Excise Tax Pass–Through on Beverage Prices

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Abstract

The purpose of this project is to study tax shifting of excise taxes on alcoholic and non–alcoholic beverages at the micro–level in Denmark. We focus on six episodes of tax changes. Taxes on liquor were cut in 2003, taxes on soft drinks were raised in 1998 and 2001 and cut in 2003 whereas taxes on beer were increased in 1997 and cut in 2005. These episodes are interesting experiments since they involve both tax increases and tax cuts allowing us to look at possible asymmetries in the response of prices to excise taxes. We use a unique data set of micro data collected by Statistics Denmark used to compute the Danish CPI. We find a considerable heterogeneity across products, brands, types of stores and regions. In general the empirical evidence suggests overshifting of tax hikes and undershifting of tax cuts. There is some evidence suggesting that tax pass–through also is determined by border effects. These results suggest that it is very important to condition estimates of revenue gains or losses and public–health outcomes on specific market conditions for different brands and products.

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1 Introduction

The theory of tax incidence suggests that sales and excise taxes are fully shifted onto consumers in a model with full competition and constant marginal costs, see Kotlikoff and Summers (1987) and Fullerton and Metcalf (2002). If we relax the assumption of constant marginal costs and instead assume increasing marginal costs, there is less than full shifting. These predictions do not hold under imperfect competition (Bishop (1968), Stern (1987) and Delipalla and Keen (1992)), however. In this case it is possible that there is over–shifting of taxes onto consumers. The share of the tax incidence borne by the consumer depends on the elasticity of demand which varies across different goods implying that it is likely that there could be both over–shifting and less than full shifting even on markets with imperfect competition (the pass–through of sales and excise taxes may be less than, equal to or greater than 100%). Over–shifting can be shown to occur for iso–elastic demand curves (constant elasticity of demand) and constant marginal costs (or if the marginal cost is rising sufficiently weakly in the neighborhood of optimum). For a linear demand curve and constant marginal cost curve, the burden is divided equally between consumers and producers.

Despite the attention paid in the theoretical literature, there are surprisingly few empirical studies of the effects of sales and excise taxes on prices.[1] Poterba (1996) and Besley and Rosen (1999) examine a limited number of goods prices, three commodity groups and 12 specific goods, respectively. Carbonnier (2005) studies three VAT reforms in France focusing on the asymmetric effects of tax hikes and tax reductions. There are also case studies mainly focusing on tobacco and gas prices, see, e.g., Delipalla and O'Donnel (2001) and Doyle and Samphantharak (2008). The main result from these studies is that tax incidence is heterogeneous across products, for some types of goods there is less than full shifting whereas for other products the evidence suggests over–shifting. These differing results are very often interpreted as indicating that certain markets are operating under imperfect competition. There are some attempts in the literature to examine this relation in more detail. For example, Delipalla and O'Donnel (2001) use data on markups and producer prices to measure the degree of market power and find that the cigarette market in Europe is neither a competitive market nor a collusive market.

There is also a literature focusing on alcoholic beverages. Young and Bielińska–

[1] Poterba (1996) reviews the early empirical studies going back to the 1930s whereas Fullerton and Metcalf (2002) review both theory and more recent empirical results.

Kwapisz (2002) examine whether beer taxes are good proxies for the price of alcohol and analyze also how taxes on alcoholic beverages are passed through to consumers. They find that beer taxes are poor predictors of alcohol prices and the excise taxes are overshifted to consumers using US data. Kenkel (2005) collects data on several brands of alcoholic beverages in Alaska and estimates the tax pass–through of the tax hike in October 2002. The main result is that excise taxes are overshifted (except for Miller beer), prices increase between 1.40–4.9 times the tax change. He also observes a high degree of heterogeneity both across brands and different products. Common to these two studies is that they only examine the effects of tax hikes and that they do not distinguish between types of stores or the location of stores, two aspects that may be of potential interest.

The purpose of this project is to study tax shifting of excise taxes on beverages (both alcoholic and non–alcoholic beverages) at the micro–level in Denmark. We focus on a total of six episodes of tax changes during the period 1997 to 2005. There are two episodes of tax changes on beer (a tax hike in 1997 and a tax cut in 2005), three episodes for soft drinks (two tax hikes in 1998 and 2001 and one tax cut in 2003) and one episode of tax cuts on liquor (in 2003). The underlying reason for tax hikes was to raise tax revenue whereas the tax cuts were implemented in order to prevent further increases in cross–border shopping between Denmark and Germany where alcohol taxes are much lower. Since we also have access to data for different outlets and locations, we can examine whether the distance to the Danish–German border is important (and the proximity to Sweden where taxes on alcohol are considerably higher than in Denmark) and how tax shifting to consumers differs across types of stores. In addition, since our sample includes both tax hikes and tax cuts we can examine the symmetry of tax pass–through. Our study extends the literature in several ways. First, we focus on both the effect of excise taxes on homogeneous goods and the dispersion of these effects across outlets and across regions. Second, we examine the effects of both tax hikes and tax cuts on the same type of good.

The paper is organized in the following way. In section 2, we review the theoretical results on tax incidence of excise taxes in a model where we condition on the existence of *ad valorem* taxes. Section 3 describes the data in more detail. Section 4 contains our empirical analysis. Section 5 concludes.

2 The Model

In this section we briefly discuss tax incidence of both *ad valorem* and excise taxes on prices. We will follow Delipalla and Keen (1992) and use the conjectural variations model in an oligopoly with both fixed number of firms and with free entry.[2] The model as it is formulated encompasses both the Cournot–Nash model where a firm takes prices as given and chooses the quantity such that the profit is maximized and the Bertrand model where a firm takes quantities supplied as given and chooses prices in order to maximize profits.

Let us consider an industry comprised of n identical firms (they have the same cost structure $c(q_i)$ with strictly positive fixed costs and non–increasing marginal cost) producing a homogeneous good.[3] Output for each firm is q_i implying that output in the industry is $\Sigma_{i=1}^{n} q_i = Q$. The price level is determined by the inverse demand function $p(Q)$ where we assume that $p'(Q) < 0$.[4] We also define the elasticity of indirect demand $\varepsilon \equiv Qp'/p < 0$ and the elasticity of the slope of the indirect demand $\eta \equiv Qp''/p'$. There is a specific excise tax (t_s). The adjustment of output in firm i in response to a change in total output is, as is well–known, of particular interest. When a firm decides how much to produce, it must make a guess about how other firms in the same industry will react. The conjectural variations model provides a unified and convenient framework for discussing the bahavior of firms in an oligopoly. Defining the conjectural variation as $\lambda = \frac{dQ}{dq_i}$, we can distinguish between various cases. If $\lambda = 1$ we have the Cournot–Nash oligopol case, if $\lambda = 0$ industry output is unaffected by the decisions of firm i which is the Bertrand case (or the "competitive" case) where firms use marginal cost pricing regardless of the number of firms, and if $\lambda = n$ all firms behave exactly as firm i does implying that tacit collusion among incumbent firms is perfect, or in other words, the aggregate profit is maximization conditional on the number of firms.

