WHO PAYS ALCOHOL TAXES?

AN ANALYSIS OF ALCOHOL TAX PASS-THROUGH USING SOUTH AFRICAN DATA

ABSTRACT

This paper uses South African alcohol price data from December 2001-May 2013 to estimate the effect of changes in alcohol excise taxes on retail prices for beer and spirits. It finds that consumers of beer pay not only the entire tax amount of a tax increase, but also a premium above the tax hike. As such, the tax is overshifted. In contrast, taxes on spirits are fully passed through to prices but not overshifted. There is evidence to suggest that pass-through differs across packaging types for beer, with 750ml bottles experiencing the lowest level of overshifting. These trends in pass-through have implications for public health policy insofar as high levels of tax-shifting to prices increase the effectiveness of alcohol taxes as a tool to reduce excessive consumption and alcohol-related externalities.

1. INTRODUCTION

Central to the topic of public economics is the question of who bears the burden of taxes. Are taxes fully passed through to consumers, or do firms absorb some of the tax themselves? This question is particularly pertinent for a “sin” product such as alcohol, for which tax hikes are often considered a policy to reduce excessive consumption and alcohol- related externalities. To this end, the pass-through of the tax provides the crucial link between the implementation of a tax and its ability to affect consumer behaviour.

The incidence of taxation on a theoretical level is a long-established topic of research in microeconomics. However, the growing focus on empirical tax incidence studies, particularly for tobacco and alcohol, is a more recent development.[1] Studies from this literature have produced a wide range of results, providing evidence to support undershifting, full pass-through and overshifting, depending on the products and brands studied as well as the methods used. This wide range of tax-shifting results suggests that the question of tax incidence cannot always be clearly predicted by theory and that an empirical analysis may be required (Young and Bielińska-Kwapisz, 2002).

This paper seeks to estimate the effect of changes in alcohol excise taxes on retail prices of alcohol in South Africa, with the aim of drawing conclusions regarding the levels of undershifting, full pass-through and overshifting. To do so, South African alcohol price data for December 2001 - May 2013 is used to conduct an ordinary least squares (OLS) estimation of price changes on tax changes.[2] This paper conducts an individual brand analysis of pass-through, as well as a pooled model of pass-through for the individual alcohol categories. Full pass-through occurs if a tax hike increases prices by the amount of the tax. If prices increase by more than the tax increase, there is evidence to suggest overshifting. Conversely, prices that increase by less than the tax hike suggest undershifting. This paper focuses on categories of beer (including lager and dark beer) and spirits (including brandy, liqueur and whisky).

Previous empirical tax incidence studies have focused on products and markets in the United States (U.S.) and Europe, particularly on the cigarette industry, and to a smaller extent, the alcohol industry. This paper attempts to add to this literature by exploring the pass-through of taxes to prices in South Africa. Additionally, this paper considers the link between baseline

[1] Examples of recent empirical tax incidence studies for tobacco and alcohol include: Young and Bielińska-Kwapisz (2002), Kenkel (2005), Bergman and Hansen (2009), Hanson and Sullivan (2009), Sullivan and Dutkowsky (2012) and Espinosa and Evans (2012).
[2] Unfortunately, there is a gap in the data for the years 2006-2007.

brand prices and level of pass-through, where the baseline price refers to the price for a particular brand prior to any tax changes. There are no uniform conclusions regarding this relationship in the literature and it has not yet been explored in a South African context. Conclusions regarding the shifting of alcohol taxes to prices provide meaningful insight for policy-making to the extent that tax-shifting influences the effectiveness of alcohol taxation as a public health policy to reduce excessive consumption.

Section 2 provides an overview of the empirical tax incidence literature. A framework to illustrate how changes in taxes affect prices is presented in Section 3. Section 4 outlines the data used. Section 5 comprises the empirical methodology and regression results for the individual brand analysis and the pooled model for each alcohol category. Section 6 highlights caveats regarding the research. Section 7 concludes.

2. LITERATURE REVIEW

2.1 Tax Pass-through across Different Products

The existing literature on empirical tax incidence has produced a wide range of results. There is considerable heterogeneity in tax incidence across different products, with overshifting for some goods and undershifting for other types of goods.

Studies of sales tax incidence for different commodities generate the most varying results. Poterba (1996) finds negligible evidence of tax overshifting for clothing and personal care products across U.S. cities during 1947-1977. In contrast, for the period 1925-1938, he finds undershifting for clothing prices and cases of overshifting and undershifting for personal care items. Furthering this work, Besley and Rosen (1998) estimate the effect of sales taxes for specific retail products and find a variety of patterns: for some commodities there is full pass-through, but for others the tax is overshifted. There is also a literature considering gasoline tax incidence, which exhibits some heterogeneity in the results across different studies. However, most results suggest that gasoline taxes are not over-shifted to consumers (Chouinard and Perloff, 2004; Doyle and Samphantharak, 2008; Alm *et al*, 2009; Marion and Muehlegger, 2011).

There is more homogeneity in tax incidence results for the literature focusing on one type of product. Cigarette tax incidence has been extensively researched, generating results that support overshifting in most cases. Early studies in the U.S report overshifting of cigarette taxes with a $1 tax increase resulting in a $1.07 price increase, according to Barzel (1976) and a price increase greater than $2, according to Harris (1987). Later studies obtain comparable estimates of overshifting (Keeler *et al*, 1996; Hanson and Sullivan, 2009; Sullivan and Dutkowsky, 2013).[3]

These results are contrasted with those of Espinosa and Evans (2012) who report evidence of full pass-through of cigarette taxes but no overshifting. Exploiting variation in cigarette taxes and prices within different U.S. markets over time, they estimate that a $1 tax hike raises prices by $0.99. In contrast, Delipalla and O'Donnell (2001) find evidence of undershifting and overshifting of ad valorem and specific cigarette taxes for different European countries, with tax undershifting observed for a group of northern European countries and overshifting observed for the remainder group of predominantly southern European countries. It is likely that the use of different control variables, data, focus periods and estimation techniques have contributed to the wide variability in these results (Sullivan and Dutkowsky, 2012).

Concurring with the findings of cigarette tax incidence, the literature on alcohol taxes suggests that taxes are overshifted to prices. Kenkel (2005) uses a tax hike in Alaska to estimate tax pass-through rates for specific brands of alcohol. He estimates pass-through rates that are significantly greater than one for beer, wine and spirits, indicating overshifting of the tax. His findings indicate a large degree of within-category homogeneity in tax pass-through rates across the most popular brands, with mean pass-through rates of 2 for beer and spirits sold off-premise and higher mean pass-through rates of between 3-4 for on-premise wine and on-premise spirits. Controlling for the effects across states and time, Young and Bielińska-Kwapisz (2002) also observe comparable overshifting of U.S. state and federal alcohol taxes to prices for beer, wine and spirits. Their estimates of tax-pass through suggest less tax overshifting for beer than for spirits and wine, with a $1 tax hike raising prices by $1.05-$1.86 for beer, $1.33-$3.01 for spirits, and $1.73-$2.44 for wine.[4] Bergman and Hansen (2009) too find evidence of overshifting of alcohol taxes. Their calculations of average tax pass-through rates suggest that a $1 take hike raises beer prices by $1.35 on average.[5]

[3] A $1 state tax hike is found to increase prices by $1.11 according to Keeler *et al* (1996), by $1.10-$1.14 according to Sullivan and Dutkowsky (2012) and by $1.08- $1.17 for Hanson and Sullivan (2009).

[4] These ranges result from different specifications of the estimated fixed effects regressions of beverage prices on alcohol taxes. Variations of the specifications include: The inclusion of lagged tax variables and the restriction of lagged tax variables to zero and correction for serial correlation. For spirits and wine, the range also includes the different estimates obtained for "control" states subject to ad valorem mark-up and/or excise taxes and "license" states subject to a per unit excise tax.

[5] Conversely, they find evidence of undershifting when there is a tax cut. They estimate a $0.27 decrease in price resulting from a $1 tax cut.

2.2 Pass-through and Baseline Prices

The literature highlights several factors that may determine the degree of pass-through. One of the determinants considered is the baseline price, or the product price prior to any tax changes. While it is plausible that baseline product prices may affect the extent of tax pass-through, the evidence from the literature on this subject is mixed. Simple regressions of price changes on baseline prices can be used to illustrate a relationship between the baseline price of a brand and the extent of tax pass-through (Kenkel, 2005; Bergman and Hansen, 2009). However, these studies yield conflicting results. Kenkel (2005) finds that stores with higher baseline prices for a given brand of alcohol exhibit less overshifting than other stores and that those with the lowest baseline prices exhibit above average pass-through rates. This finding is compatible with the argument that stores with prices closer to marginal cost are less able to bear the burden of the tax, resulting in more overshifting (Carbonnier, 2007). In contrast, Bergman and Hansen (2009) find that stores with higher baseline prices for beer and soft drinks exhibit more overshifting in the face of a tax hike. [6]

Other works in the literature find no significant differential effects in tax pass-through across baseline brand prices. Sullivan and Dutkowsky (2012) find similar estimates of tax overshifting across premium and generic brands of cigarettes for different U.S. states. Other studies of U.S. cigarette taxes also yield this result (Hanson and Sullivan, 2009; Espinosa and Evans, 2012).

