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Smoke Gets in Your Eyes: Cigarette Tax Salience and Regressivity†

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Recent evidence suggests consumers pay less attention to commodity taxes levied at the register than to taxes included in a good's posted price. If this attention gap is larger for high-income consumers than for low-income consumers, policymakers can manipulate a tax's regressivity by altering the fraction of the tax imposed at the register. We investigate income differences in attentiveness to cigarette taxes, exploiting state and time variation in cigarette excise and sales tax rates. Whereas all consumers respond to taxes that appear in cigarettes' posted price, our results suggest that only low-income consumers respond to taxes levied at the register. (*JEL* D12, H22, H25, H71, L66)

Should governments levy commodity taxes at the register or include them in a good's posted price? Traditional approaches to the economics of taxation offer little guidance to policymakers choosing between the two tax types. Indeed, neoclassical theory suggests that this aspect of tax design—the choice between "posted" and "register" taxes—does not affect consumer welfare because consumers correctly compute and account for all taxes that will be assessed on a given transaction. However, a series of recent findings call that invariance prediction into doubt. For example, Chetty, Looney, and Kroft (2009), hereafter CLK (2009), present compelling evidence that consumers pay more attention to goods' posted prices than to register taxes because the former are more salient—consumers see the posted tax-inclusive price when making their purchasing decisions. Related empirical findings by Finkelstein (2009) and Cabral and Hoxby (2010) are also consistent with the hypothesis that the salience of a tax shapes the extent to which consumers perceive it. This line of research suggests that the policy choice between posted and register taxes may not be as irrelevant as neoclassical theory predicts.

This paper investigates the distributional effects of the government's choice between posted and register taxes. Section I considers the case in which consumers

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differ in their attentiveness to register taxes—that is, when only some consumers take register taxes into account when making purchasing decisions. Drawing on a stylized model of consumer behavior, we show how a revenue-neutral shift from posted to register taxes reduces the tax burden on attentive consumers, unambiguously improving the welfare of that group.

We then turn to a practical implication of this insight. A concern with many commodity taxes is that they are regressive—they constitute a proportionately greater burden for low-income taxpayers. However, if low-income consumers pay more attention to register taxes than high-income consumers do, policymakers can reduce a tax's regressivity by adding it at the register instead of including it in the commodity's posted price. Conversely, when low-income consumers are relatively less attentive to register taxes, reducing a tax's salience will exacerbate its regressivity. Hence, knowing how consumers' attentiveness to register taxes varies by income is essential for understanding the distribution of a tax's burden.

Section II investigates that question empirically in the context of cigarette taxes. Cigarette purchases are typically subject to two types of taxes in the United States: an excise tax, which is included in the cigarette's posted price, and a sales tax, which is added at the register. Drawing on individual survey data about cigarette consumption, we exploit state and time variation in cigarette sales and excise tax rates to estimate the relation between the two tax types and cigarette demand. We find that both high- and low-income consumers respond to changes in the cigarette excise tax, but that only low-income consumers respond to changes in the sales tax rate on cigarettes. Although the empirical results are not conclusive, they are consistent with the hypothesis that attentiveness to cigarette register taxes declines by income. In conjunction with the theoretical insights from Section I, our empirical findings support the notion that a revenue-neutral shift from posted to register taxes could reduce the burden of the cigarette tax on low-income consumers.

Because the choice between register and posted taxes is a practical question that policymakers must confront, the lack of economic literature on the topic is surprising. Although the recent paper by Chetty, Looney, and Kroft (discussed above) provides important insights into the relative efficiency of posted and register taxes, our analysis builds on theirs by investigating how the choice between the two tax designs affects the distribution of the tax's burden between consumers. In particular, the aggregate nature of their data preclude CLK (2009) from investigating heterogeneity in consumer attentiveness—our focus here. Moreover, the welfare analytic tools developed in CLK (2009) are geared toward assessing the efficiency of a tax in the context of a representative agent, rather than a tax faced by heterogeneous consumers. To our knowledge, our paper is the first in the literature to investigate the link between the salience of a tax and the distribution of its burden across consumers.

Our paper also fits into a nascent behavioral literature investigating heterogeneity in the extent to which individuals depart from neoclassical models of decision-making. For example, Hall (2010) documents income differences in the mental accounting heuristics that individuals employ when making financial decisions and Bar-Gill and Warren (2008) present survey evidence suggesting that low-income consumers are more likely to make financial mistakes. Similarly, Mullainathan and Shafir (2009) argue that a number of behavioral phenomena affect the poor in distinctive

ways because that group lacks many of the resources used by higher-income consumers to improve decision-making quality (such as access to financial advising). In a different context, Shue and Luttmer (2009) present evidence that low-income voters are particularly prone to accidentally selecting the wrong candidate when voting ballots are designed in confusing ways.[1]

Our paper contributes to this growing literature by exploring a particular context in which cognitive limitations faced by all decision makers (e.g., bounded attention and computational abilities) affect high- and low-income consumers in distinctive ways. Most notably, whereas other studies have found deviations from optimal decision making to be greatest for low-income decision makers, we find the opposite. At least in the context of cigarette taxation, it appears that lower-income consumers do a better job of accounting for register taxes when making purchasing decisions. Apart from our empirical results, the theoretical framework we employ can be readily applied to other contexts in which agents differ in the extent to which they respond optimally to policy changes.

The paper is organized as follows. Section I constructs a stylized model of consumer behavior and uses it to analyze the welfare effects of a policy shift from posted to register taxes. The model takes as its starting point the assumption that consumers differ in their attentiveness to register taxes. Section II investigates that assumption empirically, in the context of cigarette taxation. In particular, we investigate whether high- and low-income consumers respond differently to cigarette register taxes, using those groups' responsiveness to posted taxes on cigarettes as a baseline. Section III concludes.

I. Tax Salience and Distribution

Section I demonstrates that when consumers differ in their attentiveness to register taxes, the government's choice between posted and register taxes affects the distribution of a tax's burden. In particular, replacing a posted tax with a register tax increases total tax revenue because only attentive agents consider the full after-tax price when determining their demand for the taxed good. That extra revenue accommodates a reduction in the total tax rate, generating a positive welfare effect for attentive consumers. Inattentive consumers also benefit from the reduction in the total tax rate, but their welfare gains are offset by optimization error induced by the register tax.

A. *Setup*

Our modeling approach is similar to that employed in Chetty, Looney, and Kroft (2007), except that we allow for heterogeneity in agents' attentiveness to register taxes. Suppose that society is composed of two agents (A and B) who make

[1] One theory that has been advanced to explain these findings is the notion of "cognitive depletion," the idea that making complicated or high-stakes decisions can deplete individuals' cognitive resources, worsening the quality of subsequent decisions they make. If low-income decision makers must make more of these decisions throughout the day, they may exhibit a greater number of behavioral biases than do higher-income decision makers. See Spears (2011) or Mullainathan and Shafir (2010).

consumption decisions between some good x, and a composite of all other goods, y. Good x is subject to both a register tax and a posted tax, whereas good y is left untaxed. Both agents pay attention to posted taxes when making their consumption decisions, but only A takes register taxes into account. B ignores the register tax when choosing how much x to consume, treating it as if it was zero. The agents share a utility function $U(x,y)$, and both have budget constraints of the form

$$BC_i : (p + t_p + t_r)\, x_i + y_i \leq M_i, \tag{1}$$

where the agent's type is denoted by $i \in \{A,B\}$, p is the pre-tax price of x, t_p is the posted tax, t_r is the register tax, M is income, and the pre-tax price of y is normalized to one.

Consumption is determined in two steps. First, agents choose their intended consumption bundle according to their perceived budget constraint $\left(\widehat{BC_i}\right)$. A is attentive to the register tax, so her perceived budget constraint matches her true budget constraint, $BC_A = \widehat{BC_A}$. In contrast, B misperceives the register tax to be zero: $\widehat{BC_B} : (p + t_p)\, x_i + y_i \leq M_i$. The (x,y) pair that maximizes utility subject to the agent's perceived budget constraint is the *intended consumption bundle* $(\widehat{x_i}, \widehat{y_i})$.[2] Note that B's intended consumption bundle will be infeasible when it fails to satisfy her true budget constraint.

Because the bundle that agents consume must ultimately be feasible, closing the model requires specifying the final consumption bundle for agents whose intended consumption bundle is infeasible. Because A chooses a feasible bundle to begin with, her final bundle always equals her intended bundle, $(x_A, y_A) \equiv (\hat{x}_A, \hat{y}_A)$. To pin down consumption for B, we assume that agents who overspend on x reduce their expenditures on y by the amount that they overspent on x. In our notation: $x_B = \hat{x}_B$ and $y_B = M_B - (p + t_p + t_r)\hat{x}_B$.[3] This assumption is natural for the case in which y represents all goods other than x and agents make at least some of their consumption decisions after purchasing x; consumers who accidentally overspend on x will have less income available to spend on their remaining purchases (which are all part of y).[4]

We are now in a position to link consumer demand to the two tax types. Assume for now that production of x is governed by constant returns to scale technology and that the market for x is perfectly competitive, so that p is fixed at the (constant) marginal cost of x. Holding the pre-tax price and agents' income fixed, we can express demand as a function of the taxes, $x_i = x_i(t_p, t_r)$ and $y_i = y_i(t_p, t_r)$. For A, final consumption always equals intended consumption, so demand corresponds to the solution of the standard utility maximization problem: $(x_A, y_A) = \arg\max_{x,y} U(x,y)$ s.t. BC_A. Because the tax rates do not enter the utility function directly and because they appear

[2] That is, $(\widehat{x_i}, \widehat{y_i})$ satisfies $\arg\max U(x_i, y_i)$ s.t. $\widehat{BC_i}$ holds.

[3] Note that we are implicitly assuming that x is a small enough portion of total consumption that an agent's intended consumption of x is never infeasible, even after taking the register tax into account.

[4] In principle, one could choose a different rule for mapping consumers' suboptimal decision making into feasible consumption bundles. Chetty, Looney, and Kroft (2007) identify three intuitive "budget adjustment rules": the one that we employ, as well as two others. Appendix A demonstrates that the qualitative results in this section are robust to all three of those rules. More generally, the Appendix demonstrates that our main result holds as long as individuals who misperceive the price of x to be lower than it really is end up allocating more of their income to x and less of their income to y relative to the case in which they take the true after-tax price of x into account.

symmetrically in the budget constraint, A's demand will depend only on the total tax rate—the portion of taxes included in the posted price does not matter. Hence we can write $x_A(t_p, t_r) = x_A(t_p + t_r, 0)$, or $x_A(t_p + t_r)$ for short. And similarly for y: $y_A(t_p, t_r) = y_A(t_p + t_r, 0)$, or $y_A(t_p + t_r)$ for short. Note that in accordance with the neoclassical model's invariance prediction, we have $\frac{\partial x_A}{\partial t_r} = \frac{\partial x_A}{\partial t_p} = \frac{\partial x_A}{\partial p}$ and $\frac{\partial y_A}{\partial t_r} = \frac{\partial y_A}{\partial t_p} = \frac{\partial y_A}{\partial p}$.

Deriving B's demand is complicated by the fact that her intended consumption departs from her final consumption whenever she faces a positive register tax. By assumption, all of the income B overspends on x comes out of intended expenditures on y; hence B's final consumption of x equals B's intended consumption of x: $x_B(t_p, t_r) = \widehat{x_B}(t_p, t_r)$ for all values of t_p and t_r. Moreover, because B's *intended* consumption of x is insensitive to register taxes, $\widehat{x_B}(t_p, t_r) = \widehat{x_B}(t_p, t_r')$ for all t_r and t_r', it must also be the case that B's *final* consumption of x is insensitive to register taxes, $x_B(t_p, t_r) = x_B(t_p, t_r')$ for all t_r and t_r'. Consequently, we can write B's final consumption of x as a function of the posted tax alone: $x_B(t_p, t_r) = x_B(t_p)$. Finally, because B's perceived budget constraint matches her true budget constraint in the special case that $t_r = 0$, we can conclude that B's demand for x under any nonzero register tax corresponds to B's optimal demand for x when the register tax is zero:

$$x_B(t_p, t_r) = x_B(t_p) = x_B^*(t_p, 0), \tag{2}$$

where x_B^* represents B's optimal consumption of x, i.e., the amount of x that B would choose if her perceived budget constraint were equal to her true budget constraint.[5]

By substituting (2) into B's true budget constraint, we can solve for B's final consumption of y:

$$y_B(t_p, t_r) = M_B - (p + t_p + t_r)\, x_B(t_p). \tag{3}$$

Note that in contrast to the neoclassical model, B responds differently to the two types of taxes: $\frac{\partial x_B}{\partial t_p} = \frac{\partial x_B}{\partial p} < \frac{\partial x_B}{\partial t_r} = 0$ and $\frac{\partial y_B}{\partial t_p} = \frac{\partial y_B}{\partial p} > \frac{\partial y_B}{\partial t_r}$.

