

# CONSUMER RESPONSE TO CIGARETTE EXCISE TAX CHANGES

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## MODEL APPENDIX

### A. Model Derivation

In this section, we derive the first order conditions for the analytical solution to the Bellman model presented in (1), where the consumer does not face adjustment costs. Although we do not solve for a closed form solution of the more general model with adjustment costs, the intuition from the model without adjustment costs applies to the more general case.

Absent adjustment costs, consumers choose purchases and consumption,

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defines the optimal path of consumption. Consumption falls with prices and follows a declining (rising) trend if the discount rate is greater (less) than the interest rate on savings.

The third equation defines the subset of consumers who will purchase the low-quality tier in a particular period. If a consumer's relative preference for the low-quality good,  $\eta$ , is greater than the relative marginal cost,  $p_t^L/p_t^H$ , the consumer purchases the low-quality good in a given period and the Kuhn-tucker condition for  $H$  binds ( $\mu_t^H > 0, \mu_t^L = 0$ ). Similarly, if  $\eta < p_t^L/p_t^H$ , the consumer chooses to purchase the high-quality good. If per-unit taxes increase the level of both the high-quality and low-quality goods ( $p_{t+1}^H = p_t^H + \tau$  and  $p_{t+1}^L = p_t^L + \tau$ ), consumers with  $\eta$  in  $(p_t^L/p_t^H, p_{t+1}^L/p_{t+1}^H)$  will strictly prefer the low-quality good before the tax change and strictly prefer the high-quality good after the tax change. The substitution from low- to high-quality goods, along with the per-unit tax increase causing a bigger price increase for low-quality goods drives the familiar "flight-to-quality" result documented in the previous literature.

## B. Sensitivity Analyses

In this section, we examine the sensitivity of the low-quality tier quantity to changes in our simulation parameters. To restate, our base specification assumes the following:

The starting price of the high-quality and low-quality tiers are 10 and 8 respectively.

A per-unit tax of 2 is imposed at time 10.

Consumers discount future utility at 10 percent. Assets (or liability) appreciate at 10 percent.

A consumer's relative preference for low-quality cigarettes is uniformly distributed from [0.7, 0.9]. Absent adjustment costs, consumers with  $\eta < 0.8$  always prefer high-quality cigarettes. Consumers within [0.8, 0.833] switch from low to high-quality

cigarettes following the tax change. Consumer with  $0.833\$$  always purchase low-quality cigarettes.

In this appendix, we focus on two parameters: (i

Figure A-2 graphs the quantity of the low-quality tier for four discount rates (the reference case  $\delta = 0.1$  is omitted). As before, the discount rate is correlated with stockpiling as well as the long-term trend, but short-term flight from quality is robust to the changes.

Figure A-2: Sensitivity Analysis: Discount Rate

### C. Quantity Decomposition

In this section, we decompose the quantity of the low-quality tier into consumption of the high and low-quality tiers. In particular, we separately examine consumption for each of three consumer “classes”: (1) consumers who alwa

We first present the quantity decomposition on the reference case, the model without

adjustment costs, we no longer see a sharp drop in consumption at the time of the tax increase. Rather, we see all three groups gradually taper the consumption to lower levels. Group 1, the consumers who always consume high-quality cigarettes absent adjustment costs, now smooth their transition path by consuming low-quality cigarettes for five periods after the tax change. Group 2, the consumers who switch immediately from low-quality to high-quality cigarettes absent adjustment costs, now delay switch substantially to mitigate adjustment costs. Group 3, which cannot substitute to low-quality cigarettes, responds by borrowing against future periods to smooth the transition path after the tax change.

Finally, we present the quantity decomposition for model 2 in figure 3. In this case, consumers can partially mitigate adjustments by stockpiling goods prior to the tax change at  $t=10$ . Although stockpiling does not change the general shape of the transition path, it does allow consumers to maintain a higher level of cigarette consumption in the post-tax period.

Figure A-4: Cigarette Consumption by Tier and Consumer Group: Adjustment Costs, No  
Stockpiling



Figure A-5: Cigarette Consumption by Tier and Consumer

Stockpiling