[2]See also Katz and Rosen (1985), Stern (1987) and Besley (1989) for similar analysis of the conjectural variations model. Bishop (1968) provides an analysis of tax incidence of both *ad valorem* and excise taxes under full competition and monopoly. Fullerton and Metcalf (2002) survey the literature.

[3]Anderson, de Palma and Kreider (2001) show that all results discussed below can also be obtained in a model with heterogenous goods.

[4]Note that we do not impose any restrictions on the second derivative of the inverse demand function implying that we allow for both concave and convex functions initially. Below, it will be shown that equilibrium is guaranteed when the inverse demand function is concave but that we at the same time can allow for some convexity. For a more detailed analysis of Cournot equilibrium with convex demand, see Svizzero (1997).

The profit function for firm i in this industry is

$$\pi_i = (1 - t_v)\, p\,(Q)\, q_i - t_s q_i - c\,(q_i)\,. \tag{1}$$

The first order condition is

$$\lambda\,(1 - t_v)\, p' q_i + (1 - t_v)\, p - t_s - c' = 0 \tag{2}$$

and the second order condition is

$$\lambda^2\,(1 - t_v)\, p'' q_i + 2\lambda\,(1 - t_v)\, p' - c'' < 0 \tag{3}$$

where t_v is an *ad valorem* tax. Note that the second order condition is fulfilled for concave indirect demand but also allows for some convexity since $p' < 0$. Next we introduce the following definitions: the producer price $\tilde{p} \equiv (1 - t_v)\, p$, and the relative slope of the demand and the slope of the marginal cost curves $k \equiv 1 - c''/\lambda\tilde{p}'$.

Let us start with the case when the number of firms is fixed, i.e., the fixed–n Cournot oligopoly. Using the definitions above we can rewrite the second order condition as

$$\frac{\lambda\tilde{p}'}{n}\left[n\,(k+1) + \lambda\eta\right] < 0. \tag{4}$$

Since $\tilde{p}' < 0$, this implies that the second order condition requires that $n\,(k+1) + \lambda\eta > 0$. We will also assume from now on that $k + 1 > 0$. In a symmetric equilibrium $p = p\,(nq)$ implying that we can solve for p and q using this relation and the first order condition above.[5] Differentiate (2) with respect to t_s and q and rewrite we obtain

$$\frac{dq}{dt_s} = \frac{1}{\tilde{p}'\left[\lambda\eta + n + \lambda k\right]}$$

and

$$\frac{dQ}{dt_s} = \frac{n}{\tilde{p}'\left[\lambda\eta + n + \lambda k\right]}$$

such that

$$\frac{d\tilde{p}}{dt_s} = \tilde{p}'\frac{dQ}{dt_s} = \frac{n}{\lambda\,(\eta + k) + n} > 0 \tag{5}$$

[5]Delipalla and O'Donnel (2001) consider the non–symmetric equilibrium in the same model.

if we impose the condition that $n+\lambda(\eta+k)>0$.[6] Under this maintained assumption, we find that a rise in the excise tax will reduce output and at least parts of the tax increase is passed on to consumers. We also note that $\frac{d\tilde{p}}{dt_s}>1$ if $(k+\eta)<0$ since λ is at least positive. Overshifting may therefore occur under oligopoly, a result different from the case when there is full competition where overshifting cannot occur.[7] The reason why there may be overshifting of excise taxes is that when there is a tax increase, output will fall as a result of a reduction in demand. In some cases firms want to increase the price by more than the tax increase to compensate for the loss of revenue.[8] To illustrate, assume that the cost function is linear such that $c''=0$ implying that $k=1$. In this case the necessary and sufficient condition for overshifting is that $\eta<-1$. In case the cost function is linear and we assume that demand is also linear ($\eta=0$), we find that there is no overshifting but undershifting. Finally, if we assume constant elasticity of demand $\eta=1/\varepsilon-1$, we obtain the result that overshifting will always occur and that the degree of overshifting increases as the demand becomes less elastic (as the absolute value of ε falls, the absolute value of η increases).[9]

These results are derived under the assumption that the number of firms is fixed, i.e., the Cournot–Nash oligopoly model. We now turn to the case with free entry and exit. Under the assumption that firms may enter or exit this industry we need an additional condition in order to determine the number of firms n. As is common in the literature, we assume that firms enter until the marginal firm earns zero profit. Under the assumption that firms are identical, this condition is

$$(1-t_v)\,p(nq)\,q-c(q)-t_sq=0. \tag{6}$$

Differentiate equations (2) and (6) under the assumption of symmetric equilibrium with

[6]It is common practice in the literature to impose this stronger condition than the condition given by the second order condition, see Seade (1980) and Delipalla and Keen (1992).

[7]Delipalla and Keen (1992) show that overshifting of excise taxes is a necessary but not sufficient condition for overshifting of *ad valorem* taxes.

[8]The effect of the tax change on profits is uncertain. If demand is Cobb–Douglas, there will be no change in profits if there is a marginal increase in the excise tax even if there is overshifting, see Fullerton and Metcalf (2002). However, if $\eta<-2$ in our model, profits will increase when excise taxes are raised, see Delipalla and Keen (1992).

[9]We may compare these results to the corresponding conditions under monopoly. If we set $n=1$, we find that overshifting of excise taxes occur when $-1<\lambda(\eta+k)<0$. Also in this case, we find overshifting if the cost function is linear and that $\eta<-1$ and when we also add the assumption of constant elasticity of demand.

respect to p, t_s, t_v, and n and solve for the effects of taxes on producer prices and the number of firms. This yields the following solutions

$$\frac{d\tilde{p}}{dt_s} = \frac{n\,(k+1)}{n\,(k+1)+\lambda\eta} > 0$$

and

$$\frac{dn}{dt_s} = \frac{n\,(k+1+\eta)}{\tilde{p}'q\,(n+nk+\lambda\eta)}.$$

From these expressions we find that overshifting of excise taxes is more likely with free entry than in the case the number of firms is fixed, the difference between the tax effect under fixed number of firms and with free entry is negative. The reason for this result is that the tax also affects the number of firms, a higher tax tends to reduce the number of firms (as long as $k+1+\eta > 0$) giving remaining firms more market power. Returning to the effects of the excise tax, we find that there is overshifting if $\eta < 0$, a less restrictive condition than under fixed number of firms where overshifting occurs if $k+\eta < 0$.

