Item #1

Summary of sugar tax modelling studies

Incomplete draft summary of sugar taxes modelling studies, written for internal use only, 28 July 2014

Sugar tax modelling studies: assumptions and methodologies

1. Studies

Dharmasena and Capps, "Unintended Consequences"

- Uses QUAIDS model
- Considers only at-home consumption of beverages; does not allow for consumption at (for example) fast food outlets
- Limited to non-alcoholic beverages and does not allow for substitution effects beyond this category
- Assumes that demand response is linear
- Assumes that tax is fully shifted (1:1) into the price of the taxed goods
- Quantity/expenditure endogenous for each beverage (but total expenditure is exogenous somehow)
- Uses Homescan data, which is self-reported and may lead to underreporting
- Uses US data which may not apply to NZ

Fletcher et. al, "Non-linear effects"

- Looks only at existing US soda taxes, and so is unable to consider the effect of a really sizeable tax (eg. the proposed 18% tax in New York)
- Allows for the possibility of a non-linear demand response, but their data does not show any evidence of this.
- Uses NHANES data limited to people 18 years or older; this is individual, not household data
- Uses US data which may not apply to NZ

Sharma et. al, "The effects of taxing"

- AIDS model used
- Uses household not individual data
- All changes in body weight are assumed to be the result of changes in SSB intake – possible omitted variable bias as a result
- Controls for censored demand
- Uses Australian data which may not apply to NZ

Finklestein et. al, "Implications of a SSB tax"

- Assumes that tax is fully shifted (1:1) into the price of the taxed goods
- Doesn't use a demand system model
- Uses self-reported data (Homescan) which may lead to underreporting
- Limited to store-bought beverages; does not allow for consumption of beverages purchases elsewhere
- Uses US data which may not apply to NZ

Tiffin et. al, "The Effects of a Soft Drink Tax in the UK"

- Assumes separability of food and drinks; i.e. substitution effects are limited to drinks

- Aggregates categories of drinks to avoid censored demand (but the model disaggregates them somehow when predicting effects of tax)
- Zero observations/censored demand assumed to mean that the household is just consuming from their existing stocks – not that they never buy the product
- Uses household not individual data
- Assumes that tax is fully shifted (1:1) into the price of the taxed goods
- Limited to home consumption of beverages
- Uses UK data which may not apply to NZ

Gustavsen, "Public policies and the demand for carbonated soft drinks"

- The model only includes prices for two goods: sugary drinks, and all other non-durables
- Uses a quantile regression (?) method
- Uses self-reported data (aggregated by Statistics Norway)
- Allows for the possibility of temperature influencing soft drink demand
- Doesn't consider the possibility of substitution to other foods or beverages
- Uses Norwegian data which may not apply to NZ

Zhen et. al, "Accounting for product substitution"

- Uses a demand system (LINQUAD) model
- Food and beverage intake estimated using the NHANES data. Only includes people 20 years and older; pregnant women and people with incomplete data were not included. It is individual, not household, data.
- Doesn't appear to be limited to at-home consumption
- Classifies foods as being either high-sugar or low-sugar
- Allows for substitution across foods and beverages
- Uses 'as-consumed' food prices and assumes that these are the same as the 'as-purchased' prices
- Assumes full shifting of tax onto prices
- Uses US data which may not apply to NZ

Zhen et. al, "Predicting the effects of sugar-sweetened beverage taxes"

- Doesn't account for consumption away from home
- Uses self-reported Homescan data which may result in underreporting
- Only selects Homescan categories for the study which are significant sources of energy/fat/sodium, and so doesn't allow for substitution towards healthy foods
- Assumes full shifting of tax onto prices
- Uses US data which may not apply to NZ

Lusk and Schroeter, "When do fat taxes increase consumer welfare?"

- Ignores the welfare effects arising from externalities
- Assumes that consumers are perfectly rational and do not suffer self-control or time inconsistency problems
- Assumes that there are only two foods, a high-calorie food and a low calorie food in the world

- Assumes full shifting of tax onto prices
- Assumes that consumers' willingness to pay (WTP) is a complete and accurate measure of how much benefit derives from weight loss. Consumers might have a WTP which wildly under or over-values their private benefit.
- Assumes that Equivalent Variation (EV) is an accurate measure of welfare loss
- Does not allow for welfare benefits to individuals which result from the weight loss of others

Madden, "The Poverty Effects of a Fat tax in Ireland"

- Does not account for health benefits arising from a tax; only considers economic effects/harms
- Uses data from the Irish Household Budget Survey which is self-reported – this may not be accurate
- Uses household not individual data
- Splits foods into "good foods" and "bad foods", which is somewhat arbitrary, and also assumes that the fat tax would apply to all bad foods.
- Irish data which may not apply to NZ

Jensen and Smed, "Cost effective design of economic instruments in nutrition policy"

- Uses an AIDS demand model
- Danish data which may not apply to NZ
- Consumption quantities are estimates derived from the monetary value spent on different food item
- Assumes full shifting of tax onto prices
- Does not really account for administrative costs in its cost-effectiveness analysis
- Assumes separability between different food categories (eg plant origin and dairy foods) so inter-category substitution effects are not properly accounted for.
- Does not allow for the possibility of substitution between food and non-food items

2. Key threads

One important limitation which occurs again and again in the above modelling studies is the assumption that taxes will be fully shifted into prices at a 1:1 ratio. As discussed in the technical document, there is a good chance this won't be the case. There is evidence that in concentrated industries (does this include the SSB industry? Maybe) excise taxes will overshift, and sales taxes will undershift. The studies may therefore be systematically under or over-estimating the price increases brought on by taxes.

