

# Tax Avoidance and the Choice of Tax Base

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## Abstract

We provide a general model of the optimal mix of income and consumption taxes in the presence of tax avoidance. We find a Ramsey-type result in which each of income and consumption taxes should be imposed in inverse proportion to the combined elasticity of real and avoidance responses to the respective tax. Contrary to some prior results, we find that consumption taxes are optimally non-zero across a variety of settings, and in particular when the (weighted) elasticity of taxable income with respect to the income tax is greater than the *cross-elasticity* of taxable income with respect to the consumption tax. We then implement a calibration exercise in which we estimate this cross-elasticity using voting on local sales-tax increases in California. Our estimates suggest non-zero sales taxes would be efficient for more than nine-tenths of the distribution of potential outcomes.

## 1 Introduction

It is widely accepted that in a one-period model an income tax is perfectly equivalent to an undifferentiated consumption tax. Therefore, regimes with mixed income and consumption taxes are not optimal, as they simply add unnecessary administrative and compliance costs. However, this standard model ignores tax avoidance. Slemrod and Gillitzer (2013:96) argue that another standard tax equivalence, the irrelevance of collection obligations to economic incidence, may not hold when avoidance and enforcement opportunities vary with the legal incidence of a tax. In this paper, we attempt to show similarly that in the presence of avoidance it can be, and often is, optimal to impose both taxes on income and VAT- or sales-tax type consumption taxes.

Specifically, we provide a general model of the optimal mix of income and consumption taxes in the presence of tax avoidance. We have particularly in mind the relation between

taxes that may be collected from payroll, such as an income or cash-flow consumption tax, and those that are collected at point of sale, such as a VAT or sales tax. An additional difference between these two groups is the usual breadth of base, with most point-of-sale taxes exempting large portions of the potential consumption base, such as by omitting services. For ease of reference, we will call the first “income” taxes and the second “consumption” taxes, but our key distinction is means of collection and the associated breadth of the tax base. We leave to one side the taxation of capital.

We take as a starting point the premise that, in a model without tax avoidance, consumption taxes are often not optimal to the extent that they fail to equally burden all purchases (Atkinson and Stiglitz 1976). This basic observation has a number of wide-ranging implications, as explored thoroughly in Kaplow (2008), Kaplow (2020) and Kaplow and Shavell (2001). Many of these are seemingly remote from questions of tax system design. Finkelstein, Hendren and Luttmer (2019), for instance, observe that one key function of the American Medicaid program is to shift financing of health care for the poor from what is essentially a sales tax to general federal revenues, which are primarily income-derived. Whether this shift is welfare-improving depends in part on the optimality of strict income-tax financing (Pauly 1970; Brooks, Galle and Maher 2018). Despite its considerable generality and social importance, the question of when consumption-type taxes may be optimal has, in the words of the Mirrlees Report, “received surprisingly little formal attention” (Crawford, Keen and Smith 2010).

We therefore aim to extend earlier work showing that consumption taxes can be optimal complements to an income tax under limited circumstances. For example, Gordon and Nielsen (1997) assume that both income and consumption taxes can be designed to be undifferentiated and proportional, but that each may be subject to distinct taxpayer avoidance strategies. For simplicity, they further assume that the avoidance cost function for each tax is quadratic, and that avoidance of one tax does not affect the cost of avoiding the other. In this setting, they show that it is possible to make a revenue-neutral substitution of consumption taxes for income taxes that increases total welfare.

There are, however, a number of important major limitations on this conclusion. As they note, it is not obvious their result holds under different functional-form assumptions. In addition, they suggest their finding might have limited practical significance because of the pervasiveness of the “underworld economy” or other instances where a single technology allows for avoidance of both income and consumption taxes. Gamage (2014:24) calls these “multi-instrument” responses. Gordon and Nielsen (1997) argue that consumption taxes are likely not optimal when avoidance takes the form of multi-instrument responses. “The incentive

to [use a multi-instrument response] depends on the total amount of taxes owed if taxes are not evaded, and this would be unaffected by a shift in tax base if total tax revenue is left unaffected” (Gordon and Nielsen 1997:180).

We generalize Gordon and Nielsen (1997) in several respects. Most simply, we confirm that their basic finding holds under much less restrictive assumptions with respect to functional form. In addition, we consider a pair of extensions that take into account other significant real-world factors. In the first of these, we consider the possibility that a portion of private avoidance expenses are transferred back to the government, such as in the case where avoidance results in fines or shifts taxable income from a higher-taxed to lower-taxed base. In the second, we consider the administrative costs of enforcing compliance with two distinct tax bases.

However, we view our most crucial generalization to be our revisiting of the role of multi-instrument responses. Again, Gordon and Nielsen (1997) presume an identical, quadratic, cost structure for each form of avoidance. More realistically, there are an infinite number of ways in which the cost structure of income-tax avoidance might relate to the cost structure of consumption-tax avoidance. When these are not identical, we show, there remain many possible states of the world in which consumption taxes are optimal. In this respect our analysis is related to the finding in Slemrod and Gillitzer (2013:Ch. 7.1) that multiple tax “instruments,” which they define as “non-rate” interventions such as investments in auditing, information reporting, and withholding, are often more efficient than a narrower base definition.

Consider two intuitive examples offered by Gordon and Nielsen (1997). In the “underworld economy,” individuals may choose to be paid in cash in order to avoid reporting their wages to the tax authority. This cash may then be used to purchase goods from merchants, who in turn avoid reporting the sales transaction. If there were only a single margin for decision, entering the underworld or not, then the division of tax burden between income and consumption taxes would be, as they say, irrelevant. Kesselman (1993) offers a similar argument.

In fact, though, there are many margins, each differently affected by the mix of the two taxes. Workers might accept only a portion of their wages in cash, or might take a part-time side gig that pays additional cash, so that the “underworld” decision is a continuous, not discrete, one. So, too, each consumer transaction may be in cash or not. Perhaps the quality of products available with cash differs from those that may be purchased legally, and that as a result the marginal returns to consumption-tax avoidance diminish rapidly. At some point the worker will use her earnings for non-cash purchases, even if her earnings were in cash. Knowing this, her incentive to work off-books falls, in a way it would not have if she were

solely subject to the income tax.

Another example Gordon and Nielsen (1997) sketch is cross-border work and consumption (Kessing and Koldert 2013 likewise argue that cross-border shopping does not justify consumption taxation). Consider an individual who resides in a high-tax jurisdiction (call this Germany) near the border of a low-tax jurisdiction (call this Switzerland). Wage earnings in Switzerland may be statutorily exempt from wage tax, or at least more difficult for German authorities to verify. Since the individual is already working in Switzerland, there is little incremental cost in also purchasing goods in Switzerland. Durable purchases may be subject to tax when returned to Germany but also relatively difficult for German authorities to verify. Consumption-tax avoidance may therefore motivate cross-border employment.

But now imagine that there is a way to buy goods from Switzerland without being there in person; call this the Internet. This rival avoidance technology lowers the returns to physical cross-border shopping. If the marginal product of Swiss employment is lower than German employment, some workers will then reduce their Swiss work hours and stay in Deutschland. This in turn may require Swiss employers to raise wages, and so on (Hines Jr 2004 considers general equilibrium effects of this kind in his analysis of the impact of sales tax on the informal economy). In short, the general equilibrium effects of multi-instrument responses are neither obvious nor entirely predictable once we relax the simplifying assumption of unique tax avoidance technologies with identical cost structures.

Accordingly, we present a model in which we allow flexibly for possible interactions between income- and consumption-tax avoidance. We find a wide range of settings under which it is likely optimal to impose greater than zero consumption tax, even if that tax is imposed differentially. Specifically, we report a Ramsey-type result in which each of income and consumption taxes should be imposed in inverse proportion to the combined elasticity of real and avoidance responses to the respective tax. We also identify the necessary conditions for it to be optimal that consumption taxes are set to zero.

We find that consumption taxes are optimally non-zero when the (weighted) elasticity of taxable income with respect to the income tax is greater than the *cross-elasticity* of taxable income with respect to the consumption tax. This result is identical if avoidance costs are partially transferrable to government, and holds with minor modifications in the presence of administrative costs that are continuous and increasing in both revenue and avoidance costs.