B. *The Role of Tax Policy*

To incorporate tax policy into the model, consider a government that must raise a fixed amount of revenue, $\overline{R}$, from register and posted taxes on x. How does the government's choice between register and posted taxes affect the well-being of the agents? In particular, the policy we consider is a revenue-neutral increase in the register tax—that is, an increase in the register tax coupled with a reduction in the posted tax by an amount that leaves total revenue unchanged (at $\overline{R}$). Let R denote total revenue collected by taxes on x, so that $R(t_p, t_r) = (t_p + t_r)(x_A + x_B)$.

If both agents were fully attentive to both types of tax, a \$1 increase in the register tax could accommodate a \$1 reduction in the posted tax; changing the balance between register and posted taxes would not affect the combined tax rate necessary

[5] That is, x_B^* is the value of x that solves $\arg\max_{(x,y)} U(x, y)$ s.t. BC_B holds.

to raise a given amount of revenue. When some agents are inattentive, however, the demand reduction that typically accompanies a tax increase will be muted. As a result, an incremental increase in the posted tax will, all else equal, raise less revenue than an incremental increase in the register tax:

$$\frac{\partial R}{\partial t_p} = (x_A + x_B) + (t_p + t_r)\left(\frac{\partial x_A}{\partial p} + \frac{\partial x_B}{\partial p}\right)$$

$$< (x_A + x_B) + (t_p + t_r)\left(\frac{\partial x_A}{\partial p} + 0\right) = \frac{\partial R}{\partial t_r}.$$

The reduction in the posted tax associated with a *revenue-neutral* increase in the register tax can be found by totally differentiating the government's budget constraint:

$$\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} = -\frac{x_A + x_B + (t_p + t_r)\frac{\partial x_A}{\partial p}}{x_A + x_B + (t_p + t_r)\frac{\partial x_A}{\partial p} + (t_p + t_r)\frac{\partial x_B}{\partial p}}. \tag{4}$$

How does a revenue-neutral increase in the register tax affect the combined tax rate, $t_p + t_r$? The effect of the shift is given by $\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}} = \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} + 1$. Assuming that x is a normal good, (4) implies that $\partial t_p/\partial t_r|_{\bar{R}} < -1$.[6] Consequently, a revenue-neutral increase in the register tax is associated with a net reduction in the combined tax rate, $\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}} < 0$. Put differently, the government can maintain revenue neutrality while reducing posted taxes more than one-for-one with each register tax increase.

C. *Welfare Effects for Attentive Consumers*

What are the welfare effects of such a revenue-neutral shift towards register taxes? First, consider the effect of the shift on A's welfare. Indirect utility for A is given by $V_A(t_p, t_r) = U(x_A(t_p, t_r), y_A(t_p, t_r))$. The welfare effect of the shift for A is thus

$$\left.\frac{dV_A}{dt_r}\right|_{\bar{R}} = \frac{\partial V_A}{\partial t_r} + \frac{\partial V_A}{\partial t_p}\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} = -U_y(x_A, y_A)\, x_A\left(\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}}\right), \tag{5}$$

where the second inequality follows by application of the envelope theorem.[7]

Equation (5) states that the welfare effect of a revenue-neutral shift towards register taxes for attentive consumers stems entirely from the effect of the shift on the after-tax price of x. Increasing the register tax by \$1 accommodates a reduction in the combined tax rate on x of $\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}}$. For each dollar that the after-tax price of

[6] Note that the denominator in (4) equals $\frac{\partial R}{\partial t_p}$. Hence it is positive as long as demand for x is not so sensitive that raising the posted tax would actually decrease revenue, an assumption we maintain throughout.

[7] Note that the envelope theorem applies here because A's final consumption bundle matches her optimal consumption bundle.

x is reduced, A has x_A dollars more of income to spend on other goods (y). The greater the marginal utility of y, the greater A's welfare gain will be. Because we know that a revenue-neutral shift towards register taxes reduces the combined tax rate, $\frac{d(t_p + t_r)}{dt_r}\Big|_{\bar{R}} < 0$, we can conclude that the shift unambiguously increases the welfare of the attentive agent.

Equation (5) is the main result of the section, and the intuition is straightforward. Replacing a posted tax with a register tax raises total revenue because only attentive agents reduce their demand for x in response to the higher after-tax price. The extra revenue accommodates a reduction in the combined tax rate on x, generating a positive welfare effect for attentive consumers.[8]

In addition to allowing us to sign the welfare effect of the policy for attentive consumers, (5) also highlights that the magnitude of the welfare effect depends upon the extent to which increases in the register tax accommodate revenue-neutral reductions in the posted tax, $\frac{d(t_p + t_r)}{dt_r}\Big|_{\bar{R}}$. With some algebra, we can rewrite (4) to obtain

$$\frac{d(t_p + t_r)}{dt_r}\Big|_{\bar{R}} = -\frac{\tau \varepsilon_B \phi_B}{1 - \tau(\varepsilon_A \phi_A + \varepsilon_B \phi_B)}, \tag{6}$$

where $\tau \equiv \frac{t_p + t_r}{p + t_p + t_r}$ is tax as a fraction of the tax-inclusive price of x, $\varepsilon_i \equiv -\frac{\partial x_i}{\partial p}\frac{p + t_p + t_r}{x_i}$ is the own-price elasticity of demand for x_i, and $\phi_i \equiv \frac{x_i}{x_i + x_{-i}}$ is the fraction of x consumed by type i.

The magnitude of the reduction in the combined tax rate permitted by a revenue-neutral shift thus depends upon three factors: the fraction of x consumed by inattentive consumers, the sensitivity of demand for x, and taxes as a share of price. To understand the role of these factors, recall that inattentive consumers are the only ones who behave differently under the two taxes. The greater the fraction of x consumed by that group, the more important their inattentiveness will be in determining revenue from the taxes. Similarly, when B's demand for x is highly elastic, the revenue advantage of a register tax over a posted tax is especially large—the posted tax causes a large amount of substitution away from the taxed good that the register tax avoids. Finally, the larger are taxes as a share of x's price, the more that changes in those taxes affect consumer behavior for a given price-elasticity. Thus the welfare effect of a revenue-neutral shift towards register taxes is positive for A, and increasing in τ, ε, and ϕ_B.

[8] This result can be weakened by endogenizing agents' decisions about whether to pay attention to register taxes. If a small increase in the register tax causes a large number of formerly inattentive agents to start taking register taxes into account, the shift might necessitate an *increase* in the combined tax rate. In such cases, the shift to register taxes would actually generate a negative income effect, reducing the welfare of all agents. Consequently, the results presented here are most applicable to situations in which small changes in the tax rate do not induce dramatic shifts in which agents are attentive.

D. *Welfare Effects for Inattentive Consumers*

What about the inattentive agent? The change in B's indirect utility following a revenue-neutral shift towards register taxes is given by

$$\left.\frac{dV_B}{dt_r}\right|_{\bar{R}} = U_x(x_B, y_B)\frac{\partial x_B}{\partial t_p}\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} + U_y(x_B, y_B)\left(\frac{\partial y_B}{\partial t_p}\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} + \frac{\partial y_B}{\partial t_r}\right).$$

Differentiating B's budget constraint with respect to t_p and t_r yields

$$\frac{\partial y_B}{\partial p} = -x - (p + t_p + t_r)\frac{\partial x_B}{\partial p} \quad \text{and}$$

$$\frac{\partial y_B}{\partial t_r} = -x.$$

Substituting those conditions into the above expression gives the effect of the shift on B's welfare:

$$\left.\frac{dV_B}{dt_r}\right|_{\bar{R}} = -U_y(x_B, y_B)\, x_B\left(\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}}\right) + \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\frac{\partial x_B}{\partial p}\,\mu, \tag{7}$$

where $\mu \equiv U_x(x_B, y_B) - (p + t_r + t_p)U_y(x_B, y_B)$.

From (7), we can see that the net welfare effect for inattentive consumers is ambiguous. The first term is strictly positive: like the attentive consumer, B benefits from the fact that the shift accommodates a reduction in the combined tax rate. In particular, a revenue-neutral shift that increases the register tax by \$1 reduces the combined tax rate by $\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}}$, which frees up $-\left.\frac{d(t_p + t_r)}{dt_r}\right|_{\bar{R}} x_B$ dollars of income. On the other hand, the second term in (7) is negative and reflects the fact that by raising the register tax, the shift pushes B further from her privately optimal consumption bundle. To understand the pieces of the term, note that a revenue-neutral shift that increases the register tax by \$1 is associated with a posted tax reduction of $\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}$, which prompts B to increase her consumption of x by $\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\frac{\partial x_B}{\partial p}$ and reduce her consumption of y by $-\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\frac{\partial x_B}{\partial p}(p + t_p + t_r)$. If B's consumption bundle were optimal, this substitution would not have any utility cost because the marginal utilities of expenditures on x and y would be equal.[9] However, because B consumes too much x and too little y relative to the amounts that would be privately optimal given her true budget constraint, declining marginal utility in x and y implies that $\mu = U_x(x_B, y_B) - (p + t_r + t_p)U_y(x_B, y_B) \leq 0$. Thus a revenue-neutral increase in the register tax generates optimization error that reduces B's utility by $\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\frac{\partial x_B}{\partial p}\mu$. In general, either the positive or the negative welfare effect in (7) may dominate.

[9] That is, the standard first-order condition $U_x(x_B, y_B) = (p + t_r + t_p)\, U_y(x_B, y_B)$ implies $\mu = 0$.

That even inattentive consumers can be made better off by a shift towards register taxes is somewhat surprising. The explanation lies in the fact that when the register tax is small, the utility cost of optimization error stemming from the register tax is small as well, but the positive welfare effect stemming from the lower combined tax rate can still be sizable. In particular, when the register tax is small, (x_B, y_B) will be close to (x_B^*, y_B^*)—the optimal bundle in B's true budget set. Consequently, the marginal utilities of expenditures on x and y will be close in size, implying a value of μ near zero.[10] In contrast, the magnitude of the positive welfare effect in (7) depends on the *level* of the marginal utility of y, not the *difference* in the marginal utilities of x and y; hence it stays positive even when $t_r \approx 0$. Thus when the register tax is small, revenue-neutral increases in t_r tend to benefit both types of consumers. In the special case that $t_r = 0$, the optimization error associated with a small increase in t_r is exactly zero, implying that a revenue-neutral shift towards register taxes always benefits inattentive consumers.[11]

To better understand the other factors that determine whether a shift will benefit inattentive consumers, we can substitute (4) into (7) and rearrange terms to obtain

$$\left.\frac{dV_B}{dt_r}\right|_{\bar{R}} > 0 \Leftrightarrow \phi_B\left(U_y(x_B, y_B)\,(t_p + t_r) + \mu\right) + \phi_A\,\mu\,(1 - \tau\varepsilon_A) > 0. \tag{8}$$

When x is primarily consumed by attentive consumers, i.e., $\phi_A \approx 1$, (8) shows that revenue-neutral shifts towards register taxes tend to harm inattentive consumers.[12] Intuitively, a revenue-neutral shift towards register taxes accommodates only a small reduction in the combined tax rate when most consumers are attentive because the revenue differences between the two tax types will be small. However, inattentive consumers still bear the full utility costs of optimization errors that stem from the higher register tax following the shift. In contrast, when $\phi_B \approx 1$, inattentive consumers benefit from a shift whenever $U_y(x_B, y_B)\,(t_p + t_r) + \mu > 0$. Whether this condition holds depends on the relative welfare effects of the reduction in the combined tax rate and the optimization error induced by $t_r > 0$.[13]

E. *Summary and Extensions*

In summary, while a revenue-neutral shift towards register taxes always benefits attentive consumers, the net welfare effect for inattentive consumers is ambiguous. Like A, B benefits from the lower combined tax on x associated with the shift. However, unlike A, B is driven by the shift to misallocate income between x and y (relative to the allocation that maximizes B's private utility). When register taxes are

[10] Formalizing this intuition is straightforward. Assume that utility is additively separable in x and y so that $U(x,y) = u(x) + v(y)$. Then Taylor approximations of μ around (x_B^*, y_B^*) and of x_B around x_B^* yield $\mu \approx -t_r \frac{\partial x_B}{\partial p} \times (U_{xx}(x_B^*) + (p + t_r + t_p)^2 U_{yy}(y_B^*))$.

