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Marketed tax avoidance: an economic analysis*

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Abstract

Recent years have witnessed the growth of mass-marketed tax avoidance schemes aimed at the middle (not top) of the income distribution, with significant implications for tax revenue. We examine the consequences for the structure of income tax, and for tax authority anti-avoidance efforts, of tax avoidance of this type. In a model that allows for both demand- and supply-side considerations, we find that: there is an endogenous threshold income below which taxpayers do not avoid, and above which they avoid maximally; the per-dollar price of tax avoidance is decreasing in income under progressive taxation; endogenous adjustments in the price of avoidance make supply less responsive to anti-avoidance activity than thought previously; and avoidance may drive a non-monotone relationship between tax rates and tax revenue. These findings suggest that new approaches to anti-avoidance, beyond legal enforcement, might be needed.

Keywords: Anti-avoidance; avoidance Laffer curve; marketed avoidance schemes; progressive taxation; tax avoidance

JEL classification: *D*85; *H*26; *K*42

1. Introduction

Taxpayers take a variety of actions to reduce their tax liabilities. We can distinguish between three types of actions: those that breach tax law (tax

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evasion); those that use tax law to gain an advantage that lawmakers never intended (tax avoidance); and those that use tax allowances for the purposes intended by lawmakers (tax planning). The focus of this paper is on the second of these actions: tax avoidance.[1] Although measurement is challenging, it is thought widely that tax avoidance is responsible for significant revenue loss in developed economies. For instance, using detailed consumer survey data, Lang et al. (1997) estimate that tax avoidance costs the German exchequer an amount equal to around 34 percent of income taxes paid. This loss of revenue – and the ensuing need to devote resources to costly anti-avoidance activity – has undesirable consequences for welfare through the reduced ability of governments to provide public services. It also affects central concerns of economic policymaking, such as the effectiveness of progressive taxation as an instrument of redistribution, and income inequality.

The traditional view of tax avoidance, discussed in economics at least as far back as Cross and Shaw (1981), is "[. . .] that tax avoidance is predominantly the prerogative of the rich". This notion is consistent with high net worth individuals using exotic avoidance schemes, involving the likes of Hollywood films and gold bullion, and employing aggressive tax preparers to disguise income within their tax returns artificially.[2]

Tax avoidance, however, comes in many guises. While there remains a significant market for "bespoke" or "boutique" avoidance schemes designed on an individual basis for the super-rich, recent years have seen a decisive shift towards employment-based avoidance schemes, mass-marketed at those with middle income, including professionals, contractors, and agency workers (HM Revenue & Customs, 2021). Such marketed schemes, which purport to enable taxpayers to reduce their tax liability legally, are the focus of this paper.[3] In the past, the restriction of tax avoidance to the higher echelons of the income distribution was a source of comfort for tax authorities. Marketed schemes are eroding this comfort, and thereby magnify greatly the potential for revenue loss.

Promoting marketed schemes is a dedicated tax avoidance industry that is, in many cases, distinct from the more traditional tax-practitioner industry

[1]Much of the literature on tax avoidance is concerned with whether income tax has "real" effects upon economic activity or simply leads to changes in the "form" of compensation (e.g., Slemrod and Kopczuk, 2002; Piketty et al., 2014). Accordingly, in these studies, the term "tax avoidance" typically refers to all form-changing actions that reduce a tax liability. This definition overlaps with ours but is broader in the sense that it also includes actions that fall into the notion of tax planning.

[2]Recent research also reveals evidence of substantial (offshore) tax evasion by high net worth individuals (Alstadsæter et al., 2019; Gould and Rablen, 2020).

[3]For recent studies of tax avoidance away from the mass-marketed case we consider, see, for example, Bustos et al. (2022) and Gamannossi degl'Innocenti et al. (2022).

studied in, for example, Reinganum and Wilde (1991), Erard (1993), and Kaçamak (2022), which focuses predominantly on the preparation of tax returns. In the UK alone, where some of the most detailed empirical evidence is available, there are estimated to be 50–100 active promoters of marketed schemes in a 2012 National Audit Office report (National Audit Office, 2012), marketing some 324 schemes. Thus, the promoters of marketed schemes go far beyond the so-called "Big Four" global accountancy firms, which have been the focus of much prior research (e.g., Addison and Mueller, 2015).