The cross-elasticity of taxable income with respect to the consumption tax has not been a parameter of interest in the past, and so there are no existing empirical estimates of it. As a simple calibration exercise, we estimate the cross-elasticity using data from California. California defines its sales tax base uniformly at the state level, and imposes a statewide sales

tax, but localities are permitted to impose additional tax of their own on the same base. These taxes typically must be approved by local referendum. To obtain an exogenous source of variation, we exploit a wrinkle of California election law under which similar tax-increase ballot propositions are sometimes required to pass by fifty-percent vote and sometimes by two-thirds majority, such that for initiatives with vote shares in between passage is essentially random. We then employ public ZIP-level data on taxes paid to estimate the impact of changes in the sales tax rate on income taxes due. While our confidence intervals are relatively wide, we find that outcomes over at least nine-tenths of our potential distribution are consistent with non-zero sales tax rates. If values for the elasticity of taxable income are at least as high as the middle of the range reported in the literature, we can reject zero sales-tax rates at a traditional 5% level of confidence.

Our analysis can be related to a small prior literature on the possible optimality of consumption taxes even where other Atkinson and Stiglitz (1976) assumptions hold. Boadway, Marchand and Pestieau (1994) and Huang and Rios (2016) show that when income taxes can be evaded but consumption taxes cannot, it will often be optimal to employ consumption taxes. This represents an extreme case, of course, but it is nested in our analysis, in which there are some states of the world in which consumption-tax avoidance is less cost-effective than income-tax avoidance.

Another related prior work is Brunner, Eckerstorfer and Pech (2013), who weakly relax the Atkinson and Stiglitz (1976) homogeneity assumption by allowing for differing initial endowments of wealth. In the Brunner, Eckerstorfer and Pech (2013) model, high earning-ability households can mimic low earning-ability households, but the initial wealth endowment is correlated with earning ability. Individuals can evade the wealth tax and firms can evade the consumption tax, but income taxes are not evadable. They find that it can be optimal to impose both consumption and wealth taxes to the extent that each reduces the ability of high earners to mimic low earners. Our approach differs from theirs in many particulars, but we share the general feature that where there are different avoidance technologies for two distinct tax bases, it becomes more likely to be optimal to impose taxes on both.

As should be evident from our attention to the Atkinson and Stiglitz (1976) framework, we are modeling only the static case. We therefore do not address the role of consumption taxes in a long-run dynamic model, such as the model explored in Chamley (1986), Judd (1985), and more recently in Straub and Werning (2020); Coleman II (2000) extends this model to include the possibility of consumption taxes. Accordingly, we have no occasion to consider the realism of the assumptions, such as long-run foresight by economic agents, infinite lives, and zero evasion, that these models arguably depend upon (Economides, Philippopoulos

and Rizos 2019 explore whether consumption taxes are optimal in a dynamic setting with evasion).

The paper proceeds as follows. Section 2 sets out our model, beginning with a base Case 1 in which there are no “multi-instrument” responses, and then a series of three extensions. Section 3 reports our California calibration exercise. We then conclude.

## 2 Model

In this section, we will explore the optimal income-consumption tax structure in a representative consumer model. Case 1 begins with the assumption, as in Gordon and Nielsen (1997), that income and consumption avoidance technologies are independent of each other. Case 2 extends our analysis by considering “multi-instrument” avoidance technologies, so that income and consumption avoidances are interdependent. Case 3 then considers the possibility that a portion of private avoidance expenses are transferred back to the government. Finally, in Case 4, we add the administrative costs of enforcing compliance with two distinct tax bases.

To begin, consider a representative individual whose utility depends on the consumption of a private commodity,  $X$ , on labor income,  $Y$ , and on the public good,  $G$ . The utility function,  $U(G, H(X, Y))$ , assumes that private goods are (weakly) separable from public good  $G$ . The household’s labor supply,  $L$ , is paid at wage rate equal to constant labor productivity,  $h = 1$ , so that labor income  $Y = L$ . To finance the provision of public services,  $G$ , the government imposes tax on labor income at rate  $t_y$  and tax on consumption at rate  $t_x$ .

However, a taxpayer can reduce taxable income by avoiding some amount of income,  $Ay$ , at cost  $Cy(Ay)$ , which is increasing and convex. Similarly, a taxpayer can reduce the consumption tax by avoiding some amount of consumption receipts,  $Ax$ , at cost  $Cx(Ax)$ , which is increasing and convex. We assume that avoidance costs produce no utility. Intuitively, a reader can think of these costs as representing the difference in marginal productivity between taxed and untaxed expenditures or labor. Thus, although we include direct arguments for only one consumption good, implicitly there are two, taxed consumption and untaxed consumption. For simplicity, in this base case we model avoidance as riskless, following the well-known approach of Usher (1986).

**Case 1. Costs of income and consumption avoidances are independent of each other.** We start by assuming that the cost of income tax avoidance depends only on the amount of income avoidance. Also, the cost of consumption tax avoidance depends only on the amount

of consumption avoidance. That is, in this baseline scenario, there are no “multi-instrument” avoidance technologies. Relative price effects are still allowed. Thus, consumption-tax avoidance can still affect labor/leisure decisions by changing the after-tax returns to labor, and labor-tax avoidance can affect consumption avoidance via the household budget constraint. Realistically, we expect that consumption-tax avoidance might also impact income-tax avoidance through this channel, but for expositional purposes we rule out that possibility in this initial frame.

The taxpayer’s problem is to maximize her utility:

$$\max_{(X,Y,Ax,Ay)} U(G, H(X, Y)) \quad (1)$$

subject to the budget constraint:

$$(1 + t_x)(X - Ax) + Ax + Cx(Ax) = (1 - t_y)(Y - Ay) + Ay - Cy(Ay). \quad (2)$$

The government, in its turn, chooses two tax rates  $(t_x, t_y)$  to maximize individual utility subject to the government budget constraint, which is

$$G = t_x(X - Ax) + t_y(Y - Ay) \quad (3)$$

Let us analyze the household problem first. Because amounts of avoidance  $Ax$  and  $Ay$  affect only the budget constraint and not utility directly, an individual chooses them to maximize consumption, that is,

$$Ax^*(t_x) = \underset{Ax}{argmax} - (1 + t_x)(X - Ax) - Ax - Cx(Ax), \quad (4)$$

$$Ay^*(t_y) = \underset{Ay}{argmax} (1 - t_y)(Y - Ay) + Ay - Cy(Ay). \quad (5)$$

Hence, the optimal amounts of avoidance,  $Ax^*(t_x)$  and  $Ay^*(t_y)$ , are determined by the FOCs:

$$t_x = \frac{\partial Cx(Ax^*)}{\partial Ax}. \quad (6)$$

$$t_y = \frac{\partial Cy(Ay^*)}{\partial Ay}. \quad (7)$$

Assume throughout that  $Cx' > 0$ ,  $Cx'' > 0$  and  $Cy' > 0$ ,  $Cy'' > 0$ , and hence the taxpayer chooses strictly positive avoidance amounts when  $t_x > 0$  and  $t_y > 0$ .<sup>1</sup> The optimal

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<sup>1</sup>Note that when  $t_x = 0$ , it is optimal to have  $Ax^* = 0$  (as a corner solution for which (6) should be modified to the inequality “less than or equal to”) and when  $t_y = 0$ , it is optimal to have  $Ay^* = 0$  (as a corner solution for which (7) should be modified to the inequality “less than or equal to”).

consumption  $X^*$  and income  $Y^*$  are determined by the the individual budget constraint (3) and the following FOC

$$\frac{H'_Y}{H'_X} = -\frac{1 - t_y}{1 + t_x}, \quad (8)$$

Plugging the optimal  $X^*$  and  $Y^*$  into the "inner" utility function  $H(X, Y)$  gives us the "inner" indirect utility function  $\tilde{H}(t_x, t_y) = H(X^*(t_x, t_y), Y^*(t_x, t_y))$ .