2.3 Geographical Determinants of Pass-through

Geographical factors may also determine the degree of tax pass-through. The proximity of retailers to borders of lower-taxed states or countries is expected to result in less tax overshifting, since consumers have the option of a lower-cost substitute nearby. Controlling for costs, and area and time effects, cigarette prices tend to be lower for stores located near states with lower tax rates than stores located near states with similar or higher tax rates (Sullivan and Dutkowsky, 2012). [7] Hanson and Sullivan (2009) also find that this is true of Wisconsin's cigarette prices, with reference to the state borders of Minnesota (where tobacco taxes are lower) and the Michigan border (where tobacco taxes are higher). Doyle and

[6] Bergman and Hansen (2009) find the opposite result for tax cuts- stores that charged higher prices passed on less of the tax cut to their customers. This is true for all tax cuts observed except for the 2003 tax cut on soft drinks.

[7] This result of Sullivan and Dutkowsky (2012) is only applicable for urban areas; the relationship between tax pass-through in rural areas and distances to state borders is not analysed.

Samphantharak (2008) concur with these findings. Following the reinstatement of gasoline sales taxes in Illinois and Indiana, they find that prices for gasoline are lower closer to state borders and higher further away from the borders. Bergman and Hansen (2009) also investigate differences in tax incidence for beverages across regions and borders. Although they find differences in tax incidence across regions, their results are not consistent across the categories of beverages and across the six tax changes studied.

2.4 The Speed of Tax-Shifting

An analysis of the extent of tax shifting necessitates a discussion of how quickly the tax changes are absorbed into prices. While tax shifting may not occur instantaneously, the literature suggests that tax changes are incorporated into prices relatively quickly. Besley and Rosen (1998) find a short adjustment period, suggesting that taxes are passed through to prices within three months. A later study by Young and Bielińska-Kwapisz (2002) concurs with this result. Evidence from Carbonnier (2007) proposes an even shorter adjustment period – for French sales taxes in both the housing repair and new car market, almost all of the tax shifting occurs within the first two month after the tax reforms. Additionally, evidence from the gasoline market indicates that almost the entire effect of the tax change is reflected in prices immediately (Alm *et al*, 2009; Marion and Muehlegger, 2011).

2.5 Summary

An analysis of the tax incidence literature reveals substantial heterogeneity in the results, with a variety of factors determining how taxes are passed through to prices. A significant body of this literature focuses on the incidence of cigarette taxation, and in more recent years, alcohol taxation. These studies have mainly focused on the U.S. and Europe. This work will attempt to add to the literature by evaluating the extent to which taxes on beer and spirits are passed through to prices in South Africa. An understanding of the trends in tax pass-through would provide meaningful insight for policy-making insofar as higher levels of tax-shifting increase the effectiveness of alcohol taxation as a public health tool to reduce excessive consumption.

3. A FRAMEWORK FOR TAX PASS-THROUGH

A discussion of the extent to which taxes are passed through to prices necessitates an understanding of the mechanisms through which taxes affect consumers. Basic microeconomic theory says that the incidence of a tax depends on the elasticity of demand and supply and the market structure. In general, when demand and supply elasticities are similar, theory predicts that the tax burden is shared between the buyer and the seller. In a perfectly competitive market, with perfectly elastic supply, as is the case when marginal costs are constant, the price of a good rises, at most, by the full amount of the tax of the tax (Kenkel, 2005).

In analysing tax pass-through under perfect competition, Marion and Muehlegger (2011) point to the well-known formula for tax incidence:

$$\frac{\partial p}{\partial t} = \frac{\eta}{\eta - \mathcal{E}} \tag{1}$$

Where: η and $\mathcal{E}$ are the price elasticities of supply and demand, respectively.

The formula in (1) shows the tax pass-through rate increasing with the elasticity of supply, but decreasing with the elasticity of demand. Therefore, the expectation is that alcohol brands for which the demand elasticity is low will have high rates of observed tax pass-through. Additionally, since pass-through depends on the elasticity of supply and demand, the formula implies a pass-through that is less than or equal to one. Thus, in a competitive market, there can be no overshifting; buyers and sellers share the burden of the tax increase, with the retail price increasing by the amount of the tax increase at most.

However, it is possible that the tax is more than fully passed through to the consumer. In the case of imperfectly competitive markets, which are likely to be more representative of the alcohol industry, prices may rise by more than the amount of the tax change. For example, in the case of a monopoly with a constant marginal cost, a unit elastic demand curve will always result in the price rising by more than the tax (Delipalla and Keen, 1992; Young and Bielińska-Kwapisz, 2002). Young and Bielińska-Kwapisz (2002) also argue that taxes are over-shifted when the industry supply curve is downward sloping. In this case, individual firms may have economies of scale so that average costs decline as production increases. A tax that reduces quantity demanded will force firms to operate at a lower level of production and a higher level of average cost. Prices will be higher as a result of the tax, and also because firms have to cover the increased production costs incurred at lower production levels. This results in a price increase greater than the tax hike.

Additionally, Anderson *et al* (2001) argue that any unit tax can be overshifted in an oligopolistic industry where there are differentiated products and price-setting firms. Under Bertrand competition, firms may increase their prices in response to price increases by competitors. The combined effect of the tax hike and the firms' response to competitors' behaviour results in tax overshifting to prices. Sticky prices may also be able to explain overshifting. While it is costly to adjust prices frequently, retailers face lower profits if costs increase over time and prices are not adjusted. If this is the case, retailers facing a tax hike may raise prices by more than the tax increase to sustain profits until the next price adjustment (Sullivan and Dutkowsky, 2012).

The example of a simple monopoly can be used to build a framework within which the effects of taxes on price can be assessed for a market that is not perfectly competitive. To this end, the standard formula between marginal revenue, price and elasticity can be derived. Consider a market comprising of a single alcohol seller. The firm sells a quantity of alcohol, Q, at a tax-inclusive retail price, P. A constant marginal cost is assumed and the tax rate per unit of alcohol is t. Total revenue is given by: $TR = P(Q).Q$, where, unlike under perfect competition, price is a function of the quantity of alcohol sold.

Deriving the total revenue formula with respect to Q yields the marginal revenue formula:

$$MR = \frac{\partial TR}{\partial Q} = \frac{\partial P}{\partial Q}Q + P(Q)$$

Multiplication by $\frac{Q}{P}$, and substituting in the demand elasticity formula, $\mathcal{E} = \frac{\partial Q}{\partial p} \times \frac{P}{Q}$, yields the following formula (Young and Bielińska-Kwapisz, 2002):

$$MR = P\left(1 - \frac{1}{\mathcal{E}}\right) \tag{2}$$

As in Young and Bielińska-Kwapisz (2002), the firm profit-maximising condition can be re-written to include the tax per unit of alcohol as: $MR = MC + t$. Substitution of this formula into (2) above yields:

$$P = (MC + t)\frac{\mathcal{E}}{\mathcal{E} - 1} \tag{3}$$

Profit-maximisation for a simple monopoly requires production on the elastic portion of the demand curve, implying that $\mathcal{E} > 1$ (Parkin *et al*, 2010). However, formula (3) implies that for $\mathcal{E} > 1$, the tax is overshifted; the price increases by more than the tax increase. Thus, overshifting is a possible outcome in market structures other than perfect competition. However, the occurrence of overshifting is not indicative of any particular market structure; it is simply inconsistent with perfect competition (Besley and Rosen, 1998). This model also supports the negative relationship between pass-through and demand elasticity observed under perfect competition. From the formula in (3), it is clear that as elasticity of demand, $\mathcal{E}$, increases, so the factor $\frac{\varepsilon}{\varepsilon-1}$ decreases, resulting in a lower degree of tax-shifting.

Theory predicts a variety of tax-shifting possibilities, depending on the level of competition in the market. This is evidenced by the wide range of results in the empirical literature, including overshifting, full pass-through and undershifting. These varying outcomes point to the need for empirical pass-through analysis. Consistent across all market structures is the theoretical prediction that the demand elasticity for a product is an important determinant of pass-through, with the degree of pass-through increasing as the demand elasticity decreases. Within this framework, the relationship between pass-through and baseline prices (prices prior to any tax changes) as well as packaging type will also be considered.

4. DATA

The data is sourced from Statistics South Africa (StatsSA), which conducts detailed surveys of consumer goods prices for the computation of monthly figures for the Consumer Price Index (CPI). The dataset comprises monthly tax-inclusive price data for beer, wine and spirits.[8] These categories are covered by brand and by packaging type. Information regarding the geographical location of a retail outlet or the type of outlet is not available. Due to confidentiality restrictions, the anonymity of all brands is retained.

The data spans the period December 2001 - May 2013, with a gap in the data for 2006-2007. The coverage of the various brands has changed over the period, such that some brands have missing data over certain periods (usually 2001-2005), resulting in an unbalanced panel. However, there is no reason to believe that this leads to a bias of the sample since the exclusion of certain brands for monitoring for certain periods by StatsSA is unlikely to be correlated with unobserved factors that may affect prices for that brand. Additionally, since the most well-known and widely covered brands are included in the sample, the brands considered are likely to cover a significant percentage of the total alcohol market. Despite the missing periods, the size of the raw dataset is substantial, containing 201 085 price observations, comprising 66 425 beer observations, 91 327 spirits observations, 43 303 wine observations and 30 flavoured alcoholic beverage observations.