Let us summarize the results above. In case the number of firms is fixed we find that overshifting of excise taxes (see equation (5)) occurs if $k+\eta < 0$, undershifting if $k+\eta > 0$ and full pass–through when $k = -\eta$. We also found that overshifting of excise taxes is a necessary but not sufficient condition for overshifting of *ad valorem* taxes. These results stand in contrast to tax pass–through under full competition where there is always full pass–through, undershifting and overshifting cannot occur. The analysis above also suggest that empirical findings suggesting full shifting of excise taxes cannot be used to infer that the market under consideration is characterized by full competition as it may be the case that there is full pass–through even under oligopoly, for example when the cost function is linear ($k = 1$) we find that there is full pass–through if $\eta = -1$. From an empirical point of view it is also noteworthy that we should find less evidence of overshifting of *ad valorem* taxes than for excise taxes since overshifting of excise taxes is a necessary but not sufficient condition for overshifting of *ad valorem* taxes. This suggest that the likelihood of finding overshifting in empirical studies increases when studying excise taxes than when analyzing the effects of *ad valorem* taxes.

When allowing for free exit and entry we find a less restrictive condition for overshifting of excise taxes, $\eta < 0$ compared to $k+\eta < 0$ in the case with fixed number of firms. Full pass–through requires that $\lambda = 0$, corresponding to the Bertrand case whereas undershooting requires that η is positive implying that $p'' < 0$.

3 Data

We employ a unique data set of micro data collected on a monthly basis by Statistics Denmark used to compute the Danish CPI. The available sample is January 1997 to December 2005. The data is very detailed, for each price record we have the following information: The price of the item, the year and month, the brand name of the item, the name of the product category, a numeric code for a given outlet chain and a numeric outlet code. This information allows us to identify and track the price of each individual item, i.e., a specific product in a specific outlet. The product category code corresponds to the Classification of Individual Consumption (COICOP) 5–digit code. In addition to these series we also have zip codes for each specific outlet allowing us to study for example border effects in more detail.

The data is collected by Danish Statistics each month but the number of collected prices for each good varies considerably over time. For example, before January 2000 Danish Statistics collected 200 prices on the Danish liquor Gammel Dansk but from October 2003 they only collect 11 prices. Furthermore, for some specific brands only very few prices are collected. We have decided to focus on brands where, in general, more than five prices are collected but we also report some statistics for all brands regardless of how many prices are collected. This implies that we focus on at most six brands of beer (the Danish brands Carlsberg and Tuborg dominate the market), six brands of soft drinks (including international brands such as Coca–Cola as well domestic brands like Tuborg Squash) and seven brands of liquor.

There are in total 6 episodes of changes in excise taxes during the period 1997–2005, two tax changes on beer, three on soft drinks and one on liquor. For soft drinks the excise tax was increased on January 1, 1998 to 0.80 DKK per liter corresponding to 0.13 DKK on average per bottle and then further increased on January 1, 2001 to 1.65 DKK per liter (corresponding to 0.41 DKK per bottle on average) and on October 1, 2003 the excise tax was cut to 1.15 DKK per liter (corresponding to 0.29 DKK per bottle on average). This allows us to study the symmetry of effects of excise taxes on prices on soft drinks. The tax on beer was increased by 0.04 DKK per bottle on average on May 1, 1997 and on January 9, 2005 the tax was cut by on average 0.16 DKK per bottle.[10] The tax on liquor was cut by 125 DKK per 100 percent pure alcohol on October 1, 2003.

[10]The excise tax on beer was also changed on October 1, 2004 so that the tax reflected the strength of alcohol. This change was neutral such that prices on beer was not affected.

4 Empirical analysis

4.1 Excise tax pass–through across brands

In Table 1, we describe the data and compute the average tax incidence per brand for the different episodes of interest. The first five columns show the number of collected prices for each product and the total number of collected prices in each category. Then we show the average price, average price change, the actual tax change conditional on the amount of alcohol in each product and the computed tax pass–through (which is equal to the price change divided by the tax change).

Looking at the fifth column it is evident that the average tax pass–through for each category of goods is above one (>1.35) when taxes are increased on soft drinks and beer. There is thus evidence of overshifting for these products. This result can be compared to the effect of tax cuts. From Table 1 we find that there is on average undershifting for soft drinks and a slight overshifting for liquor when taxes are cut. For beer we find that average prices increased after the tax cut (the tax pass–through is negative but below one). This result is explained by the very sharp price increase on Tuborg Grøn registered in the data. Excluding this brand from the sample, we find that the pass–through on average is 0.27 indicating undershifting of prices. An important observation when comparing tax cuts and tax increases is that overshifting appears more likely when taxes are increased compared to when they are cut. Tax pass–through for soft drinks is above 2 when taxes are increased and below one when taxes are cut. The same holds for beer where the pass–through is 0.27 when taxes are cut but 1.35 when they are raised.

When comparing the tax pass–through across products we find considerable variation, see Table 1. For some brands we find undershifting but for others overshifting. This is not surprising since we have shown in section 2 that the elasticity of demand determines the extent of tax shifting. The large differences in pass–through across brands therefore reflect different demand elasticities.

The last four columns of Table 1 report the tax pass–through across stores. We report the fraction of stores with undershifting (defined as a tax pass–through less than 0.9), fraction of stores with full pass–through (tax pass–through between 0.9 and 1.1) and fraction of stores with overshifting (pass–through exceeds 1.1). The last column reports the fraction of stores with zero pass–through, i.e., the fraction of stores leaving prices unchanged. Also across storers, we find large differences and very different results for

the three categories of beverages. Consider first the results for beer. From Table 1 we observe that the number of stores that leave prices unchanged is higher on average when there is a tax cut (68% versus 47%). At the same time we find that there is much more variation across products when taxes are cut. For some brands very few stores leave the price unchanged (Tuborg Grøn) whereas many stores leave prices unchanged for other brands (Carlsberg Sort Guld). When the tax is increased almost 50% of the stores leave their prices unchanged. Similarly we find large differences for the number of stores with overshifting, from zero to above 30% of the stores overshift their prices when the tax is cut compared to more than 38% of the stores when taxes are raised. There is a somewhat higher fraction of stores with full pass–through when taxes are raised compared to when they are cut (10% versus 2%).