The FOCs for the government's problem (for an inner solution) are

$$U'_G \frac{\partial G}{\partial t_x} + U'_H \frac{\partial \tilde{H}}{\partial t_x} = 0, \quad (9)$$

$$U'_G \frac{\partial G}{\partial t_y} + U'_H \frac{\partial \tilde{H}}{\partial t_y} = 0, \quad (10)$$

where  $\frac{\partial G}{\partial t_x}$  and  $\frac{\partial G}{\partial t_y}$  are determined by the government budget constraint  $G = t_x(X^* - Ax^*) + t_y(Y^* - Ay^*)$ , by differentiating which we obtain

$$\frac{\partial G}{\partial t_x} = X^* - Ax^* + t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} \right) + t_y \frac{\partial Y^*}{\partial t_x}, \quad (11)$$

$$\frac{\partial G}{\partial t_y} = Y^* - Ay^* + t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} \right) + t_x \frac{\partial X^*}{\partial t_y}. \quad (12)$$

By the envelop theorem, we have

$$\frac{\partial \tilde{H}}{\partial t_x} = -\frac{\lambda}{U'_H} (X^* - Ax^*), \quad (13)$$

$$\frac{\partial \tilde{H}}{\partial t_y} = -\frac{\lambda}{U'_H} (Y^* - Ay^*), \quad (14)$$

where  $\lambda$  is the Lagrange multiplier in the individual problem. Using equations (9) - (14), we obtain that at the optimum  $(t_x, t_y)$  should satisfy

$$\frac{t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} \right) + t_y \frac{\partial Y^*}{\partial t_x}}{X^* - Ax^*} = \frac{\lambda - U'_G}{U'_G}, \quad (15)$$

$$\frac{t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} \right) + t_x \frac{\partial X^*}{\partial t_y}}{Y^* - Ay^*} = \frac{\lambda - U'_G}{U'_G}. \quad (16)$$

Introducing the notation for taxable income,  $Z_y = Y - Ay$ , and taxable consumption,  $Z_x =$

$X - Ax$ , we can rewrite the conditions for the optimal tax rates,  $(t_x, t_y)$ , as

$$\frac{t_x}{1-t_x} \left[ E(Z_x, 1-t_x) + \frac{t_y Y}{t_x Z_x} E(Y, 1-t_x) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (17)$$

$$\frac{t_y}{1-t_y} \left[ E(Z_y, 1-t_y) + \frac{t_x X}{t_y Z_y} E(X, 1-t_y) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (18)$$

where  $E(Z_y, 1-t_y) = \frac{1-t_y}{Z_y} \frac{\partial Z_y}{\partial 1-t_y}$  is the elasticity of taxable income with respect to  $(1-t_y)$  and  $E(Z_x, 1-t_x) = \frac{1-t_x}{Z_x} \frac{\partial Z_x}{\partial 1-t_x}$  is the elasticity of taxable consumption w.r.t.  $(1-t_x)$ .

It is important to note that the formula for the optimal income tax rate in our setting differs from the formula for the optimal income tax rate in case when only income tax (and not consumption tax) is used. Specifically, compare equation (18) to equation (7) from Keen and Slemrod (2017). As can be seen, in Keen and Slemrod (2017) the optimal income tax rate depends only on the elasticity of taxable income,  $E(Z_y, 1-t_y)$ . In our case, when both income and consumption taxes are imposed, it is not only the elasticity of taxable income that matters but also the elasticity  $E(X, 1-t_y)$ , which we will call the *cross-elasticity* of real consumption, that reflects how the income tax rate affects household consumption.

Where does this effect come from? When tax rates change, the relative prices of consumption and income (leisure) change. For example, when we increase the income tax rate  $t_y$ , with avoidance held constant labor and household income will fall, reducing consumption. In this way income-tax rates may impact the base of the consumption tax. Thus, this effect is a kind of "behavioral" effect in the Ramsey model.

Interestingly, this result also differs from Gordon and Nielsen (1997), in which rates for the two taxes are inversely related to their respective elasticities of taxable base (ETC & ETI). But there is no cross-elasticity effect in Gordon and Nielsen (1997), which happens by a coincidence (or perhaps by construction). In their model, the cost of avoidance, for example, of labor (income) is proportional to labor (and quadratically proportional to the fraction of labor evaded). As a result, it happens that a marginal change in one tax rate ( $t_x$ ) (that is accompanied by such a change in the other tax rate ( $t_y$ ) that government revenue,  $G$ , is fixed) causes no change in the relative prices of consumption ( $X$ ) and labor ( $Y$ ). Consequently, at the optimum, such marginal change in  $t_x$  (that is accompanied by such a change in  $t_y$  that government revenue,  $G$ , is fixed) has no effect on household consumption or labor supply decisions.

Should government impose any consumption tax in this scenario? To derive the corresponding condition, we consider when a marginal increase in  $t_x$  would reduce utility. Thus, we need to

replace the FOC (9) by

$$\left[ U'_G \frac{\partial G}{\partial t_x} + U'_H \frac{\partial \tilde{H}}{\partial t_x} \right]_{t_x=0} \leq 0.$$

Utilizing then equations (13), (11) and (18), we obtain that for the consumption tax rate to be zero it is necessary that<sup>2</sup>

$$E(Y, 1 - t_x)|_{t_x=0} \geq \frac{X}{(1 - t_y)Y} E(Z_y, 1 - t_y)|_{t_x=0}, \quad (19)$$

where  $t_y$  is determined by equation This should probably be a reference to equation 18, not 27 under condition of  $t_x = 0$ .

**Proposition 1.** A necessary condition for the the consumption tax rate to be zero is that the the cross-elasticity of income w.r.t.  $(1 - t_x)$ ,  $E(Y, 1 - t_x)|_{t_x=0}$ , should be higher than the elasticity of *taxable* income w.r.t.  $(1 - t_y)$ ,  $E(Z_y, 1 - t_y)|$ , multiplied by  $\frac{X}{(1-t_y)Y}$ .

In general, Proposition 1 suggests that consumption taxes are less likely to be optimal when real labor supply is more responsive to the consumption tax rate than taxable income is to the income-tax rate. In addition, holding all else constant, consumption taxes are less desirable when the income base is smaller than the consumption base.

## Case 2. Costs of income and consumption avoidances are overlapping (interdependent).

We assume now that the cost of income tax avoidance depends on both the amount of income avoidance and the amount of consumption avoidance,  $Cx(Ax, Ay)$ . Similarly, the cost of consumption tax avoidance depends on both the amount of income avoidance and the amount of consumption avoidance,  $Cy(Ax, Ay)$ . Note that this case is very general and nests several real-world stories about why the costs of avoiding consumption tax would be interdependent with the costs of avoiding income tax, including: 1) there is only one avoidance technology that is used to jointly avoid both income and consumption taxes; and 2) there are separate avoidance technologies, taxpayers must choose between avoiding income or consumption, and demand for one avoidance technology affects the price of the other.<sup>3</sup>

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<sup>2</sup>The key conditions required for the second-order sufficient condition to be satisfied are  $\frac{\partial^2 G}{\partial t_x^2} < 0$ ,  $\frac{\partial^2 G}{\partial t_y^2} < 0$ ,  $\frac{\partial^2 \tilde{H}}{\partial t_x^2} < 0$  and  $\frac{\partial^2 \tilde{H}}{\partial t_y^2} < 0$ , as well as  $U(G, H())$  to be concave in its arguments. But this is not the complete list of the required conditions.

<sup>3</sup>In general, we should expect that individuals will pursue a mix of single-tax and overlapping avoidance strategies. For example, let 'x' ('y') be a technology that reduces only consumption (only income) and let 'xy'

Another example is if investments in one technology also pay off partially for the other, as with cross-border working and shopping, or the example in Slemrod and Yitzhaki (2002) where research on tax evasion also reveals “barely legal” avoidance opportunities.<sup>4</sup> Cross and Shaw (1982) also model evasion when evasion and avoidance can be complements.

The taxpayer problem and the government problem are the same as stated above, with the only modification the costs of income and consumption avoidance technologies we have already mentioned.

The optimal amounts of avoidance,  $Ax^*$  and  $Ay^*$ , are now determined by the FOCs:

$$t_x = \frac{\partial}{\partial Ax} [Cx(Ax^*, Ay^*) + Cy(Ax^*, Ay^*)], \quad (20)$$

$$t_y = \frac{\partial}{\partial Ay} [Cx(Ax^*, Ay^*) + Cy(Ax^*, Ay^*)]. \quad (21)$$

In contrast to Case 1, optimal consumption avoidance,  $Ax^*(t_x, t_y)$ , depends on both  $t_x$  and  $t_y$ . Similar, optimal income avoidance,  $Ay^*(t_x, t_y)$ , depends on both  $t_x$  and  $t_y$ . How exactly they depend on those tax rates is determined by their respective cost functions, which we define here quite generally.