[8] The beer category comprises: ale, dark beer, lager, non-alcoholic beer and shandy. The wine category covers red wine, rose and white wine. Lastly, the spirits category comprises brandy, cane, liqueur, vodka and whisky.

The analysis is restricted to the most well-known and extensively monitored alcohol categories. For the beer category, lager and dark beer are considered as these categories present a number of brands and different packaging types that have been monitored extensively. For spirits, the analysis focuses on brandy, liqueur and whisky, for which there is substantial data over the entire survey period. In comparison, data is unavailable for vodka for 2008-2013 and there is only limited coverage of cane prices. For simplicity, wine is excluded from this study as wine, unlike beer and spirits, is taxed on volume, rather than by percentage of absolute alcohol. It would be worthwhile to extend this analysis to wine in future work.

The data covers a wide range of brands and types of packaging (units of volume). This analysis only considers 750ml packaging for spirits as this is the standard volume. Beer is the only category with relatively large numbers of observations across many different units of volume, namely 330ml/340ml (individual cans), 750ml (bottles) and 6×330ml/6×340ml (six-pack of 330ml/340ml cans). Since there is only a negligible difference in volume between a 330ml and 340ml can, these two volumes are treated as being the same for the sake of this analysis. Thus, three main volumes are considered: 340ml, 750ml and 6×340ml.

For each alcohol category, only the most well-known and extensively monitored brands are considered. For lager, six different brands are considered in each of the three packaging types, yielding 17 unique brand and volume combinations.[9] For the dark beer category, where brand coverage is more limited, only one brand is included for the three packaging types, with one additional brand considered in the 340ml packaging only. For brandy and liqueur, eight brands are considered, while for whisky, nine brands are considered.

Each unique combination of brand and packaging type is assigned a brand identification number and treated as a different type of brand. For clarity, this paper refers to each unique brand and packaging combination as a "brand", while the "brand category" includes all packaging types for a specific brand. For example, lager brand A (340ml) is treated as a different "brand" to lager brand A (750ml), although they belong to the same "brand category". This distinction is only relevant for beer, where multiple packaging types are considered.

[9] Lager brand C is the only brand for which 750ml packaging is not considered. This is because there was not enough data available for this brand for this type of packaging.

The substantial dataset contains multiple monthly observations for each unique brand and packaging combination. This is used to construct an average "representative" monthly price for each brand. This is also the approach of Besley and Rosen (1998). Since the price variable comprises monthly average prices for each brand, great care was taken to ensure that all monthly averages were derived from a large enough sample of component prices and to remove any outliers and errors in collection that might bias the monthly average.

All brands included in the analysis are required to have at least three component prices per month from which to base the average price calculation for that month. Periods for which brands did not have this required number of observations were not considered in the analysis, as average prices derived from a limited number of observations may not be representative. Furthermore, for each brand, observations were removed if the nominal price exceeded the average price by more than three standard deviations of the average price, for each of the months considered. Observations whose price deviation was more than 50% of the average monthly price were also excluded from the analysis. This resulted in the removal of a total of 360 observations. The data sample from which the average price variables were derived consists of 115 214 observations, yielding a total of 5330 unique monthly average price observations for the brands selected for the analysis.

For all empirical work and discussion, prices and taxes were converted to per litre equivalent. Real (inflation-adjusted) equivalents of the nominal variables were obtained by deflating these variables by the CPI index, given by StatsSA. The index base is December 2012.

5. EMPIRICAL METHODOLOGY AND REGRESSION RESULTS

This section estimates the effects of changes in taxes on price changes for individual brands, as well as for categories of lager, dark beer, brandy, liqueur and whisky. A first difference transformation is used, resulting in one monthly observation being lost at the beginning of every sample for every brand. Additionally, since data is missing for 2006-2007, the first observation after the data gap (the January 2008 observation in most cases) was removed for each brand.

The basic model is of the form:

$$\Delta P_t = \propto + B_1 \Delta T_t + u_t \quad (4)$$

Where ΔP_t is the difference in price from one month to the next in rands per litre, ΔT_t is the difference in the excise tax amount from one month to the next, in rands per litre, u_t is the error term and t=1,…,T represents the monthly time periods.

The tax-shifting parameter, β_1, is the main coefficient of interest. β_1 is expected to be positive, since an increase in tax is expected to increase prices. If there is full tax pass-through, then β_1 is expected to be close to 1.14. Retail alcohol prices in South Africa are inclusive of excise tax and value-added tax (VAT), currently levied at 14%. Accordingly, under full pass-through, a R1.00 increase in excise tax is expected to increase final tax- and VAT-inclusive prices by R1.14.[10] A coefficient greater than 1.14 indicates that prices rise by more than the tax increase, suggesting overshifting. Conversely, a coefficient less than 1.14 indicates that prices rise by less than the tax increase, suggesting undershifting.

The model in (4) is estimated by OLS for nominal and real variable equivalents. For the model in nominal terms, all nominal prices and taxes are used and an inflation variable is included in the regression. For the model in real terms, all price and tax variables are deflated by the CPI.

The nominal model is of the form:

$$\Delta P_t = \propto + B_1 \Delta T_t + Inflation + u_t \quad (5)$$

Where ΔP_t represents the difference in nominal prices from one month to the next, ΔT_t represents the difference in nominal taxes from one month to the next and the $Inflation$ variable is calculated as the percentage change in the Consumer Price Index (CPI), where Inflation = $(CPI_t - CPI_{t-1})/CPI_{t-1}$.

[10] Most studies in the literature use prices that are exclusive of sales tax or VAT and therefore use a tax coefficient of one as an indication of full pass-through.

The real model is of the form:

$$\Delta P_t = \propto + B_1 \Delta T_t + u_t \quad (6)$$

Where ΔP_t represents the difference in real (inflation-adjusted) prices from one month to the next and ΔT_t represents the difference in real (inflation-adjusted) taxes from one month to the next.

The individual brand analysis presents the estimations of the models in (5) and (6) for each brand within the categories of lager, dark beer, brandy, liqueur and whisky. For each category, the estimates based on nominal variables (5) and those based on real variables (6) are presented separately. For each brand, the coefficient on the tax variable, $\beta_{1,}$ is reported with its accompanying summary statistics, as well as the estimate for the constant, α. All standard errors are corrected for heteroskedasticity and all estimates use robust (Huber) standard errors.

5.1 INDIVIDUAL BRAND ANALYSIS FOR BEER

5.1.1 Tax Pass-Through for Lager

The regression results in Tables 1A and 1B below show that consumers pay the entire increase in excise tax, as well as a premium above the tax increase. This is true for almost all of the brands studied; 16 of the 17 lager brands present tax-shifting coefficients that exceed 1.14 in the nominal model and 15 of the 17 lager display coefficients greater than 1.14 in the real model. There is substantial variation in the level of overshifting across different lager brands, with the overshifting β_1 estimates ranging from 1.38-5.13 in Table 1A and 1.91-5.23 in Table 1B. This suggests that a R1.00 tax increase results in a price increase of R1.38-R5.13 on average, using the nominal model or R1.91-R5.23 on average, using the real model. These estimates suggest a larger degree of overshifting than has been found for beer in the literature, but they are not dissimilar to results that have been obtained for other alcohol categories (Young and Bielińska-Kwapisz, 2002; Kenkel, 2005; Bergman and Hansen, 2009). Additionally, there are some brands presenting tax-shifting coefficients in the range of 2.00-3.00, which are consistent with beer tax-shifting estimates obtained by Kenkel (2005).

There are some unexpected results. Lager brand F (750ml) presents a small negative tax-shifting parameter, in the nominal and real models. The price data reveals that this brand experiences small, or even negative price changes in the month of the tax change, accompanied by an upwards price adjustment in later months. This suggests that further analysis using a dynamic model, where the impact of tax changes on changes in prices is considered over a longer period, such as two or three months. This is acknowledged as a potential area of future study.

TABLE 1A: **BRAND-SPECIFIC PASS-THROUGH FOR LAGER USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

LAGER BRAND	α, Constant	β1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A (340ml)	0.06***	5.07***	(1.19)	4.27	0.00	2.72 - 7.42	112	0.52	Overshifting
Brand A (750ml)	0.02	2.80***	(0.52)	5.35	0.00	1.76 - 3.85	64	0.58	Overshifting
Brand A (6×340ml)	0.04**	3.81***	(0.92)	4.12	0.00	1.98 - 5.64	110	0.50	Overshifting
Brand B (340ml)	0.06**	4.78***	(0.95)	5.05	0.00	2.90 - 6.65	112	0.49	Overshifting
Brand B (750ml)	0.03*	2.00***	(0.30)	6.59	0.00	1.39 - 2.61	64	0.61	Overshifting
Brand B (6×340ml)	0.04	3.92***	(0.87)	4.50	0.00	2.18 - 5.65	64	0.53	Overshifting
Brand C (340ml)	0.13***	4.22***	(0.96)	4.40	0.00	2.30 - 6.14	64	0.40	Overshifting
Brand C (6×340ml)	0.06	4.65***	(0.81)	5.72	0.00	3.03 - 6.27	64	0.52	Overshifting
Brand D (340ml)	0.13**	4.64***	(1.10)	4.21	0.00	2.43 - 6.85	64	0.34	Overshifting
Brand D (750ml)	0.04	1.38	(0.92)	1.50	0.14	-0.46 - 3.23	64	0.07	Full Shifting
Brand D (6×340ml)	0.04	5.04***	(1.29)	3.91	0.00	2.46 - 7.62	64	0.56	Overshifting
Brand E (340ml)	0.02	5.13***	(1.40)	3.67	0.00	2.36 - 7.90	100	0.38	Overshifting
Brand E (750 ml)	0.01	2.65***	(0.64)	4.11	0.00	1.36 - 3.93	60	0.57	Overshifting
Brand E (6×340ml)	0.02	4.54***	(1.05)	4.33	0.00	2.44 - 6.63	64	0.60	Overshifting
Brand F (340ml)	0.06**	3.61***	(1.36)	2.65	0.01	0.91 - 6.31	112	0.25	Full Shifting
Brand F (750ml)	0.03	-0.14	(0.96)	-0.14	0.89	-2.07 - 1.80	49	0.01	Full Shifting
Brand F (6×340ml)	0.04	3.13***	(0.79)	3.94	0.00	1.54 - 4.72	64	0.34	Overshifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14