Although only a subset of avoidance schemes, marketed schemes themselves come in many guises. As discussed in HM Revenue & Customs (2021), one of the most popular types of scheme – and the tacit focus in this paper – is those used to avoid taxes on labor income, usually referred to as employee benefit trusts in the UK and as foreign trust schemes in the United States. Instead of an employer paying an employee directly, labor income is placed in a trust set up in an offshore tax haven, which then makes loans to the employee. The loans are not taxable and, in practice, are never repaid. Rangers Football Club – Scottish champions 55 times – was recently found to be utilizing such a scheme to pay players and executives (HM Revenue & Customs, 2017). In another example, the Hyrax scheme, which utilized a Jersey-based trust, asked employees to pay a fee of 18 percent of their gross income in return for avoiding UK income taxation (HM Revenue & Customs, 2019). A broader set of disguised remuneration schemes includes paying workers in the form of grants, salary advances, capital payments, credit facilities, annuities, shares and bonuses, or amounts held in a fiduciary capacity. Another popular variant of marketed scheme is micro-captive insurance schemes in which inflated premiums (subsequently deducted against income tax) are paid to an offshore insurance company wholly owed by the insuree. Since 2017, the Internal Revenue Service has contested (and won) three cases before the US Tax Court involving schemes of this type (Government Accountability Office, 2020). A final variant of marketed scheme that we highlight is partnership loss schemes, whereby a partnership is set up that makes an (artificially inflated) loss. The loss is then utilized to shelter other income from tax.[4]

Seemingly for legacy reasons, the economic literature has focused historically more on tax evasion than tax avoidance (Gamannossi degl'Innocenti and Rablen, 2017, herefter GR2017), and more on the demand side than the supply side (Slemrod, 2002, 2004).[5] Our analysis

[4]Inflation of the loss is achieved, for example, by using loans that are circular, or by deferred expenditure, which is never incurred.

[5]In particular, the first economic studies relating to tax compliance (e.g., Allingham and Sandmo, 1972; Yitzhaki, 1974) neglect the possibility of tax avoidance altogether.

addresses both of these imbalances. In particular, we introduce supply-side considerations – relating both to entry and pricing – into the approach to modeling marketed avoidance of GR2017. These authors assume implicitly that tax avoidance technology is supplied perfectly elastically at an exogenously determined level of price, thereby eliminating a meaningful role for the supply side.

On the supply side of the model, would-be promoters make a simultaneous entry and pricing decision. Entry entails the sinking of a fixed cost in, for example, devising a scheme, a cost that can be obviated by not entering.[6] The pricing decision is to choose a form of two-part pricing comprising a minimum fee and a per-dollar price for those clients willing to meet the minimum fee – a structure observed widely in the tax advice industry. The need for a minimum fee arises as promoters incur significant one-off implementation costs associated with setting up complex legal structures (e.g., offshore trusts) when admitting a new client. These costs imply that clients unwilling to pay a sufficiently high fee are unprofitable (Shackelford, 2000).

Relative to the analysis of GR2017, allowing for supply-side considerations has two principal implications. First, the price of avoidance becomes endogenous to the model, thereby importantly altering some comparative statics predictions. For instance, whereas the GR2017 model predicts that all avoiders will decrease their avoidance when the tax authority steps up anti-avoidance activity, in our model the private first-best level of avoidance is, in equilibrium, typically unchanged by marginal increases in anti-avoidance activity. Rather, the effect of additional anti-avoidance activity is soaked up entirely by a reduction in price. As a consequence of this finding, tackling avoidance solely through challenging the legality of schemes in the courts is likely to have less effect on supply than predicted previously. A broader regulatory approach aimed at squeezing the profits from promoting a scheme might instead be needed. To the extent such regulation goes beyond the traditional scope and expertise of tax authorities, this will demand a joined-up approach at the level of government.

The second implication is that, owing to the existence of a minimum fee requirement, not all taxpayers that demand tax avoidance in the model of GR2017 will receive a positive supply. This consideration introduces an extensive margin into the analysis of aggregate avoidance as taxpayers enter and exit the avoidance market endogenously. By contrast, in GR2017, variation in aggregate avoidance arises only at the intensive margin. Indeed, we demonstrate that the effects arising at the extensive margin may dominate those

[6]For treatments of fixed costs of entry that do not focus specifically on marketed tax avoidance, see, for example, Sharkey and Sibley (1993) and Marquez (1997).

at the intensive margin. As one consequence, a non-monotone relationship can hold at the aggregate level between tax rates and tax revenue.

We begin the analysis by examining the demand for tax avoidance for a given minimum fee and per-unit price. We establish the existence of, and characterize, a cut-off level of income above which a taxpayer engages in avoidance and below which a taxpayer is excluded from the market for avoidance by the minimum fee. The set of avoiders can, in turn, be partitioned into those (constrained) taxpayers for whom the minimum fee is binding, and those (unconstrained) taxpayers for whom the minimum fee does not bind.

In the unique Bertrand–Nash equilibrium, conditional on entry by at least one would-be promoter, taxpayers above a cut-off level of income avoid maximally. This outcome is profit-maximizing for promoters, who face price-elastic taxpayer demand for avoidance and low (zero) marginal costs of passing one extra dollar through the scheme once it has been set up (albeit setting up the scheme is costly). The per-unit price that induces full avoidance is a function of the income of the taxpayer. We show how this price can be implemented, despite promoters being assumed not to observe income directly, by allowing price discrimination based on the amount of avoidance purchased.