Equations (8), (9), (10), (13), and (14) are still valid here. The difference arises in equations (11) and (12), which now become

$$\frac{\partial G}{\partial t_x} = X^* - Ax^* + t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} \right) + t_y \left( \frac{\partial Y^*}{\partial t_x} - \frac{\partial Ay^*}{\partial t_x} \right), \quad (22)$$

$$\frac{\partial G}{\partial t_y} = Y^* - Ay^* + t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} \right) + t_x \left( \frac{\partial X^*}{\partial t_y} - \frac{\partial Ax^*}{\partial t_y} \right). \quad (23)$$

Hence, the conditions for the optimal tax rates,  $(t_x, t_y)$ , become

$$\frac{t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} \right) + t_y \left( \frac{\partial Y^*}{\partial t_x} - \frac{\partial Ay^*}{\partial t_x} \right)}{X^* - Ax^*} = \frac{\lambda - U'_G}{U'_G}, \quad (24)$$

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be a technology that reduces both wage and consumption income. Avoidance technologies 'x', 'y', and 'xy' all provide diminishing marginal returns, which means that the corresponding cost functions (call them  $cx(Ax)$ ,  $cy(Ay)$ , and  $cxy(Ax, Ay)$ ) are convex. Taxpayers choose an optimal mix of 'x', 'y', and 'xy' technologies. Unless 'xy' is exceptionally productive, it is likely that at least some expenditures on both 'x' and 'y' will be part of the optimal avoidance portfolio. The cost functions of avoidance that we introduced above,  $Cx$  and  $Cy$ , in this example can be calculated as  $Cx(Ax, Ay) + Cy(Ax, Ay) = \min_{(Ax_1, Ax_2, Ay_1, Ay_2)} [cx(Ax_1) + cy(Ay_1) + cxy(Ax_2, Ay_2)]$  s.t.  $Ax = Ax_1 + Ax_2$ ,  $Ay = Ay_1 + Ay_2$ .

<sup>4</sup>Since we assume tax reduction is riskless, we do not separately model avoidance and evasion. We offer the two here simply as examples of multiple possible tax reduction technologies.

$$\frac{t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} \right) + t_x \left( \frac{\partial X^*}{\partial t_y} - \frac{\partial Ax^*}{\partial t_y} \right)}{Y^* - Ay^*} = \frac{\lambda - U'_G}{U'_G}. \quad (25)$$

Using the notation for taxable income,  $Z_y = Y - Ay$ , and taxable consumption,  $Z_x = X - Ax$ , we can rewrite the conditions for the optimal tax rates,  $(t_x, t_y)$ , as

$$\frac{t_x}{1 - t_x} \left[ E(Z_x, 1 - t_x) + \frac{t_y Z_y}{t_x Z_x} E(Z_y, 1 - t_x) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (26)$$

$$\frac{t_y}{1 - t_y} \left[ E(Z_y, 1 - t_y) + \frac{t_x Z_x}{t_y Z_y} E(Z_x, 1 - t_y) \right] = \frac{U'_G - \lambda}{U'_G}. \quad (27)$$

As can be seen from equation (27), the optimal income tax rate depends not only on the elasticity of taxable income w.r.t.  $(1 - t_y)$ ,  $E(Z_y, 1 - t_y)$ , but also on the elasticity of taxable consumption w.r.t.  $(1 - t_y)$ ,  $E(Z_x, 1 - t_y)$ . Compared to the previous case (see equation (18)), the second term in the brackets in equation (27) accounts not only for the affect of the change in tax rate  $t_y$  on real consumption,  $X$ , but also on the amount of consumption avoidance,  $Ax$ . Similar considerations are applied to the condition that determines the optimal consumption tax rate (equation This should probably be a reference to equation 26). We therefore have a Ramsey-type result in which each tax base should be used in inverse proportion to its impact on the combination of real responses and avoidance. This is also parallel to the result in Slemrod and Gillitzer (2013), who find that individual components of the consumption tax base should face rates inversely proportional to the combined elasticity of all real and avoidance responses.

Again, one might wonder when it would be optimal to have the consumption tax rate set to zero. As explained in case 1, to derive the corresponding condition, we need to replace the FOC (9) by

$$\left[ U'_G \frac{\partial G}{\partial t_x} + U'_H \frac{\partial \tilde{H}}{\partial t_x} \right]_{t_x=0} \leq 0.$$

Utilizing then equations (13), (22) and (27), we obtain that for the consumption tax rate to be zero it is necessary that

$$E(Z_y, 1 - t_x)|_{t_x=0} \geq \frac{Z_x}{(1 - t_y)Z_y} E(Z_y, 1 - t_y)|_{t_x=0}, \quad (28)$$

where  $t_y$  is determined by equation (27) under condition of  $t_x = 0$ .

**Proposition 2.** The necessary condition for the the consumption tax rate to be

zero is that the the cross-elasticity of taxable income w.r.t.  $(1-t_x)$ ,  $E(Z_y, 1 - t_x)|_{t_x=0}$ , should be higher than the elasticity of taxable income w.r.t.  $(1-t_y)$ ,  $E(Z_y, 1 - t_y)|_{t_x=0}$ , multiplied by  $\frac{Z_x}{(1-t_y)Z_y}$ .

In words, the use of a consumption tax depends on a comparison of two key statistics. The first of these is the familiar elasticity of taxable income with respect to the income tax rate,  $E(Z_y, 1 - t_y)$ , which here should be evaluated when the consumption tax is set to zero. The second and less familiar is the extent to which reported taxable income responds to the consumption tax rate,  $E(Z_y, 1 - t_x)$ , which we might call XETI for the *cross-elasticity* of taxable income. Consumption taxes are less likely to be optimal when XETI is large relative to ETI. Intuitively, that situation captures the Gordon and Nielsen (1997) multiple-instruments hypothetical in which opportunities for consumption avoidance impact the income tax base as much or more than income tax avoidance would. A convenient feature of this relationship is that its two components are readily observable, although to our knowledge there are no prior estimates of XETI.

The ratio of the respective (reported) consumption and income tax bases is also important. A consumption tax is less likely to be optimal, all else equal, when the reported income-tax base is larger than the reported consumption-tax base. With a small consumption base, taxes raise little income at any given rate, making it more difficult for the consumption tax to be net welfare-improving. Lastly, consumption taxes become less desirable when income-tax rates are low. Again, this is quite intuitive; at low rates, the marginal excess burden of the income tax is small, so the consumption tax would have to be relatively efficient in order to replace any portion of it.

**Case 3. Avoidance cost includes component that is transferable to the government.** So far we have assumed that taxpayers can risklessly reduce tax, albeit at some cost. In addition, as Chetty (2009) emphasizes, optimality results often depend on whether behavioral changes in response to tax are pure deadweight loss or instead comprise transfers between agents. We attempt to capture both these features by now explicitly accounting in our model for the fact that taxpayers may incur a risk of sanction, such that some avoidance cost might be transferable to the government. Specifically, assume government imposes a transferable penalty,  $F$ , (i.e., a fine) for tax avoidance. Taxpayer chooses  $Ay$  (and  $Ax$ ) to account for penalty cost,  $Fy(\cdot)$  (and  $Fx(\cdot)$ ), which is some probability-weighted cost of being fined for avoidance. Specifically, assume that penalty cost functions have the following form

$$Fx(Ax, t_x) = F \cdot \alpha_x(Ax) \cdot t_x \cdot Ax,$$

$$Fy(Ay, t_y) = F \cdot \alpha_y(Ay) \cdot t_y \cdot Ay,$$

where  $\alpha_x(Ax)$  and  $\alpha_y(Ay)$  are the probability functions of being caught for consumption and income avoidance correspondingly. That is, the penalty cost is proportional to the fine,  $F$ , to the probability of being caught, and to the avoided tax ( $t_x \cdot Ax$  or  $t_y \cdot Ay$ ). See Slemrod & Yitzhaki (2002) for more detailed discussion of standard models of tax avoidance under a penalty regime. For simplicity we will build on the model of Case 2, but as will be clear these results also carry straightforwardly to Case 1.

