the tax reform also affected the structure of LBT, the change in the federal base factor affected municipalities at different intensities due to differences in the existing local business tax multiplier, which is determined at the municipal level. I exploit this variation by dividing firms into high-tax and low-tax groups based on the level of corporate tax rate which is applicable to each firm and use a Differences-in-Differences framework through an event study design to capture the impact. Given the close sequence of dates for public announcements, I consider a monthly framework to have sufficiently broad definition of the event time. Additionally, I map this data against stock market performance of publicly traded firms on the Frankfurt Stock Exchange.

As discussed, the tax reform did not only affect the base factor, but had other implications in terms of LBT deductibility and the definition of tax base. Additionally, general equilibrium effects can create a reverse effect than what would be caused solely by a change in the base factor. Overall, the reform seems to have reduced the tax base of the local corporate tax, which in turn should have favored firms facing a higher local tax rate.

Empirical findings indicate that a percentage point increase in the local corporate tax rate is translated into a positive impact onto market-clean abnormal returns. This indicates that local corporate taxes matter for firm valuation and the incidence of local corporate taxes, therefore, is at least partly born by firm owners. Consequently, my results support the conclusion that the tax base effect did overcompensate the tax rate

effect and this can explain why high tax firms fare better as a result of the tax reform decision. The empirical analysis is done by considering a window of 12 months around the event time and assessing the behavior of abnormal returns in excess of the market momentum. To also confirm the validity of the event time identification, I consider placebo-event regressions and capture no statistically significant impact in the given window.

1.2.3 VAT Differentials in the EU, Cross-border Shopping, and the Vertical Distortion of Production

This study takes a more aggregate view towards market prices and studies how differences in cross-country value added tax rates can create production inefficiency.

Sales tax differences across borders have implications for both consumers and producers and can result distortions in either sectors (Agrawal (2015)). Sinn (1990) argues that the particular design of the EU VAT regime generates a situation in which productive efficiency will typically not occur. According to his argument, the possibility of cross-border shopping implies that member states with relatively low (high) VAT rates expand their consumption (intermediate) goods sectors at the expense of the intermediate (consumption) goods sectors.

Given that the EU is still characterized by considerable differences in the VAT rates regardless of continues efforts to create harmonization across countries, I provide empirical evidence for Sinn's argument by investigating whether differences in the value added tax rates across EU borders have different implications for final consumption versus intermediate sectors. Figure 1.1 illustrates the standard tax rates across the EU, as of 2019.

I refer to a sample of around 4.6 million firms in 10 neighboring Eu-

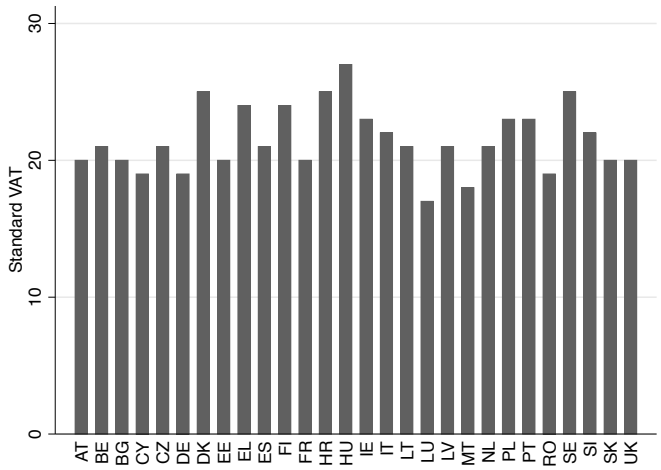

Figure 1.1: Value added taxes across EU as of July 2019
Source: European Commission database.

ropean countries and employ a Differences-in-Differences framework to compare impacts across the two sectors of final consumption versus intermediate goods. To do this, I divide the countries into two groups based on their exposure to the possibility of cross border trade by considering the share of border areas to the total area.

My results, to this end, show that changes in the relative VAT rates between member states have a differential impact onto firms in the consumption and the intermediate sectors, in line with the vertical distortion of production and, additionally, these impacts seem to be stronger in both sectors for the smaller countries. Accounting for border size in the framework enlarges these effects further. I also capture the same direction of conclusion by running a descriptive analysis using country-level producer price ratios of final consumption versus intermediate sectors and assess their long-term behavior against VAT for each country relative to its neighbors. This again suggests that, in fact, cross-border shopping is likely driving this distortion and provides an additional argument that

the EU member states should reinforce their efforts to further harmonize VAT tax rates across member states.

Chapter 2

Tax Pass-through in the European Beer Market[1]

2.1 Introduction

All 28 member states of the European Union (EU) levy specific excise taxes as well as value added taxes (VAT) on the consumption of beer. This parallels the practice in many other countries that also apply a mix of specific and ad valorem taxes on beer.[2] 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 EU member states over the time period from 1996 to 2016.

Our study provides several contributions. First, we provide evidence

[1] This chapter is based on a joint work with Sebastian G. Kessing published in Empirical Economics (2019). We would like to thank David Agrawal, William Hoyt, David Wildasin, participants of the 73rd annual congress of the IIPF (2017) and seminar participants at the University of Kentucky, and an anonymous referee for their helpful comments. The usual disclaimer applies.

[2] Some countries also levy ad valorem excise taxes either instead of, or in addition to, specific excise taxes, as well as general consumption ad valorem taxes, such as the VAT or general sales taxes. In the 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 refrain from ad valorem excise taxes.

of pass-through rates of indirect taxes on beer in the EU. While there is substantial evidence regarding the pass-through rates of alcoholic beverages in the United States (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.[3]

Second, we compare pass-through rates of specific excise taxes and of ad valorem value added taxes on beer prices. Under perfect competition, theory predicts that the pass-through of specific and ad valorem taxes should be equal, while under imperfect competition they typically differ (Keen (1998), Myles (1996), Anderson, De Palma and Kreider (2001*a*), Delipalla and Keen (1992)). These theoretical approaches conclude that the pass-through rates of specific taxes should exceed those of ad valorem taxes under imperfect competition. Intuitively, with ad valorem taxes the government receives a share of firms' gross revenue. Thus, each firm has to share the benefits of its ability to affect prices with the government. This reduces firms' incentives to increase prices in comparison to the case of specific taxes, which in turn results in lower pass-through rates. As a corollary, ad valorem taxes Pareto-dominate specific excise taxes under imperfect competition, see Denicolò and Matteuzzi (2000), Anderson, De Palma and Kreider (2001*a*) and Anderson, De Palma and Kreider (2001*b*). For the same amount of government revenues, prices are set at a lower level with ad valorem taxes implying higher consumer surplus.[4]

[3]Theoretical approaches that allow for imperfect competition can explain such over-shifting, see Weyl and Fabinger (2013). More recently, Agrawal and Hoyt (2018) have developed a perfect competition framework which also allows, under certain considerations such as small markets, overshifting of indirect taxes.

[4]Note that these theory findings can potentially be reversed, if firms have multiple

However, excise taxes may have an advantage if the tax is thought to be corrective and the excise directly targets the externality, such as alcohol content, see Bonnet and Réquillart (2013). Such considerations are less important in the case of beer since alcohol content is closely related to the quantity of beer itself.

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. This approach is similar to incidence studies in the US considering cities and states, 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). 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 rates have been estimated exploiting the time variation of within-country data. Carbonnier (2013) and Bonnet and Réquillart (2013) study the case of excise taxes and VAT reforms in France, while Bergman and Hansen (2016) provide evidence of the excise tax pass-through using Danish data, and Benzarti et al. (2017) discuss the Finish case of VAT changes. 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, we focus on price developments in member states where taxes change relative to other member state where taxes remain constant.[5]

products, see Hamilton (2009). Given that many consumption goods, including beer, are primarily sold via multi-product retailers, the potential difference between specific and ad valorem tax pass-through rates even under imperfect competition may be considered ambiguous a priori, and needs to be assessed empirically.

[5]Note that we do not discuss and compare the salience of different taxes, similar to Chetty, Looney and Kroft (2009), since it is unlikely that salience plays an important role in the European context. Unlike in the U.S., prices in Europe are always labeled tax inclusive for the consumer, i.e., neither the tax component nor

In comparison to the US, beer markets of EU member states were traditionally more segmented at the consumer level, in particular with respect to the leading brands that dominate in each market. However, Fertő and Podruzsik (2016) document that member states' exports and imports have been growing dynamically, with the value of member states' imports and exports roughly doubling from 2000 to 2010. Moreover, several member states (Czech Republic, Denmark, Germany, Ireland, The Netherlands) have been important beer exporters for a long time, whereas other member states (Greece, Italy, Spain, Sweden, United Kingdom) are major importers of beer. Moreover, market concentration on average is high and similar to the US (the exception being Germany, with a beer market characterized by fierce competition between regional, national, and international breweries). In 2013, the market share of the leading brewery ranged from 6.21% in Germany to 73.95% in Slovenia, with an unweighted EU average of approximately 37% (Loretz and Oberhofer (2016)). In the US, the leading firm had a market share of 45.6% in the same year (Marketrealist (2015)). As a consequence of large scale cross-border mergers and acquisitions in the beer industry over the last 25 years, key market players are often the same across member states, even though they may sell different brands in different member states.[6] As regards the demand side, Fogarty (2010) provides an overview of estimated elasticities of the demand for beer in various countries, including many EU member states. He concludes that little support exists for the idea that demand for alcoholic beverages varies fundamentally across countries, with only wine, but not beer, potentially being an exception. Finally, due to the Single Market, breweries' input markets have been fully integrated since

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the net price are indicated.

[6]In 2013, Carlsberg A/S was the biggest brewing company in five member states, SAB Miller also in five (In 2015 SAB Miller was taken over by Anheuser Busch InBev, which was the biggest brewing company in one member state in 2013.), Heineken NV in four, and Molson Coors Brewing Co in three, see Loretz and Oberhofer (2016).

1993.

Our analysis finds that excises taxes are almost fully shifted to beer prices, whereas ad valorem taxes (VAT) are shifted at a substantially lower rate of approximately 70%. These findings are robust to different specifications of our estimations. The difference suggests that imperfect competition plays a role in the European beer market, even though over-shifting does not occur. Excise tax increases are passed through faster and at a higher rate than excise tax decreases.

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 of 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.

Using European data, Benedek et al. (2015) estimate 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. Their results imply different effects for different VAT rates. For the standard rate, the accumulated effect of a tax change shows full-shifting. However, pass-through rates for reduced rates were only around 30%, and even zero for reclassifications. 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 the beer market, where the standard rate applies, the VAT pass-through rate is substantially below unity.

The next section sets out the conceptual framework. In Section 2.3 we describe our data and display the evolution of beer prices, beer consumption, the tax events, and macroeconomic conditions in selected member

states. We then provide our empirical approach and the estimation results in Section 2.4. Section 2.5 presents several robustness checks and extensions, and Section 2.6 discusses the results and provides conclusions.

2.2 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 us to derive the equations to be estimated in the case of VAT and specific excise taxes, respectively. We first discuss the VAT case and then consider excise taxes. In Section 2.4, we additionally consider a joint equation that includes both taxes.

2.2.1 Value added taxation

Define ϕ to be the consumer's share of the burden of an 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

$$\phi \equiv \frac{\frac{\partial P}{\partial \tau}}{\frac{\partial P}{\partial \tau}\Big|_{q=const}} = \frac{\frac{\partial q}{\partial \tau}(1+\tau)+q+t}{q+t} = 1 + \frac{1+\tau}{q+t}\frac{\partial q}{\partial \tau}. \tag{2.1}$$

Full pass-through of the VAT 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

$$P = (q^0 + mt)(1 + n\tau) \tag{2.2}$$

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 (2.2) we have $\frac{\partial P}{\partial \tau} = n(q^0 + mt)$. In addition, since $q = \frac{P}{1+\tau} - t$, we have $\frac{\partial q}{\partial \tau} = \frac{\partial P}{\partial \tau}\left(\frac{1}{1+\tau}\right) - \frac{P}{(1+\tau)^2}$. Plugging these into (2.1), 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

$$\phi = \left(\frac{P}{1+n\tau}\right)\frac{n(1+\tau)}{P} = \frac{n(1+\tau)}{1+n\tau}. \tag{2.3}$$

Equation (2.3) plays a key role in estimating VAT pass-through. Defining the operator $\delta_i(\tau) \equiv \tau_i - \tau_0$, where τ_i is 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 (2.2) 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

$$lnP_i = ln(1+n\tau_0) + ln(q_i^0 + mt_i) + ln\left(1 + \frac{n\delta_i(\tau)}{1+n\tau_0}\right). \tag{2.4}$$

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 (2.4) will be $\frac{n}{1+n\tau_0}\delta_i(\tau)$ so that

$$lnP_i = \underbrace{ln(1+n\tau_0)}_{term1} + \underbrace{ln(q_i^0 + mt_i)}_{term2} + \underbrace{\frac{n}{1+n\tau_0}\delta_i(\tau)}_{term3}. \tag{2.5}$$

This is the baseline for our VAT pass-through estimations. *Term 1* in equation (2.5) is a constant term while *term 2* comprises determinants of producer prices including the excise tax. *Term 3* is the tax-shifting term and its coefficient, according to equation (2.3), will be used to derive the VAT pass-through.

2.2.2 Excise taxes

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

$$\eta \equiv \frac{\frac{\partial P}{\partial t}}{\frac{\partial P}{\partial t}\Big|_{q=const}} = 1 + \frac{\partial q}{\partial t}. \tag{2.6}$$

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 (2.2) we have $\frac{\partial P}{\partial t} = m(1+n\tau)$. Together with equation (2.6) this gives the relationship between our measure of excise tax pass-through and the proxy variables

$$\eta = \frac{m(1+n\tau)}{1+\tau}. \tag{2.7}$$

Subsequently, with t_0 changing to t_1, given equation (2.2), 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

$$\Delta P = \underbrace{m(1+n\tau)\Delta t}_{term1} + \underbrace{(1+n\tau)\Delta q}_{term2}. \tag{2.8}$$

This is the second baseline for our estimation. In equation (2.8), *term 1* represents our tax shifting term and *term 2* includes all other controls. The coefficient of *term 1*, according to equation (2.7), determines the excise tax pass-through.

2.3 Data

We employ a monthly dataset from Jan-1996 to July-2016 which is comprised of VAT standard rates, beer excise taxes, macroeconomic variables, and member state level price indices (HICP hereafter), harmonized at

Table 2.1: Summary statistics and the number of tax rates

Variable	Mean	Std. Dev.	Min.	Max.	N
Beer(HICP)	83.393	14.56	5.2	112.4	6585
VAT rate	20.015	3.019	8	27	6842
GDP growth(%)	0.218	4.546	-41.1	27.02	6635
Unemployment rate(%)	0.09	0.044	0.017	0.279	6306
Inflation rate (%)	0.29	1.782	-4.04	123.09	6853
Transport(HICP)	84.298	17.709	2.03	116.88	6880
Energy(HICP)	77.408	23.267	6.59	127.12	6556
Number of tax changes			Increases	Decreases	Total
VAT			50	13	63
Excise tax			101	9	110

Notes: The upper panel presents summary statistics of our sample of 28 EU countries from *Jan-1996* to *July-2016*. The lower panel provides information regarding tax rate changes within these countries in the sample period. The reference year for all our price indices is 2015 (2015=100). GDP growth and unemployment are originally quarterly data.

the European level. Eurostat is the main source for all our price series.[7] Aside from beer prices, we use price indices of transport and energy as controls to account for possible variations of producer prices. Moreover, we use inflation, GDP growth and unemployment as further macroeconomic controls.[8] Table 2.1 provides summary statistics of our data as well information on the tax rate changes.

The webpage of the European Commission's Directorate-General Taxation and Customs Union offers detailed information on the evolution of VAT standard rates together with the respective dates of change for each member state.[9]

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

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

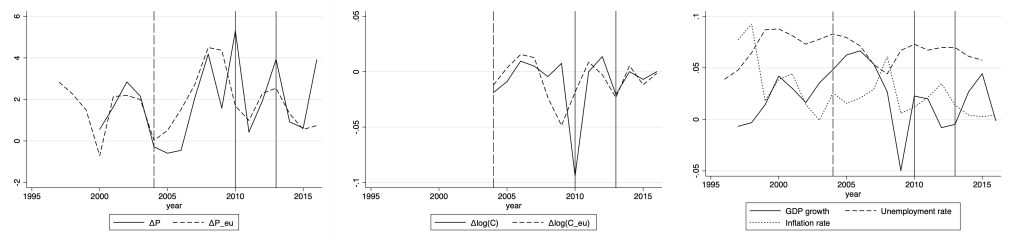
[8] The macroeconomic variables are taken from the Federal Reserve Economic Data (FRED). GDP growth and unemployment rate are of quarterly frequency.