We analyze the implications of equilibrium outcomes for a range of issues pertinent to both academics and those who make tax policy. We investigate these issues both analytically, and with a parametrized version of the model calibrated to the tax system in the UK. First, we examine how the per-unit price of avoidance varies with income. The answer to this question is endogenous to the structure of income tax. In particular, under progressive taxation, the per-unit price of avoidance is a decreasing function of income. That is, richer taxpayers buy tax avoidance technology on more favorable terms than do poorer taxpayers. Second, we consider the aggregate relationship between tax rates and tax revenue, abstracting from considerations in relation to labor supply. GR2017, who likewise treat labor income as exogenously fixed, predict that raising tax rates must raise tax revenue, yet economic policymakers document the existence of a tax avoidance Laffer curve (Papp and Takáts, 2008; Vogel, 2012). We show that the model can predict a non-monotone relationship between tax rates and tax revenue. In the calibration to the UK, the relationship is found to exhibit both a local maximum (Laffer peak) and minimum (Laffer valley). Such non-monotonicity arises when endogenous entry into tax avoidance as a result of a tax rise causes revenue to fall. Last, we consider the impact of tax progressivity on aggregate avoidance by comparing a progressive tax with a flat tax that implies an identical aggregate tax burden. Holding the tax burden constant in our analysis is important as, with risk-averse taxpayers, income effects do play a role. We find – opposing intuitions sometimes expressed in the literature (e.g., Tanzi and Zee, 2000) – that there is no unidirectional relationship between aggregate avoidance and progressivity. Instead, we find that progressive taxation yields lower expected tax revenue (relative to a flat tax) at sufficiently low levels of tax, but that the opposite result holds at sufficiently high levels of tax.

The only other study we are aware of that has considered marketed avoidance schemes is that of Damjanovic and Ulph (2010, hereafter DU2010). These authors focus on supply-side considerations, with an accordingly simple approach to the demand-side that differs markedly from that proposed here. In particular, following GR2017, we argue, first, that taxpayers are characterized by risk aversion, whereas DU2010 suppose risk neutrality. Risk neutrality induces all-or-nothing (plunging) behavior on the part of taxpayers and rules out a role for income effects. Second, we assume that marketed avoidance is sold at a price per dollar of tax liability reduction, whereas DU2010 suppose that entry to an avoidance scheme is at a fixed one-off price, regardless of the tax liability reduction on offer. Yet, a fixed price is at odds with the interview study, Kantar Public UK (2015), which notes that "fees appear to vary by investment value", as we suppose. Relative to fixed pricing, the two-part pricing we consider is desirable for promoters as it permits greater capture of taxpayer surplus. Last, we suppose that tax avoidance can only be tackled by the tax authority through costly legal challenge, whereas in DU2010 it can only be tackled through costly audit of individual taxpayers (as with tax evasion).[7] There, the tax authority is also assumed to possess the legal authority to fine avoiders, even though they were not ostensibly breaking tax law when entering the scheme. Facets of the present analysis that deviate from both DU2010 and GR2017 include an analysis of entry on the part of would-be promoters, and Bertrand competition with taxpayer search costs (rather than Cournot competition with conjectural variations in DU2010).

The paper proceeds as follows. In Section 2, we develop a formal model of marketed tax avoidance. In Section 3, we analyze aspects of the equilibrium of the model. We conclude in Section 4. Proofs are collected in the Appendix.

2. Model

There is a continuum of taxpayers. Income (wealth), $W \in \mathbb{R}_{++}$, is distributed across taxpayers according to the density function $g(W)$, where $g(W) > 0$ for all W. The associated cumulative distribution we denote by $G(W)$. We consider a fiscal environment in which each taxpayer faces a (exogenous)

[7] Tax authorities in major economies such as the UK and US operate disclosure regimes that legally oblige promoters to notify them of the schemes they market. The role of the tax authority is therefore to study the disclosed schemes, and decide whether they constitute tax planning (in which case no further action is taken) or tax evasion (in which case the scheme is challenged).

tax liability $T \equiv T(W)$ where $T : \mathbb{R}_{++} \mapsto \mathbb{R}_{++}$ is a twice differentiable and strictly increasing function with $\partial T(W)/\partial W \in (0, 1)$ for all $W > 0$ (such that $T(W) < W$) and $\partial^2 T(W)/[\partial W]^2 \geq 0$. Thus, we allow for progressive taxation, as observed in many economies, and the special case of flat taxation. $T(W)$ can be decomposed as $T = tW$, where $t \equiv t(W) \in (0, \partial T(W)/\partial W]$ is the average tax function implied by T.