Define  $f_x(Ax) = Fx(Ax, t_x)/t_x$  and  $f_y(Ay) = Fy(Ay, t_y)/t_y$ . Then, the taxpayer problem should be reformulated as

$$\max_{(X, Y, Ax, Ay)} U(G, H(X, Y)) \quad (29)$$

$$s.t. (1+t_x)(X-Ax)+Ax+t_x f_x(Ax)+Cx(Ax, Ay) = (1-t_y)(Y-Ay)+Ay-t_y f_y(Ay)-Cy(Ax, Ay). \quad (30)$$

The government problem is to choose two tax rates  $(t_x, t_y)$  to maximize individual utility subject to the government budget constraint, which is now

$$G = t_x(X - Ax + f_x(Ax)) + t_y(Y - Ay + f_y(Ay)) \quad (31)$$

The optimal amounts of avoidance,  $Ax^*(t_x, t_y)$  and  $Ay^*(t_x, t_y)$ , are now determined by the FOCs:

$$t_x \left(1 - \frac{\partial f_x(Ax^*)}{\partial Ax}\right) = \frac{\partial}{\partial Ax} [Cx(Ax^*, Ay^*) + Cy(Ax^*, Ay^*)], \quad (32)$$

$$t_y \left(1 - \frac{\partial f_y(Ay^*)}{\partial Ay}\right) = \frac{\partial}{\partial Ay} [Cx(Ax^*, Ay^*) + Cy(Ax^*, Ay^*)]. \quad (33)$$

Following similar solution steps as in Case 1 (see Appendix), the conditions for the optimal tax rates,  $(t_x, t_y)$ , become

$$\frac{t_x \frac{\partial(X^* - Ax^* + f_x(Ax^*))}{\partial t_x} + t_y \frac{\partial(Y^* - Ay^* + f_y(Ay^*))}{\partial t_x}}{X^* - Ax^* + f_x(Ax^*)} = \frac{\lambda - U'_G}{U'_G}, \quad (34)$$

$$\frac{t_y \frac{\partial(Y^* - Ay^* + f_y(Ay^*))}{\partial t_y} + t_x \frac{\partial(X^* - Ax^* + f_x(Ax^*))}{\partial t_y}}{Y^* - Ay^* + f_y(Ay^*)} = \frac{\lambda - U'_G}{U'_G}. \quad (35)$$

If we introduce (let us call it) *adjusted* taxable income,  $\tilde{Z}_y = Y - Ay + f_y(Ay^*)$ , and *adjusted* taxable consumption,  $\tilde{Z}_x = X - Ax + f_x(Ax^*)$ , we can rewrite the conditions for the optimal

tax rates,  $(t_x, t_y)$ , as

$$\frac{t_x}{1-t_x} \left[ E(\tilde{Z}_x, 1-t_x) + \frac{t_y \tilde{Z}_y}{t_x \tilde{Z}_x} E(\tilde{Z}_y, 1-t_x) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (36)$$

$$\frac{t_y}{1-t_y} \left[ E(\tilde{Z}_y, 1-t_y) + \frac{t_x \tilde{Z}_x}{t_y \tilde{Z}_y} E(\tilde{Z}_x, 1-t_y) \right] = \frac{U'_G - \lambda}{U'_G}. \quad (37)$$

Thus, we see that once we change taxable income to adjusted taxable income and taxable consumption to adjusted taxable consumption, the conditions for the optimal tax rates,  $(t_x, t_y)$ , look exactly the same as in Case 2.

**Case 4. The government has bureaucratic (administrative) costs.** Another unrealistic component of the model thus far is that we have ignored the likelihood that expanding the tax base to include consumption will result in additional administrative costs. If administrative costs from expanding to a consumption base are relatively fixed in each period, the optimal conditions could be derived but are not very informative. However the intuitions are straightforward, as discussed in Gamage (2014) and in the analogous case for use of non-rate instruments in Slemrod and Gillitzer (2013:117). A consumption tax would only be welfare improving if the net utility gains from adding the tax exceed the fixed costs of administration.

It is likely, though, that administrative costs are not wholly fixed but instead have a relationship to rates and base. Let us return to the assumption of Case 2 and additionally suppose that the government has bureaucratic (administrative) costs of collecting consumption and income taxes,  $Bx(Ax, X)$  and  $By(Ay, Y)$ . For tractability, we assume these are each continuous and increasing in both arguments' functions, although we acknowledge that in reality administrative costs can often be discontinuous (Slemrod & Yitzhaki 2002).

Under these assumptions, the taxpayer problem and its solution stay the same as in Case 2. The government problem is to choose two tax rates  $(t_x, t_y)$  to maximize individual utility subject to the government budget constraint, which is now

$$G = t_x(X - Ax) - Bx(Ax, X) + t_y(Y - Ay) - By(Ay, Y). \quad (38)$$

Accounting for this modification and following similar solution steps as in Case 1 (see Appendix), the conditions for the optimal tax rates,  $(t_x, t_y)$ , become

$$\frac{t_x \frac{\partial(X^* - Ax^*)}{\partial t_x} + t_y \frac{\partial(Y^* - Ay^*)}{\partial t_x} - \frac{\partial(Bx(Ax^*, X^*) + By(Ay^*, Y^*))}{\partial t_x}}{X^* - Ax^*} = \frac{\lambda - U'_G}{U'_G}, \quad (39)$$

$$\frac{t_y \frac{\partial(Y^* - Ay^*)}{\partial t_y} + t_x \frac{\partial(X^* - Ax^*)}{\partial t_y} - \frac{\partial(Bx(Ax^*, X^*) + By(Ay^*, Y^*))}{\partial t_y}}{Y^* - Ay^*} = \frac{\lambda - U'_G}{U'_G}. \quad (40)$$

Applying the notation for taxable income,  $Z_y = Y - Ay$ , and taxable consumption,  $Z_x = X - Ax$ , we can rewrite the conditions for the optimal tax rates,  $(t_x, t_y)$ , as

$$\frac{t_x}{1 - t_x} \left[ E(Z_x, 1 - t_x) + \frac{t_y Z_y}{t_x Z_x} E(Z_y, 1 - t_x) - \frac{Bx + By}{t_x Z_x} E(Bx + By, 1 - t_x) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (41)$$

$$\frac{t_y}{1 - t_y} \left[ E(Z_y, 1 - t_y) + \frac{t_x Z_x}{t_y Z_y} E(Z_x, 1 - t_y) - \frac{Bx + By}{t_y Z_y} E(Bx + By, 1 - t_y) \right] = \frac{U'_G - \lambda}{U'_G}, \quad (42)$$

where for brevity  $Bx$  denotes  $Bx(Ax^*, X^*)$  and  $By$  denotes  $By(Ay^*, Y^*)$ .

As we see, compared to equation (26) for the optimal tax rate  $t_x$  in Case 2, in this case with bureaucratic cost we have an additional (third) term in the left-hand side of equation (41), which reflects that a higher tax rate likely raises bureaucratic costs. Note that  $E(Bx + By, 1 - t_x)$  and  $E(Bx + By, 1 - t_y)$  are likely to be negative. Similar considerations applies to equation (42) for optimal tax rate  $t_y$ .

Again, we would like now to explore when it would be optimal to have the consumption tax rate set to zero. Following the same logic as in case 1, we obtain that for the consumption tax rate to be zero it is necessary that

$$E(Z_y, 1 - t_x)|_{t_x=0} \geq \frac{Z_x}{(1-t_y)Z_y} \left\{ E(Z_y, 1 - t_y)|_{t_x=0} + \frac{1-t_y}{t_y} \frac{Bx+By}{Z_x} E(Bx + By, 1 - t_x) \Big|_{t_x=0} - \frac{Bx+By}{t_y Z_y} E(Bx + By, 1 - t_y) \Big|_{t_x=0} \right\}, \quad (43)$$

where again for brevity  $Bx$  denotes  $Bx(Ax^*, X^*)$  and  $By$  denotes  $By(Ay^*, Y^*)$  and  $t_y$  is determined by equation (27) under condition of  $t_x = 0$ .

**Proposition 3.** The necessary condition for the consumption tax rate to be zero is given by equation (43).

Compared to Case 2 (see equation (28)), to determine whether the consumption tax rate should be set to zero, the cross-elasticity of taxable income w.r.t.  $(1 - t_x)$ ,  $E(Z_y, 1 - t_x)|_{t_x=0}$ , should not be simply compared to the elasticity of taxable income,  $E(Z_y, 1 - t_y)|_{t_x=0}$ , multiplied by  $\frac{Z_x}{(1-t_y)Z_y}$ . The first term on the right-hand side for the two equations is the same, so that the factors we described in Case 2 continue to hold with administrative costs. The second and third right-hand side terms here capture the (weighted) incremental combined bureaucratic costs of increasing the consumption and income taxes, respectively. It is more

difficult to rule out a consumption tax when the second term is larger than the third. In short, then, we show that when the elasticity of combined income- and consumption-tax bureaucratic cost to the consumption tax is smaller than its elasticity to the income tax, a consumption tax becomes relatively more desirable.