[11] Because the shift also benefits attentive consumers, this result implies that the optimal register tax is always positive.

[12] Note that $\tau\varepsilon < 1$ follows from our maintained assumption that $\partial R/\partial t_p > 0$, i.e., that demand for the taxed good is not so sensitive that increasing the posted tax reduces revenue.

[13] Because our focus in the rest of the paper is on heterogeneity between agents, we do not further develop the case in which all agents are inattentive. See Goldin (2012) for further results.

small, the utility cost of that misallocation is small as well, and the positive welfare effect dominates. But when register taxes are large, the utility cost of the misallocation may be large as well. Additionally, when x is primarily consumed by attentive consumers, the positive welfare effects of the shift are muted for attentive and inattentive consumers alike.

For simplicity, we have assumed that the pre-tax price of x is fixed at p. In reality, firms may adjust the price they charge for x in response to changes in the type of tax imposed. If a shift from posted to register taxes induced firms to raise p by a sufficient quantity, the policy could end up *increasing* the after-tax price of x, generating a negative welfare effect for all consumers.

Appendix A expands the model to the case of endogenous producer prices. We show that a revenue-neutral shift towards register taxes makes attentive consumers better off when supply of the taxed good is relatively elastic, in particular when $\varepsilon^S \tau > 1$, where $\varepsilon^S \equiv \frac{\partial s(p)}{p} \frac{(p + t_p + t_r)}{x_A + x_B}$ is the supply elasticity of x with respect to its after-tax price. In contrast, when $\varepsilon^S \tau < 1$, the reduction in t_p caused by the shift is more than offset by an increase in p, resulting in a net increase in the after-tax price of x. Intuitively, when the supply of x is inelastic, the incidence of a posted tax falls on producers; reducing the posted tax and replacing it with a register tax—to which some consumers are less sensitive—allows producers to shift the incidence of the tax back on to consumers. Thus once one accounts for the endogeneity of producer prices, the welfare results presented in Section I apply only to goods for which demand is relatively inelastic and supply is relatively elastic—that is, goods for which posted taxes are most likely to be passed on to consumers.[14]

II. The Relation between Cigarette Tax Attentiveness and Income

In Section I, we showed that policymakers can manipulate the salience of a tax to redistribute the tax's burden between attentive and inattentive agents. In practice, policymakers are often concerned with how the burden of a tax is distributed by income. In particular, a concern with many commodity taxes is that they are regressive—that is, they constitute a disproportionately greater burden for low-income consumers. An implication of the results in Section I is that if the poor tend to pay more attention to register taxes than the rich, a shift towards register taxes will make a commodity tax more progressive. On the other hand, if low-income consumers are less attentive to register taxes, such a shift would exacerbate the tax's regressivity. As such, it is important to determine whether

[14] An important implication of this result concerns the case in which $\varepsilon^S \tau < 1$. For such goods, a revenue-neutral shift from posted to register taxes—the *opposite* of the policy considered above—will benefit both attentive and inattentive consumers. Attentive consumers benefit because the reduction in the pre-tax price more than offsets the increase in the total tax on x, resulting in a net decrease in x's after-tax price. Inattentive consumers also benefit from the after-tax price reduction, and because the shift is from register to posted taxes, it reduces the magnitude of their optimization error. Of course, the final incidence of either type of shift depends on the relative degree to which each type of consumer gains from producer surplus.

attention to register taxes varies by income, and if so, whether high- or low-income consumers are the more attentive.

In Section II, we undertake that task in the context of cigarette taxes. There are good reasons to expect that low-income consumers will be more attentive to register taxes on cigarettes. In particular, the utility cost of optimization errors will tend to be greater for those with less income to spend on other goods. As a result, low-income consumers should be particularly motivated to spend the effort required to take register taxes into account. On the other hand, other factors could push high-income consumers to pay more attention to register taxes. For example, because the rich tend to consume more of each good, the magnitude of their optimization errors tends be greater as well. Online Appendix B utilizes a cognitive cost model to explore these tensions more formally. For the case of cigarettes, the analysis suggests that attentiveness to cigarette register taxes is likely to decline by income.[15] However, because it is difficult to predict which group will be more attentive on the basis of theory alone, the remainder of Section II is primarily empirical.

Our goal is to investigate whether low-income cigarette consumers are more attentive to register taxes than high-income consumers are. Cigarette purchases are subjected to two types of tax in the United States: an excise tax, which consumers see reflected in the posted price, and a sales tax, which is typically added at the register. We use state and time variation in these tax rates to estimate how consumers respond to each type of tax. We assume that consumers fully account for posted taxes, so that inattention to register taxes can be measured by the gap between consumers' responsiveness to register taxes and their responsiveness to posted taxes.

Section II is structured as follows. We begin by investigating whether the general population appears to pay more attention to register taxes than to posted taxes on cigarettes. The analysis applies the basic empirical strategy of CLK (2009) to a new product (cigarettes instead of beer) and at a different unit of observation (individual instead of aggregate consumption data). We then turn to our central question, whether attentiveness to cigarette register taxes differs by income, which we assess empirically by interacting the excise and sales tax variables with respondents' income. Finally, we undertake a number of robustness tests to investigate whether our results actually reflect heterogeneous attentiveness to register taxes as opposed to various alternative explanations.

A. *Data*

We obtain cross-sectional micro data on cigarette consumption from the Behavioral Risk Factor Surveillance System (BRFSS), supported by the National Center for Chronic Disease Prevention and Health Promotion and the Centers for Disease Control and Prevention. The BRFSS is a state-based telephone survey system that tracks health conditions and risk behaviors of individuals 18 years

[15] The framework we develop does not make a uniform prediction for all goods, but rather highlights the factors that determine which income group will be more attentive to register taxes on a particular good. In general, high-income consumers tend to be less attentive to register taxes on goods, like cigarettes, for which demand is relatively insensitive to income.

and older. The number of states participating in the survey has grown over time, from 15 in 1984 to 50 in 1994 (as well as the District of Columbia).[16] We follow CLK (2009) by dropping two states from the analysis: Hawaii, because sales taxes in that state are included in the posted price, and West Virginia, because of frequent changes to that state's sales tax base over the sample period. After dropping observations that are missing demographic variables, our final dataset contains approximately 1.3 million observations. Because the survey disproportionately samples certain groups, we use weighted regressions to obtain representative estimates.

The BRFSS data contains two measures of smoking demand: whether the respondent is a smoker (smokes at least one cigarette every day) and how many cigarettes the respondent typically consumes each day. Although the BRFSS questionnaire asked respondents about smoking participation in each year of the survey, data on the number of cigarettes consumed are only available through 2000. Consequently, our analysis restricts the sample to those interviewed between 1984 and 2000.[17] The BRFSS also collects information on a number of demographic variables, including income.[18]

Data on state-level cigarette excise tax rates, sales tax rates, and average cigarette prices were obtained from the *Tax Burden on Tobacco* 2008 report, published by Orzechowski and Walker (and previously by the Tobacco Institute). We gathered information on the exact date of enactment of sales tax changes from a number of sources including the World Tax Database (University of Michigan), state government websites, and archives of local newspaper accounts. Following convention, our measure of state tax rates includes local taxes to the extent that they are uniform across the state.

Whereas the sales tax is an ad valorem tax (consumers are charged a fixed fraction of a good's price), the excise tax is a unit tax (consumers pay a set dollar amount per pack, regardless of the pre-tax price). In order to make the two types of taxes comparable for the empirical analysis, we convert the excise tax to an ad valorem tax using the method described in CLK (2009).[19]

Both sales and excise taxes increased between 1984 and 2000 (Figure 1, panels A and B). In 1984, 38 states imposed sales taxes on cigarettes, and the median sales tax rate was 4 percent. By 2000, 45 states imposed sales taxes on

[16] To investigate whether the changing composition of states was biasing our results, we restricted our analysis to the 33 states that have been in the sample since 1987. The qualitative results were unchanged by that restriction.

[17] Extending our empirical analysis through 2009 and using only the outcome variables available in the later years yields results similar to those obtained from our sample.

[18] We make use of information concerning the respondent's age, race, sex, educational attainment, marital status, employment status, and income. Household income is measured in terms of income categories. Two problems arise when using this variable. First, the income measure is top-coded at a relatively low value ($75,000 for much of our sample period). Second, the income categories are not adjusted for inflation, making it difficult to compare respondents in the same category over time. Rather than attempt to convert the BRFSS income category data into a measure of real income, we measure income in percentile terms, assigning respondents the midpoint of the percentiles of their income category boundaries. For example, if 10 percent of the sample in one year reports an income between zero and $10,000, all individuals in that income category in that year are assigned a value of 0.05. This approach is similar to that employed by Franks et al. (2007).

[19] We divide the excise tax by the average national price of a pack of cigarettes in 2000, adjusted for inflation. The rationale for using the inflation-adjusted national price in 2000 as a proxy for the true price is to avoid endogeneity problems arising from the fact that changes in cigarette prices are likely correlated with unobserved shocks to smoking demand.

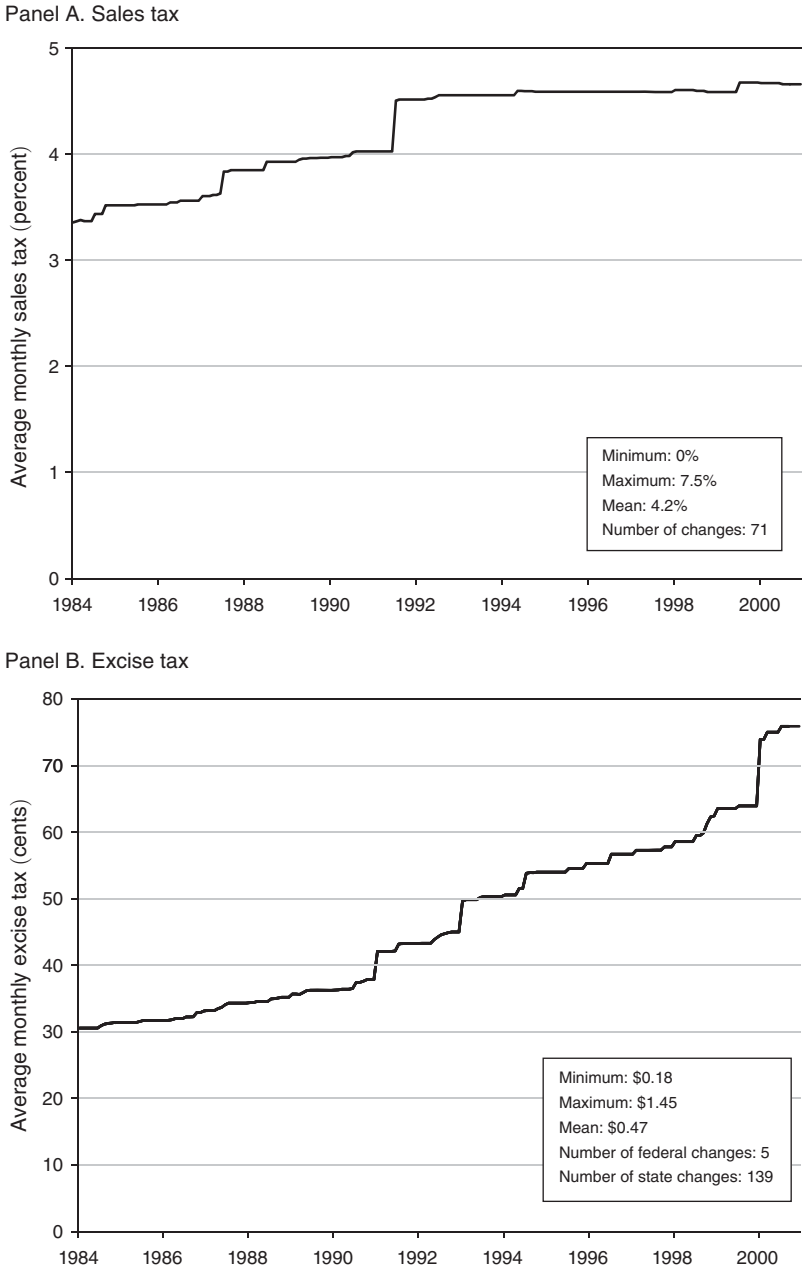

FIGURE 1. AVERAGE MONTHLY TAXES, 1984–2000

cigarettes, and the median sales tax rate had climbed to 5 percent. Similarly, median state excise taxes on cigarettes increased from 14 cents in 1984 to 34 cents in 2000. In addition, the federal excise tax on cigarettes increased three times over the same period, climbing from 16 to 34 cents per pack. Table 1 presents summary statistics on US cigarette taxation.