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

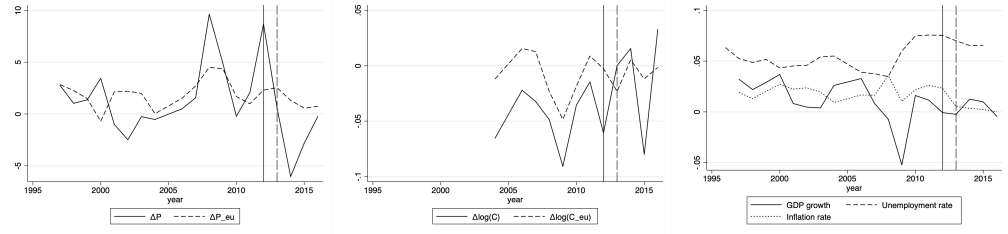
this information is not indicated in the table, especially during the 1990s. To overcome this issue, and to capture the correct month of change for each country, we additionally compile this information from the *Reform Database* of the European Commission. For the few cases where neither of the two 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 member state correspond to the price index of the same member state, see the Appendix for details.

Figure 2.1 displays the behavior of key variables over our sample period for four selected EU member states. For each of these, we provide three panels. The first panel displays the development of beer prices in the respective country and in the EU. We plot prices in first differences in line with our theoretical and empirical approach. The second panel shows the growth rate of per capita consumption in the member state and in the EU. The consumption data is at the annual frequency level and only starts from 2003, so that 2004 is the first observation for the growth rates.[10] Finally, the last panel provides the macroeconomic conditions in terms of GDP growth, inflation, and the unemployment rate in each country. Moreover, in each of the three panels we indicate tax increases by a solid vertical line, and tax decreases by a dashed vertical line. Further details about the nature of the tax changes are provided directly in the caption of Figure 2.1. The displayed data indicate that, in the absence of tax changes, beer prices and beer consumption of individual member states and the entire EU move broadly together. Following tax increases, prices increase relative to the EU and consumption decreases relative to the EU. Finally, the evidence regarding the relationship between macroeconomic conditions and tax changes is somewhat inconclusive from these graphs. We assess the latter aspect in Section 2.5.

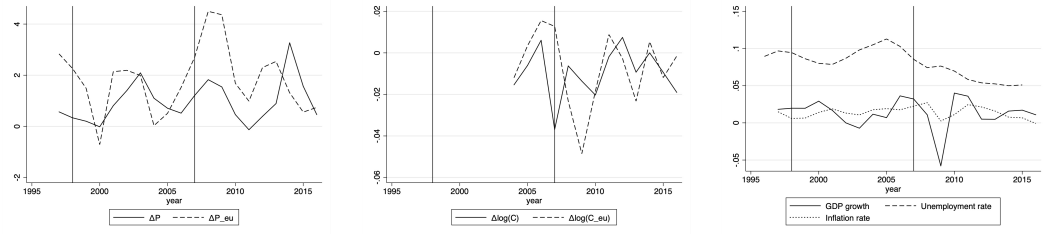
[10]The data is compiled from various issues of The Brewers of Europe (2016).



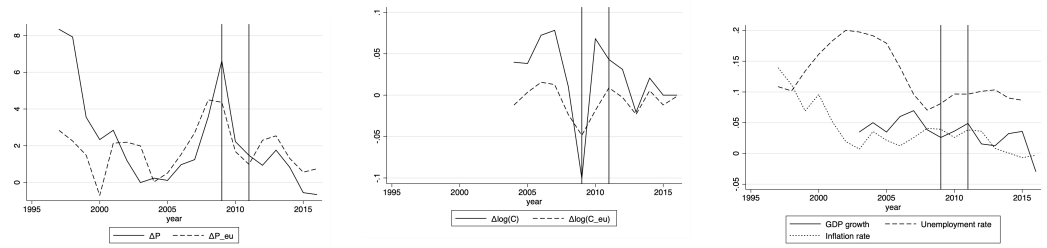
Czech Republic (CZ)



Denmark (DK)



Germany (DE)



Beer price | Beer consumption per capita | Macroeconomic variables

Poland (PL)

Figure 2.1: Beer prices, consumption, and macroeconomic variables.
Notes: Left panel: change in yearly beer price (in member state and the EU average). Middle panel: growth rate of beer consumption per capita. Right panel: macroeconomic variables. Solid vertical lines indicate tax increases (VAT or excise) and dashed vertical line show tax decreases (VAT or excise). Excise tax changes are, increase: CZ (2010), DK (2012 and 2013), PL (2009), and decrease: DK (2013). VAT changes are, increase: CZ (2010 and 2013), DE (1998 and 2007), PL (2011), and decrease: CZ (2004).

2.4 Empirical analysis and results

Based on equations (2.5) and (2.8), we estimate VAT and excise tax pass-through on beer prices. However, before estimating equation (2.5) all our series are tested for the presence of a unit root to avoid spurious regressions. Applying the Im-Pesaran-Shin test (Im, Pesaran and Shin (2003)) indicates 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

$$\Delta ln(P_{ci}) = \alpha_c + \alpha_i + \alpha_t + \gamma^1 \Delta ln X_{ci} + \gamma^2 M_{ci} + \sum_{j=-k}^{k} \beta_j^\tau \Delta \tau_{ci}^j + \varepsilon_{ci}, \quad (2.9)$$

where i and c refer to the month and member state, respectively. Moreover, α_c and α_i correspond to member states (not necessarily included) and time fixed effects, and α_t is a vector of dummies indicating changes in excise taxes. The set of cost controls, X_{ci}, comprises the indices of energy and transport cost. The macro controls, M_{ci}, are GDP growth, inflation and unemployment. The coefficients to be estimated are γ^1, γ^2 and β_j^τ. Moreover, k is the number of leads and lags for the tax change term. Thus, $\Delta\tau^j$ denotes the change in the VAT rate j periods ago (or ahead if j is negative). With $k = 1$, estimation of equation (2.9) provides a value for $\beta^\tau \equiv \sum_{j=-1}^{1} \beta_j^\tau$, which is the coefficient of the entire tax-shifting term. We consider a single lead and a single lag here, since the complete effect of the tax change may not occur contemporaneously within the same period.[11] We are interested in the VAT pass-through ϕ from equation (2.1), i.e. the consumers' share of the tax burden. Based on (2.3), 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 (2.9), the estimated pass-through is

[11] We discuss extensions to several leads and lags further below.

$$\hat{\phi} = \hat{\beta}^{\tau}(1 + \bar{\tau_0}), \tag{2.10}$$

where $\bar{\tau_0}$ is the average of τ_0 in all member states, i.e. the average VAT rate at the beginning of our sample period, and $\hat{\beta}^{\tau}$ is calculated from the estimation of equation (2.9). Finally, comparing equations (2.5) and (2.9), note that using the first differences is fully in line with our theoretical framework. For the first difference $\Delta\left[\frac{n}{1+n\tau_0}\delta(\tau_i)\right] = \frac{n}{1+n\tau_0}\left[\delta(\tau_i) - \delta(\tau_{i-1})\right]$. Subtracting the tax rate τ_0 yields the new tax shifting term $\frac{n}{1+n\tau_0}\Delta(\tau_i)$.

Similarly structured to equation (2.9), but directly based on (2.8), we estimate the following equation for the excise tax pass-through,

$$\Delta P_{ci} = \alpha_c + \alpha_i + \alpha_\tau + \gamma^1 \Delta X_{ci} + \gamma^2 M_{ci} + \sum_{j=-k}^{k} \beta_j^t \Delta t_{ci}^j + \varepsilon_{ci}, \tag{2.11}$$

where α_c and α_i again capture country and time fixed effects, respectively. In addition, α_τ is a vector of dummy variables to capture the impact of VAT rate changes. Potential controls are again the price indices of transport and energy in each member state in first differences, ΔX_{ci}, as well as the macro controls, M_{ci}, comprising GDP growth, inflation and the unemployment rate, and γ^1, γ^2 and β^t are the coefficients to be estimated, and k is the number of leads and lags for the tax change term. With $k = 1$, $\beta^t \equiv \sum_{j=-1}^{1} \beta_j^t$ is the coefficient of our tax-shifting term. Given equation (2.7), the coefficient of Δt corresponds to $\eta(1 + \tau)$, so that

$$\hat{\eta} = \frac{\hat{\beta}^t}{1 + \bar{\tau}} \tag{2.12}$$

indicates the consumers' share of the excise burden, where $\bar{\tau}$ is the average VAT rate across all periods and member states.

Equations (2.9) and (2.11) are created following the framework laid out in Section 2.2, and changes in the respective other tax are dummied out to address potential omitted variable bias. Additionally, given that

$\Delta log(P) \approx \%\Delta P$, we estimate the following regression that includes both taxes

$$\Delta P_{ci} = \alpha_c + \alpha_i + \gamma^1 \Delta X_{ci} + \gamma^2 M_{ci} + \sum_{j=-k}^{k} \beta_j^{\tau} \Delta \tau_{ci}^{j} + \sum_{j=-k}^{k} \beta_j^{t} \Delta t_{ci}^{j} + \varepsilon_{ci}, \quad (2.13)$$

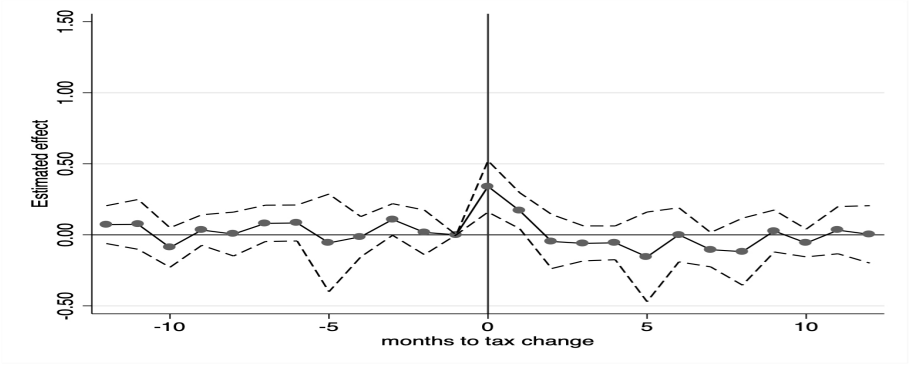
and we compare the corresponding results to those from equations (2.9) and (2.11).[12]

Subsequently, we extend our regressions (2.9), (2.11), and (2.13) by including 12 periods of lead and lag for the tax change, turning our approach into an event study design. The inclusion of lead terms allows to observe systematic price effects before tax changes, which may occur because firms are adjusting their prices beforehand. All of the lead and lag terms are interacted with the magnitude of the tax change, following the suggested procedure by Sandler and Sandler (2014) for events with different treatment intensity. Sub-figures *a* and *b* in Figure 2.2 correspond to equations (2.9) and (2.11). Additionally, sub-figure *c* depicts the event study graph related to equation (2.13). The month prior to the event is set as the reference period in all of these graphs.

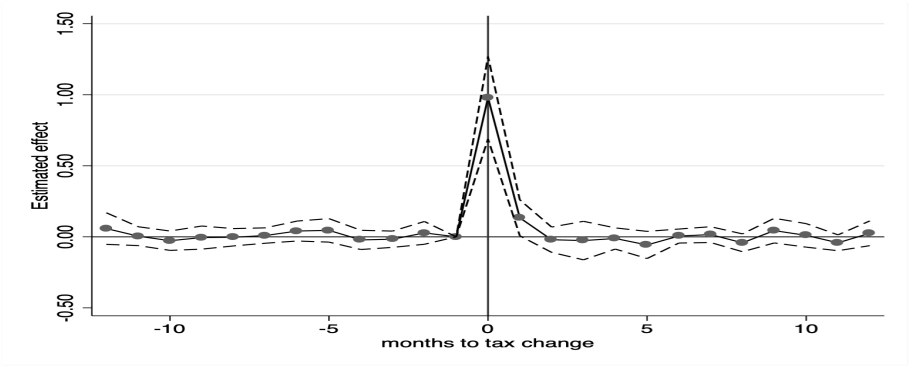
The event study sub-graphs in Figure 2.2 show that, for excise tax changes, the effects are concentrated in the first two months in which the tax change is implemented. For VAT changes, which are substantially less frequent, the effects are also concentrated in these first two months. Additionally, there are some preceding price increases, 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.

Table 2.2 summarizes our results of estimating different forms of equation (2.9). The dependent variable is the first-differenced natural log-

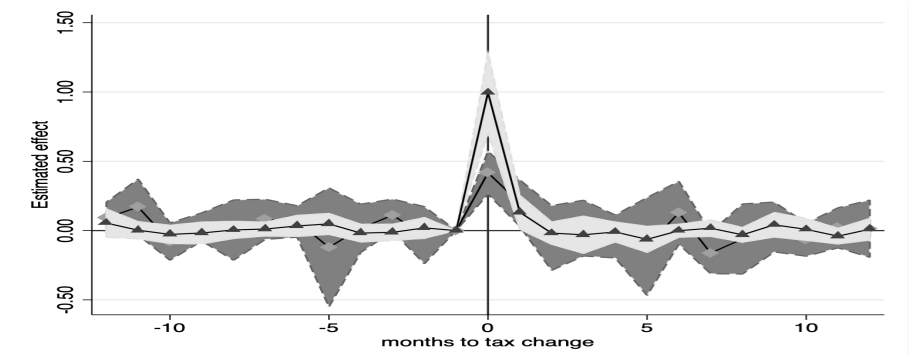
[12] We also extend equation (2.9) for the inclusion of both tax rates. The results (not reported) are very similar to those from estimating (2.13).



(a) VAT (equation 9)



(b) Excise tax (equation 11)



(c) Excise tax and VAT (equation 13)

Figure 2.2: Event study graphs

Notes: Sub-figure (a) shows the event study for VAT changes with twelve leads and lags. Sub-figure (b) displays the event study for excise tax changes. Sub-figure (c) corresponds to the event study with changes in both tax rates. All estimations include time and member state-fixed effects as well as cost controls. Estimations corresponding to (a) and (b) also include dummies for changes in the other tax. 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.

Table 2.2: 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) $\Delta ln(P)$	(8) $\Delta ln(P)$	(9) $\Delta ln(P)$
Δ VAT	0.380***	0.338***	0.341***	0.344***	0.344***	0.347***	0.348***	0.323***	0.317***
	(0.102)	(0.0891)	(0.0865)	(0.0887)	(0.0888)	(0.0878)	(0.0880)	(0.0846)	(0.0828)
Δ VAT$_{-1}$	0.130*	0.132*	0.162**	0.164**		0.163**		0.173**	0.166**
	(0.0716)	(0.0709)	(0.0611)	(0.0605)		(0.0600)		(0.0628)	(0.0617)
Δ VAT$_{+1}$	0.0204	0.0509	0.0789	0.0798		0.0807		0.0909	0.0868
	(0.0577)	(0.0553)	(0.0617)	(0.0610)		(0.0600)		(0.0629)	(0.0613)
macro controls								yes	yes
cost controls				yes	yes	yes	yes	yes	yes
excise tax D.			yes	yes	yes	yes	yes	yes	yes
time f.e.		yes	yes	yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes			yes	
adj. R^2	0.001	0.013	0.192	0.192	0.190	0.192	0.190	0.203	0.201
$\hat{\phi}_{EU}$	0.631	0.620	0.693	0.700	0.409	0.703	0.414	0.699	0.678

Notes: Robust standard errors in parentheses clustered at the member state level. In all regressions, the dependent variable is 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. Macroeconomic controls are GDP growth, inflation, and unemployment. The coefficients of inflation and unemployment are statistically significant in (8) and (9) with a positive sign and a negative sign, respectively. The subscript -1 corresponds to the month *after* the tax change. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

arithm of beer prices (HICP-beer). Standard errors are clustered at the member state level. Note that, in line with our notation above, the subscript -1 corresponds to the month *after* the tax change. As discussed in Section 2.2, and according to equation (2.10), our estimated VAT pass-through $\hat{\phi}$ is computed according to the estimated coefficients of the tax shifting term in (2.9), which are provided in the last row. Since the variables are first-differenced, we also consider an alternative version of (2.9) without member states fixed effects. Columns 6, 7 and 9 in Table 2.2 indicate the corresponding results, which are very similar to

Table 2.3: Excise tax pass-through across the European Union

	(1) ΔP	(2) ΔP	(3) ΔP	(4) ΔP	(5) ΔP	(6) ΔP	(7) ΔP	(8) ΔP	(9) ΔP
Δ Excise	0.977***	0.941***	0.930***	0.933***	0.931***	0.931***	0.930***	0.927***	0.924***
	(0.135)	(0.122)	(0.121)	(0.122)	(0.122)	(0.122)	(0.122)	(0.118)	(0.117)
Δ Excise$_{-1}$	0.128**	0.124*	0.121*	0.122*		0.121*		0.115*	0.113*
	(0.0608)	(0.0600)	(0.0602)	(0.0602)		(0.0589)		(0.0609)	(0.0593)
Δ Excise$_{+1}$	0.00474	0.0133	0.00997	0.0115		0.0109		0.0158	0.0150
	(0.0162)	(0.0136)	(0.0117)	(0.0121)		(0.0121)		(0.0130)	(0.0128)
macro controls								yes	yes
cost controls				yes	yes	yes	yes	yes	yes
VAT D.			yes	yes	yes	yes	yes	yes	yes
time f.e.		yes	yes	yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes	yes			yes	
adj. R^2	0.136	0.158	0.164	0.164	0.161	0.164	0.161	0.173	0.172
$\hat{\eta}_{EU}$	0.925	0.899	0.885	0.889	0.776	0.887	0.775	0.881	0.876

Notes: Robust standard errors in parentheses clustered at the member state level. In all regressions the dependent variable is the first-differenced beer HICP. $\hat{\eta}$ is our measure of tax pass-through, $\hat{\eta} = \frac{\hat{\beta_3}'}{1+\bar{\tau}}$ with $\bar{\tau} = 20.016\%$. Cost controls are the price indices of transport and energy. Macroeconomic controls include GDP growth, unemployment, and inflation. The coefficients of inflation and unemployment are statistically significant in (8) with a positive sign and a negative sign, respectively. In (9) the coefficient of inflation is positive and significant. The subscript -1 corresponds to the month *after* the tax change. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the estimates with member states fixed effects.[13]

The comparison of the contemporaneous VAT pass-through, in Columns 5 and 7 of Table 2.2, to the pass-through computed by including lead and lag terms, in Columns 4 and 6, again shows 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

[13]Using member states fixed effects, which imply member state-specific trends, corresponds to the diverse medium term macroeconomic developments across member states.

pass-through, according to Column 5, only implies a pass-through rate of around 40% to beer prices. The computed values of pass-through indicate under-shifting of beer prices with respect to VAT changes in the EU.[14]

Table 2.3 presents the results of estimating different forms of equation (2.11) for the pass-through of excise taxes where the dependent variable is the beer HICP in first differences. The standard errors are again clustered at the member state level. Based on equation (2.12) our measure of excise tax pass-through $\hat{\eta}$ is computed according to the estimated coefficients of the tax shifting term in (2.11), which are indicated in the last row. The $\bar{\tau}$ used in the calculation is the VAT average across all periods and member states. Similar to our VAT analysis, we allow for a single period of lead and lag of the tax change since the effect may not occur instantaneously. Moreover, we again estimate equation (2.11) without member state fixed effects. The corresponding results, which are very similar, are shown in Columns 5, 6 and 8 of Table 2.3.