### 3 Calibration Exercise

In this section, we attempt to provide an empirical sense of the extent to which our model would judge the use of real-world consumption taxes to be efficient. In essence, we test Proposition 2 using data from California. To do this, we first will estimate the key term from Proposition 2, the cross-elasticity of taxable income. Then, drawing on equation 28, we compute the critical value for this cross-elasticity required for a sales tax to be optimally non-zero. We then estimate what portion of the potential distribution of outcomes falls in the range required for non-zero sales taxes.

Note that our empirical analysis relies on the following assumption. Because Proposition 2 depends on elasticities when the consumption-tax rate is close to zero, our exercise requires us to assume that the elasticities we measure are not sensitive to changes in rates. Alternately, to the extent we conclude that California data supports the use of a consumption tax, we must at least assume that the elasticity when rates are not close to zero is no more favorable to the use of a consumption tax than elasticities at close to zero. Since if anything elasticities are likely to be larger in magnitude when rates are higher, we think this second assumption is defensible.

California provides a useful setting in which to estimate the key term from Proposition 2, XETI, that is  $E(Z_y, 1 - t_x)$ . Although California imposes a statewide retail sales tax, city and county governments within California are also allowed to adopt their own increments to the tax. The definition of the tax base, such as whether certain items are exempt as food or services, is uniform throughout the state.<sup>5</sup> Thus, unlike in a typical cross-jurisdictional setting, there is variation only with respect to rates. This crucial feature allows us to identify effects caused by rate changes alone, without having to be worried that this effect is confounded by difficult-to-observe changes in tax base. The rate changes here are relatively small in terms of

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<sup>5</sup>California's retail sales tax has numerous major exceptions. Among others, it does not reach services. While in theory purchases outside California are taxable under a complementary "use" tax at the same rates, this tax was effectively unenforceable for most transactions during our sample period. And even for tangible goods, many items, such as food, are untaxed. Quite similar items can receive different tax treatment, as in the often-reported legal distinction between large marshmallows (taxable snacks) and small marshmallows (untaxed baking supplies).

$1 - t_x$ , though, with the typical local increment falling in the range of one-quarter to one-half of a percentage point on top of the statewide rate of 7.5%.

Another very useful feature of California’s sales tax is that it offers several potential sources of random variation. This is critical because we might expect that political and bureaucratic correlates of a consumption-tax change might confound any efforts to identify its impact on the income tax. For instance, jurisdictions might increase sales taxes when they become aware of looming threats to their income-tax base, or willingness to vote for sales-tax increases might be correlated with preferences for income-tax compliance.

Our main source of identification exploits a quirk of California’s voting rules. Every city or county sales-tax increase must be approved by voters in the affected jurisdiction. The threshold for success for tax proposals arbitrarily changes from fifty percent to a two-thirds threshold depending on relatively unimportant features of the proposal. Specifically, if the proponents of a tax increase (who need not be public officials) want the ballot seen by voters to include a statement that the tax proceeds will be used for any particular purpose, the proposal must receive two-thirds of the vote in order to pass. Only fifty percent is required otherwise. Since tax funds are largely fungible, these statements are not in practice binding, and as best we could determine there has never been a reported law suit seeking to enforce one. In short, there is only a small difference in labeling between the two kinds of tax proposals. For propositions receiving votes between fifty percent and two-thirds of the vote, therefore, whether the vote results in a tax increase is close to random.<sup>6</sup>

We scrape these results from the California Secretary of State web site, which reports the results of all city and county elections, back to 2001. We then combine the vote information with zip-code level data on aggregate California income tax liability from the California Franchise Tax Board, as well as similar zip-level aggregates of U.S. tax liability from the I.R.S. Statistics of Income Division. Finally, of course, we include zip-level measures of the applicable California retail sales tax in a given zip-year. Our data cover a statewide panel ranging in time from 2001 to 2017, though federal zip-level tax data are missing values for the 2003 and 2006 tax years. We deflate dollar amounts to 2017 values using chained CPI. Table 1 provides summary statistics.

In order to obtain a clean comparison between winning and losing elections within the fifty percent to two-thirds window, we limit our observations to zip-years in affected zip

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<sup>6</sup>Results using a regression-discontinuity design, in which the discontinuity is the relevant vote threshold, are qualitatively similar to those we report in more detail. Due to the small number of observations close to fifty percent, and the even smaller number close to a two-thirds vote, these estimates are highly imprecise.

Table 1: **Summary Statistics**

Variable	All Zips		Zips in Election Window	
	Mean	SD	Mean	SD
Vote Share	.602	.120	.602	.0765
Sales Tax Rate	8.100	.609	8.212	.589
City Population	49694	70676	42370	65577
CA Tax Liability	21.0*	49.1*	29.0*	64.6*
CA Returns	6207	8223	7320	8646
CA Tax Per Filer	4870	70807	5403	39919
US Tax Liability	96.2*	165.9*	121.8*	196.1*
US Returns	8601	8998	10026	9155
US Tax Per Filer	11337	18721	12927	21579

Notes: Dollar values in 2017 dollars. \*: millions.

codes during the five-year windows around elections with votes falling in that range.<sup>7</sup> We drop observations that fall within the five-year window of more than one election, regardless of whether the second or additional elections were in the fifty percent to two-thirds window. We also omit zip codes that cross city or county boundaries, so that zips are nested within cities which in turn are nested within counties. Because year-over-year changes in zip-level tax liability exhibit extreme swings at the tails of the distribution, we trim the sample to exclude zip-years in the top and bottom five percent by this measure.<sup>8</sup>

We then estimate fixed-effects panel regressions, with zip code as the panel variable, in which the treatment effect is successful passage. To obtain an elasticity estimate, we interact this treatment with the difference in  $\log 1 - t_x$  between the year before and the year after the election.<sup>9</sup> As Slemrod and Gillitzer (2013) explain, although the elasticity of the income-tax base is often referred to as ETI, where some taxpayer responses can include shifting between income brackets, the more direct measure is tax liability, not taxable income. Thus, our outcome variables are either California or federal tax liability, aggregated to the zip code level. We include controls for year and for city-by-year trends. Since local economic conditions may be an outcome of the sales tax regime, we omit economic controls.

Conceptually, it is not clear whether the appropriate measure of taxable income is aggregate income or instead income per tax filer. In theory, inter-jurisdictional mobility and

<sup>7</sup>We retain observations near the beginning of our data because we are able to observe the existence of prior elections through 1999.

<sup>8</sup>Results are essentially unchanged if we instead trim only the top and bottom one percent.

<sup>9</sup>During the sample period, statewide sales tax rates changed several times. Since these changes affected all our observed jurisdictions simultaneously, we can account for them simply by including a control for year effects. All other observed rate changes were the result of local elections.

local economic conditions are both potential outcomes of a change in the sales-tax rate, which could in turn affect taxable income. It seems implausible to us, however, that sales-tax changes of this magnitude would cause measurable short-run relocations. Whether they could potentially affect the decision whether to file a return is less clear. Thus, we present both results where tax liability per filer is the outcome (essentially ruling out relocation and filing decisions as outcomes of the tax increase) and those for which the outcome is total zip tax liability. For each, we present estimates weighted by the number of filing households in the jurisdiction as well as unweighted.

Equation (44) summarizes our approach.

$$I_{it} = \alpha_i + \beta_1 Pass * \Delta_{post-pre} (1 - t_x) + \lambda_t + \Phi_m \lambda_t + \epsilon_{it} \quad (44)$$

In this equation,  $Pass * \Delta_{post-pre} (1 - t_x)$  refers to the increase, in the time from the year before to the year after each election, in logs of one minus the sales-tax rate. The coefficient  $\beta_1$  can thus be interpreted as our key coefficient of interest, the cross-elasticity of taxable income with respect to one minus the sales-tax rate.  $\lambda_t$  is a year fixed effect, while  $\Phi_m \lambda_t$  is a municipality-by-year trend.  $\epsilon_{it}$  is the error term. The  $\alpha_i$  term reflects zip-code level fixed effects. We cluster errors at the county level, as that is the largest treated unit.