TABLE 1—SUMMARY OF CIGARETTE TAX CHANGES

	Excise tax		Sales tax		Pre-tax price	
	1984	2000	1984	2000	1984	2000
Minimum	$0.29	$0.36	0.0%	0.0%	$0.91	$1.84
Maximum	$0.68	$1.43	7.5%	7.5%	$1.28	$2.47
Mean	$0.50	$0.75	3.8%	5.0%	$1.03	$2.20
Number of state changes	91		45			
Number of federal changes	3		N/A			

Note: Excise taxes and prices are denoted in 2000 dollars.

TABLE 2—AVERAGE CIGARETTE CONSUMPTION BY INCOME QUARTILE

	Smoking rate (Extensive margin, %)			Daily consumption among smokers (Intensive margin, cigarettes)			Share of total cigarette consumption (%)
	1984	2000	All years	1984	2000	All years	All years
Q1	30.1	21.7	25.3	18.3	17.7	17.7	24.6
Q2	29.2	20.1	25.1	19.8	18.2	18.5	27.6
Q3	29.1	17.4	22.5	20.6	18.2	19.1	26.9
Q4	23.7	11.9	16.8	21.1	18.1	19.5	20.8
All	27.8	17.6	22.3	20.0	18.0	18.7	100.0

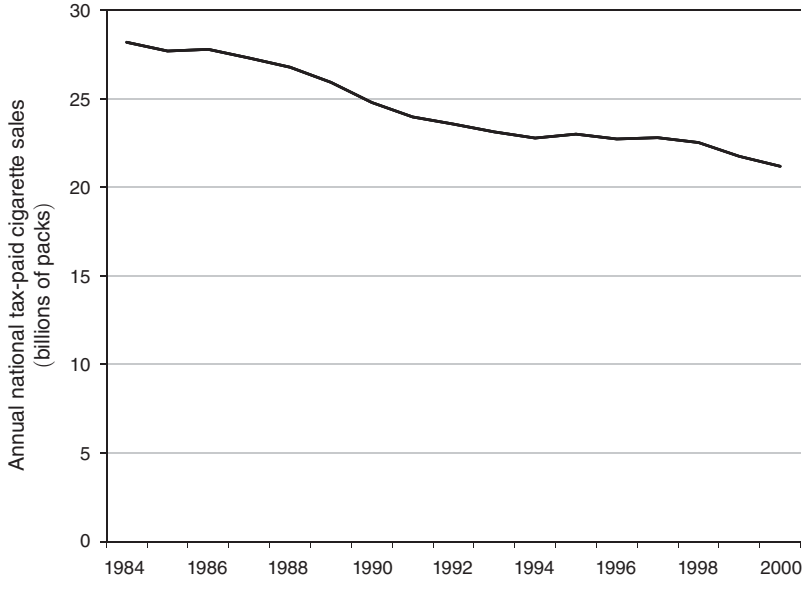

FIGURE 2. AGGREGATE CIGARETTE CONSUMPTION

Figure 2 shows that aggregate cigarette consumption in the United States declined between 1984 and 2000. That decline, however, was not uniform across the population. Figure 3 separately plots smoking participation rates over time for the highest and lowest income quartiles. Low-income individuals were more likely to smoke than high-income ones in 1984, and that gap widened over time. Smoking demand measures are summarized in Table 2.

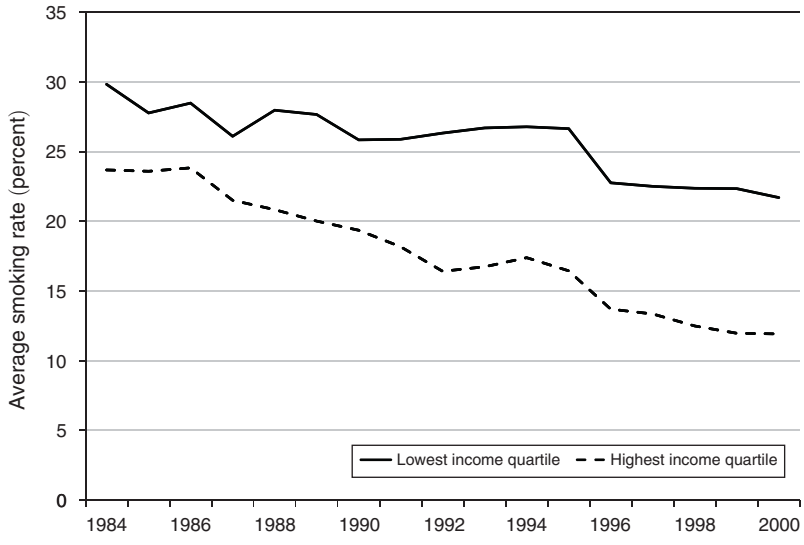

FIGURE 3. SMOKING RATES BY INCOME

B. *Attentiveness to Cigarette Taxes in the General Population*

We begin our empirical analysis by investigating whether consumers in the general population respond differently to register and posted taxes on cigarettes. The neoclassical model predicts that the salience of a tax (e.g., whether it is included in the posted price or added at the register) should not affect how consumer's respond to it. To see this formally, suppose that demand for a good x depends on a consumer's income I and the price of x, p_x: $x = x(p_x, I)$.

Purchases of x are subject to both a sales tax and an excise tax, so that the final price of x is given by $p_x = p(1+t)(1+s)$, in which p is the pre-tax price of x, t is the excise tax rate, and s is the sales tax rate.[20]

Because the excise and sales tax affect the price of x symmetrically, we have that

$$\frac{\partial x}{\partial \log(1+t)} = \frac{\partial x}{\partial \log p_x}\frac{\partial \log p_x}{\partial \log(1+t)} = \frac{\partial x}{\partial \log p_x}\frac{\partial \log p_x}{\partial \log(1+s)} = \frac{\partial x}{\partial \log(1+s)}.$$

In words, how consumers adjust their demand for x in response to a tax change should not depend on whether the change occurred in the excise tax rate or the sales tax rate.[21]

[20] Some states do not include the excise tax in the price used to calculate the sales tax, so that final prices are given by $p_x = p(1+t+s)$. Because the excise and sales tax still affect the price of x symmetrically in such states, the neoclassical model predicts that demand should respond identically to sales and excise tax changes of the same proportion.

[21] Two assumptions are important for this result: first, that tax rates only enter consumer utility through their effect on product prices, and second, that p_x is the only price that affects demand for x. We maintain the first assumption throughout but consider the implications of relaxing the second in Section IIE.

CLK (2009) assess this prediction for the case of beer by linking changes in aggregate beer consumption by state to changes in the state's sales tax rate and excise tax on beer. They find that changes in the beer excise tax are negatively and significantly correlated with changes in beer consumption, whereas sales tax changes appear to have little effect. As a result, CLK (2009) conclude that the neoclassical model is mistaken and that the salience of a tax affects how consumers respond. Because they lack disaggregated consumption data, CLK (2009) are unable to assess whether the salience of a tax affects different parts of the population differently, our goal in Section IIC.

Our analysis in this section differs from CLK (2009) by focusing on cigarettes instead of beer and by using individual survey data rather than aggregate state consumption data. Our baseline empirical model takes the form:

$$(9) \qquad y_{ismt} = \alpha + \beta_1 \tau^e_{smt} + \beta_2 \tau^s_{smt} + \gamma x_{smt} + \delta z_{ismt} + \mu_s + \lambda_t + \pi_m + \varepsilon_{ismt},$$

where the unit of observation is an individual i in state s, calendar month m, and year t. The dependent variable (y) represents cigarette demand, τ^e is the log excise tax rate, τ^s is the log sales tax rate, x are covariates that do not vary between individuals interviewed in the same state, month, and year, and z are individual-level covariates. We include state fixed effects μ_s to capture unobserved factors that are correlated with both state tax rates and the level of smoking demand. Year fixed effects λ_t capture time trends in smoking demand as well as yearly shocks to national cigarette consumption, such as a national antismoking campaign. Finally, π_m is a calendar month effect, which accounts for seasonal or monthly patterns in cigarette demand.

As is standard in the cigarette demand literature,[22] we model the decision of whether an individual smokes (the extensive margin) separately from the decision of how much to smoke, conditional on being a smoker (the intensive margin). Consequently, in some specifications y is a binary choice variable indicating whether the individual reports being a smoker, and in other specifications y is the nonzero count of the number of cigarettes consumed in the last month, where the sample is restricted to self-reported smokers. This "double-hurdle" model is common in the cigarette demand literature because the decision of whether to smoke may be fundamentally different than the decision of how much to smoke, and is informative as to whether taxes affect consumption by turning smokers into nonsmokers or by inducing current smokers to reduce the number of cigarettes they smoke.[23]

Table 3 presents the results of this analysis.[24] The specifications in columns 1 and 4 regress smoking demand on the two tax rates, individual demographic variables, and state, year, and calendar month fixed effects. Since state taxes are often increased to meet budgetary shortfalls in bad economic times, it is likely that tax rate changes are correlated with state-level economic variables that are not captured

[22] See Chaloupka and Warner (2000) for a helpful review of the extensive literature on estimating cigarette demand.

[23] A drawback of the two-part approach is that estimation results for the intensive margin may be biased by changes to the composition of the smoking population. We investigate the robustness of this specification in Section IIE.

[24] We estimate demand on the extensive margin with a linear probability model. A probit model yields similar results. Because unobserved shocks to smoking demand may be correlated across time for consumers living in the same state, all tables report standard errors that are clustered at the state level.

Table 3—Effect of Taxes on Cigarette Demand: Extensive and Intensive Margins

	Extensive margin			Intensive margin		
	(1)	(2)	(3)	(4)	(5)	(6)
Excise tax	−0.127***	−0.116***	−0.117***	−0.358***	−0.336***	−0.341***
	(0.030)	(0.026)	(0.026)	(0.049)	(0.055)	(0.056)
Sales tax	−0.261*	−0.132	−0.132	−0.136	−0.019	−0.022
	(0.140)	(0.100)	(0.101)	(0.273)	(0.289)	(0.290)
Income	−0.099***	−0.099***	−0.075***	0.007	0.007	0.058**
	(0.005)	(0.005)	(0.008)	(0.019)	(0.019)	(0.027)
Female	−0.039***	−0.039***	−0.039***	−0.187***	−0.187***	−0.187***
	(0.003)	(0.003)	(0.003)	(0.007)	(0.007)	(0.007)
White	0.082***	0.082***	0.082***	0.452***	0.452***	0.452***
	(0.006)	(0.006)	(0.006)	(0.026)	(0.026)	(0.026)
High school grad	−0.062***	−0.062***	−0.062***	−0.058***	−0.058***	−0.058***
	(0.009)	(0.009)	(0.009)	(0.014)	(0.014)	(0.014)
College grad	−0.123***	−0.123***	−0.123***	−0.144***	−0.144***	−0.144***
	(0.005)	(0.005)	(0.005)	(0.009)	(0.009)	(0.009)
Married	−0.067***	−0.067***	−0.067***	−0.019***	−0.019***	−0.019***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.006)
Unemployed	0.086***	0.087***	0.087***	0.054***	0.055***	0.056***
	(0.004)	(0.004)	(0.005)	(0.007)	(0.007)	(0.007)
Age	0.034***	0.035***	0.034***	0.018	0.018	0.018
	(0.005)	(0.005)	(0.005)	(0.012)	(0.012)	(0.012)
Age^2	−0.001***	−0.001***	−0.001***	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log unemployment rate		−0.028***	−0.028***		−0.020	−0.021
		(0.008)	(0.008)		(0.013)	(0.013)
Log state income		−0.014	−0.014		0.063	0.065
		(0.029)	(0.029)		(0.058)	(0.058)
Income trend			−0.003**			−0.006***
			(0.001)			(0.001)
Economic conditions		X	X		X	X
Income trend			X			X
F-stat	0.97	0.02	0.02	0.59	1.05	1.05
prob > *F*	0.33	0.88	0.89	0.45	0.31	0.31
Observations	1,288,031	1,288,031	1,288,031	274,137	274,137	274,137

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Third- and fourth-order age polynomials are included in the regression but not displayed. Outcome variables: probability of smoking (extensive) and log cigarette demand (intensive). The *F*-stat is for the test of equality between the excise tax and the sales tax coefficients.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

by state fixed effects. If cigarette consumption is also correlated with the business cycle, this omitted variable could bias our results. To account for this possibility, columns 2 and 5 include state-level measures of real income and unemployment rate.[25]

Columns 3 and 6 add an interaction between income and a linear time trend. To motivate this addition, recall that smoking participation rates fell more steeply over the sample period for higher income consumers (Figure 3). Although this decline

[25] Real state income data comes from the Bureau of Economic Analysis and the state unemployment rate data comes from the Bureau of Labor Statistics. Both variables are measured quarterly.

