Appendix to "The Window Tax: A Case Study in Excess Burden"

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November, 2014

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In Oates and Schwab (forthcoming), we presented a simulation model that allowed us to derive a rough estimate of the deadweight loss from the British window tax. Here we provide additional details on the structure of the model and our calibration of the model. We also discuss the development of our data set and tests for masses at the notches..

Simulation Model

The simulation model in Oates and Schwab (forthcoming) has the following structure. There are 1,000 consumers in the simulation. Consumer i has an inverse demand function for windows (i.e., willingness to pay) of $exp(A_i)z_i^{-1/\eta}$ where η is the price elasticity of demand and z_i is the number of windows. That is, in this model all consumers have the same constant price elasticity of demand but their demands for windows differ by a multiplicative constant. We assume that the A_i are uniformly distributed between A^0 and A^1. We discuss the calibration of the model below.

The simulation first solves for the demand for windows in the absence of the tax. Each of the 1,000 consumers calculates consumer surplus (willingness to pay minus expenditure) if they buy 0, 1, 2, ….. 60 windows and chooses the number of windows that maximizes consumer surplus. We then re-run the model under a tax policy that is similar to the 1747-57 window tax. Consumers in our model who own nine or fewer windows pay no tax, those who own 10-14 windows pay a tax of 6d per window, and those who own 15 or more windows pay a tax of 9d per window.[1] Each consumer in the model re-optimizes given this tax policy. The model captures

[1] The tax policy we looked at in the simulation did not include the third notch that existed under the 1747-57 tax (consumers with homes with 20 or more windows paid 1s per window). Only 11 percent of the homes in our sample have 20 or more windows.

each consumer's demand for windows with and without the tax, consumer surplus with and without the tax, and taxes paid.

A key parameter in the simulation is the pre-tax price of windows, or its equivalent, the excise tax rate given a tax on windows of 6d or 9d. We could find no direct evidence on this point, but our reading of the literature suggests that the tax was very large relative to the price of windows. There is a good deal of evidence that the window tax was a significant fraction of rent. For example, consider this quote from a debate in the House of Commons in 1850:

> "In the smaller houses in the metropolis, for instance in Baker-street, the window tax amounted to not less than from 29 to 30 per cent upon the rental. In many other streets, which were composed of smaller houses, the window tax was found to press most unequally, to the extent of sometimes of 30 to 40, and occasionally even 50 per cent on the rentals as ascertained by the rate book. When they came to Oxford Street, however, in which there were very large houses, the window tax instead of being 29 per cent, did not amount, in many instances, to more than 5 per cent on the rental." (HCDeb., 9 April 1850, p.71)

Suppose the window tax was on the order of 20 percent of rent, a figure that seems reasonable. A little arithmetic and an assumption on the ratio of window rents to total rent yield an estimate of the excise tax rate. If window rents are 20 percent of total rents – and it seems nearly certain that this estimate is high – then the excise tax rate on windows is 100 percent. If window rents are 10 percent of total rent then the excise tax rate is 200 percent. Our simulation is based on an assumption that a tax of 6d is a 100 percent excise tax on windows.

We searched for values of the other important parameters of the model that yield results that closely match our 1747-57 data. More specifically, we undertook a grid search for the values of the price elasticity of demand and the lower and upper bounds of the distribution of the constants in the demand function that minimizes a loss function that equals the sum of the

squared differences between the actual and the model's value of (i) the percentage of homes with exactly nine windows, (ii) the percentage of homes with exactly 14 windows, and (iii) the average number of windows for all homes. The optimal values are shown in Table 1 below.

Table 1 Optimal Parameter Values	
A^0	7.8256
A^1	20.6923
η	0.1485

Data

The empirical section of Oates and Schwab (forthcoming) draws on a data set that tracks the number of windows per household for nearly 1,400 households over the years 1747 to 1830. We could find no such data published in any websites, journal articles, books, or other secondary sources. In fact, the online sources provided only very limited information on the tax rate structure and revenues.

But, as a result of a very careful and determined effort by our superb research assistant, Katherine Hamilton, we were able to go back to original sources at the local level from which we were able to assemble our data set.[1] With help from the Family History Center in Kensington, Maryland, she was able to identify 67 microfilm reels that were potential sources of local

[1]We are grateful to Dr. Richard Price, Professor of English History, who pointed out to us that national records at such an early date would not be available and that we would have to search out local records.

window tax records. From these, we selected nine reels of microfilm that provided the longest spans of data and which encompassed a widely distributed sample of counties.

What these microfilms revealed was local window tax records with the name of the owner of the dwelling along with the "number of windows owned" and the "window tax charged" next to each name for each year. We kept track of each household to see how the number of windows changed over time.

This, incidentally, involved an extended effort. The data (which were not always very clear on the microfilm) had to be manually transcribed. There were a number of problems to be addressed. For instance, if a particular household disappeared from the records, we had no way to determine whether the individual had died, moved away, or simply changed name (perhaps as a result of marriage).

Drawing on these records, we have assembled tabulations of window and tax data by household and by year that provide the basic information that we use for the empirical analysis in the next section. As we argued in the body of this paper, these data themselves tell a very compelling story about the impact of the window tax.

Statistical Tests

We have completed chi-square tests of the six hypotheses that there are an equal number of observations just to the left of a notch, at a notch, and just to the right of a notch. We

summarize those tests in Tables 2 and 3 below. Five of the tests reject the hypothesis of equal numbers at the 1-percent level; the remaining test rejects that hypothesis at the 5-percent level.

Table 2 Tests for Masses at the Notches 1747-57 Sample	
Number of Windows	Number of Observations
8	21
9	93
10	21
Chi-Square Statistic	76.80*
13	30
14	88
15	8
Chi-Square Statistic	81.33*
18	17
19	32
20	5
Chi-Square Statistic	20.33*

* Significant at the 1-percent level.

Table 3 Tests for Masses at the Notches 1761-65 Sample	
Number of Windows	Number of Observations
6	9
7	48
8	5
Chi-Square Statistic	54.61*
10	9
11	16
12	4
Chi-Square Statistic	7.52**
18	0
19	13
20	2
Chi-Square Statistic	19.60*

* Significant at the 1-percent level.

** Significant at the 5-percent level.