Another important limitation is that many of the models allow only for limited substitution possibilities. They may limit their analysis only to beverages and ignore the possibility of substitution towards foods. Others aggregate foods and beverages into categories, assuming either that inter-category substitution is not possible, or not accounting for the possibility that consumers may substitute within a category.

Thirdly, some of studies tend to consider only at-home consumption of food and beverages (the ones which use Homescan data). This does not account for consumption of sugary

food or drink at, for example, fast food restaurants, which may be a significant source of intake. However the NHANES studies, which use interviews, account for all intake sources. Another downside of Homescan data is that it is conducted at the level of the household and then has to be deconstructed to estimate individual consumption and purchasing. NHANES does not have this problem because it is based on individual interviews, although it does have a number of other unique biases.[1]

I find the Lusk and Schroeter paper "When do fat taxes increase consumer welfare?" to be especially problematic. Our justifications for a tax are explicitly (1) externalities, (2) asymmetric information and (3) time-inconsistent consumers. This paper assumes that all three of these problems do not exist, and analyses only the welfare effects on self-contained, fully rational private individuals. For this reason I think this study is of very limited use for us.

I am ill-placed to comment on the statistical validity of their methods or on the robustness of the AIDS demand system models which they use. If a truly comprehensive analysis of these studies is required, it may be worth recruiting someone with econometrics, mathematics and statistics expertise in order to evaluate these aspects of the studies.

3. How realistic are these assumptions?

Full shifting of tax into prices: Not particularly realistic given that we know excise taxes can over or undershift depending on their type. Many of the studies above assume a straight sales tax which would likely lead to undershifting.

However, it seems more likely that an excise tax would be used (as it is with tobacco) if this policy were adopted. This may lead to overshifting if the industry is sufficiently concentrated. Nevertheless, there are so many 'ifs' in this space that it may not be unreasonable to provisionally assume full shifting.

Substitution limitations: I think the limitations are generally realistic. Both Dharmasena and Capps, and Tiffin et. al do not allow for substitution outside of beverages, but Finklestein et. al (2010) found that substitution from drinks to food is unlikely to occur anyway. This therefore seems like a reasonable limitation.

More worryingly, however, Gustavsen does not allow for *any* kind of substitution effects in his analysis. His conclusion that a tax would help reduce calorie consumption is therefore of limited validity because calorie-increasing substitutions are not possible in his model. Later and more detailed studies (such as those described above) allow for the initial calorie reductions to be offset through substitution to other beverages.

Household-level analysis: Studies which use Homescan data (such as Sharma et. al and others) obtain consumption and purchasing data for households, not individuals. This has some potential for masking the consumption patterns of individuals – for example, one household member may increase SSB consumption while another decreases it by a similar amount, leading the household data to show little or no change in SSB consumption when in fact changes have been occurring.

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[1] Sharma et. al, "The Effect of Taxing Sugar-Sweetened Beverages Across Different Income Groups" 2.

On the whole, though, it seems reasonable to assume that household members generally consume similarly. Certainly the household-level Homescan data has many advantages over the NHANES individual-level data used in other studies: individual reporting in interviews is subject to a number of biases including recall problems, underreporting and sampling error.[2]

At-home consumption only: Several of the studies use only data on at-home consumption of food or beverages. This appears to be a major limitation. Fast-food and SSB consumption are linked,[3] indicating that much SSB consumption takes place in these out-of-the-home locations. Those studies would not count this kind of consumption and may therefore give an inaccurate picture of how SSB consumption changes as the result of a tax.

SSBs are tend to be more expensive at fast food and other restaurants than when bought at stores. This would mean that a valoric/percentage tax would be greater in absolute value, while a volumetric/per litre tax would be a smaller increase as a proportion of the price for away-from home drinks.

It is not immediately clear how this would impact upon total SSB consumption – are consumers' responses driven more by the absolute value of the price increase, or by the percentage increase over the original price? However it seems safe to say that the higher prices for away-from-home consumption might lead to different consumer responses from a tax.

	No tax	20% valoric tax	$0.20/L volumetric tax	% price increase, valoric	% price increase, volumetric
Regular coke (330 mls, dairy)	$2.00 (approx.)	$2.40	$2.07	20%	3.5%
Regular coke (330 mls, McDonalds)	$2.90 (McDonalds Lambton Quay)	$3.48	$2.97	20%	2.4%

Note also that this analysis assumes full shifting of the tax into prices. This may not be the case. To add to the complexity, it could even be that the shifting ratio differs between at-home and away-from-home consumption: a supermarket might undershift the tax, while fast foods outlets could overshift it (for example).

In conclusion, the exclusion of away-from-home data is a significant limitation for the studies which use Homescan data. On the other hand, NHANES data (which includes at-home consumption) is subject to its own range of biases which Homescan does not suffer. Neither dataset is perfect.

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[2] Ibid.

3 Park et. al, "Factors Associated with Sugar-Sweetened Beverage Intake among United States High School Students", accessed via http://jn.nutrition.org/content/142/2/306.long