As might be expected given the relatively small changes in rates we observe, our estimates for the cross-elasticity are somewhat imprecise. For California taxable income estimates, we find 95% confidence intervals that range from slightly above zero to as low as -6. Federal tax estimates are somewhat smaller in magnitude but more precisely measured. Since our estimand is one minus the sales tax rate, these results imply that increases in the sales tax rate are correlated with greater taxable incomes. Among other possible explanations, this could be consistent with a hypothesis that higher sales tax rates increase the productivity of sales-tax avoidance, shifting taxpayer budgets towards that instrument and away from income-tax avoidance. While the point estimates are sizable, they are small in economic terms. The median rate change is one-quarter point, about a .27 percent change in terms of one minus the rate. Thus our point estimate in Table Two, Column One implies an accompanying change in total CA income tax of about .78 percent.

Of greater interest, our estimates allow us to pin down whether XETI is consistent with an efficient non-zero sales-tax rate, as defined in Proposition 2 and Equation 28.<sup>10</sup> Using sample means and prior literature, we compute a critical value for XETI such that a non-

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<sup>10</sup>Note that Proposition 2 (Equation (28)) states a necessary condition for the consumption tax rate to be zero, which is XETI greater than some critical value. To obtain the necessary condition for the consumption tax rate to be positive, we flip the sign, asking whether XETI is less than the critical value.

Table 2: **Cross-Elasticity of Income Tax Liabilities w.r.t Sales Tax Rates**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	CA Tax	CA Tax (Weighted)	CA Tax Per Filer	CA Tax Per Filer (Weighted)	U.S. Tax	U.S. Tax (Weighted)	U.S. Tax Per Filer	U.S. Tax Per Filer (Weighted)
<i>Post</i> ×								
$\Delta Sales$	-2.845* (1.599)	-3.150 (2.249)	-3.984*** (1.361)	-3.576* (1.792)	-2.032** (0.786)	-2.551*** (0.656)	-2.141*** (0.792)	-2.188*** (0.606)
Observations	7,595	7,595	7,595	7,595	4,270	4,270	4,270	4,270
R-squared	0.298	0.574	0.316	0.565	0.738	0.818	0.763	0.829
One-sided p-Value at ETI:								
.12	.967	.927	.998	.979	.996	.999	.997	.999
.4	.982	.949	.999	.988	.999	.999	.999	.999
1.2	.997	.983	.999	.998	.999	.999	.999	.999

Notes: Fixed-effects OLS panel estimates with zip code as panel variable. Standard errors clustered by county in (parenthesis). Weights by number of filing households in zip code. One-sided p-Value panel reports test statistic for a one-sided test that the estimated coefficient on  $Post \times \text{Log}(1 - t)$  is less than the critical value implied by the listed ETI.

zero rate would be efficient if the critical value exceeds our estimated XETI. We then report the portion of the distribution of potential outcomes falling below the critical value, i.e., what portion are consistent with non-zero consumption taxes.

NBER taxsim data report that the mean federal income tax rate in California (net of deductions for California or other state taxes) is .2131 over the latter period of our sample, while the mean California rate we observe in our data is .0635. This yields a value for  $1 - t_y$  of .7234. Our review of the literature on the elasticity of taxable income suggests a range of possible values, ranging from a low of .12 reported in the survey by Saez, Slemrod and Giertz (2012) to a high of 1.2 in Mertens and Montiel Olea (2018). Saez, Slemrod and Giertz (2012) report a top-range estimate of .4, and this is also close to other recent estimates in Burns and Ziliak (2017) and Doerrenberg, Peichl and Siegloch (2017), albeit the latter with German data. We therefore calculate three critical values for equation (28). These critical values are .1785, .5950, and 1.785, respectively.

The bottom panel of Table 2 reports a p-value for a one-sided test that the estimated

coefficient for  $E(Z_x, 1-t_y)$  is less than the critical value (offered with the usual caveats about one-sided tests). Across our various specifications, we find p-values consistently above .92, suggesting that for at least nine-tenths of the distribution of potential outcomes, non-zero sales taxes are optimal. If ETI is at least as high the middle value in the literature, .4, then all our estimates reject zero sales tax with 95% confidence, and most reject with 99.9% or greater confidence. This is not to say that California’s rate is efficient. As Gruber and Saez (2002) find for ETI, we cannot reject equal XETI of California and federal tax, notwithstanding the likelihood that California’s tax base offers more margins of response, though point estimates for California tax are larger in magnitude.

In short, we find suggestive evidence that even a highly differentiated consumption tax, such as the California sales tax, may be efficient, at least if measured elasticities are representative of elasticities at rates close to zero. Admittedly, though, we have not considered the more realistic but less readily estimable cases in which government faces enforcement costs and taxpayers incur transferable compliance costs.

## 4 Conclusion

Prior explorations of the optimality of consumption taxes under the Atkinson and Stiglitz (1976) framework have relied on relatively extreme sets of assumptions, such as the assumption in Boadway, Marchand and Pestieau (1994) that the consumption tax cannot be avoided. We generalize these findings and show the range of cases under which it is optimal to impose sales or VAT-type consumption taxes in addition to the income tax.

We do not mean to suggest that our analysis represents the only basis for determining the optimal mix of income and consumption taxes. As we noted at the outset, we assume that the explicit assumptions of Atkinson and Stiglitz (1976) are met. A long literature addresses cases in which these assumptions fail to hold, such as when some goods are necessary for work (Bastani, Blomquist and Pirttilä 2015), there is uncertainty about individual wages (Cremer and Gahvari 1995), agents are heterogeneous in dimensions other than earning ability (Cremer, Pestieau and Rochet 2001; Saez 2002), or there are different underlying production technologies (Naito 2007). Consumption taxes may also in practice offer a broader base and so allow for lower rates (Pestel and Sommer 2017). Differentiated tax rates may be appropriate for goods with externalities. Boadway and Song (2016) and Nygård and Revesz (2016) provide useful overviews of many of these arguments.

## Appendix

### Derivation of Equations (34) and (35)

We start by solving the taxpayer problem. The optimal consumption  $X^*$  and income  $Y^*$  are determined by the the individual budget constraint (3) and the following FOC

$$\frac{H'_Y}{H'_X} = -\frac{1 - t_y}{1 + t_x}, \quad (45)$$

Plugging the optimal  $X^*$  and  $Y^*$  into the "inner" utility function  $H(X, Y)$  gives us the "inner" indirect utility function  $\tilde{H}(t_x, t_y) = H(X^*(t_x, t_y), Y^*(t_x, t_y))$ .

The FOCs for the government's problem (for an inner solution) are

$$U'_G \frac{\partial G}{\partial t_x} + U'_H \frac{\partial \tilde{H}}{\partial t_x} = 0, \quad (46)$$

$$U'_G \frac{\partial G}{\partial t_y} + U'_H \frac{\partial \tilde{H}}{\partial t_y} = 0, \quad (47)$$

where  $\frac{\partial G}{\partial t_x}$  and  $\frac{\partial G}{\partial t_y}$  are determined by the government budget constraint  $G = t_x(X^* - Ax^* + f_x(Ax)) + t_y(Y^* - Ay^* + f_y(Ay))$ , by differentiating which we obtain

$$\frac{\partial G}{\partial t_x} = X^* - Ax^* + t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} + \frac{\partial f_x(Ax^*)}{\partial t_x} \right) + t_y \left( \frac{\partial Y^*}{\partial t_x} - \frac{\partial Ay^*}{\partial t_x} + \frac{\partial f_y(Ay^*)}{\partial t_x} \right), \quad (48)$$

$$\frac{\partial G}{\partial t_y} = Y^* - Ay^* + t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} + \frac{\partial f_y(Ay^*)}{\partial t_y} \right) + t_x \left( \frac{\partial X^*}{\partial t_y} - \frac{\partial Ax^*}{\partial t_y} + \frac{\partial f_x(Ax^*)}{\partial t_y} \right). \quad (49)$$

By the envelop theorem, we have

$$\frac{\partial \tilde{H}}{\partial t_x} = -\frac{\lambda}{U'_H} (X^* - Ax^* + f_x(Ax^*)), \quad (50)$$

$$\frac{\partial \tilde{H}}{\partial t_y} = -\frac{\lambda}{U'_H} (Y^* - Ay^* + f_y(Ay^*)), \quad (51)$$

where  $\lambda$  is the Lagrange multiplier in the individual problem. Using equations (46) - (51), we obtain equations (34) and (35).