The results for soft drinks very much confirm this general picture. A larger fraction of stores leaves their prices unchanged when there is a tax cut compared to when taxes are increased and there is a larger fraction of stores with undershifting when taxes are cut than when they are increased. A larger number of stores overshift prices when there is a tax increase. However, there is one notable difference between the price setting of soft drinks and beer. There are a considerably larger number of stores with full pass–through when the tax was cut in 2003 compared to the two tax increases in 1998 and 2001. For beer we found the opposite result even though the difference was minor.

Finally, for liquor we find that almost no stores left their prices unchanged when the tax was cut in 2003. The majority of stores cut their prices in full accordance to the tax cut whereas one fourth of the stores undershifted and overshifted prices, respectively. There is also one interesting result when comparing brands. The price on Gin was cut more than the tax cut in all stores and there was full pass–through in all stores for Ålborg Taffel Akvavit and Gammel Dansk, two Danish brands.

In Table 2 we test whether the average tax pass–through for our focus brands are complete, i.e., testing whether average pass–through reported in Table 1 is unity. The table only reports the p–value from these tests. There is no uniform result from these tests. Comparing tax hikes with tax cuts for soft drinks and beer we find that there are fewer cases of full tax pass–through for beer for a tax hike but the opposite results for soft drinks. Looking more closely at the results in Table 2 and the point estimates reported in Table 1 we find that for beer there is one case (out of four cases) of overshifting in case there are a tax hike and two cases when there is undershifting when taxes are

cut.[11] Turning to soft drinks, the empirical evidence suggests that taxes are overshifted to consumers for almost all brands when taxes are raised and undershifted for three out of six cases. One conclusion that can be drawn from these tests is that the beer market seems to be more competitive than the market for soft drinks. There are only a few cases where tax changes are not fully passed on to consumers. For liquor we find three cases (out of seven cases) of overshifting and one case of undershifting. Even though the tests suggest over and undershifting, the point estimates are very close to unity suggesting that the market for liquor is very competitive, at least in comparison to the market for soft drinks.

Another way to further explore the relations between excise taxes and the pass–through of such taxes is to run regressions of the type

$$\Delta p_t = \beta_0 + \beta_1 p_{t-1} \tag{7}$$

where $p_{t,i}$ is the price change following a change in the excise tax and p_{t-1} is the baseline price prior to the excise tax change. According to our model discussed in section 2, we know that the tax pass–through is independent on the price suggesting that the parameter $\beta_1 = 0$. The estimate of β_0 then provides an estimate of average tax pass–through (if we divide β_0 with the tax change). We may also extend this simple regression, for example, by distinguishing between different brands. The results when running regressions for the three different types of beverages and for all six episodes of tax changes are reported in Table 3. Consider first the regressions where we do not distinguish between brands. For tax hikes we find that stores that charged higher baseline prices, passed on more of the tax hike on to customers (for tax hikes on soft drinks but not for beer) whereas for tax cuts we find the opposite result, stores that charged higher prices passed on less of the tax hike to their customers (except for the tax cut on soft drinks in 2003). This pattern also hold when we allow for different brand effects. These parameters are very often significant and lend support to the hypothesis that baseline price also is an important determinant of the tax pass–through.

It may be the case that an excise tax change on beer, for example, also has an effect on pre–tax prices on soft drinks and liquor, stores may use strategic price adjustments when the excise tax on one type of beverage is altered. To examine whether the frequency

[11] The results also suggest that there is overshifting for one additional brand, Tuborg Grøn.

of price changes is related across types of beverages, we run simple regressions of the frequencies in Figure 1 on a constant and dummies indicating excise tax changes on other beverages. These regressions show that we cannot reject the null hypothesis that the frequency of price changes on one type of beverage is affected when the excise tax is changed for the other two types of beverages. This indicates that retailers do not engage in strategic pricing when there is an excise tax change. However, as was mentioned above, the frequency of price changes on each type of beverage is significantly higher than on average during the month when there is an excise tax change.

4.2 Excise tax pass–through across chains of stores

In Figure 2 we show the tax pass–through of the three categories of goods (all brands) across different chains of stores. The data base available has records of the particular store where the price is collected. This allows us to distinguish between different stores, for example between a store in a national chain or if the store is independent. We have, in our sample, 17 different chains of stores and they are numbered accordingly. For both beer and soft drinks we find that there are stores raising the after tax price following a tax cut or (less seldom) cutting the after tax price following a tax hike. There are large differences across different chains of stores suggesting that the responses to excise tax changes are not identical. This may indicate that certain chains of stores have considerable market power. It is also interesting to note that there seems to be more conformity in their response to the tax cut on liquor, there are only very small differences across chains of stores, and not only across brands as was illustrated above in Table 1.

Figure 3 shows the fraction of stores within each type where prices change more or less than the tax change and whether the pass–through is complete. We only compare the results for beer and soft drinks since we here mainly are interested in the symmetry of price responses across stores. There is no uniform result across the two products except that the fraction of stores with undershifting is higher when there is a tax cut. A majority of stores with undershifting do not change their prices at all. In particular, it is surprising that 65% of the stores do not change the price when the tax on beer was cut in 2005. At the same time, 41% of the stores did not change the price when the tax was increased in 1997. Similar results are found for soft drinks even though a much smaller fraction of stores did not adjust their prices. As a comparison we find that only 1% of the stores kept their prices unchanged on liquor when the tax was cut in 2003 and that 62% of the

stores fully adjusted their prices.[12]

4.3 Excise tax pass–through across regions

Since we have full information about the location of all stores where prices are collected, we can also study the pattern of tax pass–through across zip codes. In Figure 4 we show the fraction of under, over and full tax pass–through in stores within each zip code. The zip codes are described in Appendix A. This analysis reveals that there are differences across regions but as these effects may be related to border effects we will turn to tests of such hypotheses in the next section.

Comparing the tax hike and tax cuts on beer we find a higher frequency of overshifting for the tax hike and a higher frequency of undershifting of the tax cut, a result also evident in Figures 2 to 3 and Table 1 above. A surprising result is that stores in Southjutland (zip code 6) undershifted the tax cut in 2005. Beer prices are much lower across the border in Germany and it could have been expected that Danish stores took the opportunity of reducing prices further in order to compete better with German stores. On the other hand, the price difference fell as a result of the tax cut and it may be the case that stores located close to the border counted on increased sale after the tax cut.

Turning to soft drinks we find that the tax hike in 1998 in particular but also the tax hike in 2001 was overshifted to consumers. The fraction of stores increasing prices less than the tax hike increased somewhat in 2001 compared to after the tax change in 1998. This may reflect competition from both Germany and Sweden where prices on soft drinks in general are lower. This was also recognized by the government and in 2003 the excise tax was cut resulting in lower prices and many stores also cut their prices more than what was motivated by the tax cut, except for Northjutland (zip code 9). There is less competition from cross–border shopping in this region.