The comparison of the contemporaneous excise tax pass-through, in Columns 5 and 7 of Table 2.3, 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 increase in the excise tax rate, according to Column 4, increases prices by around 90 percent while the contemporaneous pass-through according to Column 5, implies a 77 percent increase in beer prices.[15] Overall, the values of $\hat{\eta}$ under different specifications in Table 2.3 indicate that excise taxes are almost fully-shifted to prices.

[14]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.

[15]The inclusion of up to 6 or 12 leads and lags 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 2.4: Tax pass-through across the European Union

	(1) ΔP	(2) ΔP	(3) ΔP	(4) ΔP	(5) ΔP	(6) ΔP	(7) ΔP	(8) ΔP
Δ Excise	0.976***	0.941***	0.943***	0.940***	0.942***	0.940***	0.937***	0.935***
	(0.135)	(0.122)	(0.122)	(0.122)	(0.122)	(0.122)	(0.118)	(0.118)
Δ VAT	0.416***	0.379***	0.394***	0.398***	0.397***	0.401***	0.363***	0.359***
	(0.0738)	(0.0537)	(0.0639)	(0.0649)	(0.0634)	(0.0645)	(0.0628)	(0.0608)
Δ VAT$_{+1}$	0.0223	0.0510	0.0564		0.0590		0.0683	0.0694
	(0.0561)	(0.0577)	(0.0571)		(0.0567)		(0.0603)	(0.0585)
Δ VAT$_{-1}$	0.159*	0.181**	0.186**		0.189**		0.196**	0.195**
	(0.0780)	(0.0751)	(0.0772)		(0.0769)		(0.0798)	(0.0789)
Δ Excise$_{-1}$	0.124*	0.120*	0.121*		0.120*		0.113*	0.112*
	(0.0609)	(0.0600)	(0.0600)		(0.0587)		(0.0606)	(0.0591)
Δ Excise$_{+1}$	0.00837	0.0162	0.0177		0.0171		0.0217	0.0208
	(0.0175)	(0.0153)	(0.0156)		(0.0148)		(0.0165)	(0.0155)
macro controls							yes	yes
cost controls			yes	yes	yes	yes	yes	yes
time f.e.		yes	yes	yes	yes	yes	yes	yes
country f.e.	yes	yes	yes	yes			yes	
adj. R^2	0.142	0.163	0.163	0.160	0.163	0.160	0.172	0.171
$\hat{\phi}_{EU}$	0.711	0.727	0.758	0.474	0.768	0.477	0.747	0.742
$\hat{\eta}_{EU}$	0.924	0.898	0.902	0.784	0.900	0.784	0.892	0.889

Notes: Robust standard errors in parentheses clustered at the member state level. The dependent variable is the first-differenced beer HICP. ϕ and η are the pass-through rates of VAT and excise taxes, respectively. Their calculation follows the same procedures as in Tables 2 and 3. Cost controls are the price indices of transport and energy. The coefficients of inflation and unemployment are statistically significant in (8) with a positive sign and a negative sign, respectively. In (9) the coefficient of inflation is positive and significant. The subscript -1 corresponds to the month *after* the tax change. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.4 shows the results of estimating equation (2.13), where both of the tax rates are included. In all joint estimations the VAT pass-through rates are consistently lower than those of specific excise tax rates, and

they are under-shifted to prices.[16] This is also in line with the graphical evidence from Figure 2.2. Finally, the inclusion of macroeconomic controls hardly changes the estimated pass-through rates of VAT and excise taxes in all specifications, as is evident from Tables 2.2, 2.3, and 2.4. The substantial difference between the excise tax and VAT pass-through rates continues to hold.

2.5 Robustness and Extensions

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

Based on Figure 2.2, 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 estimations which only control for contemporaneous change of the other tax.[17] We therefore re-estimate equations (2.9) and (2.11) with the given structure but also dummy out the period after the tax change in the respective other tax. The results are provided in Columns 1 and 2 of Table 2.5 for the VAT pass-through, and in the same columns of Table 2.6 for the excise tax pass-through. The results are very similar to the benchmark estimates.

[16] A post-estimation F-test on the estimated coefficients of VAT and excise taxes in our encompassing specification (Column 3 of Table 2.4) rejects the hypothesis that these are equal at the one percent level.

[17] This issue does not apply to the joint estimation (equation (2.13)).

Table 2.5: 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*		0.208*		0.0551	
	(0.0739)		(0.118)		(0.0984)	
ΔVAT$_{+1}$	0.0796		0.0519		-0.0836	
	(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 clustered at the member state level. The dependent variable is the first-differenced beer HICP in logs. ϕ is the ad valorem tax pass-through measure, $\hat{\phi} = \hat{\beta}_3(1 + \bar{\tau}_0)$ 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 are the price indices of transport and energy. The subscript -1 corresponds to the month *after* the tax change. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Second, in the baseline model we estimate 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 be included in the analysis. 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 (2.9) for VAT and equation (2.11) for excise taxes. The results are provided in Columns 3 and 4 of Table 2.5 and Table 2.6, respectively. Pass-through

Table 2.6: 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*		0.122		0.144	
	(0.0618)		(0.0856)		(0.0854)	
ΔExcise_{+1}	0.0113		0.0287		0.0265	
	(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 clustered at the member state level. The dependent variable is the first-differenced beer HICP. η is the excise tax pass-through measure, $\hat{\eta} = \frac{\hat{\beta_3}'}{1+\bar{\tau}}$ 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 are the price indices of transport and energy. The subscript -1 corresponds to the month *after* the tax change. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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 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 2.5 and Table 2.6, 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.

We now turn to two further aspects, the asymmetry of tax pass-through, and the times in which tax changes occur, respectively. First, tax increases may be passed-through at a different rate or speed relative to tax decreases. Table 2.7 provides some mixed results for the VAT case. For the estimation using only the contemporaneous tax changes shown in Column 1, only the tax increase coefficient is significant, and it is substantially larger than the insignificant coefficient of VAT reductions. However, for the estimations using an additional lead and an additional lag, the results look somewhat different. The overall effect appears larger for the VAT decreases, and, in the case of the tax decreases, the lead and the lag are both significant, but the coefficient of the contemporaneous tax change is not. Table 2.8 provides more conclusive evidence for the case of excise taxes. These are passed-through at a slightly higher rate in case of tax increases relative to decreases. Moreover, the pass-through of increases is faster, occurring within the same month of the tax change, whereas the pass-through of tax decreases is spread out over the contemporaneous and the following month.

As a final point, we investigate whether tax changes occur at specific times. It is usually assumed in the tax pass-through literature that tax changes are exogenous. However, it may be argued that VAT or excise tax changes occur at particular instances. Both, excise taxes or VAT may be increased to balance the government budget, which, particularly in Europe with its relatively high level of welfare state provisions, is often driven by the dynamics of social spending. The latter typically arises in economic downturns, which by themselves may attenuate price dynamics.

Negative and positive tax changes

Table 2.7: VAT

	(1) $\Delta log(P)$	(2) $\Delta log(P)$	(3) $\Delta log(P)$
Δ VAT $^{+}$	0.384***	0.384***	0.385***
	(0.110)	(0.110)	(0.107)
Δ VAT $^{+}_{+1}$		-0.0198	-0.0211
		(0.0527)	(0.0517)
Δ VAT $^{+}_{-1}$		0.137**	0.137**
		(0.0635)	(0.0625)
Δ VAT $^{-}$	0.0865	0.0896	0.110
	(0.197)	(0.195)	(0.182)
Δ VAT $^{-}_{+1}$		0.347*	0.354*
		(0.193)	(0.198)
Δ VAT $^{-}_{-1}$		0.244**	0.242**
		(0.101)	(0.103)
country f.e.	yes	yes	
time f.e.	yes	yes	yes
cost controls	yes	yes	yes
excise tax D.	yes	yes	yes
adj. R^2	0.190	0.193	0.193
$\hat{\phi}^{+}_{EU}$	0.457	0.597	0.596
$\hat{\phi}^{-}_{EU}$	0.103	0.810	0.841

Table 2.8: Excise tax

	(1) ΔP	(2) ΔP	(3) ΔP
Δ Excise $^{+}$	0.990***	0.993***	0.988***
	(0.147)	(0.146)	(0.145)
Δ Excise $^{+}_{+1}$		0.0117	0.00772
		(0.0186)	(0.0192)
Δ Excise $^{+}_{-1}$		0.161	0.154
		(0.0978)	(0.0964)
Δ Excise $^{-}$	0.851***	0.852***	0.855***
	(0.200)	(0.200)	(0.200)
Δ Excise $^{-}_{+1}$		0.0125	0.0161
		(0.0214)	(0.0221)
Δ Excise $^{-}_{-1}$		0.0792***	0.0827***
		(0.0271)	(0.0279)
country f.e.	yes	yes	
time f.e.	yes	yes	yes
cost controls	yes	yes	yes
VAT D.	yes	yes	yes
adj. R^2	0.162	0.164	0.164
$\hat{\eta}^{+}_{EU}$	0.824	0.971	0.957
$\hat{\eta}^{-}_{EU}$	0.709	0.786	0.794

Notes: Robust standard errors in parentheses clustered at the member state level. The subscript -1 corresponds to the month *after* the tax change. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

Similarly, VAT or excise tax reductions may be used as counter-cyclical policy instruments to jump-start the economy in an economic slump. Thus, if the VAT changes were to occur at different times relative to the excise tax changes, this could bias the estimations and potentially explain the different pass-through rates, as well as the different findings for tax increases and decreases. Table 2.9 shows the result of regressing changes in the VAT and excise tax rates on GDP growth, inflation, and unemployment. These regressions include season-year fixed effects, since

Table 2.9: Tax changes and macroeconomic conditions

	(1) Δ Excise	(2) Δ VAT
GDP growth	-0.353	0.194
	(0.411)	(0.277)
Unemployment rate	0.0384	0.0276
	(0.235)	(0.0695)
Inflation rate	1.079	0.963
	(1.562)	(0.704)
season-year f.e.	yes	yes

Notes: Robust standard errors in parentheses clustered at the member state level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

tax changes are more likely to occur during particular times of the year. Neither for the VAT nor the excise tax changes, the results indicate any significant correlation. This provides some evidence that tax changes may not occur too systematically at particular times during which beer prices could be affected in particular ways through other channels, or in which the transmission from taxes to prices may be systematically different from "normal" times.

2.6 Discussion and conclusion

We investigate beer price responses to changes in specific beer excise taxes and VAT exploiting the tax and price variation in a panel of the 28 EU member states. The approach thus emulates the research design that has been used to estimate pass-through rates of indirect local and state taxes in the US. 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 excise tax pass-through rate is substantially larger, 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. Moreover, the pass-through of excise tax increases occurs faster and tends to be somewhat higher relative to the pass-through of excise tax decreases.

In our analysis we have compared the pass-through of ad-valorem VAT to the specific excise taxes on beer. It is important to realize that these taxes not only differ along the ad valorem versus specific tax dimension, but also with respect to the consumption goods for which they apply. An increase in VAT also affects other products, whereas an increase in beer excise taxes only affects other goods indirectly. In general, it should be easier to pass-on the tax increase to consumers in a situation where other consumption goods, including important substitutes, also experience a tax increase. However, it could be that monetary policy is not sufficiently accommodating to the VAT increase, so that part of the VAT increase is pushed back to workers. This could be an alternative explanation of the lower VAT pass-through rates observed, besides imperfect competition.

Our findings of differential pass-through rates of specific and ad valorem taxes can thus, with some caveats, be interpreted in the sense that imperfect competition plays an important role in the European beer market.[18] This is in line with the relatively high market concentration in many European countries. Moreover, concentration is, on average, lower than in the US, which can explain the somewhat lower excise tax

[18]In addition to the presented results we also estimated an equation where we interacted the market share of the largest firm in 2013 as provided by Loretz and Oberhofer (2016) with the tax changes. However, the coefficient of interest did not turn out significant. These results could, however, be just due to the particular, potentially ill-suited, concentration measure, or due to the fact that we did not have access to a time-varying concentration measure.

pass-through rates. 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 can raise higher tax revenues without reducing consumer surplus and without compromising public health concerns or other negative externalities originating from alcohol consumption.

2.7 Appendix: Re-scaling of excise tax rates

As reported by Eurostat, member states compute the harmonized indices of consumer prices separately and according to their national consumption basket. 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[19], 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 onwards. 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)).

We exploit the differences between the values of HICP and HICP-CT with an identical reference year (2015 = 100) relative to the value of effective tax change to identify the tax. 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 $P_1 - P_1^{ct} = m\Delta t(1 +$

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

$n\tau_1$). Rearranging and multiplying both sides by $\frac{1}{(1+\tau_1)\Delta t}$ gives

$$\frac{P_1 - P_1^{ct}}{(1+\tau_1)\Delta t} = \frac{m(1+n\tau_1)}{1+\tau_1} = \eta. \tag{2.14}$$

The term on the right hand side corresponds to the pass-through of excise tax (η). The underlying assumption of Eurostat's 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 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 hectoliter per degree alcohol or hectoliter degree Plato) and the price index which are used as a weight in each country to re-scale excise tax rates. Finally, for all periods in which a member state had already adopted the Euro as the national currency, all excise tax rates are converted into pre-existing national currencies using the irrevocably fixed conversion rates.

Chapter 3

Does capital bear the burden of local corporate taxes? Evidence from the 2008 tax reform in Germany[1]

3.1 Introduction

The incidence of corporate taxes is one of the classic questions in public finance. The seminal closed economy analysis by Harberger (1962) indicated that, under several reasonable assumptions, capital bears the entire burden of the tax in the long run. The theoretical literature has argued that this finding is largely reversed in open economies (Harberger (2008)), and even more so at the state or local level. A growing literature on place-based policies also argues that mobile factors of production such as capital or mobile workers will typically not bear the burden of local taxes and subsidies, see Kline and Moretti (2014) for an overview. Recently, Suarez Serrato and Zidar (2016), however, provided a model with heterogeneous firms and monopolistic competition where capital can bear the burden of local corporate taxes, and they estimate that capital roughly bears 30% of corporate taxes at the state level in the US.

[1]This chapter is based on a joint work with Sebastian G. Kessing, Salmai Qari, and Malte Zoubek. We would like to thank seminar participants of the 75th annual congress of the IIPF (2019) for their helpful comments. The usual disclaimer applies.

We study the tax incidence of the local business tax (LBT)[2], a tax levied on all incorporated as well as non-incorporated businesses by local governments in Germany. This provides a compelling institutional setting which is characterized by substantial taxation of business profits at the local level, where local tax rates have ranged from 10% to over 24%. Not only are these taxes quantitatively important, but there is also considerable tax rate variation among local governments. Moreover, capital mobility should be high in this context, given that individual jurisdictions are rather small in population and area, and since Germany is relatively densely populated, on average. The system of local corporate taxation in Germany therefore provides an excellent empirical laboratory to analyze the incidence of such taxes. Fuest, Peichl and Siegloch (2018) show that roughly half the burden of these local corporate taxes is shifted onto workers in the form of lower wages in Germany. Given that the tax may also be shifted upwards to suppliers of intermediate inputs, see Goolsbee (1998) for evidence that investment tax credits are shifted to supplier prices in the US, or to land owners via lower rents, or downwards to the firms' customers (consumers or customer firms), it remains an open question whether, and to what extent, capital owners bear the burden of corporate taxes at the local level.