Although the 95% confidence intervals for the lager tax-shifting estimates tend to be large, most do not contain the full pass-through estimate of 1.14. This is true for 14 of the 17 brands in the nominal model and 15 of the 17 brands in the real model, supporting the conclusion of overshifting. For the remaining brands in the nominal and real models, the β_1 estimates do not equal 1.14, suggesting overshifting in some instances and undershifting in others. However, that the confidence intervals of these estimates contain the full pass-through estimate, suggests that taxes are fully passed through to prices for these brands. Thus, the evidence largely supports overshifting of lager taxes, with full pass-through for a small number of brands.

TABLE 1B: **BRAND-SPECIFIC PASS-THROUGH FOR LAGER USING REAL VARIABLES**

Dependent Variable: ΔPrice

LAGER BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A (340ml)	0.02	4.25***	(1.14)	3.73	0.00	1.99 - 6.50	112	0.40	Overshifting
Brand A (750ml)	-0.01	2.85***	(0.49)	5.82	0.00	1.87 - 3.83	64	0.52	Overshifting
Brand A (6×340ml)	0.02	3.84***	(0.87)	4.40	0.00	2.11 - 5.57	110	0.45	Overshifting
Brand B (340ml)	0.01	3.95***	(1.02)	3.86	0.00	1.92 - 5.98	112	0.35	Overshifting
Brand B (750ml)	0.01	1.91***	(0.28)	6.83	0.00	1.35 - 2.47	64	0.52	Overshifting
Brand B (6×340ml)	0.01	3.69***	(0.80)	4.60	0.00	2.09 - 5.29	64	0.45	Overshifting
Brand C (340ml)	0.02	4.03***	(0.97)	4.15	0.00	2.09 - 5.97	64	0.34	Overshifting
Brand C (6×340ml)	0.00	4.37***	(0.78)	5.62	0.00	2.81 - 5.92	64	0.43	Overshifting
Brand D (340ml)	0.01	3.95***	(1.03)	3.82	0.00	1.88 - 6.01	64	0.25	Overshifting
Brand D (750ml)	-0.00	0.96	(0.80)	1.21	0.23	-0.63 - 2.55	64	0.02	Full Shifting
Brand D (6×340ml)	0.01	4.90***	(1.12)	4.37	0.00	2.66 - 7.15	64	0.51	Overshifting
Brand E (340ml)	0.04	4.35***	(1.26)	3.47	0.00	1.86 - 6.84	100	0.17	Overshifting
Brand E (750 ml)	-0.00	2.58***	(0.57)	4.49	0.00	1.43 - 3.73	60	0.49	Overshifting
Brand E (6×340ml)	0.00	4.47***	(0.91)	4.93	0.00	2.66 - 6.28	64	0.53	Overshifting
Brand F (340ml)	0.04	5.23***	(1.72)	3.05	0.00	1.83 - 8.64	112	0.32	Overshifting
Brand F (750ml)	0.00	-0.16	(0.77)	-0.21	0.84	-1.71 - 1.39	49	0.00	Full Shifting
Brand F (6×340ml)	-0.00	3.26***	(0.79)	4.12	0.00	1.68 - 4.85	64	0.32	Overshifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14

While this paper focuses on the tax-shifting parameters, the time trend evident in prices can also be analysed by interpreting the constant terms, α, from the regression. These terms represent the average monthly increase in the price that is not due to a tax change. These values are expected to be positive for prices in nominal terms, but could be negative or positive for prices in real terms. Negative values for α are not expected in the nominal model since nominal prices tend to increase over time. The findings in Tables 1A and 1B are consistent with these expectations.

5.1.2 Tax Pass-Through for Dark Beer

The regression results for dark beer shown in Table 2A and 2B concur with the picture for lager above. Three of the four dark beer brands present tax-shifting coefficients that exceed 1.14 in both the nominal and real models. Supporting the conclusion of overshifting, the 95% confidence intervals for these β_1 estimates do not contain the full pass-through estimate. Dark beer brand A (750ml) is the only brand that does not display strong evidence of overshifting and whose β_1 estimate suggests a result closer to full pass-through. Lastly, the tax-shifting coefficient for dark beer brand B (340ml) using nominal and real variables is implausibly high, as this brand appears to have experienced substantial price increases in response to even modest tax changes. Due to this anomalous result, this brand is excluded from further analysis.

***TABLE 2A:* BRAND-SPECIFIC PASS-THROUGH FOR DARK BEER USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

DARK BEER BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A (340ml)	0.04***	2.81***	(0.66)	4.24	0.00	1.50 - 4.13	101	0.81	Overshifting
Brand A (750ml)	0.03	1.24**	(0.50)	2.51	0.02	0.25 - 2.24	52	0.10	Full Shifting
Brand A (6×340ml)	0.00	3.69***	(1.05)	3.50	0.00	1.57 - 5.80	52	0.67	Overshifting
Brand B (340ml)	-0.05	20.77**	(8.05)	2.58	0.01	4.57 - 36.98	48	0.43	Overshifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14

***TABLE 2B:* BRAND-SPECIFIC PASS-THROUGH FOR DARK BEER USING REAL VARIABLES**

Dependent Variable: ΔPrice

DARK BEER BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A (340ml)	0.01	3.75***	(0.98)	3.83	0.00	1.81 - 5.69	102	0.55	Overshifting
Brand A (750ml)	-0.01	1.11**	(0.46)	2.43	0.02	0.19 - 2.02	52	0.06	Full Shifting
Brand A (6×340ml)	0.02	3.87***	(0.96)	4.01	0.00	1.93 - 5.81	52	0.61	Overshifting
Brand B (340ml)	0.04	22.67**	(8.67)	2.61	0.01	5.21 - 40.13	48	0.40	Overshifting

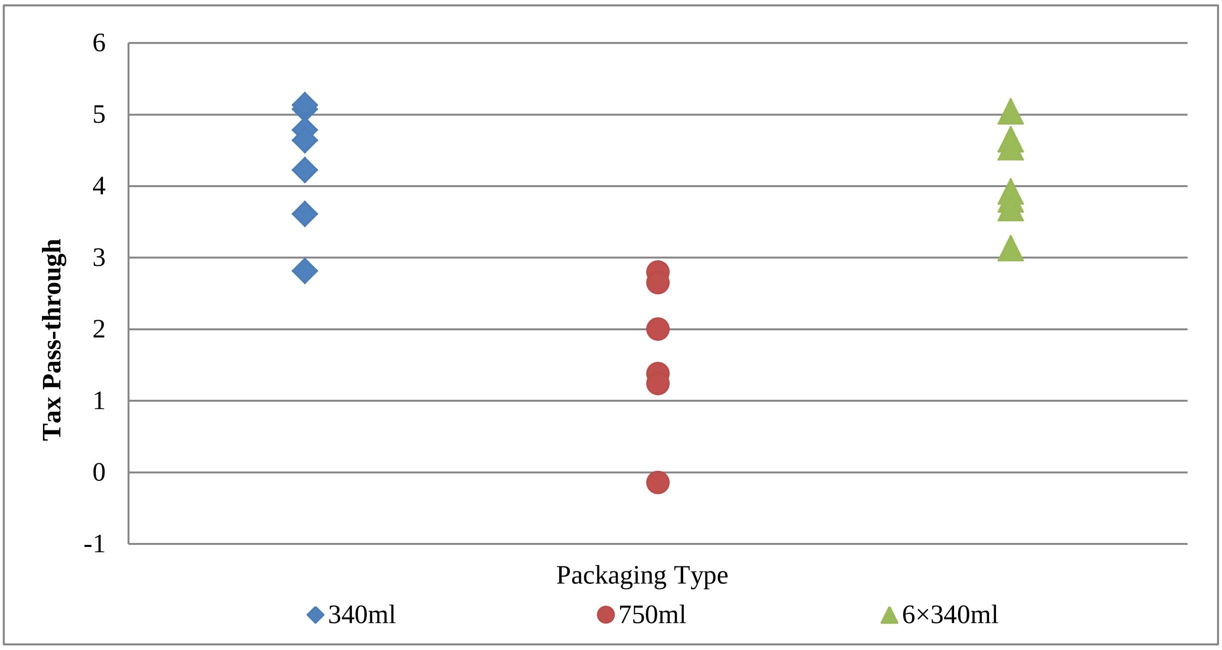
Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14

5.1.3 Packaging and Tax Pass-through for Beer

The regression results for lager and dark beer reveal considerable heterogeneity in pass-through within the same brand category. However, there is a similar trend in pass-through observed for certain types of packaging. In particular, the pass-through is much lower for 750ml packaging than for the other types. This trend is observed for both lager and dark beer.