For liquor we find that a very large fraction of stores in zip code 1 (Copenhagen City) cut their prices more than the tax cut. This may reflect a highly competitive market for liquor. Such a conclusion is also supported by the absence of stores where prices were cut less than what was motivated by the tax cut. Stores located in zip code 4 (North Zealand and Bornholm) reduced the price less than the reduction in the tax or fully adjusted their prices. The market in these regions seems to be somewhat less competitive. It could also

[12]These results are not shown here for brevity.

be noted also that stores in North Zealand compete with the Swedish state monopoly where alcohol taxes are much higher. It is likely that stores close to the Swedish border already are competitive in relation to the Swedish monopoly which could explain why the adjustment of prices in response to the tax cut in 2003 was fully shifted or even overshifted to consumers, some of them Swedish residents.

4.4 Excise tax pass–through and border effects

In order to study the effects of cross–border shopping in more detail, we now focus on the existence of a border effect. One underlying argument for excise tax cuts used by the government was to prevent and limit cross–border trade with Germany where excise taxes on alcoholic beverages are considerably lower. This same argument also applies to the excise tax cuts on soft drinks. Historically, retail prices on soft drinks are very high in Denmark, much higher than in most other European countries including Germany. In Sweden, on the other hand, excise taxes on alcoholic beverages are much higher than in Denmark resulting in a higher demand in regions close to the Danish border. Prices on soft drinks are, in general, lower in Sweden. Cross–border trade with Sweden is particularly high in the Greater Copenhagen Region which may affect the general price level in this region and therefore also potentially affect the tax pass–through. From these observations we conjecture that the tax pass–through of a tax hike (tax cut) should be smaller (larger) as the distance to the German border decreases. The opposite effects can be expected for retailers located close to the Swedish border.

In order to examine if this is the case we run regressions similar to the ones presented in Table 3 above. i.e., we regress the change in the after tax price on a constant and the lagged price adding also the distance to the German border measured in km's (the distance from the center of the zip code to the nearest town in Germany) and a dummy variable that takes the value 1 if the retailer is located in zip codes 1 and 3 and zero otherwise. The results are shown in Table 4. Looking at the first column of this table reporting the parameter estimate of the exact distance to the German border measured in km's we find that there is no significant effect for any of the six episodes. This is a surprising result and instead of using the exact distance we therefore set up a set of dummy variables where we group retailers together depending on their distance to the German border. In particular, we define five dummy variables that takes on the value one if the retailer is located less than 50 km from the German border and zero otherwise.

Similarly we define dummy variables for distances between 50 and 100 km, 100 to 150, 150 to 200 and above 250 km away from the border. The results change considerably as can be seen in columns two to six in Table 4. Consider first the excise tax cuts. As was found earlier, the tax cut on beer in 2005 resulted in a price increase, not a price decrease as was expected. It also turns out that the price increase was highest, the closer the retailer is to the German border. This is an unexpected and surprising result. For the other tax cuts we find the expected results, the closer the retailer is to the German border, the less tax pass–through in general. For example, the tax cut on liquor in October 2003 had a larger effect on the after tax price change in stores located close to the German border compared to stores located far away from the border. Similar results can also be found for the tax cuts on soft drinks in 2001 and 2003 even though retailers located between 200 and 250 km from the border cut their prices more than retailers located close to the border in 2001.

The effects of tax hikes on beer and soft drinks are also related to the distance to the German border, but there is no uniform result. For beer, the after tax price change is increasing in the distance from the German border whereas it is decreasing in the distance to the German border for soft drinks in 1998.

Finally, Table 4 also reports the result from testing the Swedish border effect. Here we find no significant effect at all (regardless of how we define the dummy variable representing proximity to the Swedish border). It seems to be the case that the proximity to the German border is much more important, although not always in the expected direction, as the distance to the Swedish border. On reason for these results is that it may not be possible to take advantage of price differences on beer and soft drinks to the same extent as on price differences on liquor since the potential gain of cross–border trade per unit is higher on liquor.

5 Conclusions

This paper, studying six episodes of excise tax changes on beverages in the Danish economy, finds that taxes are more than fully passed through to consumers when there is a tax hike while there is undershifting when taxes are cut. The former result is consistent with earlier empirical evidence, for example Kenkel (2005) analyzing the Alaskan tax hike in October 2002. The latter results complement these findings.

Our results also suggest large differences across brands and across different types of beverages. For liquor we find that the tax pass-through is very close to unity, on average across all brands we cannot reject full tax pass–through. Furthermore, our point estimates are much smaller than the point estimates in Kenkel. We also find undershifting for one brand out of seven brands studied in more detail. For soft drinks and beer we typically find higher point estimates suggesting that excise tax hikes on these products are overshifted (or undershifted in case of a tax cut), full tax pass–through is rejected in nine out of 13 cases (and in six out of 12 cases when the tax is cut).

These results suggest that there is no clear and uniform effect of changes in excise taxes on prices. This is an important finding as it has consequences for the links from tax policy to alcohol consumption and further on to public–health outcomes even though such arguments were not used by the Danish government when they decided to change taxes. Instead, the main argument for the tax cuts was to prevent cross–border shopping with Germany. Tax hikes were not motivated explicitly. One would anticipate that the pass–through of tax cuts therefore should differ across regions with less pass–through for regions in the proximity to the German border.

Our empirical results suggest that the distance measured in km's cannot significantly explain the extent of the after tax price change. However, when we group retailers depending on their distance to the German border, our results change considerably. Now we find significant effects but not very often in the expected direction. The tax cut on liquor in 2003 had expected effects. The tax pass–through close to the German border (less than 100 km from the border) is larger in absolute values than it is for stores located more than 100 km from the border. Similar results are found for the tax cut on soft drinks in 2001 where there are larger price effects the closer to the border a store is located, except for the unexpected result that stores located more than 200 km from the German border cut there prices more than stores at the border. The tax cut on beer in 2005 had the opposite effect on prices, prices increased more the closer to the German border a store is located. For tax hikes we also find opposing results. The tax hike on soft drinks in 1998 had larger price effects closer to the border. The tax hike on beer in 1997 and in particular on soft drinks in 2001, had expected effects. Prices on soft drinks fell in stores close to the German border, not increased as could have been expected, but prices also fell sharply in stores located more than 150 km away from the border. The tax hike on beer lead to smaller price increases in stores close to the German border. Our evidence thus suggest

that there are large differences across regions but the results are not consistent across tax changes and across types of beverages. There is no strong empirical result suggesting a German border effect on the tax pass–through. The same result holds for regions close to the Swedish border. There is no effect of the proximity to the Swedish border and the extent of tax pass–through.