We exploit the legislation of the 2008 tax reform in Germany to identify the incidence of local corporate taxes using an asset price approach, cf. Summers (1985), Cutler (1988) Lang and Shackelford (2000), Knight (2006), and Ohrn and Seegert (2019), among others. The key idea of the asset price approach maintains that the tax incidence corresponding to a tax reform should be immediately reflected in asset prices once the decision occurs. We apply this logic to local corporate taxes, arguing that changes in tax rates and the tax base should be directly reflected in the stock price of firms that are located, and thus potentially affected,

[2]The German LBT ("Gewerbesteuer") is also translated as "trade tax" in the literature.

in the jurisdiction where the change occurs. Systematic variations in stock market reactions of firms located in jurisdictions with different tax rates indicates that these taxes matter for the owners of these firms. At the heart of our strategy is thus the comparison of the behavior of stock market prices of firms as a function of each firm's location and its corresponding change in the liability to local corporate taxes in response to reform-induced changes.[3]

Due to the construction of the local tax rate and the design of the reform, the tax reduction was a function of the existing level of local taxes. Depending on each firm's location the reform resulted in a different tax reduction for each firm. Moreover, tax base changes of the reform affected firms differently depending on the prevailing local tax rate. A firm facing a high local tax rate benefits relatively more from a base reduction than a firm based in a low tax jurisdiction. Thus, focusing on local tax rates in 2007 allows us to compare the differential effects for the different treatment intensities induced by the tax reform decision. Furthermore, since the reform was decided at the federal level, the event time coincided for all firms. Finally, given that the decision to reform was at the federal level, the resulting differential effects on local tax levels can be largely seen as exogenous.

As we describe in detail in Section 3.2, the 2008 tax reform affected firms in several ways. First, the reform reduced corporate tax rates, but this reduction was a function of the existing local tax rate, where the

[3]Similar to Fuest, Peichl and Siegloch (2018), we exploit differential effects of local corporate taxes across local governments. While local tax rates change substantially over time, we do not focus on the effects of these individual tax changes by individual local governments over a range of years. Since we employ a financial market event study research design, a clear definition of the event time is necessary. However, the timing and the communication of the decentralized decisions by local governments to change local tax rates are rather in-transparent. Thus, while the data on the actual tax rates and changes for any given year are available, it is typically not possible to collect information on the local decision to change tax rates at the local level over several years with the necessary precision with respect to the event time.

tax reduction was slightly larger for firms located in low tax jurisdictions. Moreover, the reform changed the definition of the tax base. Overall, the reform seems to have reduced the tax base of the local corporate tax. This should have favored firms facing higher local tax rates. We are agnostic a priori about which effect should be dominant, and our main interest is to determine whether the incidence of local taxes can fall on capital owners or not. Finally, note that potentially opposing effects of the tax rate and tax base changes could, in principle, offset each other.

Our results indicate that local corporate taxes matter for firm value. We find that stocks of firms facing higher local corporate tax rates perform substantially better than those firms facing lower taxes. Thus, local corporate taxes matter for the value of firm owners. For the German 2008 tax reform, we show that the differential tax base effects due to differences in local tax rates dominates the tax rate effects of smaller tax rate reductions in high tax jurisdictions. The latter effect is rather small given the small differences in tax reductions as a function of the prevailing tax rate before the reform. This can be traced back to the efforts of policy makers to balance tax reductions relatively evenly across local governments. Our analysis confirms the findings of Suarez Serrato and Zidar (2016), who also argue that firm owners partially bear the burden of state level corporate taxation, but our empirical results go beyond that by showing the existence of such incidence effects on firm owners at the local level.

In Section 3.2 we describe the institutional setting and explain in detail how the 2008 tax reform changed the definition of the tax base of local corporate taxes, and how the expected tax rates changes were a function of the prevailing local tax rates. Section 3.3 describes the data and provides some descriptive analysis. We explain our identification strategy, the corresponding econometric frameworks, and the results in Section 3.4. In Section 3.5 we discuss our findings and conclude.

3.2 Institutional setting

3.2.1 The local business tax in Germany

The LBT is levied on all incorporated and unincorporated businesses, with different rules applying to different legal forms. Given that we focus on publicly traded firms, only the rules for incorporated businesses matter for our analysis. Corporate businesses are subject to the federal corporate tax and the LBT.

The LBT is a tax on firm profits that operate an establishment in a given municipality. The tax base is determined at the federal level and does not depend on the municipality. It largely corresponds to the tax base of the federal corporate income tax, but is corrected by several additions and deductions. Interest payments, which are fully deductible from the federal corporate tax base, are partly added to the tax base of the local tax. Similarly, other financial payments such as leasing rates are also partly added to the tax base. For firms that operate more than a single establishment the total tax base is apportioned to the municipalities, where at least a single establishment of the firm is located, according to their share in the total wage bill of the firm.

The LBT rate in municipality i in year t, denoted by τ_{it}^{g} results from the multiplication of the federally determined base factor ("Gewerbesteuermesszahl") b_t, which is the same for all local governments, and the locally determined tax multiplier m_{it} ("Hebesatz"), such that $\tau_{it}^{g} = b_t m_{it}$. The federal base factor had always been constant before the 2008 reform. Local governments can change their local multiplier at a yearly frequency, and thus determine the overall tax rate. In the sample of headquarter municipalities, which we use in our analysis, roughly 8% of the local governments change their tax rate in any given year, on average.

3.2.2 Main Changes of the tax reform 2008

The 2008 tax reform was a major tax reform in the history of the Federal Republic of Germany. Given the difficult economic situation in the early 2000s in Germany, the reform was aimed at reducing the tax burden on firms and investors to complement fundamental labor market reforms that were legislated between 2003 and 2006. In terms of the effective marginal and effective average tax rates, the reform moved Germany from being one of the OECD countries with the highest tax rates to a more average position. The reform not only changed the federal corporate tax and the LBT, but also addressed personal income taxes, in particular by moving towards a dual income tax for labor and capital income. Moreover, the reform also changed the determination of tax bases, of the federal corporate tax and the LBT. Changes of the personal income tax became effective in 2009, the changes in corporate taxation in 2008.

At the level of personal income taxation, the reform introduced a variant of dual income taxation. Before the reform, 50% of dividend income and realized capital gains were taxed at the personal income tax rate plus the solidarity surcharge. The top marginal tax rate in Germany in 2007 was 45% for yearly income above 250,000 EUR plus "solidarity surcharge", an additional tax factor of 5.5% of the tax liability, which was introduced in 1994 to finance the cost of German reunification. After the reform, capital income was taxed at 25% plus solidarity surcharge.[4]

For corporate businesses the main changes of the tax reform 2008 where as follows. Starting from 2008, the federal corporate tax rate was lowered from 25% to 15%. Before and after the reform the federal corporate tax was subject to the solidarity surcharge. Thus, the actual

[4]Given that there is no strict separation of state and church in Germany, there is an additional surcharge for registered members of religious congregations, which is deductible from the personal income tax base. The corresponding tax rate depends on the state of residence and may be cut above a certain income level. This surcharge applied before and after the reform.

total federal rate was reduced from $25\% + (5.5\% * 25\%) = 26.375\%$ to $15\% + (5.5\% * 15\%) = 15.825\%$. Finally, the base factor of the local business tax was changed from 5% to 3.5%, and this tax was not subject to the solidarity surcharge.

The reform also affected the effective tax rates via deduction possibilities. Before the reform, the LBT could be deducted from the tax base of the federal corporate tax. This was no longer the case after the reform. Moreover, before the reform, the LBT was also deductible from its own base, which was not the case after the reform. Altogether these measures implied a substantial reduction of the combined (federal plus local) statutory corporate tax rate. Moreover, the reduction was larger for firms based in low tax municipalities, mostly due to the fact that the local corporate tax rate could no longer be deducted from the federal corporate tax base. The effective total corporate tax rate (as a function of location) before the reform (indicated by the subscript $t = 0$) was given by

$$\tau_{i0} = \frac{\tau_{i0}^g}{1+\tau_{i0}^g} + \tau_0^f \left(1 - \frac{\tau_{i0}^g}{1+\tau_{i0}^g}\right)(1+s) = \tau_0^f (1+s) + \frac{\tau_{i0}^g}{1+\tau_{i0}^g}\left[1 - \tau_0^f (1+s)\right],$$

where the superscripts g and f indicate the local and federal tax rate, respectively. s is the rate of the "solidarity surcharge", and $\tau_{it}^g = b_t m_{it}$, in which location is shown by i and time with $t = 0, 1$. After the reform (indicated by the subscript $t = 1$) the combined tax rate was changed to

$$\tau_{i1} = \tau_1^f (1+s) + \tau_{i1}^g.$$

In Figure 3.4, see also Figure 3.8 in the Appendix, we provide evidence that the years 2007, 2008, 2009, were characterized by relatively few local tax changes due to local governments adjusting their local multipliers. Thus, it seems reasonable that, at least approximately, the prevailing multiplier provides an obvious anchor for the expected levels of local

corporate taxation after the reform. Under the assumption that the local multiplier remains unchanged, i.e., $E[m_{1i}] = m_{0i}$, the expected tax reduction in absolute value, $D = \tau_0 - \tau_1$, is

$$D = C + \frac{\tau_0^g}{1+\tau_0^g}\left[1 - \tau_0^f\,(1+s)\right] - \tau_1^g. \tag{3.1}$$

where $C \equiv \left(\tau_0^f - \tau_1^f\right)(1+s)$ is the reduction of the federal corporate tax which is identical for all locations. Figure 3.1 plots $D\left(m_0^i\right)$ and the graph indicates that $D'\left(m_0^i\right) < 0$ for the values of m_0^i in our sample. The expected reduction in the effective local corporate tax rate is lower for high tax municipalities. Note that the tax reduction slightly changes at all locations (by 2.625 percentage points) if we additionally allow for the change in personal income taxation as explained above. The differential effect of the prevailing local tax rates on the expected tax rate changes is only slightly affected by taking this aspect into account.

The tax bases were also directly changed. With respect to the federal corporate tax, thin capitalization rules were introduced to reduce tax base shifting to foreign countries.[5] Importantly for our study, the reform changed the determination of the LBT base. Before the reform, 50% of the interest on permanent debt (i.e. debt with duration of more than one year) were added to the tax base of the local business tax, whereas after the reform, this figure was reduced to 25% of all debt. Moreover, there were new rules regarding the treatment of leasing rates and rents. Finally, in the context of the reform, Germany introduced the legal possibility to create real estate investment trusts (REITs), and allowed for tax preferred transfers of property from corporations to these newly created vehicles. This introduced the possibility to realize firms' hidden reserves in a tax-preferred way, i.e., bypassing local and federal corporate taxes.

[5]This thin capitalization rule consisted of a cap on tax deductibility of paid interest, for the local as well as the federal corporate tax. This cap was set to 30% of the earnings before interest, taxes, depreciation and amortization (EBITDA).

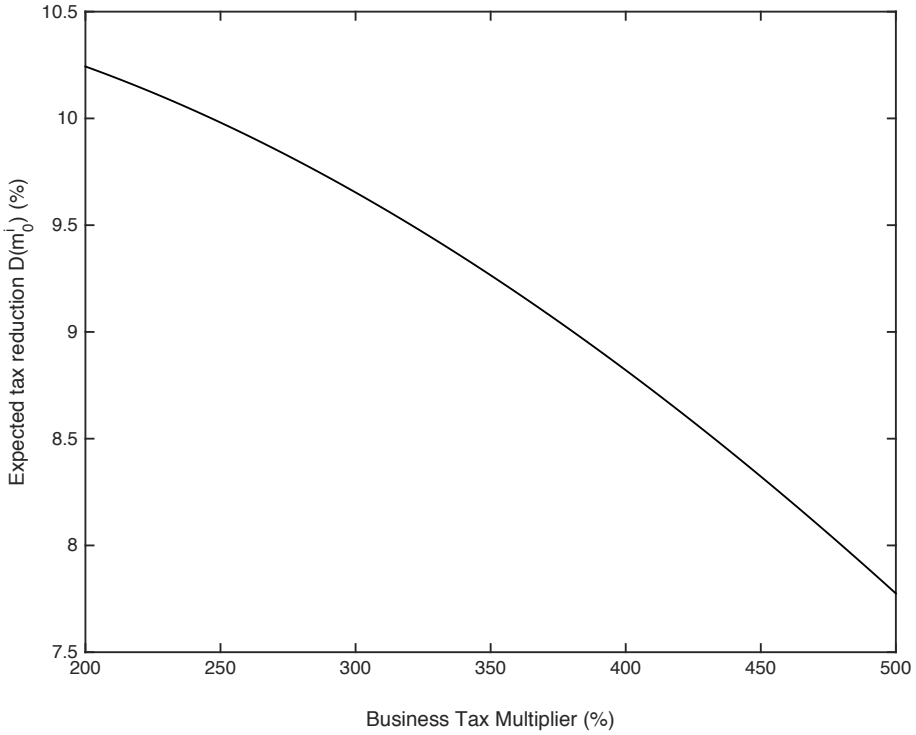


Figure 3.1: Expected corporate tax differential

Notes: Expected corporate tax differential (for constant local multipliers) $\tau_0 - \tau_1$ as a function of the local business tax multiplier. Values on both axes are in percentage points.

This constituted another measure that reduced the expected future tax base.[6]

While the potential net effect of these tax base measures were debated at the time of the reform, the available evidence supports the notion that the reform measures reduced the LBT base. Such a tax base reduction benefits firms in high tax jurisdictions more than their counterparts in low tax jurisdictions.

[6]The introduction of REITs followed their previous introduction in other European countries, in particular in France, where these vehicles had become very popular among investors. While not directly part of the tax reform legislation, the corresponding legislation was largely discussed in the context of the reform discussion. Moreover, the corresponding legislation was voted on the same day as the other elements of the tax reform.

3.2.3 Tax reform effects on firms' valuation

The valuation of a firm V depends on the firm's local tax liability T, $V = V(T), V'(T) < 0$, provided that firm owners actually bear the burden of local taxes.[7] Since the reform changed the corporate tax rates as a function of the location and changed the determination of the tax base of the local corporate tax, it is useful to decompose the change of a firm's tax liability in response to a tax reform that changes local tax rates as well as the tax base. Abstracting from the differences between the tax base of the federal and the local taxes, the tax burden of a firm with tax base B depends on its location and is given by $T = \tau_i B(\tau_i)$ so that $V = V(T(\tau_i, B))$. The base itself is a function of the tax rate τ_i and a measure of the strictness of the rules defining the tax base a. The tax base may be decreasing in the tax rate, because of real and tax shifting responses, $T = T(a, \tau_i) = \tau_i B(a, \tau_i)$. The total change of the tax liability in response of tax reform that changes the tax rate and the tax base is

$$dT = \left[B(a, \tau_i) + \frac{\partial B}{\partial \tau_i} \right] d\tau_i + \tau_i \frac{\partial B}{\partial a} da$$

Given that we want to exploit the differences in local tax levels we now consider the change in the tax liability, which affects firm valuation, as a function of the local tax rate. Therefore note that the change in the tax liability depends on the local tax rate

$$\frac{\partial [dT]}{\partial \tau_i} \approx \left[B(a, \tau_i) + \frac{\partial B}{\partial \tau_i} \right] \frac{\partial [d\tau_i]}{\partial \tau_i} + \frac{\partial B}{\partial a} da,$$

under the assumption that $\partial \left[B(a, \tau_i) + \frac{\partial B}{\partial \tau} \right] / \partial \tau_i \approx 0$. If we also neglect the effect of the tax rate on the tax base, i.e., $\frac{\partial B}{\partial \tau_i} = 0$, such that

[7] Note that this implies that we are in world in which the Johansson-Samuelson tax neutrality result regarding the valuation of an asset (the firm) does not hold, either because of depreciation and deduction rules, or because alternative investments are not subject to local taxation.

$\frac{\partial B}{\partial a} da = dB$ would be the entire change in the tax base, we can reformulate

$$\frac{\partial [dT]}{\partial \tau_i} \approx B(a, \tau_i) \frac{\partial [d\tau_i]}{\partial \tau_i} + dB = B \left[\frac{\partial [d\tau_i]}{\partial \tau_i} + \frac{dB}{B} \right].$$

This illustrates how the effect of the tax reform on the tax burden as a function of the locally prevailing rate can be decomposed into two principal effects, the tax rate and the tax base effect. These two effects could well offset each other, but as our empirical analysis below shows, this was not the case.