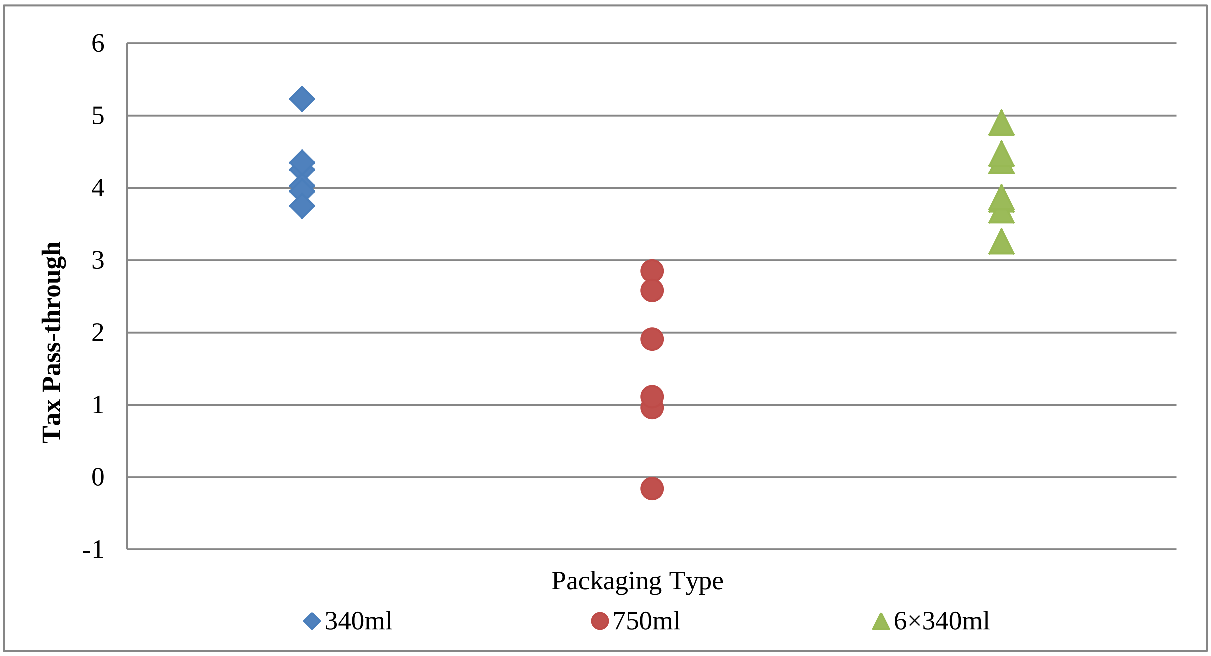
To analyse this trend, Figure 1 constructs a plot of the pass-through coefficients for lager and dark beer by the three main packaging types.

FIGURE 1A: **BEER TAX PASS -THROUGH BY PACKAGING TYPE USING VARIABLES IN NOMINAL TERMS**



*Dark beer brand B (340ml) is excluded

FIGURE 1B: **BEER TAX PASS-THROUGH BY PACKAGING TYPE USING VARIABLES IN REAL TERMS**



*Dark beer brand B (340ml) is excluded

It is evident that the tax pass-through is significantly lower for beer in 750ml packaging than for beer in the six-pack and individual can packaging. There is also more variation in pass-through for brands in 750ml packaging, while the pass-through coefficients for the 340ml and 6×40ml packaging are more concentrated at the higher levels of pass-through.

This empirical result is consistent with the negative relationship between pass-through and demand elasticity predicted by the tax-shifting framework. Since bulk purchases reduce the average price per litre, buying beer in 340ml individual cans is likely to be the most expensive way of purchasing beer, with 750ml purchases being the most cost-effective (Van Walbeek, 2014). It is plausible that consumers buying beer in bulk packaging have a higher price elasticity of demand than consumers who are willing to pay a higher average price per litre. Accordingly, any substantial price increase is likely to result in lost market share for the firm, resulting in less overshifting for beer in 750ml packaging.

Conversely, consumers of 340ml cans, who pay a higher average price per litre, are likely to have a lower price elasticity of demand, allowing overshifting of the tax to a greater extent. The lower levels of overshifting observed for beer in packaging of higher volumes has worrying implications for public health policy to the extent that the degree of overshifting reflects an attempt by manufacturers to promote the bulk purchase of beer in 750ml bottles.

5.2 INDIVIDUAL BRAND ANALYSIS FOR SPIRITS

5.2.1 Tax Pass-Through for Brandy

The pass-through estimates for brandy presented in Table 3 differ considerably from those for beer. Not only are the pass-through coefficients smaller, but the excise tax appears to be undershifted, with five of the eight brands presenting β_1 estimates less than 1.14 in both tables. The coefficients that indicate undershifting range from 0.72-0.85 in the nominal model and 0.72-0.92 in the real model. This suggests that a R1.00 tax hike increases brandy prices by R0.72-R0.85 on average, in the nominal model and by R0.72-R0.92 on average, in the real model. The other three brands yield tax-shifting coefficients that are very close to the point estimate 1.14, suggesting full pass-through of the tax. The confidence intervals for the brandy tax-shifting estimates are much smaller than those observed for beer, suggesting a larger degree of accuracy regarding these conclusions.

***TABLE 3A*: BRAND-SPECIFIC PASS-THROUGH FOR BRANDY USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

BRANDY BRAND	α, Constant	$\beta_{1,}$ Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	0.33**	0.85***	(0.17)	5.08	0.00	0.52 - 1.18	112	0.33	Full Shifting
Brand B	0.25**	1.16***	(0.07)	17.01	0.00	1.02 - 1.29	112	0.65	Full Shifting
Brand C	0.31	0.76**	(0.37)	2.06	0.04	0.03 - 1.49	112	0.08	Full Shifting
Brand D	0.25	1.41***	(0.18)	7.70	0.00	1.05 - 1.77	112	0.53	Full Shifting
Brand E	0.48***	1.61***	(0.31)	5.16	0.00	0.99 - 2.23	112	0.52	Full Shifting
Brand F	0.42***	0.79***	(0.19)	4.25	0.00	0.42 - 1.16	112	0.32	Full Shifting
Brand G	0.08	0.72***	(0.24)	3.04	0.00	0.24 - 1.19	64	0.32	Full Shifting
Brand H	0.35*	0.77***	(0.13)	5.70	0.00	0.50 - 1.03	64	0.44	Undershifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

***TABLE 3B:* BRAND-SPECIFIC PASS-THROUGH FOR BRANDY USING REAL VARIABLES**

Dependent Variable: ΔPrice

BRANDY BRAND	α, Constant	$\beta_{1,}$ Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	0.11	0.82***	(0.18)	4.47	0.00	0.46 - 1.19	112	0.26	Full Shifting
Brand B	0.10	1.19***	(0.11)	11.21	0.00	0.98 - 1.40	112	0.57	Full Shifting
Brand C	0.07	0.78*	(0.44)	1.78	0.08	-0.09 - 1.64	112	0.06	Full Shifting
Brand D	0.09	1.39***	(0.20)	7.10	0.00	1.00 - 1.78	112	0.49	Full Shifting
Brand E	0.09	1.42***	(0.31)	4.57	0.00	0.80 - 2.03	112	0.43	Full Shifting
Brand F	0.16	0.92***	(0.26)	3.49	0.00	0.40 - 1.45	112	0.29	Full Shifting
Brand G	-0.06	0.72***	(0.24)	3.01	0.00	0.24 - 1.21	64	0.23	Full Shifting
Brand H	0.11	0.76***	(0.16)	4.78	0.00	0.44 - 1.07	64	0.35	Undershifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

However, any conclusions regarding pass-through that are based on tax-shifting coefficients must be assessed with reference to the confidence intervals of the estimates. While the majority of the β_1 estimates suggest undershifting, the point estimate 1.14 is contained within the 95% confidence interval for all brands in both nominal and real models, with the exception of brandy brand H. This suggests that for brandy, the tax pass-through outcome is closer to full pass-through of taxes to prices, rather than undershifting.

5.2.2 Tax pass-through for Liqueur

At first glance, Table 4 appears to suggest overshifting of the liqueur excise tax. For the nominal specifications, five of the eight liqueur brands present tax-shifting coefficients greater than 1.14, in contrast to four of the eight liqueur brands for the real specifications. The β_1 estimates indicating overshifting range from 1.31-2.61 in Table 4A and 1.49-2.63 in Table 4B. This suggests that a R1.00 tax increase raises liqueur prices by R1.31-R2.61 on average, according to the nominal model and by R1.49-R2.63 on average, according to the real model. In contrast, three of the eight liqueur brands for the nominal specification and four of the eight liqueur brands for the real specification indicate undershifting, with β_1 estimates lower than 1.14. An unusual result is the negative pass-through coefficient obtained for liqueur brand H. The prices for this brand do not appear to respond immediately to a change in tax, warranting future analysis using a dynamic model to capture the effect of a price adjustment over time.