The conclusion from our empirical analysis is that the market for beverages in Denmark is segmented and that different types of stores apply different price strategies. One observation is that establishments do not seem to change prices uniformly across the price spectra and across brands. When comparing the tax pass–through of tax hikes on beer and soft drinks, we find no clear evidence that the same price setting strategy is used within the same type of stores or chains of stores. The same result holds for tax cuts. There is a high degree of heterogeneity across time. Our interpretation of these results is that retailers in Denmark have substantial local market power. The findings in this paper also have consequences for policy makers. As there is a considerable variation in tax pass–through across products, across brands, across types of stores and across regions it is very difficult to evaluate the effects of tax changes on alcohol consumption and therefore also on public-health outcomes.

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Appendix A: Zip codes in Denmark

Zip code	Region
1	Copenhagen City
2	Greater Copenhagen Region
3	North Zealand and Bornholm
4	South Zealand
5	Funen
6	Southern Jutland
7	Western Jutland
8	Eastern Jutland
9	Northern Jutland

Table 1: Tax pass–through for beverages.

Beer									
	♯ obs	**Base price**	**Price change**	**Tax increase (DKR)**	**Tax pass-through**	**Stores with undershifting (<0.9)**	**Stores with full pass-through (0.9-1.1)**	**Stores with overshifting (>1.1)**	**Stores with zero pass-through**
Event: May 1997									
Carlsberg Hof	48	4.63	0.07	0.04	1.84	54%	0%	46%	52%
Tuborg Grøn	87	4.71	0.06	0.04	1.46	53%	0%	47%	51%
Tuborg Guld	101	6.70	0.05	0.05	1.08	55%	7%	38%	51%
Carlsberg Sort Guld	53	6.74	0.08	0.05	1.57	53%	2%	45%	53%
Total	420	5.14	0.06	0.04	1.35	50%	10%	40%	47%
Event: January 2005									
Carlsberg Can	9	6.48	-0.19	-0.14	1.31	67%	0%	33%	56%
Tuborg Can	19	5.89	-0.01	-0.14	0.04	79%	21%	0%	74%
Carlsberg Hof	17	4.46	0.00	-0.14	-0.01	71%	0%	29%	47%
Tuborg Grøn	73	3.51	0.64	-0.14	-4.46	93%	1%	5%	27%
Tuborg Guld	72	7.19	-0.05	-0.18	0.25	93%	0%	7%	81%
Carlsberg Sort Guld	22	6.99	-0.08	-0.18	0.45	91%	0%	9%	82%
Total	365	5.45	0.08	-0.16	-0.62	90%	2%	7%	68%

Table 1: Continued.

Soft Drinks									
	♯ obs	**Base price**	**Price change**	**Tax increase (DKR)**	**Tax pass-through**	**Stores with undershifting (<0.9)**	**Stores with full pass-through (0.9-1.1)**	**Stores with overshifting (>1.1)**	**Stores with zero pass-through**
Event: January 1998									
Coca–Cola	55	7.23	0.35	0.13	2.82	27%	0%	73%	24%
Fanta	17	7.39	0.33	0.13	2.61	18%	0%	82%	12%
Pepsi Cola	27	7.13	0.36	0.13	2.84	15%	0%	85%	11%
Tuborg Squash	52	7.15	0.37	0.13	2.92	17%	0%	83%	17%
Total	212	6.56	0.33	0.13	2.64	20%	0%	80%	17%
January 2001									
Coca–Cola	86	8.21	1.01	0.41	2.49	34%	0%	66%	29%
Fanta	21	8.28	1.14	0.41	2.81	24%	0%	76%	24%
Faxe Kondi	2	7.50	1.73	0.41	4.25	0%	0%	100%	0%
Pepsi Cola	18	8.13	1.28	0.41	3.14	22%	0%	78%	17%
Tuborg Squash	29	8.49	1.05	0.41	2.58	17%	0%	83%	14%
Total	206	7.37	0.94	0.41	2.31	36%	0%	64%	24%
October 2003									
Coca–Cola	103	5.70	-0.23	-0.31	0.73	45%	40%	16%	21%
Fanta	7	6.49	-0.24	-0.31	0.76	57%	29%	14%	29%
Faxe Kondi	13	5.36	-0.28	-0.31	0.91	46%	31%	23%	31%
Pepsi Cola	4	7.06	-0.35	-0.31	1.12	50%	0%	50%	50%
Tuborg Squash	5	5.92	-0.13	-0.31	0.43	60%	40%	0%	60%
Coca–Cola Can	33	7.08	-0.09	-0.21	0.44	64%	27%	9%	64%
Total	211	6.06	-0.21	-0.29	0.72	54%	30%	16%	33%

Table 1: Continued.

Liqour									
	♯ obs	**Base price**	**Price change**	**Tax increase (DKR)**	**Tax pass-through**	**Stores with undershifting (<0.9)**	**Stores with full pass-through (0.9-1.1)**	**Stores with overshifting (>1.1)**	**Stores with zero pass-through**
Event: October 2003									
Jægermeister:	9	150.62	-38.48	-38.28	1.01	11%	89%	0%	0%
Cognac De Luze VSOP	5	272.99	-44.70	-43.75	1.02	0%	80%	20%	0%
Gammel Dansk	11	136.23	-43.11	-41.56	1.04	0%	100%	0%	0%
Gin, Gordon Dry	10	168.76	-40.03	-43.75	0.91	20%	80%	0%	0%
Liqueur, Cointreau	5	168.78	-34.20	-18.59	1.84	0%	0%	100%	0%
Whisky, Ballentine	5	199.92	-47.75	-43.75	1.09	20%	40%	40%	0%
Ålborg Taffel Akvavit	10	153.54	-50.32	-49.22	1.02	0%	100%	0%	0%
Total	155	171.75	-38.81	-37.30	1.09	21%	56%	23%	1%

Table 2: Testing whether tax pass–through is constant across brands.

Beer			
Product	May-97	Jan-05	
Carlsberg Hof	0.07	0.24	
Tuborg Grøn	0.10	<.0001	
Tuborg Guld	0.72	0.11	
Carlsberg Sort Guld	0.10	<.0001	
Carlsberg can	na.	0.62	
Tuborg can	na.	0.00	
Soft Drinks			
Product	Jan-98	Jan-01	Oct-03
Coca–Cola	<.0001	<.0001	0.02
Fanta	0.00	0.00	0.50
Faxe Kondi	na.	0.13	0.74
Pepsi Cola	0.00	0.00	0.86
Tuborg Squash	<.0001	<.0001	0.09
Coca–Cola can	na.	na.	<.0001
Liqour			
Product	Oct-03		
Jægermeister:	0.80		
Cognac De Luze VSOP	0.59		
Gammel Dansk	0.00		
Gin, Gordon Dry	0.03		
Liqueur, Cointreau	0.02		
Whisky, Ballentine	0.56		
Ålborg Taffel Akvavit	0.06		

Note: Results are based on regressions of tax pass–through on a constant and brand dummies. Only p–value of tests whether brand dummy variable is equal to unity are reported in the table.