3.2.4 Timing of the reform

The tax reform followed a prolonged discussion that originally showed substantial involvement of academics, administrators, civil society actors and politicians. While the first key details on the envisioned reform were circulated as early as July 2006, there was a lengthy discussion between the involved policy actors. Given the German tradition of cooperative government and compromise, it is well known that "no piece of legislation leaves the parliament the same way it enters". Changes and amendments to proposed legislation are rather commonplace. Thus, for a substantial period of time there was uncertainty about the reductions in the federal corporate tax and the LBT, as well as on the tax base measures. Since the LBT is the most important source of revenue for local governments in Germany, politicians at the local level were concerned about potential losses of tax revenue. Moreover, given the federal nature of the German political system, the reform had to be agreed upon by the first (The Bundestag) and second chamber (The Bundesrat). The latter consists of the representatives of the state governments which in turn are fiscally closely connected to their local governments. Finally, the government was run by a center-right center-left coalition government. While the Minister of Finance (Peer Steinbrück) was from the center-left party,

the government was led by the Chancellor (Angela Merkel) from the center-right party. Thus, while the Ministry of Finance prepared the draft legislation, it was substantially disputed in the coalition and had to be agreed by the coalition government. The bottom line is that there was substantial uncertainty throughout the preparation and legislation process.

The first key date of the reform was July 12, 2006, when the "Corner-stones" ("Eckpunkte") of its proposed legislation were decided by the government. On February 1, 2007 the joint working party of the state and federal governments agreed on a draft legislation, and on February 6, 2007, the draft legislation was presented by the Ministry of Finance. On March 14, 2007 the government decided to propose the draft legislation to the parliament. On April 25, the Bundestag Committee on Public Finances publicly discussed the draft, and the Committee agreed on the proposal on May 23. The second chamber had provided its opinion already on May 11, along with some suggested changes to the draft legislation. The latter were agreed by the government on May 21. The Bundestag passed the reform on May 25. The Second Chamber passed the reform on July 6.

Given the complicated interaction of the actors within the federal and corporatist structures that characterize policy-making in Germany, it is challenging to define a particular breakthrough day, that could be used in an event study design. We therefore focus on monthly stock market returns similar to Asher and Novosad (2017), Wolfers (2006), Chen (2007), among others. Moreover, the key decisions in both legislative chambers took place in April and May 2007. While the implementation of the reform can be seen as a somewhat gradual process, it was becoming evident during April that the reform was going to pass in its final form. Therefore, we focus on this month as our event time.

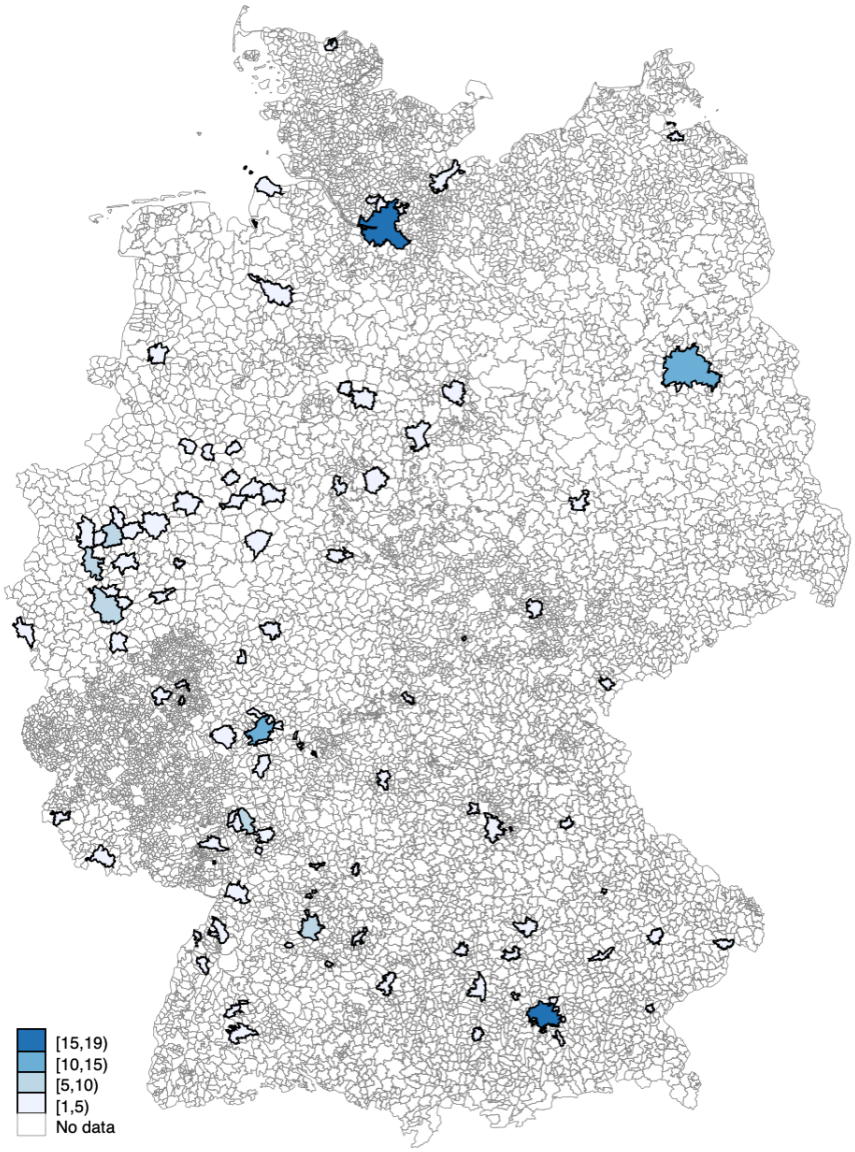


Figure 3.2: Distribution of Headquarters across German municipalities

Notes: The map shows those municipalities where at least one firm headquarter was located along with classes of the absolute number of firms at the respective location. *Source:* Own calculations based on Hoppenstedt and Amadeus.

3.3 Data and descriptive analysis

Our sample of publicly listed firms correspond to all firms that comprise the composite German stock market index (CDAX) on the Frankfurt Stock Exchange (FSE), which meet the ”prime standard” requirement.

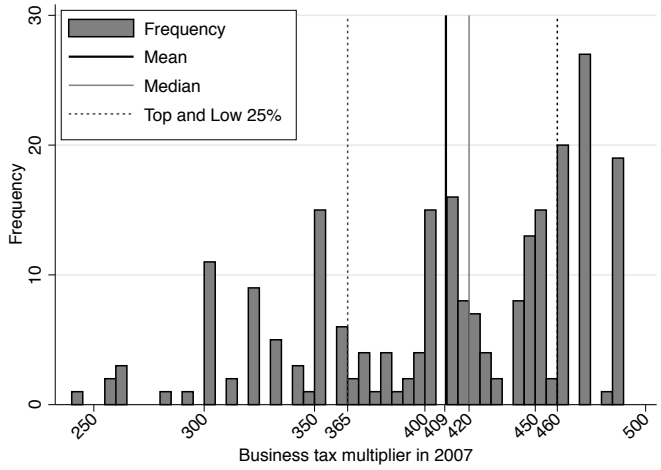


Figure 3.3: Distribution of local tax multipliers across municipalities.

Notes: The figure illustrates the distribution of local tax rate across German municipalities, where our sample of firms are located. The local tax rate is determined by multiplying the tax multiplier with the base factor, which corresponded to of 5% in 2007. Source: Data on the location of firms are retrieved from Hoppenstedt and Amadeus databases.

Thus, we use all firms that meet key transparency requirements and are frequently traded. Moreover, daily or monthly data for various market factors for the FSE are readily available from Stehle's German stock market data, see (Brückner et al. (2015)). The resulting portfolio of firms includes a diverse set of stocks. The data on individual companies' daily returns are taken from Datastream. This total return index for individual firms accounts for dividend reinvestment and stock splits. To estimate market factor models, we employ the market factors for the FSE, which are available from Richard Stehle's webpage, see Brückner et al. (2015).

Information on the municipalities where firms' headquarters are located is taken from the Hoppenstedt database[8], and from the firm profiles of the Amadeus database, which provides the history for most of the firms, including previous names, locations, and etc. By combining the two sources, it is possible to trace firms back in time and establish their

[8]Hoppenstedt database provides detailed information on the German companies. We have accessed it through LexisNexis database.

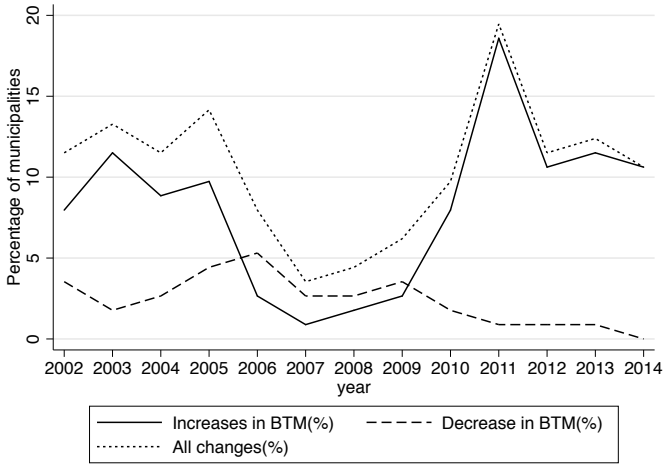


Figure 3.4: Frequency of local tax rate changes

Notes: The graph shows the percentage of headquarter locations changing their local tax rate 2002-2014 (also disaggregated in increases and decreases).

location in 2007. Firms without location information were dropped from the sample. The final sample corresponds to 235 firms. Figure (3.2) shows the regional distribution of these firms in Germany. The darker the shade of a municipality on the map, the higher is the number of firms in that municipality, which indicates a relatively high dispersion across 113 municipalities.

Municipalities' LBT rates are available from the Federal and States' Statistical Offices. These rates are matched with the firm-level data via the headquarter location. While the federal corporate tax rate is the same for all the publicly listed firms, the local tax rate taxes faced by firms differs across municipalities. Figure 3.3 shows the distribution of the 2007 tax multipliers within our sample of headquarter locations.

Since municipalities can adjust their local tax multipliers once a year, they could have, in principle, reacted to the federally legislated reform by adjusting their multiplier. However, state and federal policy makers had argued that local tax revenues should remain largely constant after the reform. In Figure (3.4) we plot changes of business tax multiplier

in different years. Apparently, at least in 2008 and 2009, municipalities hardly changed their tax multipliers. These years were characterized by rather few tax changes, and only after the financial crisis did local governments engage in substantial tax increases in 2010 and 2011.[9] The evidence supports the assumption that firms did not necessarily expected changes in the local multipliers. Thus, considering tax base and tax rates effects as functions of the existing local tax rates in 2007 is a reasonable approximation.

3.4 Empirical Framework

3.4.1 Approach and identification

To identify the effects of local taxation on firm owners we investigate whether stock market valuation of firms located in high tax municipalities were affected differently by the reform relative to firms in low tax municipalities. Conceptually, such firms should benefit less, since they enjoyed a smaller tax rate reduction, but they may have benefited more, if the reform sufficiently reduced the size of the tax base. Thus, our key variable of interest is the local tax rate (the local multiplier) in 2007, since this variable will determine the size of these effects for the firms.

With respect to the units of observations, we consider two alternatives. We employ a portfolio approach where we compare the performance of the portfolio of firms residing in high tax jurisdictions relative to the portfolio of firms with headquarters located in low tax jurisdictions. Alternatively, we consider the individual firms in our sample. For identification, we rely on an event study approach which considers the stock market reactions to the reform. Since we only observe a single event, i.e. the 2007 decision to pass the tax reform 2008, we interact the event with the prevailing

[9] The German economy was hit hard by the global financial crisis in 2009. However, it rebounded quickly in 2010 and 2011, so that local governments pressure to raise tax rates to refill their depleted coffers after the crisis was rather moderate.

local tax rate at each firm's headquarter. Provided that capital (firm owners) do bear the local corporate tax, this local tax rate can be seen as a measure of the event intensity, since it determines the size of the tax rate and tax base effects, respectively. In the portfolio approach, we just interact the event time with the performance difference of the high and the low tax portfolio.

Since the legislative process extended over several weeks, the event time is somewhat unclear. Moreover, given that information on local tax rate differences may not be very widespread, the diffusion of the implications of the tax reform in conjunction with the expected tax change as a function of the prevailing tax rates may have been rather slow. This challenge can be met by either considering cumulative returns over a period starting before the legislation process was started and ending after the information had surely been taken into account into stock prices. Such an approach amounts to a simple cross-sectional regression of such cumulative returns on the local corporate tax rate. We provide such an analysis in the appendix, confirming our main results. Alternatively, and this how we proceed, we can use monthly abnormal returns, similar to Asher and Novosad (2017), Wolfers (2006), Chen (2007), among others.

3.4.2 Evolution of returns

We first illustrate how stock market performed over the sequence of events discussed in Section 3.2.4, employing a portfolio approach. For this, we divide our sample of firms into two groups depending on whether their headquarter is located in a high or a low tax jurisdiction. Using the mean of the 2007 tax multiplier, which is equal to 409 (%), as the cut-off we form two unweighted portfolios of these firms, and we plot the evolution of these portfolios of high and low tax firms, respectively, in Figure (3.5). The two portfolios move closely together until March 2007. Starting around March 15, they start to diverge. The difference

between the two portfolios becomes strong only after April 25th when the Bundestag Committee on Public Finances publicly discussed the draft. Around the beginning of June 2007, the divergence comes to an end. The plot indicates that the stock prices of high and low tax firms reacted rather differently to the reform, with the portfolio of high tax firms substantially outperforming the portfolio of low tax firms.

As discussed, given the relatively long period of the legislative process that took several weeks, we refer to monthly returns to empirically assess the impact of the event. Figure 3.7 in the Appendix shows how these two portfolios evolve in the monthly frequency, with point zero set at April 2007. This graph is created using a High-minus-Low tax portfolio, which is constructed based on difference of the two portfolios of high tax versus low tax illustrated in Figure (3.5).

In what follows, we study more formally the effect of the reform during the spring of 2007. In terms of share price levels, our approach would correspond to a Differences-in-Differences framework with different treatment intensities. However, we do not specify our empirical framework in the share price levels, but rather follow the finance literature and consider an event study approach.

3.4.3 Abnormal returns

The rate of return on stock i at time t is $r_{i,t} = ln(R_{i,t}) - ln(R_{i,t-1})$, where R refers to the total return index corrected for stock splits and dividend reinvestments. We then estimate the following four factor market models

$$r_{i,t} - r_t^f = \alpha_i + \beta_i^1[r_t^m - r_t^f] + \beta_i^2 SMB_t + \beta_i^3 HML_t + \beta_i^4 WML_t + \varepsilon_{i,t}, \quad (3.2)$$

where r_t^f is the risk free rate (the return of the Bund) and r_t^m is the return of the market portfolio. SMB_t (Small minus big), HML_t (High minus low), and WML_t (Winners minus losers) are additional market

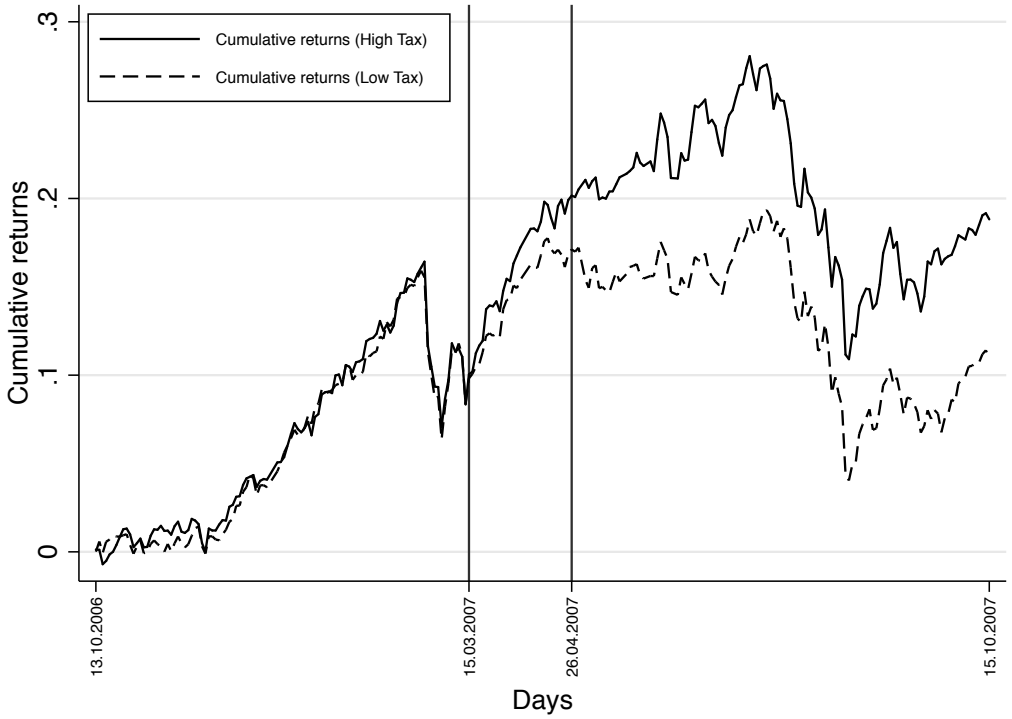


Figure 3.5: Cumulative returns of high and low tax portfolios

Notes: The figure shows the evolution of cumulative returns in a six-months-window around the 25.April 2007 for the two portfolios. On this date the public hearing on the reform took place in the Finance Committee.

factors that correspond to the market models of Fama and French (1993) and Carhart (1997). We estimate these regressions in their complete form with all market factors. Our results are robust to alternative formulations that use a CAPM or a Fama-French three factor model instead of the above form. We estimate regression (3.2) over a window of one year, ending six months before the event time. Additionally, all firms which do not have sufficient data in their estimation window are dropped, and this leaves 188 firms in our sample. The difference between the actual price realizations, adjusted for the risk-free rate, and the predicted values from regression (3.2) correspond to the abnormal returns. Finally, we calculate cumulative abnormal returns over the entire reform period by

summing up the abnormal returns.