While the β_1 estimates suggest either overshifting or undershifting, the 95% confidence intervals in Table 4A and Table 4B contain the point estimate of 1.14 for six of the eight brands, indicating full tax pass-through. The remaining two brands, whose confidence intervals do not contain the full pass-through estimate, display evidence of overshifting. This supports the conclusion that, for most liqueur brands, consumers pay the entire amount of the tax, but not a premium above the tax amount.

TABLE 4A: **BRAND-SPECIFIC PASS-THROUGH FOR LIQUEUR USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

LIQUEUR BRAND	α, Constant	$\beta_{1,}$ Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	0.13	1.31***	(0.47)	2.81	0.01	0.39 - 2.24	112	0.28	Full Shifting
Brand B	0.05	1.66**	(0.63)	2.61	0.01	0.40 - 2.91	112	0.24	Full Shifting
Brand C	0.03	1.60*	(0.81)	1.98	0.05	-0.02 - 3.22	63	0.06	Full Shifting
Brand D	0.15	1.91***	(0.19)	10.33	0.00	1.55 - 2.28	108	0.56	Overshifting
Brand E	0.49**	2.61***	(0.51)	5.09	0.00	1.58 - 3.63	64	0.51	Overshifting
Brand F	0.51*	0.92***	(0.32)	2.84	0.01	0.27 - 1.57	52	0.30	Full Shifting
Brand G	-0.46	0.48	(1.14)	0.42	0.68	-1.82 - 2.78	46	0.13	Full Shifting
Brand H	0.24	-0.51	(0.84)	-0.60	0.55	-2.21 - 1.19	52	0.01	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

TABLE 4B: **BRAND-SPECIFIC PASS-THROUGH FOR LIQUEUR USING REAL VARIABLES**

Dependent Variable: ΔPrice

LIQUEUR BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	0.00	1.49***	(0.53)	2.82	0.01	0.44 - 2.54	112	0.24	Full Shifting
Brand B	-0.06	1.76***	(0.62)	2.83	0.01	0.53 - 2.99	112	0.19	Full Shifting
Brand C	-0.87	1.00	(0.94)	1.07	0.29	-0.88 - 2.88	63	0.02	Full Shifting
Brand D	0.03	1.75***	(0.28)	6.23	0.00	1.19 - 2.31	108	0.38	Overshifting
Brand E	0.33	2.63***	(0.62)	4.25	0.00	1.40 - 3.87	64	0.45	Overshifting
Brand F	0.04	0.75**	(0.31)	2.39	0.02	0.12 - 1.38	52	0.18	Full Shifting
Brand G	-0.34	0.88	(1.30)	0.68	0.50	-1.73 - 3.50	46	0.06	Full Shifting
Brand H	0.18	-0.38	(0.87)	-0.43	0.67	-2.13 - 1.38	52	0.01	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

5.2.3 Tax Pass-Through for Whisky

Turning to the results for the last category of spirits, presented in Table 5, the excise tax appears to be undershifted for six of the nine brands studied, in both the nominal and real models. The β_1 estimates that are less than 1.14 range from 0.41-1.08 in Table 5A and 0.46-1.02 in Table 5B. This suggests that a R1.00 tax hike raises whisky prices by between R0.41-R1.08 on average, according to the nominal model and by R0.46-R1.02 on average, according to the real model, so that consumers pay less than the entire tax increase. The remaining three brands display coefficients that exceed 1.14, suggesting overshifting of the tax for these brands.[11]

While the tax-shifting coefficients for most brands differ from the full pass-through estimate, this difference is generally not substantial. Additionally, both nominal and real specifications of the model show that the 95% confidence interval contains the full pass-through estimate for seven of the nine whisky brands. This suggests an overall tendency for whisky taxes to be fully passed through to prices, rather than undershifted or overshifted.

Although there are slight differences in trends across the brandy, liqueur and whisky categories, the majority of the evidence supports a conclusion of full pass-through of spirits taxes to prices. Interestingly, this result differs from those obtained in the empirical tax incidence literature for the U.S. alcohol industry. Previous work by Kenkel (2005) and Young

[11] The exception to this observation is whisky brand F in the real model which presents a tax-shifting coefficient that is exactly equal to 1.14, indicating exact full pass-through of the tax.

and Bielińska-Kwapisz (2002) find larger estimates of tax-shifting for brands of spirits and conclude that alcohol taxes in the U.S. are overshifted to prices. This is contrasted with the results found for South Africa in this study, which are not only much smaller, but support full pass-through, rather than overshifting.

***TABLE 5A*: BRAND-SPECIFIC PASS-THROUGH FOR WHISKY USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

WHISKY BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	0.47	0.85***	(0.16)	5.31	0.00	0.53 - 1.17	64	0.28	Full Shifting
Brand B	0.20	1.52***	(0.09)	16.57	0.00	1.34 - 1.70	111	0.67	Overshifting
Brand C	0.23	0.41	(0.38)	1.09	0.28	-0.34 - 1.17	64	0.07	Full Shifting
Brand D	0.20**	0.95***	(0.11)	8.56	0.00	0.73 - 1.17	112	0.60	Full Shifting
Brand E	0.22*	1.08***	(0.10)	10.67	0.00	0.88 - 1.28	112	0.55	Full Shifting
Brand F	0.80	1.25	(0.95)	1.32	0.19	-0.65 - 3.16	64	0.17	Full Shifting
Brand G	0.24	0.85***	(0.13)	6.41	0.00	0.58 - 1.12	64	0.49	Undershifting
Brand H	-0.19	2.08***	(0.49)	4.20	0.00	1.09 - 3.06	64	0.24	Full Shifting
Brand J	-0.29	0.66	(0.55)	1.20	0.24	-0.44 - 1.75	64	0.11	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

***TABLE 5B:* BRAND-SPECIFIC PASS-THROUGH FOR WHISKY USING REAL VARIABLES**

Dependent Variable: ΔPrice

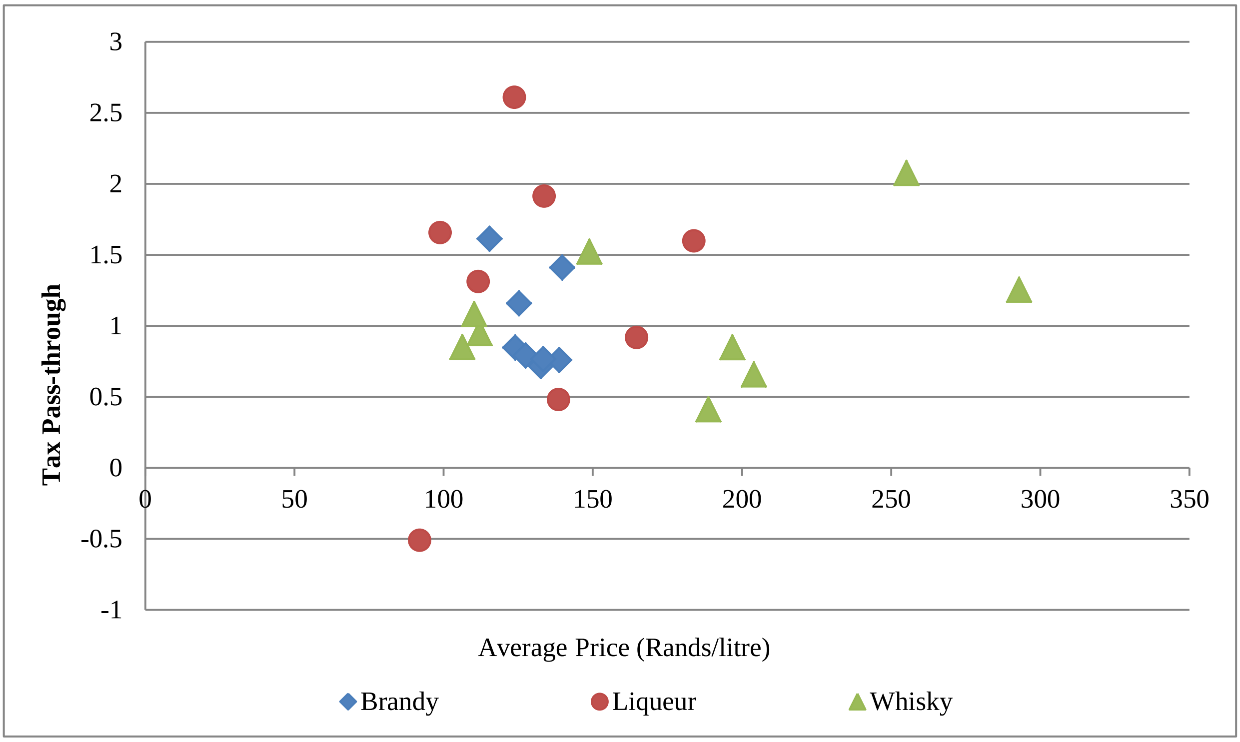
WHISKY BRAND	α, Constant	β_1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Brand A	-0.03	0.76***	(0.16)	4.80	0.00	0.44 - 1.08	64	0.18	Undershifting
Brand B	0.06	1.50***	(0.12)	12.44	0.00	1.26 - 1.74	112	0.61	Overshifting
Brand C	-0.20	0.46	(0.44)	1.05	0.30	-0.42 - 1.34	64	0.04	Full Shifting
Brand D	0.06	0.99***	(0.14)	7.13	0.00	0.71 - 1.26	112	0.56	Full Shifting
Brand E	0.11	1.02***	(0.11)	9.23	0.00	0.80 - 1.24	112	0.47	Full Shifting
Brand F	0.20	1.14	(0.85)	1.34	0.18	-0.56 - 2.84	64	0.10	Full Shifting
Brand G	0.23	0.90***	(0.14)	6.44	0.00	0.62 - 1.17	64	0.44	Full Shifting
Brand H	-1.02	2.25***	(0.63)	3.56	0.00	0.99 - 3.51	64	0.21	Full Shifting
Brand J	-0.32	0.92	(0.71)	1.31	0.20	-0.49 - 2.33	64	0.06	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.