### Derivation of Equations (39) and (40)

Equations (20), (21), (8), (9), (10), (13), and (14) are still valid here. The difference arises

in equations (11) and (12), which now become

$$\frac{\partial G}{\partial t_x} = X^* - Ax^* + t_x \left( \frac{\partial X^*}{\partial t_x} - \frac{\partial Ax^*}{\partial t_x} \right) + t_y \left( \frac{\partial Y^*}{\partial t_x} - \frac{\partial Ay^*}{\partial t_x} \right) - \frac{\partial(Bx(Ax^*, X^*) + By(Ay^*, Y^*))}{\partial t_x}, \quad (52)$$

$$\frac{\partial G}{\partial t_y} = Y^* - Ay^* + t_y \left( \frac{\partial Y^*}{\partial t_y} - \frac{\partial Ay^*}{\partial t_y} \right) + t_x \left( \frac{\partial X^*}{\partial t_y} - \frac{\partial Ax^*}{\partial t_y} \right) - \frac{\partial(Bx(Ax^*, X^*) + By(Ay^*, Y^*))}{\partial t_y}. \quad (53)$$

Combining all the equations mentioned above, we obtain equations (39) and (40).

## References

- Atkinson, Anthony, and Joseph Stiglitz.** 1976. “The Design of Tax Structure: Direct versus Indirect Taxation.” *Journal of Public Economics*, 6(1-2): 55–75.
- Bastani, Spencer, Sören Blomquist, and Jukka Pirttilä.** 2015. “How Should Commodities be Taxed? A Counter-Argument to the Recommendation in the Mirrlees Review.” *Oxford Economic Papers*, 67(2): 455–478.
- Boadway, Robin, and Zhen Song.** 2016. “Indirect Taxes for Redistribution: Should Necessity Goods be Favored?” *Research in Economics*, 70(1): 64–88.
- Boadway, Robin, Maurice Marchand, and Pierre Pestieau.** 1994. “Towards a Theory of the Direct-Indirect Tax Mix.” *Journal of Public Economics*, 55(1): 71–88.
- Brooks, John R., Brian Galle, and Brendan S. Maher.** 2018. “Cross-Subsidies: Government’s Hidden Pocketbook.” *Georgetown Law Journal*, 106: 1229–1286.
- Brunner, Johann K, Paul Eckerstorfer, and Susanne Pech.** 2013. “Optimal Taxes on Wealth and Consumption in the Presence of Tax Evasion.” *Journal of Economics*, 110(2): 107–124.
- Burns, Sarah K, and James P Ziliak.** 2017. “Identifying the Elasticity of Taxable Income.” *The Economic Journal*, 127(600): 297–329.
- Chamley, Christophe.** 1986. “Optimal Taxation of Capital Income in General Equilibrium with Infinite Lives.” *Econometrica: Journal of the Econometric Society*, 607–622.
- Chetty, Raj.** 2009. “Sufficient Statistics for Welfare Analysis: A Bridge Between Structural and Reduced-Form Methods.” *Annual Review of Economics*, 1: 451–488.

- Coleman II, Wilbur John.** 2000. “Welfare and Optimum Dynamic Taxation of Consumption and Income.” *Journal of Public Economics*, 76(1): 1–39.
- Crawford, Ian, Michael Keen, and Stephen Smith.** 2010. “Value Added Tax and Excises.” *Dimensions of Tax Design: the Mirrlees Review*, 1: 275–362.
- Cremer, Helmuth, and Firouz Gahvari.** 1995. “Uncertainty and Optimal Taxation: In Defense of Commodity Taxes.” *Journal of Public Economics*, 56(2): 291–310.
- Cremer, Helmuth, Pierre Pestieau, and Jean-Charles Rochet.** 2001. “Direct versus Indirect Taxation: the Design of the Tax Structure Revisited.” *International Economic Review*, 42(3): 781–800.
- Cross, Rodney, and Graham K Shaw.** 1982. “On the Economics of Tax Aversion.” *Public Finance= Finances publiques*, 37(1): 36–47.
- Doerrenberg, Philipp, Andreas Peichl, and Sebastian Siegloch.** 2017. “The Elasticity of Taxable Income in the Presence of Deduction Possibilities.” *Journal of Public Economics*, 151: 41–55.
- Economides, George, Apostolis Philippopoulos, and Anastasios Rizos.** 2019. “Optimal Tax Policy under Tax Evasion.” *International Tax and Public Finance*, 1–24.
- Finkelstein, Amy, Nathaniel Hendren, and Erzo FP Luttmer.** 2019. “The Value of Medicaid: Interpreting Results from the Oregon Health Insurance Experiment.” *Journal of Political Economy*, 127(6): 2836–2874.
- Gamage, David.** 2014. “The Case for Taxing (All of) Labor Income, Consumption, Capital Income, and Wealth.” *Tax L. Rev.*, 68: 355.
- Gordon, Roger H, and Soren Bo Nielsen.** 1997. “Tax Evasion in an Open Economy:: Value-Added vs. Income Taxation.” *Journal of Public Economics*, 66(2): 173–197.
- Hines Jr, James R.** 2004. “Might Fundamental Tax Reform Increase Criminal Activity?” *Economica*, 71(283): 483–492.
- Huang, Jason, and Juan Rios.** 2016. “Optimal Tax Mix with Income Tax Non-Compliance.” *Journal of Public Economics*, 144: 52–63.
- Judd, Kenneth L.** 1985. “Redistributive Taxation in a Simple Perfect Foresight Model.” *Journal of Public Economics*, 28(1): 59–83.

- Kaplow, Louis.** 2008. “Optimal Policy with Heterogeneous Preferences.” *Advances in Economic Analysis and Policy*, 8(1): 1–28.
- Kaplow, Louis.** 2020. “A Unified Perspective on Efficiency, Redistribution, and Public Policy.” *National Tax Journal*, 73(2): 429–472.
- Kaplow, Louis, and Steven Shavell.** 2001. “Fairness versus Welfare.” *Harvard Law Review*, 114(4): 961–1388.
- Keen, Michael, and Joel Slemrod.** 2017. “Optimal Tax Administration.” *Journal of Public Economics*, 152: 133–142.
- Kesselman, Jonathan R.** 1993. “Evasion Effects of Changing the Tax Mix.” *Economic Record*, 69(2): 131–148.
- Kessing, Sebastian G, and Bernhard Koldert.** 2013. “Cross-Border Shopping and the Atkinson–Stiglitz Theorem.” *International Tax and Public Finance*, 20(4): 618–630.
- Mertens, Karel, and José Luis Montiel Olea.** 2018. “Marginal Tax Rates and Income: New Time Series Evidence.” *The Quarterly Journal of Economics*, 133(4): 1803–1884.
- Naito, Hisahiro.** 2007. “The Use of Both the Consumption Tax and the Wage Tax in an Incomplete Market.” *Available at SSRN 995667*.
- Nygård, Odd E, and John T Revesz.** 2016. “A Literature Review on Optimal Indirect Taxation and the Uniformity Debate.” *Hacienda Pública Española*, 218(3): 107–140.
- Pauly, Mark V.** 1970. “Efficiency, Incentives and Reimbursement for Health Care.” *Inquiry*, 7(1): 114–131.
- Pestel, Nico, and Eric Sommer.** 2017. “Shifting Taxes from Labor to Consumption: More Employment and More Inequality?” *Review of Income and Wealth*, 63(3): 542–563.
- Saez, Emmanuel.** 2002. “The Desirability of Commodity Taxation under Non-linear Income Taxation and Heterogeneous Tastes.” *Journal of Public Economics*, 83(2): 217–230.
- Saez, Emmanuel, Joel Slemrod, and Seth Giertz.** 2012. “The Elasticity of Taxable Incomes with Respect to Marginal Tax Rates: A Critical Review.” *Journal of Economic Literature*, 50(1): 3–50.
- Slemrod, Joel, and Christian Gillitzer.** 2013. *Tax Systems*. MIT Press.

**Slemrod, Joel, and Shlomo Yitzhaki.** 2002. “Tax Avoidance, Evasion, and Administration.” In *Handbook of Public Economics*. Vol. 3 of *Handbook of Public Economics*, , ed. A. J. Auerbach and M. Feldstein, Chapter 22, 1423–1470. Elsevier.

**Straub, Ludwig, and Iván Werning.** 2020. “Positive Long-Run Capital Taxation: Chamley-Judd Revisited.” *American Economic Review*, 110(1): 86–119.