Table 4—Effect of Taxes on Cigarette Demand: Combined Effect

	(1)	(2)	(3)
Excise tax	−3.749***	−3.508***	−3.577***
	(0.481)	(0.479)	(0.479)
Sales tax	−5.007**	−2.350	−2.366
	(2.156)	(2.200)	(2.199)
Economic conditions		X	X
Income trend			X
F-stat	0.30	0.25	0.27
prob > *F*	0.58	0.62	0.60
Observations	1,288,031	1,288,031	1,288,031

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variable: cigarette demand in levels. The *F*-stat is for the test of equality between the excise tax and the sales tax coefficients.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

might stem from rising tax rates over the sample period, it could also reflect a secular trend in smoking consumption at the top of the income spectrum, such as a shift in cultural attitudes about smoking among high SES individuals. Because tax rates trend upwards over the sample period, a secular trend in smoking demand among high-income consumers could be conflated with the two tax-income interaction terms in the regression. The inclusion of the time trend in columns 3 and 6 accounts for this possibility.

The regressions in Table 3 show the effect of taxes on the intensive and extensive margins separately. In order to provide a better picture of the overall effect of a tax change on cigarette demand, Table 4 follows the procedure laid out in McDonald and Moffitt (1980) to combine the intensive and extensive margin estimates. In particular, one can decompose the conditional expectation of cigarette demand into its intensive and extensive components:

$$E[y|x] = E[y|x, y > 0] \times P(y > 0|x),$$

where y represents cigarette demand and x represents the covariates. Using the product rule, the total effect of a change in one of the covariates on cigarette demand is given by

$$\frac{\partial E[y|x]}{\partial x} = \frac{\partial E[y|x, y > 0]}{\partial x} \times P(y > 0|x) + \frac{\partial P(y > 0|x)}{\partial x} \times E[y|x, y > 0].$$

By utilizing sample estimates of $P(y > 0|x)$ and $E[y|x, y > 0]$, evaluated at the sample mean of each covariate, we can combine the estimated coefficients from the intensive and extensive margin regressions into a rough estimate of the overall effect of the taxes on cigarette demand.[26]

[26] When calculating standard errors for the aggregate effect, we ignore uncertainty in the sample averages of $P(y > 0|x)$ and $E[y|x, y > 0]$. This approximation is reasonable because the size of our sample guarantees those quantities are estimated precisely.

The results in Tables 3 and 4 are consistent with a salience effect on the intensive margin: under our preferred specification, a 1 percent increase in the cigarette excise tax is associated with a 0.34 percent reduction in cigarettes per month among smokers, whereas the point estimate on the sales tax term is close to zero and is not statistically significant. However, the coefficient on the sales tax is measured imprecisely, and consequently, we cannot reject the null hypothesis of equality between the two coefficients. On the extensive margin, the point estimate of the sales tax is slightly greater in magnitude than that of the excise tax, although here, too, the difference is not statistically significant.[27] The coefficients on the excise tax estimates imply price elasticities of -0.52 on the extensive margin, -0.31 on the intensive margin, and -0.87 for combined demand. For the sales tax, the implied price elasticities are -0.32 on the extensive margin, -0.02 on the intensive margin, and -0.32 for overall cigarette demand.[28] Overall, the evidence is inconclusive regarding the presence of a salience effect for the general population.

C. *Attentiveness to Cigarette Taxes by Income*

The inconclusive results for the general population in Section IIB might mask heterogeneous responsiveness across income groups. We now turn to our primary question of interest, whether low-income consumers are particularly attentive to cigarette register taxes. The baseline empirical model for this section is given by

$$(10)\qquad y_{ismt} = \alpha + \beta_1 \tau^e_{smt} + \beta_2 \tau^s_{smt} + \rho_1 \tau^e_{smt} LI_{ismt} + \rho_2 \tau^s_{smt} LI_{ismt} + \eta LI_{ismt} + \gamma x_{smt} + \delta z_{ismt} + \mu_s + \lambda_t + \pi_m + \varepsilon_{ismt},$$

where *LI* is a binary variable indicating whether the respondent is low income, defined as having income below the 25th percentile. Compared to the econometric model in IIB, this specification adds interaction terms between low-income status and the two tax rate variables.[29] The coefficients on the two tax types, β_1 and β_2,

[27] One complication also confronted by CLK (2009) is that the simple comparison between estimated tax coefficients can be misleading as a test of salience if the two tax types are passed through to consumers at different rates—that is, if $\frac{\partial(p + t_p + t_r)}{\partial t_r} \neq \frac{\partial(p + t_p + t_r)}{\partial t_p}$. Although a finding of differential pass-through is consistent with tax salience—see CLK (2009, pp. 1167–69)—it could also arise solely from differences in the two tax bases. As explained in Section E.1 below, we address this issue by comparing the sales tax coefficient with the effect of the pre-sales tax price of x, instrumented with the excise tax. For the general population analysis, an IV approach differs from Table 3 in that the estimated excise tax coefficient becomes greater in magnitude than the estimated effect of the sales tax, consistent with a salience effect. However, for both margins, the difference between the estimated coefficients remains statistically insignificant.

[28] To compute the price elasticity implied by a tax coefficient, one must scale the coefficient by the rate at which the tax is passed through to the after-tax price, $\varepsilon_{x,p} = \frac{1}{x}\frac{\partial x}{\partial \log(p_x)} = \frac{1}{x}\frac{\partial \log(x)}{\partial \log(1+t)} \times \frac{\partial \log(1+t)}{\partial \log(p_x)} = \varepsilon_{x,t}/\varepsilon_{p,t}$. The pass-through rate may be obtained from Table 11. The estimated excise tax elasticities we find are on the larger side of those typically reported in the smoking literature. For example, Chaloupka and Warner (2000) report that recent estimates of (overall) cigarette demand range from elasticities of -0.14 to -1.23, but that most fall in the narrower range of -0.3 to -0.5. Gruber and Koszegi (2004) find an implied excise tax elasticity of -0.66 using the Consumer Expenditure Survey. Sales tax elasticities are not typically estimated in the smoking literature.

[29] In addition to the main effect for low-income status, the individual demographics vector z also includes a continuous measure of income.

describe how high-income consumers modify their demand in response to changes in the excise and sales taxes, respectively. In turn, the coefficients on the income-interaction terms, ρ_1 and ρ_2, measure whether low-income consumers are more or less sensitive to changes in the two tax types.

Our primary question is whether attentiveness to the sales tax varies by income. In answering this question, one must distinguish between attentiveness—the extent to which consumers account for a tax when making their consumption decisions—and price-sensitivity—which describes how a tax that consumers account for affects their optimal purchase. The sales $\times$ low-income interaction term (ρ_2) may reflect differences in attentiveness between high- and low-income consumers, but it may also reflect differences in price-sensitivity by income. That is, a negative coefficient on ρ_2 could stem from high-income smokers being less sensitive to cigarette prices *in any form*, even if high- and low-income smokers were equally attentive to the sales tax.

To deal with this possibility, it is useful to introduce the notion of the "attention gap," the amount by which a consumer's responsiveness to the excise tax exceeds her responsiveness to the sales tax. For high-income consumers, the estimated attention gap is simply $\beta_2 - \beta_1$. In turn, for low-income consumers, the estimated attention gap is given by $(\beta_2 + \rho_2) - (\beta_1 + \rho_1)$. Recall that the neoclassical model described above predicts that consumers should respond identically to excise and sales taxes that they take into account. Consequently, we interpret a nonzero value of the attention gap as evidence that consumers account for one type of tax more than the other.

Although the sign and magnitude of the attention gap for a particular income group are interesting in their own right, more relevant to our analysis are *changes* in the attention gap by income. That is, we are less concerned with whether a particular group of consumers pays more attention to the excise tax relative to the sales tax, and more concerned with whether low-income consumers pay more attention to the sales tax (relative to the excise tax) than high-income consumers do.[30] It is easy to see that the estimated difference in attentiveness between high- and low-income consumers is given by

$$\begin{aligned}(11)\qquad \Delta \textit{AttentionGap} &= \left[(\beta_2 + \rho_2) - (\beta_1 + \rho_1)\right] - \left[\beta_2 - \beta_1\right] \\ &= \rho_2 - \rho_1 .\end{aligned}$$

Intuitively, the sales $\times$ low-income coefficient (ρ_2) reflects changing responsiveness to the sales tax by income, and the excise $\times$ low-income coefficient (ρ_1) removes the portion of that change due to changes in consumers' price sensitivity. Hence, the gap between the coefficients on the two interaction terms rates, $\rho_2 - \rho_1$, measures the extent to which attentiveness to the register tax changes as income rises. When $\rho_2 - \rho_1 < 0$, high-income consumers pay less attention to the sales tax (relative to the excise tax) than low-income consumers do.

[30] After all, it is the *differences* in behavior between high- and low-income consumers that shapes the distribution of a tax's burden.

Table 5—Effect of Taxes on Cigarette Demand by Income: Extensive and Intensive Margins

	Extensive margin			Intensive margin		
	(1)	(2)	(3)	(4)	(5)	(6)
Excise tax	−0.152***	−0.141***	−0.132***	−0.391***	−0.370***	−0.346***
	(0.030)	(0.028)	(0.027)	(0.053)	(0.061)	(0.060)
Sales tax	−0.152	−0.023	−0.025	0.211	0.328	0.318
	(0.135)	(0.114)	(0.115)	(0.311)	(0.340)	(0.340)
Excise × low-income	0.099*	0.099*	0.058	0.119	0.121	0.020
	(0.054)	(0.054)	(0.056)	(0.086)	(0.086)	(0.112)
Sales × low-income	−0.502**	−0.502**	−0.501***	−1.389**	−1.390**	−1.379**
	(0.191)	(0.191)	(0.182)	(0.668)	(0.669)	(0.663)
Income	−0.125***	−0.125***	−0.103***	−0.027**	−0.027**	0.027
	(0.005)	(0.005)	(0.010)	(0.013)	(0.013)	(0.024)
Income trend			−0.002**			−0.007***
			(0.001)			(0.002)
Economic conditions		X	X		X	X
Income trend			X			X
F-stat	9.91	9.74	8.60	5.48	5.49	5.14
prob > *F*	0.00	0.00	0.01	0.02	0.02	0.03
Observations	1,288,031	1,288,031	1,288,031	274,137	274,137	274,137

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variables: probability of smoking (extensive) and log cigarette demand (intensive). The *F*-stat is associated with the test for equality between the excise × low-income and sales × low-income interaction coefficients.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table 5 presents our results. Columns 1 and 4 include the two tax rates, on their own and interacted with income. In addition, the regressions include demographic variables as well as state, year, and month fixed effects. As before, columns 2 and 5 add real state income and the state unemployment rate, and columns 3 and 6 include an interaction between income and a linear time trend to capture the changing relationship between income and smoking behavior over time. The estimated coefficients on the demographic and macroeconomic variables are qualitatively similar to those reported in Table 3, and are omitted. Table 6 combines the intensive and extensive margin estimates into an overall effect, using the method described in Section IIB.[31]

The results in Tables 5 and 6 are consistent with the theory that attentiveness to register taxes declines with income. As before, columns 3 and 6 are our preferred specification.[32] On both the intensive and extensive margins, the estimated tax coefficients suggest that high-income consumers respond less negatively to the sales tax than to the excise tax. The excise tax coefficients are negative and statistically significant, whereas the sales tax coefficients are statistically indistinguishable from

[31] The robustness checks that follow use the specification in columns 3 and 6 as their baseline.

[32] The only qualitative difference between specifications is the coefficient on the excise × low-income interaction, which declines sharply in magnitude once the income time trend is added to the model.