Table 3: Regression results: Price change explained by base price.

Beer							
May-97							
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7
0.047	0.002						
(0.019)	(0.003)						
0.270	-0.028	-0.032	-0.043	-0.046			
(0.079)	(0.012)	(0.012)	(0.017)	(0.017)			
Jan-05							
0.220	-0.025						
(0.037)	(0.004)						
2.270	-0.337	-0.321	-0.505	-0.469	-0.383	-0.376	
(0.184)	(0.029)	(0.026)	(0.046)	(0.051)	(0.035)	(0.035)	
Soft drinks							
Jan-98							
0.101	0.035						
(0.068)	(0.010)						
0.315	0.000	0.000	0.000	0.000			
(0.052)	(0.000)	(0.000)	(0.000)	(0.000)			
Jan-01							
-0.080	0.138						
(0.187)	(0.024)						
-5.122	0.667	0.687	0.666	0.647	0.742		
(0.387)	(0.042)	(0.043)	(0.040)	(0.041)	(0.054)		
Oct-03							
-0.318	0.018						
(0.107)	(0.018)						
-0.862	0.121	0.115	0.113	0.082	0.126	0.109	
(0.156)	(0.029)	(0.036)	(0.034)	(0.029)	(0.034)	(0.023)	
Liquor							
Oct-03							
-25.932	-0.068						
(3.279)	(0.018)						
-16.510	-0.146	-0.219	-0.102	-0.195	-0.138	-0.107	-0.159
(6.374)	(0.044)	(0.043)	(0.024)	(0.048)	(0.039)	(0.037)	(0.034)

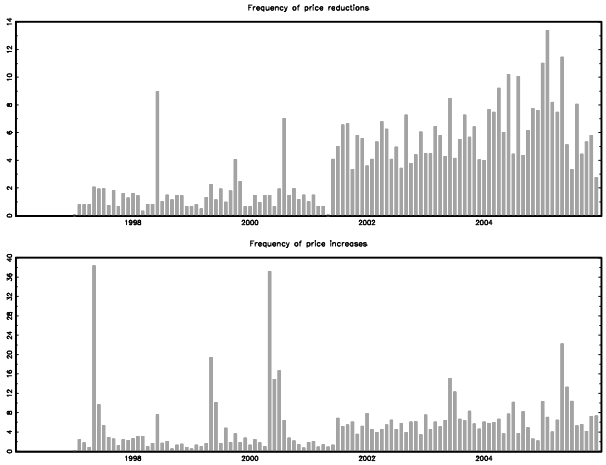
Note: All regressions are based on equation (7) in the text. Standard errors are shown below each estimate within parentheses.

Table 4: Border effects.

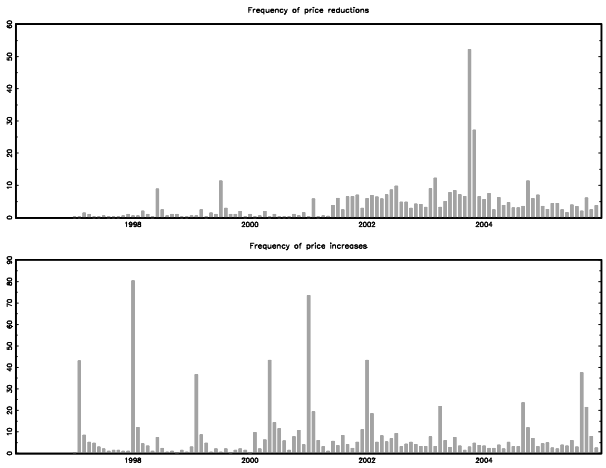
Beer						
May-97						
GE border	GE border (<50)	GE border (50–100)	GE border (100–150)	GE border (150–200)	GE border (>200)	SWE border
-0.000						
(0.000)						
	0.040	0.057	0.056	0.065	0.040	
	(0.028)	(0.025)	(0.021)	(0.026)	(0.020)	
	0.041	0.057	0.056	0.065	0.043	-0.018
	(0.028)	(0.025)	(0.021)	(0.026)	(0.020)	(0.020)
Jan-05						
-0.001						
(0.000)						
	0.344	0.256	0.295	0.182	0.183	
	(0.153)	(0.067)	(0.071)	(0.079)	(0.046)	
	0.340	0.252	0.292	0.179	0.202	-0.110
	(0.153)	(0.067)	(0.071)	(0.079)	(0.049)	(0.097)
Soft drinks						
Jan-98						
-0.001						
(0.000)						
	0.213	0.187	0.121	0.081	0.064	
	(0.090)	(0.082)	(0.070)	(0.087)	(0.069)	
	0.210	0.184	0.119	0.078	0.041	0.118
	(0.090)	(0.082)	(0.069)	(0.086)	(0.069)	(0.056)
Jan-01						
0.001						
(0.001)						
	-0.334	-0.289	0.059	-0.532	-0.083	
	(0.318)	(0.244)	(0.196)	(0.221)	(0.188)	
	-0.320	-0.276	0.071	-0.520	-0.107	0.223
	(0.318)	(0.244)	(0.196)	(0.221)	(0.189)	(0.182)
Oct-03						
-0.000						
(0.000)						
	-0.341	-0.313	-0.310	-0.251	-0.370	
	(0.161)	(0.115)	(0.114)	(0.129)	(0.114)	
	-0.345	-0.317	-0.314	-0.255	-0.360	-0.099
	(0.161)	(0.115)	(0.114)	(0.129)	(0.114)	(0.086)
Liquor						
Oct-03						
0.008						
(0.019)						
	-25.357	-25.765	-21.518			
	(3.557)	(3.409)	(6.577)			
	-26.347	-25.777	-21.729			0.221
	(3.574)	(3.428)	(7.744)			(4.253)

Note: Standard errors are shown below each estimate within parentheses. Swedish border is a dummy variable that takes on the value 1 for zip codes 1 and 3.