3.4.4 Event study

In this section, we make use of an event study methodology to study the effect of the tax reform decision on stock returns. Using the panel of abnormal returns we estimate the following firm-level regression

$$AR_{it} = \gamma_t + \gamma_I + \gamma D_{event} * \tau_{i2007} + \epsilon_{it}, \tag{3.3}$$

Where γ_t are month fixed effects, which include the event month as one of them, and γ_I indicates industry fixed effects. τ_{i2007} is the LBT rate, i.e. the 2007 multiplier times the old base factor, and D_{event} indicates the event time dummy, which is equal to one for the time of the event (April 2007) and zero, otherwise, and ϵ_{it} is the error term.

Regressions in Table 3.1 estimate various forms of equation (3.3) with different sets of fixed effects. Robust standard errors are clustered at the firm level.[10] In all specifications, the interaction term of the event dummy and the expected business tax is positive and statistically significant, which implies that a percentage point increase in the tax rate results in a positive impact of approximately 0.5 percentage points on the abnormal returns in the respective month. Given the formulation laid in the Section 3.2.3 on the firm valuation, this result provides evidence that, first, the tax rate effect overcompensates the tax base effect and overall this favors the valuation of firms which are located in high tax municipalities.

As an additional test that the interaction of local tax rates with the April 2007 dummy is picking up an extraordinary effect, we estimate placebo regressions based on (3.3) by including different time specific dummies and their interactions with the local business tax to account for placebo events over a time window of 1 year around the event. Estimation

[10]Clustering at the municipality level also yields significant estimates.

Table 3.1: Monthly firm-level response

	Monthly abnormal returns		
	(1)	(2)	(3)
D*Trade tax	0.489**	0.498**	0.498**
	(0.235)	(0.236)	(0.236)
Trade tax	-0.0124	-0.0213	-0.00661
	(0.0936)	(0.0941)	(0.0953)
D	-0.147***	-0.223***	-0.223***
	(0.0507)	(0.0507)	(0.0508)
Time FE		yes	yes
Industry FE			yes
Constant	yes	yes	yes

Notes: The table shows the estimates of regressing firm-level monthly abnormal returns on on local business tax rate that corresponds to the federal rate multiplied with business tax multiplier. D is equal to one for *April*.2007 and zero, otherwise. Tax rate refers to the local tax rate of the municipality, where the firm is located. Robust standard errors in parentheses, which are clustered at the firm level. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

results related to these regressions are provided in the Table 3.3 and illustrated in Figure 3.6. None of the coefficients on the interaction term are statistically significant or large in magnitude in comparison with our benchmark event coefficient. These results cast light on the fact that traders have priced their expectations into the valuation of stocks in the month of the event, but do not indicate significant effects before and after April 2007. In a similar vein, Figure 3.7b in the Appendix illustrates event study results based on the portfolio approach, using the High-minus-Low portfolio and yields the same conclusion. This approach allows for a direct comparison of the effects between the high tax and

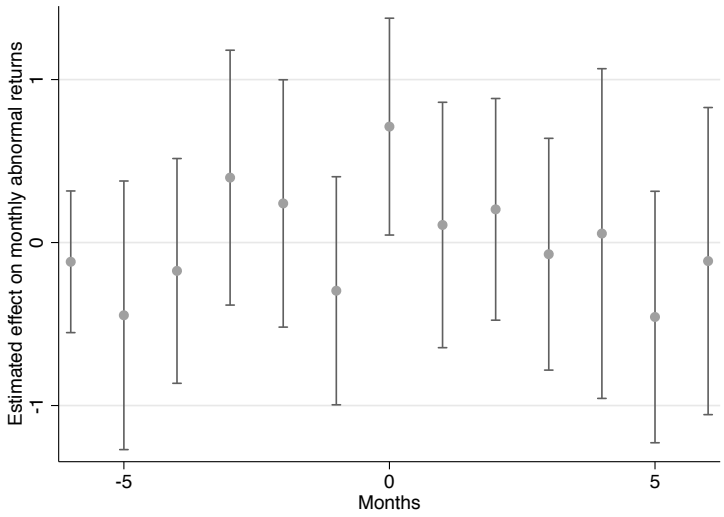


Figure 3.6: Effect of the expected business tax on monthly abnormal returns

Notes: interaction effects of the local tax rate with the tax reform month, as well as with other (Placebo) months before or after the reform decision, on monthly abnormal returns. The graph illustrates the point estimates together with their 95 % confidence intervals based on the firm-level regressions. All regressions include time and industry fixed effects. Standard errors are clustered at the firm level. According to the Table 3.3, only the coefficient at the event time is statistically significant.

low tax groups.

3.5 Discussion and conclusion

The 2008 corporate tax reform in Germany was a major reform which mainly aimed at reducing the tax burden on firms and investors and improving the competitive position of Germany internationally in terms of the effective marginal and average tax rates. In light of this change, stock market absorbed the news during the legislative process and share prices of firms responded differently according to their existing local corporate tax rates. Given that the treatment effect occurred at the same time for all the firms but at different intensities, we study the impact of this reform on the valuation of firms by exploiting a Differences-in-Differences approach and an event study design.

In Section 3.2.3, we decomposed the total effect on tax liability into the tax rate and the tax base effects, with the caveat that these two might countervail each other's impacts onto the valuation of firms. Our empirical results, however, indicated that an increase in the local corporate tax rate is translated into a positive impact onto market-clean abnormal returns. This indicates that local corporate taxes matter for firm valuation and the incidence of local corporate taxes, therefore, is at least partly born by firm owners. This plays out in favor of the firms that are located in municipalities with a higher level of business tax multiplier at the time of event. Consequently, our empirical results support the conclusion that the tax base effect did overcompensate the tax rate effect and this can explain why high tax firms fare better as a result of the tax reform decision.

In terms of the event timing, daily stock market data indicates that the effects occur rather gradual. This can be traced to the nature of the legislative process, where the likelihood of the final reform being implemented increases over time. Moreover, complex information about the firm's local tax treatment is likely not readily available, so that the

market may not necessarily be fully efficient. This corresponds to our choice of monthly returns in the analysis. To check the event definition, we carry out placebo regressions over a window of one year around the event time and none of them show statistically significant results.

3.6 Appendix

3.6.1 Event study with the portfolio approach

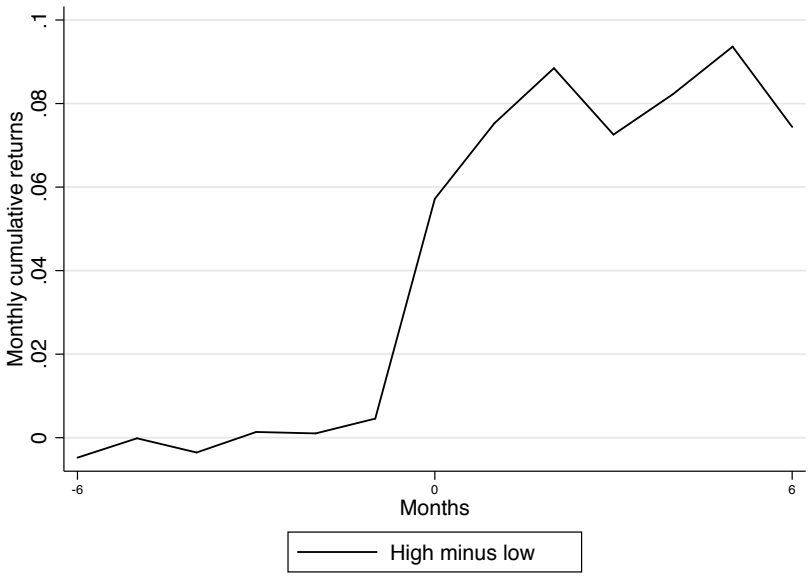
We can also apply the event study methodology to the portfolio approach. Using the two portfolios of firms based in high and low tax jurisdictions, respectively, we then calculate the average abnormal return within each group and construct a High-minus-Low portfolio. Figure (3.7) captures its performance around the time of the event, April 2007, over a window of one year around the event time. Sub-figures (a) and (b) illustrate and compare the monthly cumulative (normal) returns and the market-corrected monthly abnormal returns with their 95% confidence intervals, respectively.

3.6.2 Cross-sectional results using cumulative abnormal returns

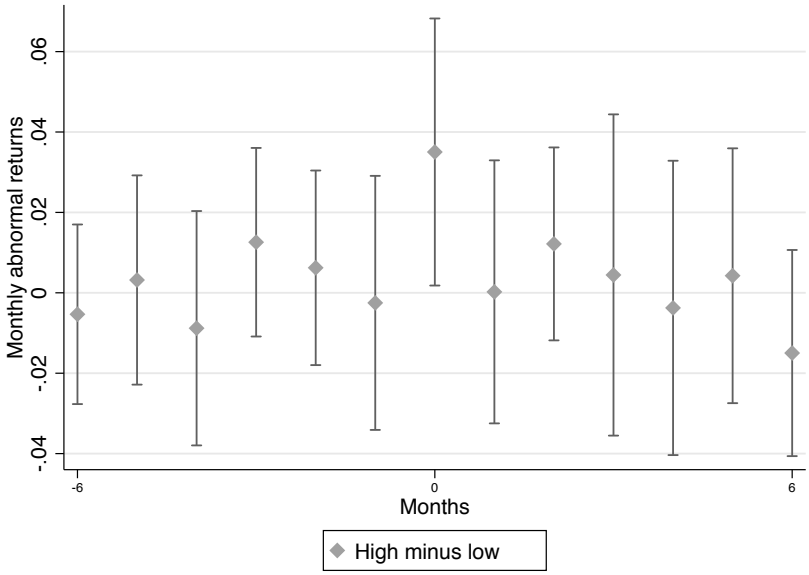
As an alternative to our event study approach, we can also analyze cumulative abnormal returns over the mentioned time period for each firm. Considering the performance of each firm over a period starting before the decision to implement the reform, and ending after the effects of the reform have surely been incorporated into prices also allows to assess whether differences in existing local corporate taxes made a difference in the impact of the tax reform, and thus to assess whether firm owners do bear the burden of local corporate taxes. We calculate cumulative abnormal returns from March 12, 2007 to July 6, 2007.

Next we consider a regression of these cumulative abnormal returns on the prevailing local tax rates in 2007,

$$CAR_i = \phi^0 + \phi^1 \tau_{i2007} + \varepsilon_i^1, \tag{3.4}$$



(a) Monthly



(b) Monthly abnormal returns

Figure 3.7: Monthly returns

Notes: Sub-figure (a) shows the evolution of monthly cumulative returns of the high tax minus low tax portfolio in a six-months-window around April 2007 corresponding to the high-tax minus low tax portfolio. Sub-figure (b) illustrates market adjusted returns together with the 95% confidence intervals.

Table 3.2: Long term firm-level responses

	Cumulative abnormal returns		
	(1)	(2)	Placebo
Tax rate	0.850**	0.878**	0.658
	(0.415)	(0.405)	(0.548)
Constant	-0.462***	-0.464***	-0.418***
	(0.0575)	(0.0558)	(0.0750)
Industry control		yes	yes
Observations	188	188	188

Notes: The table shows the estimates of regressing cumulative abnormal returns on local business tax rate that corresponds to the federal rate multiplied with business tax multiplier, which varies across municipalities. Cumulative abnormal return is calculated over the time-period between 12.03.2007 to 06.07.2007. In the first column, we estimate the effect for all firms. In the second column, we control for the industry that each firm belongs to. The placebo regression covers the entire time period, starting 6 months before (right after the end of our market estimation window) and ending on 09.03.2007 (last Friday before March 12th). Robust standard errors are in the parentheses. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

where ϕ^0 is the potentially industry-specific intercept, and τ_{i2007} the local tax rate to which each firm was subject to in 2007. Columns 1 and 2 in Table (3.2) show the results of estimating such a regression and both capture a statistically significant positive impact from the expected local tax rate onto the performance of firms in the stock market. Column 3 reports the result of a similar regression but with a different set of cumulative abnormal returns to examine a placebo time period. In this specification, we take the time period right after our estimation window in equation (3.2) up to March 9, 2007, which is the last day with market data before March 12th. This type of placebo exercise shows that, before the event period, local tax rate differences cannot systematically explain

the cumulative performance of the different stocks. However, over the event period in which the tax reform was legislated, they can. This cross-sectional results using the cumulative abnormal returns over the legislation period thus reinforce our findings from the event study design that local corporate taxes matter for firm valuation, and thus firm owners do bear part of the burden of local corporate taxes.

3.6.3 Additional figures and tables

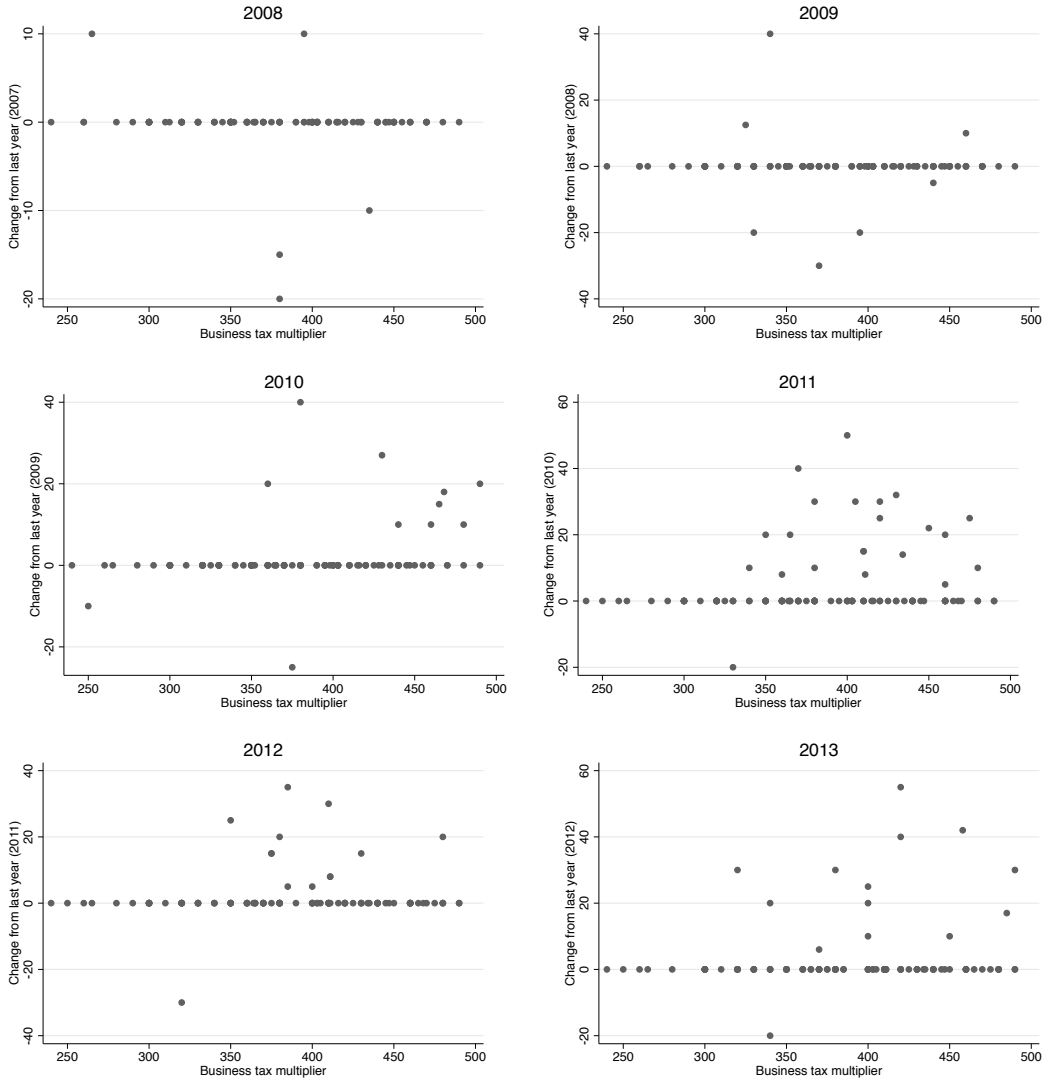


Figure 3.8: Changes in the Business tax multiplier.
Notes: Sub-figures indicate the change in business tax multiplier with respect to the previous year. In the first years, there are no considerable changes in the business tax rate multipliers and this occurs only gradually. *Source:* Own illustrations.