TABLE 6—EFFECT OF TAXES ON CIGARETTE DEMAND BY INCOME: COMBINED EFFECT

	(1)	(2)	(3)
Excise tax	−4.420***	−4.184***	−3.846***
	(0.496)	(0.494)	(0.494)
Sales tax	−2.290	0.365	0.265
	(2.196)	(2.242)	(2.239)
Excise × low-income	2.543***	2.554***	1.047*
	(0.544)	(0.544)	(0.546)
Sales × low-income	−11.987***	−11.989***	−11.888***
	(1.915)	(1.916)	(1.917)
Income	−2.375***	−2.375***	−1.565***
	(0.079)	(0.079)	(0.147)
Income trend			−0.094***
			(0.012)
Economic conditions		X	X
Income trend			X
F-stat	45.45	45.52	36.17
prob > *F*	0.00	0.00	0.00
Observations	1,288,031	1,288,031	1,288,031

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variable: cigarette demand in levels. The *F*-stat is associated with the test for equality between the excise × low-income and sales × low-income interaction coefficients.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

zero.[33] An *F*-test suggests that the difference in magnitude between the high-income tax coefficients is statistically significant on both margins.

For low-income consumers, the results paint a dramatically different picture. The coefficient on the interaction between low-income status and the sales tax is negative and significant, implying that an increase in the sale tax is associated with a larger reduction in demand for low-income consumers than for high-income consumers. The small coefficient on the excise × low-income interaction term suggests that the result reflects a difference in attentiveness rather than a mere difference in price sensitivity by income.[34]

Recall from (11) that changes in the attention gap by income are captured by $\rho_2 - \rho_1$. Hence, to investigate whether low-income consumers are particularly attentive to register taxes, we test whether $\rho_1 = \rho_2$. The associated *F*-tests are reported in Tables 5 and 6. Under our preferred specifications, the *F*-statistics for the extensive

[33] The high-income consumer price elasticities implied by these estimates are −0.61 (excise) and −0.06 (sales) on the extensive margin, and −0.31 (excise) and 0.18 (sales) on the intensive margin.

[34] The low-income consumer price elasticities implied by these estimates are −0.30 (excise) and −1.13 (sales) on the extensive margin, and −0.30 (excise) and −0.59 (sales) on the intensive margin. One interesting result is that on both margins, the point estimate of the sales tax is more negative than the point estimate of the excise tax for low-income consumers, although the difference is only significant on the intensive margin. This result could stem from differences in the goods included in the excise and sales tax bases, a possibility explored in Section IID. Of course, it is also possible that the estimated sales tax coefficient is biased downward due to some omitted variable. However, unless that omitted variable was differentially correlated with smoking demand by high- and low-income consumers, it would not drive the differences in sales tax responsiveness that we observe.

Table 7—Effect of Taxes on Cigarette Demand by Income Quartile: Extensive and Intensive Margins

	Extensive margin			Intensive margin		
	Excise (1)	Sales (2)	*F*-stat (3)	Excise (4)	Sales (5)	*F*-stat (6)
Baseline (Q1)	−0.081	−0.521***		−0.329***	−1.072*	
	(0.056)	(0.166)		(0.101)	(0.566)	
Tax × Q2	−0.104**	0.284*	6.09**	0.015	0.883	3.04*
	(0.044)	(0.153)	(0.02)	(0.137)	(0.536)	(0.09)
Tax × Q3	−0.050	0.574**	6.88***	−0.019	1.551*	4.19**
	(0.067)	(0.220)	(0.01)	(0.103)	(0.802)	(0.05)
Tax × Q4	0.002	0.628***	9.92***	−0.069	1.875**	5.56**
	(0.072)	(0.190)	(0.00)	(0.130)	(0.839)	(0.02)
Observations	1,288,031	1,288,031	1,288,031	274,137	274,137	274,137

Notes: Standard errors clustered at the state level in parentheses in columns 1, 2, 4, and 5. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variables: probability of smoking (extensive) and log cigarette demand (intensive). Tax × income group interactions represent the difference between that income group's sensitivity to the tax rate and the baseline group's sensitivity to the tax rate. The *F*-stats are associated with testing $\rho_{2,j} - \rho_{1,j} = 0$ for j in $\{2,3,4\}$. Prob > *F* in parentheses in columns 3 and 6.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

and intensive margins are 8.60 and 5.14, respectively. Hence, our results are consistent with the hypothesis that low-income consumers pay more attention to cigarette register taxes than do high-income consumers.[35]

So far, we have divided the analysis into low-income consumers on the one hand (those below the 25th percentile in income) and medium- to high-income consumers on the other. Although that aggregation is convenient for exposition, it may mask differences in attentiveness between medium- and high-income consumers. The regressions in Tables 7 and 8 introduce additional flexibility into the model by allowing consumers in each income quartile to respond to the taxes in different ways.[36] The resulting specification is given by

$$(12)\quad y_{ismt} = \alpha + \beta_1 \tau^e_{smt} + \beta_2 \tau^s_{smt} + \sum_{j \in \{II, III, IV\}} \{\eta^j Q^j_{ismt} + \rho^j_1 \tau^e_{smt} Q^j_{ismt} + \rho^j_2 \tau^s_{smt} Q^j_{ismt}\}$$

$$+ \gamma x_{smt} + \delta z_{ismt} + \mu_s + \lambda_t + \pi_m + \varepsilon_{ismt},$$

where Q^j_{ismt} indicates whether consumer i falls into income quartile j.

[35] Although the results from both margins are consistent with low-income consumers being more attentive than high-income consumers, several features of the analysis make the intensive margin results less convincing than those from the extensive margin. In particular, our finding that responsiveness to the two tax types varies by income on the *extensive* margin suggests the possibility that selection effects may confound our comparison of responsiveness on the *intensive* margin. Additionally, the positive point-estimate of the sales tax coefficient for high-income consumers, although not close to statistically significant, may indicate the presence of a selection effect or some other form of bias. A positive sales tax effect could also arise if the other goods in the sales tax base were strong substitutes for cigarettes; this possibility would bias our results if the substitution patterns between cigarettes and the other covered goods differed for high- and low-income consumers, a possibility explored in online Appendix C.

[36] The results are similar when we include income as a linear interaction with the tax rates, or use the 20th or 30th income percentile to define the low-income group.

TABLE 8—EFFECT OF TAXES ON CIGARETTE DEMAND BY INCOME QUARTILE: COMBINED EFFECT

	Excise (1)	Sales (2)	*F*-stat (3)
Baseline (Q1)	−2.917***	−11.575***	
	(0.641)	(2.663)	
Tax × Q2	−1.628**	7.055***	10.85***
	(0.665)	(2.347)	(0.00)
Tax × Q3	−0.999	13.686***	33.50***
	(0.643)	(2.260)	(0.00)
Tax × Q4	−0.279	14.810***	33.65***
	(0.660)	(2.323)	(0.00)
Observations	1,288,031	1,288,031	1,288,031

Notes: Standard errors clustered at the state level in parentheses in columns 1 and 2. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variable: cigarette demand in levels. Tax × income group interactions represent the difference between that income group's sensitivity to the tax rate and the baseline group's sensitivity to the tax rate. The *F*-stats are associated with testing $\rho_{2,j} - \rho_{1,j} = 0$ for j in $\{2, 3, 4\}$. Prob $> F$ in parentheses in column 3.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

As before, we find that income differences in how consumers respond to the excise tax tend to be small and statistically insignificant. In contrast, responsiveness to the sales tax declines monotonically with income. *F*-tests for the equality of the attention gap between consumers in different income quartiles are reported in Tables 7 and 8 as well. The results suggest that attentiveness to cigarette register taxes declines monotonically by income.[37]

D. *Tax Base Differences between the Excise and Sales Tax*

Our strategy for measuring attentiveness has been to compare consumer responsiveness to excise and sales tax rates. When demand for cigarettes depends only on the price of cigarettes and income, any gap between how consumers respond to the sales tax and how they respond to the excise tax implies a departure from the neoclassical model (as explained in Section IIB). In reality, the price of goods other than cigarettes may enter the cigarette demand function as well; if some of those other goods are also covered by the sales tax, the effect of a sales tax increase on

[37] An implicit assumption in our analysis (and throughout the smoking literature) is that changes in cigarette taxes are uncorrelated with unobserved shocks to individuals' cigarette consumption. However, cigarette taxes are not set randomly; a positive shock to cigarette demand might prompt state legislators to raise excise taxes to capture additional revenue. Although such correlations could provide an alternative explanation for the discrepancy between the excise and sales tax coefficients in Section IIB, it is more difficult to imagine them driving the heterogeneous attentiveness results in Section IIC. That is, although there are many possible reasons for cigarette taxes to be correlated with unobserved shocks to smoking demand, there are fewer plausible reasons why adoption of such laws would be differently correlated with shocks to cigarette demand for high- and low-income consumers. Moreover, to the extent that policymakers do consider cigarette demand by high- and low-income consumers differently when setting tax rates, it would be surprising if they took such behavior into account when setting the *sales tax* (for which cigarette sales constitute only a small fraction of total revenue). So although it appears unlikely that the endogenous adoption of tax laws is driving our main results, we cannot rule that possibility out definitively.

cigarette demand will differ from the effect of an excise tax increase. This observation complicates our analysis because income differences in the attention gap may be due to differences in the excise and sales tax bases, rather than differences in attentiveness.

To clarify the nature of the problem, it will be helpful to discuss this tax-base effect in some detail. Under the neoclassical model, a tax can affect cigarette demand in two ways: by raising the price of cigarettes (a direct effect), and by raising the price of other goods (an indirect effect). Because the excise tax applies only to cigarettes, it generates only a direct effect. In contrast, the sales tax applies to many goods,[38] and consequently, it generates both a direct effect and an indirect effect on cigarette consumption. As a result, income differences in the attention gap could reflect both income differences in attentiveness as well as income differences in the nature of the sales tax's indirect effect. In particular, if the indirect effect of the sales tax on cigarette demand were more negative for low-income consumers than for high-income ones, it could be that a tax base effect rather than changing attentiveness is driving our results. That is, low-income consumers' greater responsiveness to the sales tax could stem from income differences in how consumers adjust cigarette demand in response to price changes on other sales-taxed goods.

Might income differences in the indirect effect of the sales tax be driving our results? It is difficult to dismiss this possibility out of hand. The indirect effect of the sales tax can be decomposed into an income effect and a substitution effect. By raising the price of many goods at once, the sales tax diminishes consumers' purchasing power, causing them to reduce their consumption of cigarettes (the income effect). In addition, raising the price of other goods might cause consumers to substitute toward or away from cigarettes, depending on whether the other goods covered by the sales tax are primarily substitutes or complements to cigarettes (the substitution effect). In theory, either of these effects could be more negative for low-income consumers. For example, the other sales-taxed goods could be important substitutes with cigarettes for well-off consumers, but not for low-income consumers. Similarly, the loss in real income associated with a sales tax increase could induce a bigger reduction in cigarette demand for low-income consumers.

Although we are unable to reject the possibility, we present two pieces of evidence that tax base effects are not responsible for all of the observed differences in consumer behavior by income. Our first check is motivated by the fact that some states impose a general sales tax, but exempt cigarettes from it.[39] In states that exempt cigarettes from the sales tax, changes in the sales tax rate would not directly affect the price of cigarettes; the sales tax would not have a direct effect on cigarette consumption. However, sales tax changes would still affect the price of other sales tax-eligible goods. Hence, the indirect effect of the sales tax would still occur. Consequently, analyzing the effect of the sales tax in cigarette-exempting states allows us to measure income differences in the indirect effect of the sales tax.

If indirect effects were responsible for the observed differences in responsiveness to the sales tax by income, responsive to the sales tax should decline by income as

[38] Approximately 40 percent of retail sales, according to CLK (2009).

[39] In our sample, seven states exempt cigarettes from the sales tax base for at least one year.