5.2.4 An Analysis of Tax Pass-Through by Price

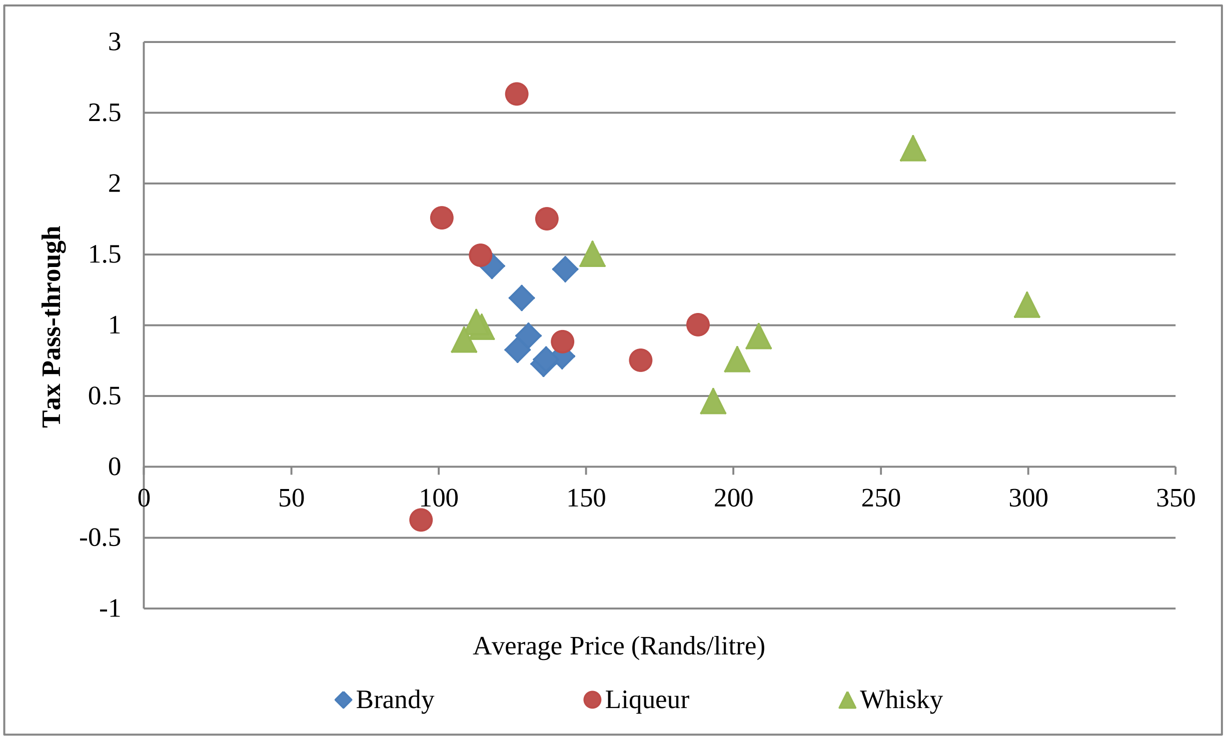
In the case of brandy, liqueur and whisky, it is evident that there is greater homogeneity across the pass-through coefficients than for beer. However, the tax pass-through still differs across brands to some extent. For beer, it was found that the tax pass-through differed according to the packaging type. This study is limited to one type of packaging for spirits, but the relationship between brand prices and tax pass-through can be explored. To analyse whether such a relationship exists for spirits, the tax pass-through coefficient is plotted against the average price for each brand. This is done for all spirits brands, shown in Figure 2A and 2B. Prices for 2008 are used to calculate a measure of average price for each brand, as all brands have data available for this period.

FIGURE 2A: **SPIRITS TAX PASS-THROUGH BY BASELINE PRICES USING VARIABLES IN NOMINAL *TERMS***



*2008 prices are used to calculate the average price measure for each brand

FIGURE 2B: **SPIRITS TAX PASS-THROUGH BY BASELINE PRICES USING VARIABLES IN REAL TERMS**



*2008 prices are used to calculate the average price measure for each brand

If the relationship between baseline prices and tax pass-through for spirits is similar to the relationship between packaging types and pass-through for beer, an upwards trend would be observed in Figures 2A and 2B. This would suggest that higher baseline prices result in greater pass-through. However, the plots show that tax coefficients across all categories of spirits differ across price in a way that is not clearly related to the average prices for each brand. Thus, regardless of whether nominal or real variables are used, there is no evidence to suggest that baseline prices for brands of spirits affect the extent to which taxes are passed through to retail prices.

This finding differs from that of Kenkel (2005) and Bergman and Hansen (2009) who observe a relationship between baseline brand price and pass-through for alcoholic beverages but do not concur on the direction of the relationship. However, empirical results in the cigarette tax literature also find no such relationship. Sullivan and Dutkowsky (2012) find that degrees of tax-shifting are similar across both premium and generic brands of cigarettes in the U.S. Other studies of cigarettes pass-through in the U.S. by Espinosa and Evans (2012) and Hanson and Sullivan (2009) also find no differential effects in tax pass-through across baseline prices.

5.3 A POOLED MODEL OF TAX PASS-THROUGH FOR DIFFERENT CATEGORIES OF ALCOHOL

The previous section considered tax pass-through at an individual brand level. To consider the general trends in tax pass-through for lager, dark beer, brandy, liqueur and whisky, a pooled model of pass-through is estimated for each category. This results in a substantially larger sample size for each regression. The models in (5) and (6) are estimated by OLS as before, with the difference that variables of all brands in all periods are included in the estimation.

The nominal pooled model is of the form:

$$\Delta P_{\text{it}} = \propto + B_1 \Delta T_{\text{it}} + Inflation + u_{\text{it}} \quad (7)$$

Where ΔP_{it} represents the difference in nominal prices from one month to the next for all brands, ΔT_{it} represents the difference in nominal taxes from one month to the next for all brands, where i=1,…N represents the brands and t=1,…N represents the monthly survey periods. $Inflation$ is calculated as the percentage change in the Consumer Price Index (CPI), where Inflation = (CPI_t-CPI_{t-1})/CPI_{t-1}.

The real pooled model is of the form:

$$\Delta P_{\text{it}} = \propto + B_1 \Delta T_{\text{it}} + u_{\text{it}} \quad (8)$$

Where ΔP_{it} represents the difference in real (inflation-adjusted) prices from one month to the next for all brands, T_{it} represents the difference in real (inflation-adjusted) taxes from one month to the next for all brands, i=1,…N represents the brands and t=1,…N represents the monthly survey periods.

For each alcohol category, Table 6A contains the results from the OLS regressions of (7), while Table 6B contains the results from the OLS regressions of (8).

***TABLE 6A:* POOLED MODEL OF PASS-THROUGH FOR DIFFERENT ALCOHOL CATEGORIES USING NOMINAL VARIABLES**

Dependent Variable: ΔPrice

CATEGORY	α, Constant	β1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Lager	0.05***	3.70***	(0.29)	12.67	0.00	3.12 - 4.27	1,293	0.37	Overshifting
Dark Beer[c]	0.03*	2.59***	(0.51)	5.11	0.00	1.59 - 3.59	205	0.60	Overshifting
Brandy	0.33***	1.03***	(0.10)	9.91	0.00	0.83 - 1.24	800	0.34	Full Shifting
Liqueur	0.17*	1.34***	(0.24)	5.52	0.00	0.86 - 1.82	608	0.19	Full Shifting
Whisky	0.22*	1.09***	(0.16)	6.86	0.00	0.78 - 1.40	720	0.22	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.
[c]Dark Beer Brand B (340ml) is excluded from the regression

***TABLE 6B:* POOLED MODEL OF PASS-THROUGH FOR DIFFERENT ALCOHOL CATEGORIES USING REAL VARIABLES**

Dependent Variable: ΔPrice

CATEGORY	α, Constant	β1, Coefficient on ΔTax	Std. Error[a]	T-stat	P-value	95% Confidence Interval	N	R^2	Pass-through[b]
Lager	0.02*	3.13***	(0.44)	7.05	0.00	2.26 - 4.00	1,297	0.27	Overshifting
Dark Beer[c]	0.00	3.16***	(0.67)	4.69	0.00	1.83 - 4.49	206	0.42	Overshifting
Brandy	0.28	0.76***	(0.18)	4.26	0.00	0.41 - 1.11	801	0.01	Undershifting
Liqueur	0.06	1.00	(1.83)	0.54	0.59	-2.60 - 4.59	610	0.01	Full Shifting
Whisky	-0.05	1.11***	(0.16)	6.93	0.00	0.79 - 1.42	720	0.17	Full Shifting

Significance levels: *significant at 10%; **significant at 5%; ***significant at1%
Notes: All price and tax variables are in per-litre terms and the volume for all spirits brands is 750ml.
[a]Standard errors are robust to heteroskedasticity.
[b]Classification of pass-through according to whether the confidence interval includes 1.14.
[c]Dark Beer Brand B (340ml) is excluded from the regression

The results for the pooled model are consistent with those observed at brand level. For lager and dark beer, the excise tax is overshifted to consumers. For lager, the tax-shifting estimates of 3.70 (95% C.I.=3.12;4.27) in Table 6A and 3.13 (95% C.I.=2.26;4.00) in Table 6B suggests that a R1.00 increase in tax raises prices by R3.70 on average, according to the nominal model and by R3.13 on average, according to the real model. For dark beer, the tax-shifting estimates range from 2.59 (95% C.I.=1.59; 3.59) in Table 6A to 3.16 (95% C.I.=1.83;4.49) in Table 6B. Similarly, this suggests that a R1.00 tax increase raises dark beer prices by R2.59 on average, according to the nominal model and by R3.16 on average, according to the real model. Additionally, the 95% confidence intervals for all beer estimates support the conclusion of overshifting as they do not contain the full pass-through estimate 1.14. The estimates suggest a higher level of over-shifting for beer than is observed for the U.S. in the empirical tax incidence literature (Young and Bielińska-Kwapisz, 2002; Kenkel, 2005; Bergman and Hansen, 2009).