Table 3.3: Placebo estimates

	Monthly abnormal returns											
	(-5)	(-4)	(-3)	(-2)	(-1)	(0)	(1)	(2)	(3)	(4)	(5)	(6)
D*Tax rate	-0.446	-0.174	0.398	0.240	-0.296	0.498**	0.108	0.204	-0.0716	0.0552	-0.457	-0.114
	(0.418)	(0.350)	(0.396)	(0.385)	(0.385)	(0.236)	(0.382)	(0.345)	(0.360)	(0.513)	(0.391)	(0.478)
D	0.0109	-0.0291	-0.153***	-0.102*	-0.000838	-0.223***	-0.0805	-0.127***	-0.114**	-0.0308	-0.0821	-0.0954
	(0.0613)	(0.0498)	(0.0571)	(0.0538)	(0.0501)	(0.0508)	(0.0517)	(0.0471)	(0.0515)	(0.0736)	(0.0565)	(0.0698)
Tax rate	0.0811	0.0579	0.0144	0.0264	0.0672	-0.00661	0.0364	0.0292	0.0501	0.0404	0.0794	0.0533
	(0.132)	(0.135)	(0.134)	(0.138)	(0.122)	(0.0953)	(0.122)	(0.134)	(0.140)	(0.121)	(0.132)	(0.122)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: The table shows placebo estimates of regressing firm-level monthly abnormal returns on the local business tax rate. The number above each column corresponds to the event time, with column (0) as the reference period for which D is equal to one in *April*.2007 and zero, otherwise. Robust standard errors in parentheses, which are clustered at the firm level. In our placebo-event regressions, we account for a time period of one year around the event time. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

Chapter 4

VAT Differentials in the EU, Cross-border Shopping, and the Vertical Distortion of Production

4.1 Introduction

Governments' interests for employing consumption tax measures, and at the core of it value added taxes, as a secure source of tax revenue has been growing worldwide over the past decades[1]. VAT has several interesting administrative properties (Pomeranz (2015)) and can potentially be used across both developing and developed countries (Keen (2008)) as an effective tax tool. However, it has been discussed that the nature of VAT also makes it prone to adverse consequences such as tax evasion and fraud (Slemrod (2007)). While such topics have been widely studied, little empirical evidence has been provided on the possible distortionary impacts of VAT on the production side, especially considering policies of open borders or zero-rating of exports.

Regardless of the simplified textbook notion that the final consumer bears the burden of consumption taxes, several empirical studies and,

[1] According to the Tax Revenue Statistics by Eurostat, in 2018, more than 26.4 % of tax revenues in the EU came from VAT types, in comparison to the share of capital taxes that incorporate less than 1 %.

in general, economic theory predict that the burden of such taxes may partially fall onto producers (See for instance, Kosonen (2015), Alm, Sennoga and Skidmore (2009), Christensen, Cline and Neubig (2001), Fullerton and Metcalf (2002a), Poterba (1996), Ardalan and Kessing (2019), Werner and Olbert (2018), among others). The extend to which firms bear the burden of taxes depend on the relative elasticities of demand and supply (Fullerton and Metcalf (2002a), Atkinson and Stiglitz (1976)). Should firms bear part of the tax burden, consumption taxes correspond to a cost factor and lower the surplus of firms. Jacob, Michaely and Müller (2019) suggest that sales tax regimes and VAT around the world imply a negative impact onto corporate investment. This finding is regarded as demand for capital decreasing in firm's burden of consumption taxes (Werner and Olbert (2018)). In this study, I focus on this mechanism from a more direct perspective, by focusing on the relationship among the output of the firms and VAT.

A cornerstone of optimal taxation established by Diamond and Mirrlees (1971) is the idea that taxes should not distort production efficiency. Advocates of the VAT point out that, next to its self-enforcing nature, it is exactly this property of taxing consumption without distorting production which makes the VAT an essential part of modern tax systems.

The completion of the single European market in 1993 brought along the challenge of making the European value added tax system compatible with the single market. The transitional arrangements with respect to the structure of the European VAT system to move towards an origin-based system was supposed to either expire on December 31, 1996 and be replaced by the new directive of the ECONFIN Council or be made permanent in case of no decisions (Fehr, Rosenberg and Wiegard (2012)).

Since that date, the transitional system has been renewed every few years and the European Commission has stepped up efforts, in terms of different regulatory pieces or proposals to overhaul the European

common system of VAT[2]. The appearance of the single market made border controls and border tax adjustments among different EU member states hard to be controlled by the customs authorities (Genser (2003)). Since it eliminated the tax-related formalities at the border, cross-border shopping is not anymore restricted by the relatively small allowances on the tax-paid products between member states and customers may carry tax-paid goods across borders without such restrictions (Keen and Smith (1996)).

Several studies have proposed alternatives for the current system. Lockwood et al. (1994, 1995), and Genser et al. (1995) have advocated an origin-based taxation system, in which the final value added tax base is in each country where the good is produced. Keen and Smith (1996) have proposed the viable integrated value added tax (VIVAT) scheme, which incorporates a harmonized VAT rate across the European VAT-registered trades[3]. Regardless of all the debates and efforts to increase harmonization across member states, still after 25 years, substantial differences in VAT rates exist and the current system has been susceptible to evasion and fraud (See Poniatowski et al. (2016) that provides descriptive statistics in this regard and Smith and Keen (2007) for data on revenue losses due to VAT gaps).

Sinn (1990) argues that the particular design of the EU VAT regime generates a situation in which production efficiency will typically not occur. According to his argument, the possibility of cross-border shopping implies that member states with relatively low (high) VAT rates expand

[2]The existing situation is mainly governed by the following three pieces: Council Directive 2006/112/EC on the EU's common system of value added tax, which sets a framework for VAT rates within/between member states. Council Regulations (EU) No. 904/2010 which refer to administrative cooperation against fraud, and No. 282/2011 that lays down measures for implementing the Directive 2006/112/EC Alfieri (2018) and Remac (2017)

[3]See a through discussion over *How to solve the European VAT problem* in McLure (2000), Keen (2000), Keen and Smith (2000), Fehr and Polo (1999), Bird and Gendron (2000), Cnossen (2003), Genser (2003) and Smith (2010), all aiming at proposing a system that is welfare improving in comparison to the existing regime.

their consumption (intermediate) goods sectors at the expense of the intermediate (consumption) goods sectors. As a result, production is inefficient. This conceptual argument is reviewed in detail in Section 4.2. The aim of my analysis is to investigate empirically, whether this distortion exists and whether it is important quantitatively.

Looking at a group of neighboring countries in the internal market with a considerable share of cross-border trade, I focus on how varying cross-country VAT rates under the current system have different implications for intermediate and final consumption sectors.

The study relies on a large sample of more than 4.6 million firms in ten neighboring European countries belonging to intermediate and final consumption sectors and, to this end, I employ an indirect test to analyze whether VAT rate differences induce a vertical distortion in the production structure. Performance of the firms are captured by operating revenues through the primary activity of each firm. It is tested whether differences between tax rates of the home-country with respect to the neighboring countries induce a distinct impact across these two sectors.

In the empirical framework, I address the importance of cross-border trade in each country, by first, dividing the countries into large and small groups based on their geographical features. The intuition for this is that, in case of smaller member states, a significant fraction of the population is living close to the border to another member state.

My results show that changes in the relative VAT rates between member states have a differential impact onto firms in the consumption and the intermediate sectors, in line with the vertical distortion of production and, additionally, these impacts seem to be stronger in both sectors for the smaller countries. Accounting for the border size in the framework enlarges these effects further. This again suggests that, in fact, cross-border shopping is likely driving this distortion and provides an additional argument that the EU member states should reinforce their efforts to

further harmonize VAT tax rates across member states.

I also capture the same direction of conclusion by running a descriptive analysis using country-level producer price ratios of final consumption versus intermediate sectors and assess their long-term behavior against VAT for each country relative to its neighbors. It is shown that, the higher the VAT ratio, the more distorted relative producer price ratio will be and in case of smaller countries this relationship is more pronounced.

The rest of the paper is organized as follows. Section 4.2 provides a conceptual background for the study. In section 4.3, I provide details on data sources, summary statistics and the preliminary descriptive analysis using producer price ratios. Section 4.4 clarifies the empirical framework, followed by the results, which are shown in 4.5. Section 4.6 discusses the results and concludes.

4.2 Conceptual background

The topic discussed in this paper appears to have been a largely neglected aspect relative to the much debated aspects of tax competition for cross-border shoppers (see for example, Kanbur and Keen (1993), Nielsen (2001), Nielsen (2002), Agrawal (2015) Kessing and Koldert (2013), among others). Sinn (1990) refers to this distortion by considering the transformation curves of two neighboring countries, a and b, based on a simple model of pure exchange. These two countries produce two homogeneous final consumption (C) and intermediate (I) goods and τ^a and τ^b show the VAT rate in each country, respectively. Free trade of the intermediate goods and trade in consumption goods according to the destination principle implies equality between country-specific producer price ratios ($P_C^a/P_I^a = P_C^b/P_I^b$). This efficiency condition can be indicated by point M on sub-figure (a) of Figure 4.1, where the two transformation curves of country a and b are tangent. On the other

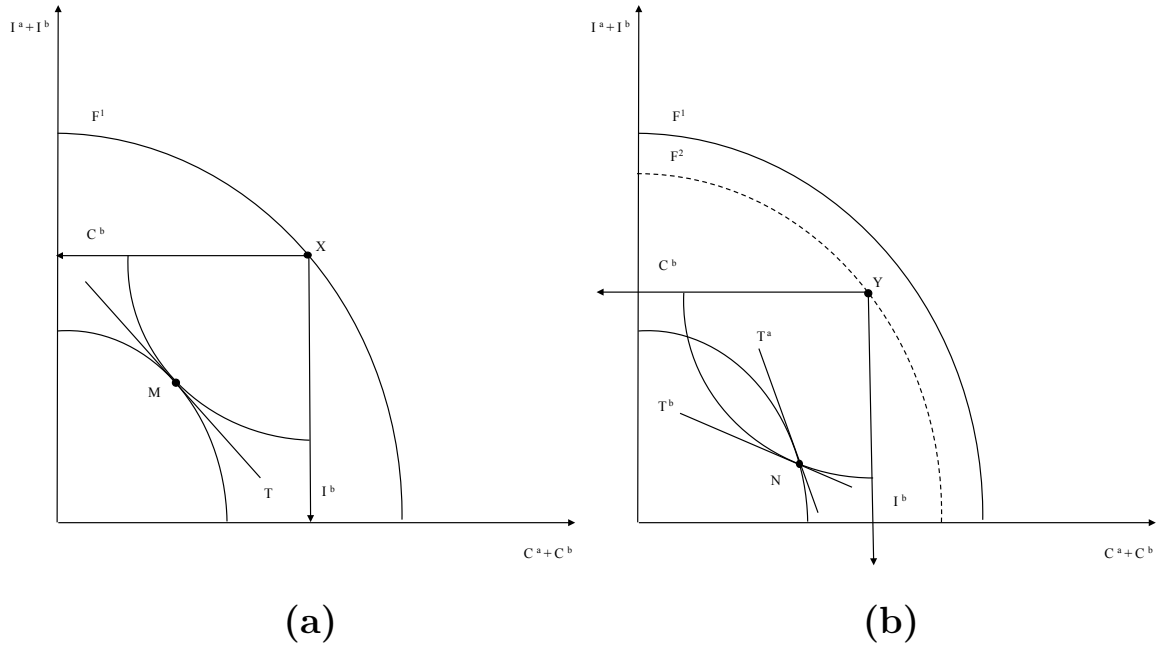


Figure 4.1: Distortion and the cost of non-harmonization

Notes: Sub-figure (a) refers to the case where the ratio of the relative producer prices (slope of the transformation curve in each state) is equal. Sub-figure(b) indicates the case where the two ratios diverge. *Source:* Based on the paper of Sinn (1990).

hand, with direct consumer purchases and given that consumers can cross-border shop without limitations under the current system, prices for consumer goods must converge, $P_C^a(1+\tau^a) = P_C^b(1+\tau^b)$. In practice, the degree of price convergence will depend on the importance of cross-border shopping. Sinn (1990) abstracts from these in his theoretical approach, but I exploit it in my empirical investigation. Assuming that the VAT rates between the two countries diverge, such that $\tau_b > \tau_a$, this would imply that the relative producer prices between the two countries also diverge, $P_C^a/P_I^a > P_C^b/P_I^b$. This corresponds to an allocation like point N on sub-figure (b) of Figure 4.1, where the two transformation curves intersect and the joint production of a and b is now Y which is located on an inferior transformation curve F^2 in comparison to F^1. Low-tax countries, like a, experience a boom in their final consumption goods

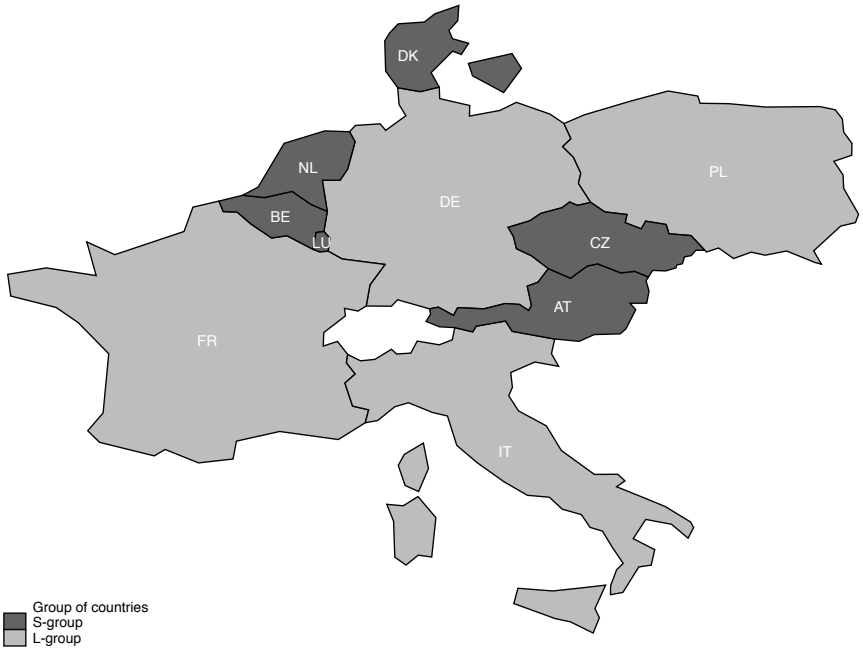


Figure 4.2: Set of countries in the study

Notes: S-group characterizes those countries belonging to the to the smaller countries group shown with dark gray on the figure and L-group refers to larger countries with light gray.

sector at the expense of their intermediate goods industries which means that their consumption sector will be, in relative terms, inefficiently large and the intermediate sector will be inefficiently small. Since this procedure appears due to direct purchases of cross-borders, those countries which have a higher share of borders relative to their total area, should be more exposed to this distortion. This is the intuition of categorizing countries into two groups of large and small. Figure 4.2 indicates the countries, where the firms are located in and the way I group these countries. Those with dark gray are in the small-country group (S-Group, thereafter), including Austria, Belgium, Czech Republic, Denmark, Luxembourg, and Netherlands, and the rest, including France, Germany, Italy, and Poland are in the large-country group (L-Group, thereafter).

The selection of countries included in the sample was restricted by firm-level data coverage, but this does not restrict the general validity of

the results as at least within the Internal Market, cross-border shopping is important across these neighboring countries. It is unclear, however, to what extent this distortion is operational. The aim of this paper is to study whether this distortion is an empirically important one.

4.3 Data and descriptive analysis

The Amadeus is the main source of data for firm level data. The clean panel of firms, excluding those firms with no data, covers more than 4.6 million firms over a period of 10 years, from 2005 to 2014. An advantage of using this source of data is that, it includes many private and small firms and provides detailed information on them. The activity of each firm can be identified and categorized using several industry codes and I use NAICS 2012 [4] 4-digit industry codes to classify firms' activities. Based on firms' major activity, I have classified them into final consumption category and intermediate.

Data for VAT rates are taken from the webpage of the European Commission[5], which provides monthly data on the evolution of these rates in each member state. The monthly data are then aggregated using arithmetic mean in each year to generate the annual rate. Land boundary data are taken from *The World Fact book* of the Central Intelligence Agency (CIA) which lists the border length with all the neighbors for each country. This information is then used to calculate a weighted-average of the value added tax rates of all neighbors. Weights for each neighboring country is calculated based on the land-border the two countries share divided by the length of total land-border for each country. To generate real values, I employ data on country GDP deflators which are retrieved from Eurostat. To observe the distribution of firms within each country in this study, Figure 4.4 in Appendix 1, shows the number of firms

[4]Source: United States Census Bureau.