Table 9—Sales Tax Exemptions for Cigarettes

	Extensive (1)	Intensive (2)	Combined (3)	Extensive (4)	Intensive (5)	Combined (6)
Excise tax	−0.124***	−0.338***	−3.701***	−0.124***	−0.333***	−3.693***
	(0.029)	(0.061)	(0.688)	(0.029)	(0.061)	(0.688)
Excise × low-income	0.045	−0.016	0.794	0.047	−0.035	0.772
	(0.060)	(0.114)	(1.395)	(0.060)	(0.115)	(1.401)
Sales tax × non-exempt	−0.451*	0.334	−7.146	−0.453*	0.358	−7.151
	(0.262)	(0.572)	(6.656)	(0.262)	(0.573)	(6.656)
Sales × low-income × non-exempt	−0.501**	−1.450*	−11.872**	−0.489*	−1.587**	−11.884**
	(0.249)	(0.755)	(5.812)	(0.253)	(0.762)	(5.911)
Sales tax × exempt	−0.392	−1.398	−13.158	−0.281	−2.037	−10.516
	(0.364)	(1.355)	(9.193)	(0.338)	(1.752)	(9.538)
Sales × low-income × exempt	0.001	−0.276	0.224	−0.420	1.553	−9.849
	(0.346)	(0.962)	(7.000)	(0.473)	(2.347)	(13.450)
Low-income	−0.016	0.023	−0.201	−0.016	0.030	−0.202
	(0.018)	(0.048)	(0.448)	(0.018)	(0.048)	(0.456)
Exempt	2.982**	2.813	75.639***	3.092**	−5.541	49.926*
	(1.360)	(3.048)	(28.828)	(1.226)	(3.932)	(27.631)
Exempt × low-income				0.018	−0.002	0.718
				(0.033)	(0.122)	(0.815)
F-stat	9.92	1.94	23.00	0.02	1.60	0.02
prob > *F*	0.00	0.17	0.00	0.90	0.21	0.89
Observations	1,288,031	274,137	1,288,031	1,288,031	274,137	1,288,031

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics, state, year, and calendar month fixed effects, and linear time trends interacted with exempt and low-income. Columns 4–6 include linear time trends in exempt × low-income. Outcome variables: probability of smoking (extensive), log cigarette demand (intensive), and cigarette demand in levels (combined). The *F*-stat is for the test of equality between the sales × low-income interaction between states that exempt cigarettes from the sales tax and states that do not.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

much in states that exempt as in states that do not. Table 9 compares the effect of the sales tax in states that exempt cigarettes from the sales tax ("exempt states") with the effect of the sales tax in states that include cigarettes in the sales tax base ("non-exempt states"). To do so, we modify our econometric model to allow heterogeneity in the effect of the sales tax between exempt and non-exempt states:

$$
\begin{aligned}
(13) \qquad y_{ismt} = {} & \alpha + \beta_1 \tau^e_{smt} + \beta_2 \tau^s_{smt} \times E_{st} + \beta_3 \tau^s_{smt} \times (1 - E_{st}) \\
& + \rho_1 \tau^e_{smt} LI_{ismt} + \rho_2 \tau^s_{smt} LI_{ismt} \times E_{st} + \rho_3 \tau^s_{smt} LI_{ismt} \times (1 - E_{st}) \\
& + \phi E_{st} + \eta LI_{ismt} + \gamma x_{smt} + \delta z_{ismt} + \mu_s + \lambda_t + \pi_m + \varepsilon_{ismt},
\end{aligned}
$$

where E_{st} indicates whether state s exempts cigarettes from the sales tax base in year t.

Table 9 presents the results of this analysis. In all specifications, the small number of state-year cells in the exempt category makes inference difficult. Columns 1–3 show that the effect of the sales tax on cigarette demand appears to

vary substantially more by income in non-exempt states than in exempt states. The estimated sales × low-income coefficient in exempt states, ρ_2, is small in size and is statistically insignificant on both the extensive and intensive margins. In contrast, the sales × low-income coefficient in the non-exempt states, ρ_3, remains large and statistically significant. On the extensive margin, we are able to reject the hypothesis that the sales × low-income coefficient in the exempt states is as large as in the non-exempt states. A concern with these specifications is that high- and low-income consumers may exhibit different smoking behavior in exempt versus non-exempt state-years, independent of the sales tax. To address this possibility, columns 4–6 introduce an interaction for low-income × exempt.[40] On the extensive margin, column 4 shows that the estimated effect of the sales tax on low-income consumers is only slightly more negative in non-exempt versus exempt states. In contrast, the intensive margin results in column 5 are similar to those reported in column 2: the point estimate of the sales × low-income coefficient is substantially more negative in exempt states, but the large standard errors on the sales × low-income coefficient for exempt states make conclusions of statistical significance impossible.

We also present a second check that tax base effects are not driving our results. Tax base effects are most likely to dampen the impact of the sales tax relative to the excise tax when the excise tax exempts important substitutes for cigarettes.[41] Because other tobacco products constitute likely substitutes for cigarettes, there is less potential for tax base differences to play a role in states where the excise tax also applies to other tobacco products. Consequently, we restrict the analysis in Section IIC to states that apply the excise tax to cigars and smokeless tobacco. Table 10 shows that the difference in sales tax responsiveness between high- and low-income consumers persists after restricting the sample to those states.

In summary, there are plausible reasons to believe that differences in the excise and sales tax bases could generate results similar to those presented in Section IIC. However, the evidence in Tables 9 and 10, while not conclusive, suggests that tax base effects cannot fully supplant attentiveness as an explanation for the large differences in behavior that we find between high- and low-income consumers.

E. *Robustness Checks*

Including Pre-tax Prices in the Regression.—One variable not included in our basic econometric model is the pre-tax price of cigarettes. On the one hand, the pre-tax price depends on both supply and demand; including it as a regressor could bias our results if it were correlated with unobserved shocks to consumer demand (the classic simultaneous systems problem). On the other hand, the pre-tax price enters the consumers' demand function symmetrically with the excise and sales tax rates; excluding it from the regression may create an omitted variable bias if pre-tax price

[40] The low-income × exempt interaction is not statistically significant in any of the specifications.

[41] For example, raising the excise tax might reduce cigarette demand substantially by inducing cigarette smokers to switch to cigars. In contrast, raising the sales tax would raise the price of both cigarettes and cigars, dampening the effect on cigarette consumption.

TABLE 10—STATES THAT APPLY EXCISE TAX TO OTHER TOBACCO PRODUCTS

	Extensive margin	Intensive margin	Combined effect
	(1)	(2)	(3)
Excise tax	−0.081***	−0.309***	−2.980***
	(0.026)	(0.101)	(0.625)
Sales tax	0.319*	1.060	6.686**
	(0.163)	(0.805)	(2.737)
Excise × low-income	0.066	0.101	1.419
	(0.064)	(0.110)	(1.471)
Sales × low-income	−0.757***	−1.512**	−16.982***
	(0.178)	(0.690)	(4.503)
F-stat	17.52	5.47	15.22
prob > *F*	0.00	0.02	0.00
Observations	904,206	185,740	904,206

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variables: probability of smoking (extensive), log cigarette demand (intensive), and cigarette demand in levels (combined). The *F*-stat is associated with the test for equality between the excise × low-income and sales × low-income interaction coefficients.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

fluctuations were not equally correlated with the two tax types for high- and low-income consumers.[42]

In this section, we modify our empirical strategy to account for the pre-tax price of cigarettes. Whereas previously we compared sales tax changes to excise tax changes, we now compare sales tax changes to changes in the posted price of cigarettes (the pre-tax price plus the excise tax). As before, this approach isolates income differences in attentiveness rather than changing price-sensitivity. The econometric model takes the following form:

$$(14) \qquad y_{ismt} = \alpha + \beta_1 pp_{smt} + \beta_2 \tau^s_{smt} + \rho_1 pp_{smt} LI_{ismt} + \rho_2 \tau^s_{smt} LI_{ismt}$$

$$+ \gamma x_{smt} + \delta z_{ismt} + \mu_s + \lambda_t + \pi_m + \varepsilon_{ismt},$$

where pp represents the (excise tax inclusive) log posted price of cigarettes. To address the possible correlation between pre-tax prices and unobserved demand shocks, we utilize the excise tax as a supply shifter. In particular, we employ the excise tax (τ^e) and the excise × low-income interaction ($\tau^e \times LI$) as instruments for the posted price (pp) and the posted price × low-income interaction ($pp \times LI$). This identification strategy is valid under the same assumptions as the main specification, namely that cigarette tax changes are uncorrelated with unobserved shocks to cigarette demand. Tables 11 and 12 show that the results from the IV specification are similar to the specifications that omit pre-tax prices. Table 11 shows that both excise

[42] For example, Harding, Leibtag, and Lovenheim (2012) find that excise taxes are passed through differently to high- and low-income consumers.

Table 11—Instrumenting for Price with Excise Tax: First Stage

	Extensive margin		Intensive margin	
	(1)	(2)	(3)	(4)
Excise tax	1.018***	−0.296***	1.126***	−0.332***
	(0.182)	(0.058)	(0.161)	(0.068)
Sales tax	0.822*	0.185	0.793*	0.183
	(0.466)	(0.137)	(0.432)	(0.149)
Excise × low-income	−0.041***	2.284***	−0.050***	2.298***
	(0.011)	(0.096)	(0.018)	(0.105)
Sales × low-income	0.009	0.138	0.008	0.127
	(0.020)	(0.309)	(0.028)	(0.314)
R^2	0.95	0.98	0.96	0.98
Observations	1,288,031	1,288,031	274,137	274,137

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Columns 1 and 3: Dependent variable = excise tax-inclusive price. Columns 2 and 4: Dependent variable = excise tax-inclusive price × low-income.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 12—Instrumenting for Cigarette Prices with Excise Tax

	Extensive margin		Intensive margin		Combined effect	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Posted price	−0.051***	−0.124***	−0.093***	−0.306***	−1.301***	−3.533***
	(0.013)	(0.030)	(0.029)	(0.067)	(0.250)	(0.781)
Sales tax	−0.040	0.070	0.227	0.557	−0.477	2.992
	(0.116)	(0.117)	(0.348)	(0.384)	(2.739)	(2.984)
Posted price × low-income	0.019	0.026	0.016	0.003	0.372	0.444
	(0.016)	(0.025)	(0.040)	(0.050)	(0.399)	(0.606)
Sales × low-income	−0.492***	−0.495***	−1.411**	−1.368**	−11.547***	−11.723***
	(0.179)	(0.182)	(0.679)	(0.654)	(4.431)	(4.362)
F-test	8.44	8.04	4.68	4.73	7.80	8.14
prob $> F$	0.01	0.00	0.04	0.03	0.01	0.00
Observations	1,288,031	1,288,031	274,137	274,137	1,288,031	1,288,031

Notes: Standard errors clustered at the state level in parentheses. All specifications include individual demographic characteristics and state, year, and calendar month fixed effects. Outcome variables: probability of smoking (extensive), log cigarette demand (intensive), and cigarette demand in levels (combined). Price includes the excise tax. The F-stat is for the test of equality between the price × low-income and sales × low-income interaction coefficients.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

and sales tax changes are passed on slightly differently for high- and low-income consumers (e.g., retailers may decide how much to raise prices based on neighborhood income) but that these differences are quite small in magnitude, particularly for the sales tax. Table 12 confirms that these differential pass-through rates do not drive our finding of increasing attentiveness by income.

Additional Robustness Checks.—Online Appendix C investigates the robustness of our analysis to three additional concerns. First, our use of a two-part model for

smoking demand may be biased by changes to the composition of the smoking population. To investigate this issue, we estimate smoking demand for the entire population with a linear regression and with a Tobit model censored at zero. Second, our results could reflect differences in the amount of time it takes high- and low-income consumers to learn about sales tax changes. Consequently, we include lagged tax rate values to determine whether the attentiveness gap fades over time. Finally, we try including state-specific time trends to account for the possibility that changes in a state's tax rates are correlated with unobserved trends in that state's smoking demand (such as antismoking sentiment). As detailed in the Appendix, all three robustness checks are consistent with the results of the main analysis.

III. Conclusion

Policymakers at all levels of government depend on commodity taxes to raise revenue, but such taxes are typically regressive, constituting a greater burden for low-income consumers. This paper has suggested a novel way for policymakers to lessen that regressivity: manipulating the fraction of the tax that is levied at the register as opposed to being included in a good's posted price. In particular, we showed that levying a greater proportion of a commodity tax at the register shifts the tax's burden away from attentive consumers. When low-income consumers pay more attention to register taxes than high-income consumers do, designing a tax in this way can lessen its regressivity. Conversely, when high-income consumers are the more attentive, imposing a commodity tax at the register will exacerbate its regressivity.

With this motivation in mind, we investigated whether high- and low-income consumers respond differently to register taxes on cigarettes. Exploiting state and time variation in tax rates, we found that low-income consumers reduce cigarette demand in response to both excise and sales taxes on cigarettes, whereas higher-income consumers only reduce cigarette demand in response to excise taxes. Although the empirical results do not allow us to definitively rule out alternative explanations, our findings are consistent with the hypothesis that attentiveness to cigarette register taxes declines by income. Hence, policymakers may be able to ease the financial burden of cigarette taxes on the poor by levying such taxes at the register instead of including them in cigarettes' posted price.