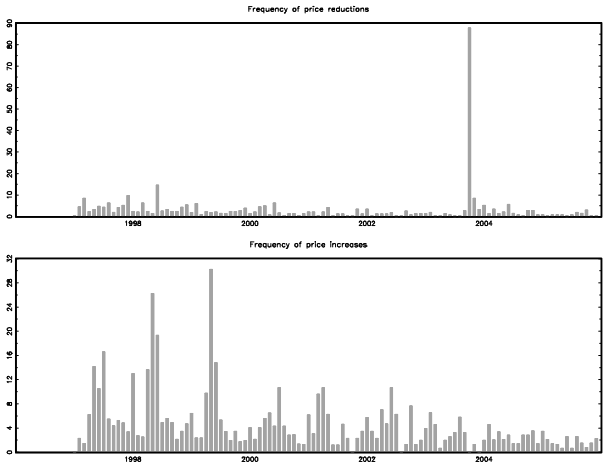
Figure 1: Frequency of price reductions and price increases.



(a) Beer



(b) Soft drinks



(c) Liquor

Figure 2: Tax pass-through across types of stores, beer and soft drinks.

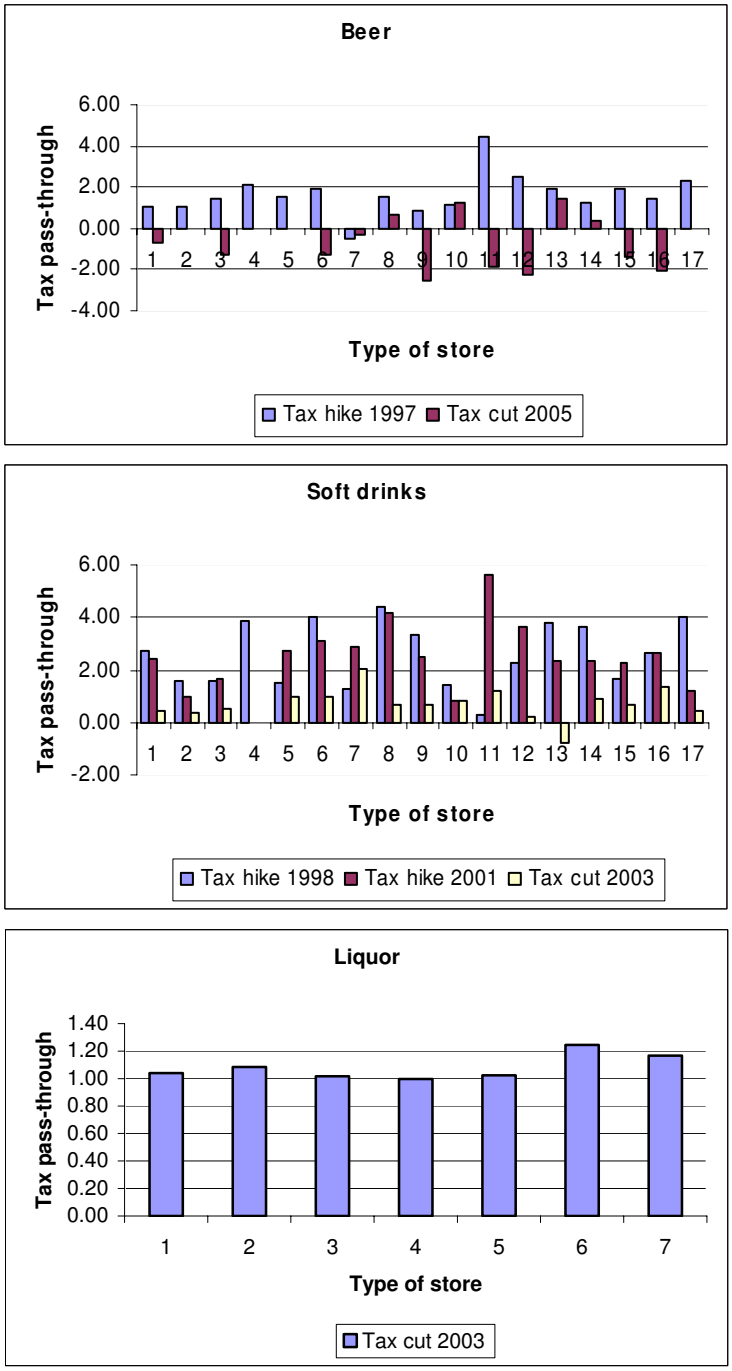


Figure 3: Fraction of undershifting, overshifting and full pass-through across types of stores, beer and soft drinks.

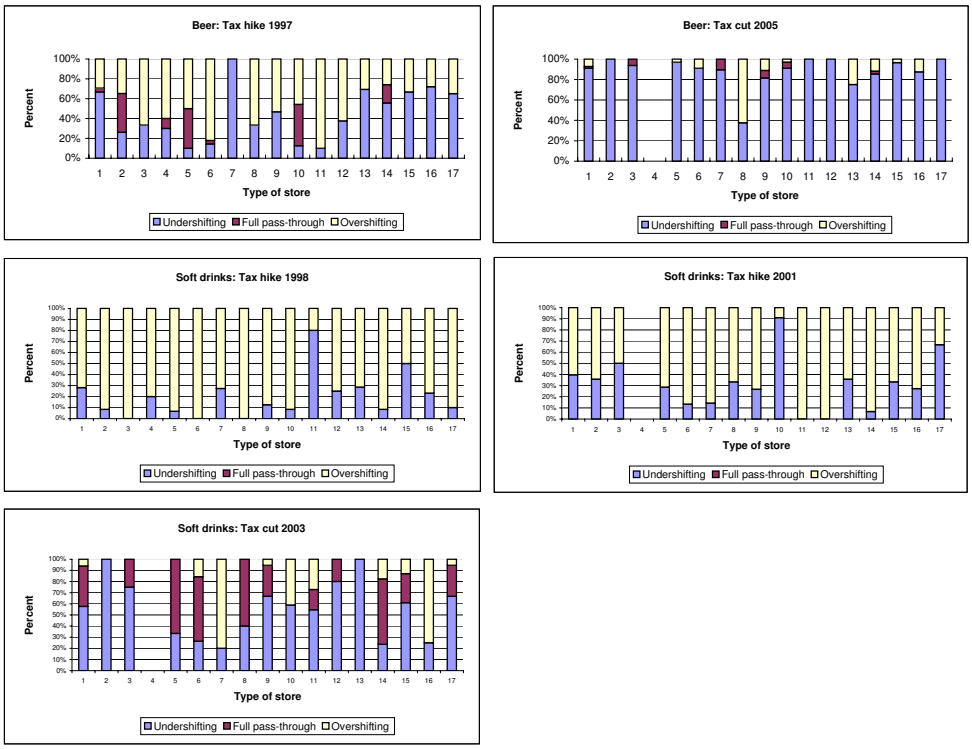


Figure 4: Fraction of undershifting, overshifting and full pass-through across zip codes.