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

Table 4.1: Summary statistics

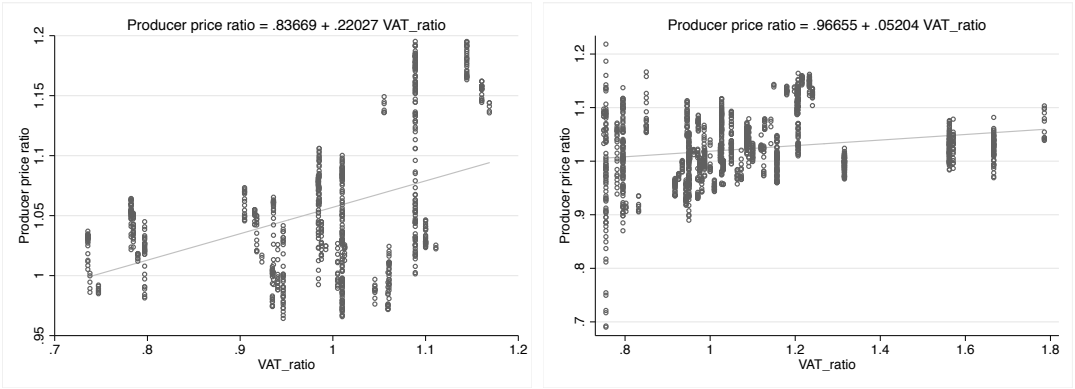
Variable	Mean	Std. Dev.	Min.	Max.
rev^{int}	176.227	3553.694	-71.760	747030.625
rev^{cons}	330.099	4878.275	-119.621	737319.526
vat^{H}	19.827	1.146	15	25
vat^{N}_{border}	3.432	1.324	2.255	19

Notes: *rev* stands for revenues of firms over the period of 2005 to 2014 in the consumption/intermediate categories in thousand Euros. VAT^{H} indicates the VAT rate in each country while VAT^{N}_{border} is the average VAT of all neighboring countries weighted according to the land border every two countries share divided by the total border length of each country. Table 4.4 in appendix shows the average values for VAT^{diff} per country, as the total average of this variable is around zero. This variable corresponds to the difference between VAT^{H} and VAT^{N}

categorized in the final consumption and the intermediate sectors. These neighboring countries have different sizes within each category, in relative terms with respect to each other.

Table 4.1 shows the summary statistics of the main variables used in the empirical framework. Interestingly, looking at the minimum and maximum values for the value added tax rates across different countries signifies lack of harmonization in tax rates and the importance of studying its implications for possible distortions in the Internal Market.

Subsequently, before moving to the analysis of firm level data, given the structure laid in this section in terms of grouping neighboring countries into large and small and industries into intermediate and final consumption sectors, I take a more aggregate view towards the impacts of cross-country VAT differences and across sectors, by illustrating the behavior of producer price ratios of the intermediate and final consumption sectors against relative VAT ratios in Figure 4.3. Monthly producer price indices of the intermediate and final consumption sectors are provided by OECD, to create the producer price ratio of P_{int}/P_{cons} corresponding to the time period after 1993, after the completion of the single European



(a) Small group **(b)** Large group

Figure 4.3: Relationship between the producer price ratio and relative VAT rates.

*N*otes: Vertical axes correspond to the producer price ratio of P_{int}/P_{cons} calculated using the producer price indices of OECD, for each country in the sample. Horizontal axes show the ratio between the VAT of each country and the average VAT of all its land-border neighbors. *Source:* own calculations.

market. Member states have, however, different availability of data within this time period.

VAT ratio is calculated by dividing the tax rate of the home country by the average rate of the neighboring countries. To differentiate between the two groups characterized earlier, small and large, they are plotted separately. The conclusions drawn based on the graphs are twofold: (1) The trend lines capturing a positive slope imply that as the VAT ratio increases, the producer price ratio between the two sectors for the home country diverges more from unity, in other words, the two sector become more distorted as the VAT differences increase, inline with the discussion in the previous section and Figure 4.1 from a theoretical perspective. (2) The impact seems to be stronger in case of smaller countries that are more exposed to cross-border shopping as they constitute a higher share of the border areas with respect to their total area.

4.4 Empirical framework

To assess the impacts of VAT differences across countries and sectors, I employ of the following framework using Differences-in-Differences

$$log(R_{it}) = \alpha_i + \delta_t + \beta_1 VAT_{it}^{diff} + \beta_3 D_{int} VAT_{it}^{diff} + \varepsilon_{it}, \tag{4.1}$$

Where R_{it} indicates operating revenues of firm i in year t[6]. Revenue encompasses price and quantity effects and indicates the relative expansion of firms related to a given sector. α and δ stand for firm and year fixed effects, respectively. VAT^{diff} shows the annual value added tax rate of the country where firm i is located minus the arithmetic average of VAT rates of neighboring countries to the home-country of firm i. Finally, D^{int} indicates a dummy for those industries categorized as the intermediate group.

In smaller countries, border areas constitute a larger share of the total area which implies a higher relative exposure to the border and, consequently, cross-border shopping. This may, in turn, amplify the structural imbalance discussed in section 4.2, especially in case of higher relative differences in VATs. To test this, I extend equation (4.1) into a triple Differences-in-Differences by interacting a dummy variable for smaller countries, as captured in Figure 4.2.

$$\begin{aligned} log(R_{it}) =& \alpha_i + \delta_t + \beta_1 VAT_{it}^{diff} + \beta_2 D_s VAT_{it}^{diff} + \beta_3 D_{int} VAT_{it}^{diff} \\ &+ \beta_4 D_s D_{int} VAT_{it}^{diff} + log(GDP) + Inflation + \varepsilon'_{it} \end{aligned} \tag{4.2}$$

D_s in the above equation equals to one for those countries categorized in the s-group, including DK, NL, BE, LU, AT, CZ, and zero, otherwise.

[6]Note that all the estimations are also done using real operating revenues, generated using GDP deflator in each country, and the results are in line with what is shown in the upcoming tables.

In both equations 4.1 and 4.2, the structure of VAT^{diff} implies $VAT^{H} - VAT^{N}$, in which VAT^{N} is the arithmetic mean over value added tax rates of neighboring countries. In some form of the regression 4.2, I also include GDP and the inflation rate to account for market characteristics.

In a further step, I define a different form of VAT^{diff} to capture the tax differences between the home and neighboring countries. VAT^{diff}_{border} follows the same structure as VAT^{diff} with the difference that VAT^{N} is weighted according to the land border every two country share divided by the total border length of each country. This allows giving a higher importance to the tax rates of those neighboring countries with which the home country shares a larger border and has a higher possibility of cross-border shopping. Table 4.3 shows the results of estimating equations 4.1 and 4.2, but instead of VAT^{diff} the alternative form of VAT-difference measure VAT^{diff}_{border} is included.

4.5 Results

Table 4.2 summarizes the results of estimating different forms of equations (4.1) and (4.2). Since all regressions are estimated using a measure of VAT rate corresponding to the difference between the home and neighboring countries (variable VAT^{diff}), in Column 1, I first provide the coefficients on non-differenced tax rates to see the impacts of each rate separately (while controlling for the other one) onto the operating revenues, without the existence of sectoral/country-group decompositions. According to column 2, a one percent increase in VAT^{diff} decreases operating revenues by around 0.05 percent. Column 3, also captures the same direction of result, but the interaction of the dummy variable for intermediate sector allows comparing the effects across the two sectors such that, a one percent increase in VAT^{diff} is translated into a higher decrease in the revenues of consumption sector, equal to 0.05 percent, versus around 0.03

Table 4.2: Cross-country impacts of VAT differences

	Operating Revenues in Log				
	(1)	(2)	(3)	(4)	(5)
VAT^{diff}		-0.0489***	-0.0539***	-0.0515***	-0.0400***
		(0.00115)	(0.00137)	(0.00146)	(0.00151)
$D_{int} * VAT^{diff}$			0.0191***	0.0158***	0.0356***
			(0.00245)	(0.00259)	(0.00255)
$D_s * VAT^{diff}$				-0.0219***	-0.0185***
				(0.00423)	(0.00412)
$D_s * D_{int} * VAT^{diff}$				0.0173***	0.0154**
				(0.00754)	(0.00749)
VAT^{H}	-0.0518***				
	(0.00172)				
VAT^{N}	0.0440***				
	(0.00285)				
$Log(GDP)$					0.767***
					(0.0136)
$Inflation$					-0.0124***
					(0.000378)
Year F.E.		yes	yes	yes	no
Firm F.E.	yes	yes	yes	yes	yes

Notes: Robust standard errors in parentheses clustered at the firm level. The dependent variable is the operational revenue of firms in all regressions based on high dimensional fixed effects estimator by Correia (2016). VAT^{H} shows the yearly value added tax rate of each country and VAT^{N} corresponds to the arithmetic average of the neighboring countries. VAT^{diff} indicates the difference between the two. D_{int} indicates a dummy, which is equal to one for those sectors categorized in the intermediate group and zero otherwise. D_s is another dummy variable which is equal to one for the countries belonging to the s-group (DK, NL, BE, LU, AT, CZ) and zero otherwise. I include two controls for market characteristics, GDP in logarithm form and the inflation rate. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

percent decrease in the intermediate sector. Subsequently, Column four, which corresponds to equation (4.2), extends the results by differentiating

between small and large countries. This has an important implication in this study, since smaller countries embody a higher share of border to their total area and are more subject to cross-border shopping.

According to Column four, for a one percent increase in VAT^{diff}, revenue of the intermediate and consumption sectors decrease by 0.03 and 0.05 percentage points in case of the L-group, respectively. Comparing these values with those of the S-group, the difference between the impact of relative tax rate increase across intermediate and final consumption categories becomes higher and equal to 0.04 and 0.07 for each sector. This indicates that those countries which have a higher exposure to cross-border shopping also tend to have a higher distortion between their intermediate and consumption sectors. In Column five, I estimate the same regression but also account for GDP and inflation to address possible market characteristics into the framework. The results are inline with the case that I include time FE, in addition to firm FE, and no controls for the market.

These differences between the two groups of large and small countries become much more pronounced when I account for the effect of border size in the framework by employing VAT^{N}_{border} in the calculation of VAT^{diff}. Looking at the Table 4.3, impacts are clearly higher in Columns 2 and 3 in comparison to Table 4.2 and according to Column 4, a one percent increase in the tax measure, decreases operating revenues by nearly 4 times the value in the case of S-group in comparison to L-group (0.2 versus 0.05 percentage points) and with the same pattern for the intermediate sector across the two groups.

Comparing the findings from the two tables shows that, although VAT differences create distortions in production across intermediate and final consumption sectors, smaller countries which are more exposed to cross-border shopping are more adversely affected and the distortion in production seems to be more severe in these countries, while accounting

Table 4.3: Cross-country impacts of VAT differences with border effect

	Operating Revenues in Log				
	(1)	(2)	(3)	(4)	(5)
VAT^{diff}_{border}		-0.0643***	-0.0705***	-0.0510***	-0.0252***
		(0.00148)	(0.00184)	(0.00195)	(0.00182)
$D_{int} * VAT^{diff}_{border}$			0.0178***	0.00515*	0.00501*
			(0.00289)	(0.00297)	(0.00292)
$D_s * VAT^{diff}_{border}$				-0.133***	-0.182***
				(0.00580)	(0.00568)
$D_s * D_{int} * VAT^{diff}_{border}$				0.0854***	0.0925***
				(0.00892)	(0.00896)
VAT^{H}	-0.0445***				
	(0.00178)				
VAT^{N}_{border}	0.274***				
	(0.0133)				
$Log(GDP)$					0.961***
					(0.0112)
$Inflation$					-0.0143***
					(0.000360)
Year F.E.		yes	yes	yes	no
Firm F.E.	yes	yes	yes	yes	yes

Notes: Robust standard errors in parentheses clustered at the firm level. The dependent variable is the operational revenue of the firms in all regressions based on high dimensional fixed effects estimator by Correia (2016). VAT^{H} shows the yearly value added tax rate of each country and VAT^{N}_{border} corresponds to the average of VAT rates scaled for the border size of the neighboring countries. VAT^{diff}_{border} indicates the difference between the two. D_s and D_{int} are dummy variables capturing the group of small countries (DK, NL, BE, LU, AT, CZ) and those firms belonging to the intermediate sector, respectively. I include two controls for market characteristics, GDP in logarithm form and the inflation rate. * $p < 0.10$,** $p < 0.05$, *** $p < 0.01$

for all time-invariant characteristics. This evidence is in line with what was shown earlier in the descriptive analysis in Figure 4.3 that a higher relative VAT ratio is associated with a more distorted producer price ratio.

4.6 Discussion and conclusion

While VAT remains as a popular tax tool across different economies, the particular design of the EU VAT regime generates a situation, in which production efficiency will typically not occur. The possibility of cross-border shopping implies that member states with relatively low (high) VAT rates expand their consumption (intermediate) goods sectors at the expense of the intermediate (consumption) goods sectors. As a result, production is inefficient.

To capture this impact empirically, I employed a large sample of firms in 10 neighboring European countries and controlled for firm and time invariant characteristics as well as possible market drivers. To this end, estimation results show that a one percent increase in the VAT rate difference between the home country and those of the neighbors reduces firm's operating revenues. This negative impact onto producers is inline with the literature that shows, first, firms which bear part of the tax burden shrink their output due to lower expectations on after-tax profits. Second, firms with the freedom on where to report their sales for VAT purposes tend to shift sales due to the comparative advantage of a country in terms of having a lower relative VAT rate (Jacob, Michaely and Müller (2019), Olbert and Werner (2019)).

Results, in addition, provide evidence that increasing relative value added tax rate of the home country to the neighboring countries, distorts the intermediate and final consumption sectors at different intensities such that, on average, final consumption sector seems to be more ad-

versely affected than those firms active in the intermediate sector. This observation supports the findings of Miao, Beghin and Jensen (2012) that compare the EV loss associated with taxing intermediate versus final products and show that the response associated with the latter is almost 5 times higher than that of the former. Depending on the ability of firms to set prices and considering market conditions, a result of increasing consumption taxes would imply a higher burden for firms producing final goods than intermediate products.

Subsequently, cross-border shopping seems to play an important role. The results outlined above seem to become accentuated, when I differentiate between small and large countries and the reductions are higher in case of the smaller ones, that are more exposed to cross-border shopping. In principle, these countries constitute a larger proportion of their territory with their neighbors and it is more reasonable to assume that tax savings compensate transportation costs. The differential impact captured when accounting for cross-border shopping in the framework is inline with a large strand of the literature that discuss tax-incentives at the border can create distortions along various dimensions of the local economy (Agrawal (2012), Agrawal and Fox (2017), Johansson, Pekkarinen and Verho (2014), Cawley et al. (2019) and Leal, Lopez-Laborda and Rodrigo (2010)).

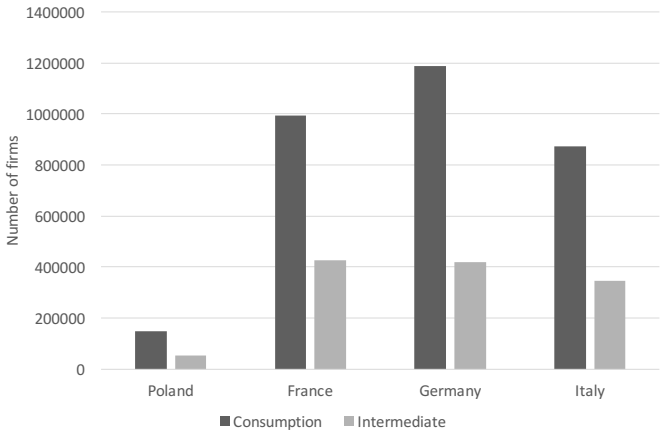
From a policy perspective, my results advocate further efforts to pursue value added tax rate harmonization across member states in the EU, which would then result in closing/narrowing the gap between the two sectors and how they evolve over time, given that these cross-country tax differences are the likely driver of the discussed distortion.

While this study builds on different parts of the literature, limitations associated with data availability and coverage restrict the power of my empirical framework. It makes sense to extend it by incorporating other firm level characteristics, such as international sales, the location of

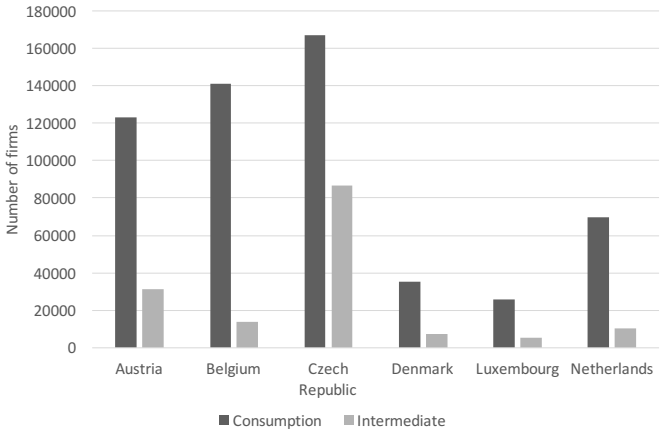
subsidiaries abroad and information on the tax base related to each firm.

4.7 Appendix

4.7.1 Additional figure



(a)



(b)

Figure 4.4: Distribution of firms in the sample

Notes: Sub-figure (a) shows the case for those countries that are categorized into the large group and sub-figure (b) indicates the case for the small group. *Source:* Own illustration.

4.7.2 Additional table

Table 4.4: Average value of VAT^{diff} per country

Country	VAT^{diff}
AT	−0.36
BE	2.87
CZ	−0.35
DE	−1.9
DK	6.59
FR	1.14
IT	0.47
LU	−4.69
NL	−0.25
PL	3.1

Notes: The table shows average values for VAT^{diff} per country in the sample. VAT^{diff} is calculated by subtracting VAT^{N}, which shows the average VAT of all the neighboring countries, from VAT^{H} that indicates the tax rate of the home country.

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