How important are these welfare effects quantitatively? To provide a rough idea, recall from Section I that the welfare effect for attentive consumers of a revenue-neutral shift towards register taxes stemmed from the effect of the shift on the after-tax price of x, $\frac{d(t_p + t_r)}{dt_r}\Big|_{\bar{R}}$.[43] From equation (5), we can express the combined tax change in terms of estimable quantities, $\frac{d(t_p + t_r)}{dt_r}\Big|_{\bar{R}} = -\frac{\tau \varepsilon_B \phi_B}{1 - \tau(\varepsilon_A \phi_A + \varepsilon_B \phi_B)}$. In our sample, the (weighted) average ratio of taxes to the after-tax price is $\tau = 0.33$. Determining the share of cigarettes consumed by attentive consumers (ϕ_A) is complicated by the fact that our empirical procedure is designed to

[43] For this approximation, we ignore the effect of the shift on the pre-tax price of x. As online Appendix B shows, that omission is justified when posted cigarette taxes are fully passed on to consumers, a condition consistent with the results in Table 10.

assess whether income differences in attentiveness exist, rather than identify exactly which consumers are attentive and which are not. In particular, our results suggest that the bottom income quartile of consumers are more attentive to cigarette register taxes than higher income consumers, but the evidence in Tables 7 and 8 is consistent with consumers in the second income quartile also falling into the attentive group. To be conservative, we compute the welfare effect assuming that only consumers below the 50th income percentile are in the attentive group; the magnitude of the effect increases when the attentive group is defined as consumers with income below the 25th percentile. From Table 2, we know that consumers above the 50th income percentile consume approximately 48 percent of cigarettes, so that $\phi_A = 0.52$ and $\phi_B = 0.48$. From Table 8, we compute the overall elasticity of cigarette demand with respect to the posted price to be $\varepsilon_A = 0.84$ and $\varepsilon_B = 0.96$. Using (5), these values imply $\frac{d(t_p + t_r)}{dt_r}\Big|_{\overline{R}} = -0.21$, so that a \$1.00 increase in the cigarette register tax could accommodate a \$1.21 reduction in the cigarette posted tax. For perspective, that revenue-neutral shift would free up approximately \$77 a year for an attentive consumer who smokes a pack of cigarettes per day.[44]

Three qualifications are important when interpreting our results. First, we have treated cigarettes as a standard consumption good, abstracting away from their addictive nature. However, the fact that cigarettes are addictive could alter the welfare implications of our results. For example, models along the lines suggested by Gruber and Koszegi (2004) or Gruber and Mullainathan (2002) suggest that cigarette taxes can benefit consumer welfare when voters adopt such taxes as a method of exercising self-control; consequently, shifting a cigarette tax to the register could deprive some consumers of a valuable tool for self-discipline. At the other extreme, a rational-addiction model such as that presented in Becker, Grossman, and Murphy (1994) would imply that cigarette consumption decisions are informed by consumers' expectations concerning future prices; if such expectations are important, the demand equations employed here are misspecified.

Second, readers should be cautious about extrapolating our results to goods other than cigarettes. Although we have presented some evidence that attentiveness to cigarette register taxes declines by income, the cognitive cost model presented in online Appendix B highlights the fact that this result can vary between goods. In particular, low-income consumers may well be less attentive to register taxes on goods that are relatively sensitive to income and that constitute a larger share of expenditures for high-income consumers. Moreover, Appendix A shows that in certain markets, shifting to a register tax has the potential to induce producers to raise a good's pre-tax price. In particular, for goods characterized by elastic demand and inelastic supply, shifting to a register tax could actually worsen the burden of those taxes on all consumers, including the poor.

Finally, much of our analysis implicitly assumes that consumers' attentiveness to register taxes is fixed. In reality, however, a revenue tax increase may drive

[44] For comparison, defining the inattentive group threshold at the 25th income percentile implies that a revenue-neutral \$1.00 increase in the register tax accommodates a \$1.34 reduction in the posted tax, resulting in yearly savings of \$123 for an attentive pack-a-day smoker.

some inattentive consumers to *become* attentive by increasing the utility loss from ignoring the tax (discussed in online Appendix B). If one endogenizes the boundaries of the attentive and inattentive groups, a sufficiently large shift towards register taxes could necessitate a net increase in the combined tax rate if the register tax's revenue advantage was more than offset by the reduction in revenue caused by some inattentive consumers becoming attentive. Similarly, our empirical specifications may be incomplete if high-income consumers' attentiveness to cigarette register taxes depends on the size of the register tax already in place. Although our data lack the power to confirm that theoretical prediction convincingly, policymakers should be cautious before adopting large shifts towards register taxes on the basis of results like ours.

Although our discussion has focused on taxes designed to raise revenue, the empirical findings presented here also speak to broader questions of tax design. For example, a number of public health advocates have suggested raising taxes on soft drinks as a way to combat population obesity, with some proponents calling for an expanded tax of any form on those products (Engelhard, Garson, and Dorn 2009) and others arguing that including the tax in the posted product price would be most effective (Brownell et al. 2009). Our results suggest an important consideration is missing from this discussion, namely that taxes imposed at the register may affect the eating habits of high- and low-income consumers in different ways. Such issues deserve further investigation.

Appendix A: Welfare Analysis under Endogenous Producer Prices

This Appendix expands the model developed in Section I to the setting in which firms adjust their prices in response to changes in the type of tax imposed. As before, the policy we consider is an increase in the register tax coupled with a reduction in the posted tax calibrated to keep government revenue unchanged. Like CLK (2009), we assume that taxes on x are fully-salient for producers.

Let p_x denote the after-tax price of p, $p_x \equiv p + t_p + t_r$. The net effect of the shift on the after-tax price of x is given by

$$\left.\frac{dp_x}{dt_r}\right|_{\bar{R}} = \left.\frac{\partial p}{\partial t_r}\right|_{\bar{R}} + \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} + 1. \tag{15}$$

Applying the same approach as in Section I, it is straightforward to show that the welfare effects of the shift for the two types of agents are given by

$$\left.\frac{dV_A}{dt_r}\right|_{R} = -U_y(x_A, y_A), x_A \left(1 + \left.\frac{\partial p}{\partial t_r}\right|_{R} + \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\right) \tag{16}$$

and

$$\left.\frac{dV_B}{dt_r}\right|_{\bar{R}} = -U_y(x_B, y_B)\, x_B \left(1 + \left.\frac{\partial p}{\partial t_r}\right|_{R} + \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\right) + \left(\left.\frac{\partial p}{\partial t_r}\right|_{R} + \left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}\right) \frac{\partial x_B}{\partial p}\, \mu\,. \tag{17}$$

Let $s(p)$ denote the supply of x as a function of x's pre-tax price (p), so that the price-elasticity of supply is given by $\varepsilon^S \equiv \frac{\partial s(p)}{\partial p}\frac{p_x}{s}$. Moreover, supply and demand of x must be equal in equilibrium

$$s(p) \equiv x_A(p + t_p + t_r) + x_B(p + t_p). \tag{18}$$

Totally differentiating (18) along with the government's revenue constraint yields

$$\left.\frac{\partial p}{\partial t_r}\right|_R = \frac{\varepsilon_B \phi_B}{\bar{\varepsilon} + \varepsilon^S(1 - \tau\bar{\varepsilon})} \tag{19}$$

and

$$\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}} = -\frac{1 - \gamma\tau\varepsilon_A\phi_A}{1 - \gamma\tau\bar{\varepsilon}}, \tag{20}$$

where $\bar{\varepsilon} \equiv \varepsilon_A\phi_A + \varepsilon_B\phi_B$ and $\gamma \equiv \frac{\varepsilon^S}{\varepsilon^S + \bar{\varepsilon}}$.[45]

Equation (19) shows that for $\gamma < 1$, a revenue-neutral shift towards register taxes results in a higher pre-tax price for all consumers. Because some consumers are more sensitive to posted taxes than to register taxes, replacing the former with the latter allows producers to shift some of the tax's incidence back on to consumers. In turn, the higher pre-tax price reduces demand for x, necessitating a larger t_p than otherwise in order for the government to meets its revenue constraint. Consequently, the reduction in the combined tax rate accommodated by the shift is smaller than when producer prices are fixed.

To illustrate, suppose that the supply of x is completely inelastic, $\varepsilon^S = 0$. What are the effects of a revenue-neutral increase in register taxes in this setting? As always, the increase in the register tax accommodates a reduction in the posted tax. Because $\varepsilon^S = 0$, producers had absorbed the entire incidence of the posted tax; as t_p is reduced, the pre-tax price rises one for one. If all consumers were inattentive, the story would end here; for a \$1 increase in the register tax, the posted tax would fall by $\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}$ and the pre-tax price would rise by $\left.\frac{\partial t_p}{\partial t_r}\right|_{\bar{R}}$. When some consumers are attentive, the pre-tax price of x will fall somewhat in response to the new register tax; but as long as *some* consumers ignore the tax, producers will not have to reduce the pre-tax price in the full amount of the register tax increase. Hence the net effect of the shift on the after-tax price will be positive.

From (16), it is clear that a shift towards register taxes benefits attentive consumers if and only if the net effect of the shift on x's after-tax price is negative. By substituting (19) and (20) into (15), it follows that

$$\left.\frac{dV_A}{dt_r}\right|_R > 0 \Leftrightarrow \left.\frac{dp_x}{dt_r}\right|_{\bar{R}} > 0 \Leftrightarrow \tau\varepsilon^S > 1. \tag{21}$$

[45] Recall that $\tau \equiv \frac{t_p + t_r}{p + t_p + t_r}$, $\varepsilon_i \equiv -\frac{\partial x_i}{\partial p}\frac{p + t_p + t_r}{x_i}$ and $\phi_i \equiv \frac{x_i}{x_i + x_{-i}}$. Note that $\tau\bar{\varepsilon} < 1$ follows from our maintained assumption that $\frac{\partial R}{\partial t_p} > 0$.

Thus when ε^S is sufficiently small, shifting towards a register tax makes even the attentive consumers worse off.[46]

Similarly, $\tau\varepsilon^S > 1$ is a necessary condition for inattentive consumers to benefit from a shift towards register taxes. When $\tau\varepsilon^S \leq 1$, (21) implies that $\frac{dp_x}{dt_r}\Big|_{\overline{R}} \geq 0$, which in turn implies that the first term in (17) is non-positive. Also, from (19) and (20), one can show that $\frac{\partial p}{\partial t_r}\Big|_R + \frac{\partial t_p}{\partial t_r}\Big|_{\overline{R}} \leq 0$, implying that the second term in (17) is non-positive as well. Thus when $\tau\varepsilon^S < 1$, shifting from register to posted taxes makes all consumers worse off.

Finally, even when the supply of a taxed good is too inelastic for the government to raise welfare by shifting towards register taxes, the government's choice between posted and register taxes still has important effects on consumer welfare. In particular, when $\tau\varepsilon^S < 1$, the government can raise the welfare of all consumers through a revenue-neutral shift towards *posted* taxes—the opposite of the policy considered in Section I. Mechanically, this result follows directly from (16), (17), and (21). In words, when supply of the taxed good is sufficiently inelastic, producers will have to absorb the majority of the incidence of the new posted tax. Although the combined tax rate on x will increase, that increase will be more than offset by the reduction in the pre-tax price. Thus by increasing the salience of the tax for inattentive consumers, the government can precipitate a reduction in the market clearing price faced by attentive consumers. Attentive consumers are better off because of the net reduction in the after-tax price and inattentive consumers benefit both from the lower pre-tax price and because the associated reduction in register taxes reduces the magnitude of their optimization error.[47]

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[46] Another way to understand this dynamic is to observe that *B*'s inattentiveness to register taxes impose two distinct externalities on *A*. First, *B*'s inattentiveness benefits *A* because it reduces the tax rate (which is levied on both *A* and *B*) needed for the government to obtain a given amount of revenue. Second, *B*'s inattentiveness harms *A* vis-à-vis producers because it reduces the overall market sensitivity to higher prices for x. When some consumers are inattentive, demand for x does not fall as much in response to a given price increase, and consequently, producers do not have to reduce the pre-tax price of x by as much in order to maintain demand. As ε^S shrinks, the second externality grows in importance, and for small enough ε^S, the second externality will dominate the first.

[47] Of course, whether or not such a welfare transfer is socially desirable depends upon how one values the trade off between consumer welfare and producer surplus.

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