As was observed at the brand level, the pass-through estimates for the spirits categories are substantially lower than those for beer. For brandy, Table 6A presents a pass-through estimate of 1.03 (95% C.I.=0.83; 1.24), while Table 6B presents a pass-through estimate of 0.76 (95% C.I.=0.41; 1.11). This suggests that a R1.00 tax hike increase brandy prices by R1.03 on average, according to the nominal model and by R0.76 on average, according to the real model, indicating undershifting of the tax.

For liqueur, the β_1 estimates obtained are 1.34 (95% C.I.=0.86; 1.82) in Table 6A and 1.00 (95% C.I. = -2.60; 4.59) in Table 6B. These estimates indicate that R1.00 tax hike increases liqueur prices by R1.34 on average, according to the nominal model and by R1.00 on average, according to the real model. In contrast, the tax-shifting coefficient for whisky is 1.09 (95% C.I.=0.78;1.40) in Table 6A and 1.11 (95% C.I.=0.79;1.42) in Table 6B. This suggests that a R1.00 tax hike raises prices by R1.09 on average, using nominal variables and by R1.11 on average, using real variables.

With the exception of the tax-shifting coefficient for liqueur in Table 11A, all β_1 estimates across all spirits categories are below the full pass-through estimate, suggesting undershifting. However, the point estimates do not differ substantially from the full pass-through estimate and the 95% confidence intervals for these estimates also contain the point estimate 1.14. [12] This may indicate that the spirits tax is actually fully passed through to prices and not undershifted. Interestingly, the estimates of pass-through obtained using South African data are lower than those observed for the U.S. in the empirical literature. Previous studies by Young and Bielińska-Kwapisz (2002) and Kenkel (2005) suggest overshifting of taxes on spirits to prices for the U.S., while for South Africa, full pass-through or even undershifting appears to be more likely.

Brandy displays the lowest levels of tax-shifting for the spirits categories in both the nominal and real specifications of the model. Not only are the β_1 estimates for brandy smaller than those estimated for the liqueur and whisky, but brandy is also the only category for which the

[12] The exception is the confidence interval for the brandy category in the real model, in which the 95% confidence interval (0.41-1.11) falls slightly short of the point estimate 1.14.

confidence interval of the tax-shifting estimate does not contain 1.14 in the real specification. While the nominal model suggests full pass-through of brandy taxes, the real model suggests slight undershifting of brandy taxes. Thus, brandy experiences lower levels of pass-through than other types of spirits. This may be because brandy prices are much lower than other types of spirits such as whisky, despite the excise tax on brandy and whisky being levied at the same nominal tax rate per litre of absolute alcohol. Accordingly, if consumers of brandy are more sensitive to price changes, this allows a lower degree of tax shifting for brandy manufacturers than manufacturers of other types of spirits, such as whisky.

The confidence intervals for most β_1 estimates in both Table 11A and 11B are not substantial, suggesting a degree of confidence in the accuracy of the estimates. However, the confidence interval for the liqueur tax-shifting coefficient in Table 11B is unusually large. This may be driven by unusual tax pass-through results obtained for a small number of liqueur brands. For example, liqueur brand H presented a negative tax-shifting coefficient and while liqueur brand G presented a tax-shifting coefficient in line with those obtained for other brands, it also displayed a much larger standard error and confidence interval. Further research is required to investigate this result.

The R-squared values differ considerably across categories, with some brands displaying low proportions of price variability explained by variation in tax changes. This is similar to what was observed in the individual brand analysis. It is acknowledged that the explanatory power of the model is limited by the lack of control variables available. Additionally the pooled OLS model is limited in its assumption that estimated parameters are the same for all brands and does not address unobserved heterogeneity between brands (Baltagi, 2005). This issue is discussed in section 6 below.

6. CAVEATS

To analyse the main trends in pass-through in South Africa, this paper has estimated regressions of price changes on tax changes by OLS for individual brands and for a pooled model for different alcohol categories. Although similar methods have been used in the literature, such as by Kenkel (2005) and Bergman and Hansen (2009) who estimate regressions of price changes on baseline prices, there are several factors that limit the accuracy of the estimates obtained. The results may be biased to the extent that the limited data available meant that factors such as costs, geographical location, and outlet type are unable to be controlled for.

Panel data offers methods to address the problem of unobserved heterogeneity. There are likely to be many time-varying and time-invariant factors that affect prices and tax pass-through that differ across brands, such as the level of market competition, strategic price behaviour or consumer perceptions. Some of these factors are likely to remain constant over time. Ideally, a fixed effects regression is used to control for unobserved heterogeneity between brands.

Unfortunately, the nature of the data yielded by the South African tax system does not allow for a fixed effects model that controls for heterogeneity across brands. Taxes are set at a national level so that all brands within the same alcohol categories are subject to the same tax by percentage of absolute alcohol and, for all brands, the tax changes in March every year. This results in there being insufficient variation in the tax variable across different brands. This is true even for the beer category, which has different absolute levels of tax across different brands because of the different volumes for different packaging types. This problem of insufficient "between-group" variation makes it impossible to use fixed effects to control for unobserved heterogeneity between brands (Wooldridge, 2013). The empirical tax incidence studies in the literature that use fixed effects models are, for the most part, conducted in the U.S., where the peculiarities of the tax system result in variation in alcohol taxes across different states and cities (Besley and Rosen, 1998; Young and Bielińska-Kwapisz, 2002; Sullivan and Dutkowsky, 2012). This facilitates the use of a fixed effects model to control for unobserved heterogeneity across states, instead of brands.

Furthermore, this paper only considers a static model of pass-through, which does not capture the effect of price adjustment over time. The static model is not unrealistic to the extent that evidence in the literature supports a relatively quick price adjustment to taxes (Carbonnier, 2007; Alm *et al*, 2009; Marion and Muehlegger, 2011). However, the anomalous pass-through results obtained for certain brands suggest that it would be worthwhile to extend this analysis to a dynamic model.

7. CONCLUSION

Using South African price data for beer and spirits, this paper finds evidence that excise taxes on lager and dark beer are overshifted to prices. In contrast, the evidence suggests full pass-through of taxes on brandy, liqueur and whisky, with possible undershifting for brandy. These results are consistent at an individual brand and alcohol category level. The pass-through estimates obtained are plausible to the extent that they are similar in magnitude to those obtained in other tax incidence studies. However, studies of alcohol tax incidence in the literature find lower levels of overshifting for beer in the United States than suggested for South Africa. A particularly different result is the finding of overshifting of spirits taxes in the U.S. (Young and Bielińska-Kwapisz, 2002; Kenkel, 2005; Bergman and Hansen, 2009). This study does not provide insight as to why these differences in trends arise. Possible reasons include differences in market structure or differences in consumer demand elasticities.

No evidence is found to support a relationship between brand prices and tax pass-through for spirits. A similar conclusion is found in the literature focusing on cigarette tax incidence (Hanson and Sullivan, 2009; Sullivan and Dutkowsky, 2012; Espinosa and Evans, 2012). However, clear evidence is found for the effect of different packaging types on tax pass-through for beer. Bulk packaging appears to experience the lowest level of tax pass-through with the 750ml packaging type, usually regarded as the most cost-effective way to purchase beer, exhibiting the lowest level of overshifting.

The observed trends in tax pass-through provide meaningful insight for policy-making. The high levels of overshifting observed for beer prices suggest that taxes on these products may be more burdensome than expected. To the extent that alcohol taxation is a public health tool to reduce excessive consumption, the low levels of tax-shifting observed for spirits, whose alcohol content is the highest, is worrying. Similarly, the lower levels of pass-through observed for beer purchases of larger volumes presents difficulties for government attempts to curb excessive alcohol consumption through taxes.

This paper has provided a static analysis of pass-through, but it would be worthwhile to extend this analysis to a dynamic model and to apply the analysis to wine as well. There is the concern that the results are subject to bias arising from the limited control variables available. Additionally, the nature of the South African tax system results in there being insufficient variation in taxes across different brands so that a fixed effects model cannot be applied to address unobserved heterogeneity. Despite these limitations, the overall picture presented of the trends in pass-through for South Africa is a useful starting point for policy-making.

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