A taxpayer's true income is not observed by the tax authority. Thus, the taxpayer may desire to avoid an amount of tax $A \equiv A(W) \in [0, T]$. When it is profitable to do so, this desire is facilitated by a set of promoters (firms) that each market a tax avoidance scheme. Finding ways to reduce tax liability in an ostensibly legal manner typically requires a detailed understanding of tax law and a degree of ingenuity; capabilities few taxpayers possess.[8] Remunerating the human capital of the attorneys, accountants, bankers, etc., who perform this activity comes at a (symmetric) cost $\upsilon > 0$. This cost is incurred if a would-be promoter wishes to enter the market, but not if they choose against entering the market in the first place.

As in Diamond (1971), taxpayers search across promoters, hoping to find the best deal. Search continues until the certain (but small) cost of sampling one more promoter outweighs the expected benefit from potentially finding a better deal. Each scheme does not ostensibly break tax law, and is marketed as being legal. We assume, however, that the nature of each scheme is such that the tax authority will deem it tax evasion, and mount a legal challenge. Although the scheme offered by each promoter need not be identical, we make the simplifying assumption that each is of a common type, or exploits a common loophole. Thus, a legal challenge by the tax authority, if upheld, applies to all schemes. In this event, all promoters cease trading and the tax authority is able to seize details of the clients of each promoter. However, promoters may continue to promote their scheme while the legal challenge is in progress. As such, even if the tax authority eventually succeeds in shutting the promoters down, each may walk away with a profit.

Promoters utilize a form of two-part pricing. First, to participate in the scheme of promoter j, a taxpayer must pay at least a minimum fee $\underline{F}_j > 0$. A study that interviews former users of various marketed avoidance schemes in the UK (Kantar Public UK, 2015) finds that respondents encountered minimum fees ranging from £5,000 to £1 million. The presence of the minimum fee implies that, as discussed in Shackelford (2000), a feature of the equilibrium shall be that poorer taxpayers unwilling to pay the minimum fee are excluded from the market for tax avoidance. Second, for those taxpayers willing to pay

[8]People not only have difficulties in understanding tax law and codes, but also show poor knowledge of tax rates and basic concepts of taxation (Blaufus et al., 2015; Gideon, 2017; Stantcheva, 2021).

at least the minimum fee, avoided tax can be purchased at a price per-unit, $p_j \equiv p_j(A) \in (0, 1)$, which can depend upon the quantity of avoidance being purchased. In effect, every dollar of tax avoided is split $(1 - p_j : p_j)$ between the taxpayer and the promoter. Empirically, per-unit prices are found to be up to 0.2 (Committee of Public Accounts, 2013). Accordingly, if the taxpayer chooses promoter j, the total fee payable is given by

$$F_j = \begin{cases} 0 & \text{if } A = 0; \\ \max(\underline{F}_j, p_j(A)A) & \text{otherwise.} \end{cases} \tag{1}$$

The timing of the model is as follows.

Stage 1. Would-be promoters make simultaneously an entry decision (enter or not-enter) and a pricing decision $\{\underline{F}, p(A)\}$.

Stage 2. Conditional on entry, taxpayers search optimally for a promoter, choosing so as to maximize expected utility. The tax authority mounts a legal challenge.

Stage 3. Conditional on entry, the legal challenge of the tax authority is upheld or not upheld.

We proceed to analyze the model by backward induction. As stage 3 involves only a move by nature, however, we pick up analysis of the model at stage 2.

2.1. Stage 2

In stage 2, taxpayers search for a scheme, and avoid optimally within their chosen scheme.[9] We first consider optimal avoidance taking as given the chosen scheme – as characterized by the pair $\{\underline{F}, p(A)\}$.

In choosing avoidance, taxpayers behave as if they maximize expected utility, where utility is denoted by $U(z) = \log(z)$.[10] If a taxpayer does not engage in avoidance, they receive a net disposable income $X \equiv X(W) = W - T$. If, in stage 3, the tax authority's legal challenge is upheld – an outcome that occurs with probability $\phi \in (0, 1)$ – it will observe all clients of affected promoters and has the legal authority to recover the tax, A, which

[9]This is without loss of generality in the present context, which precludes diversification of risk by avoiding via more than one scheme. We return to this point in the conclusion.
[10]Thus, taxpayers have a constant (unit) coefficient of relative risk aversion. We adopt the logarithmic form as it is both tractable analytically and supported empirically (see, e.g., Chiappori and Paiella, 2011).

each such client had sought to avoid. In this event, a taxpayer cannot recover the fee paid to the promoter, a point in keeping with empirical evidence from the UK in Committee of Public Accounts (2013).[11] Thus, the monetary risk associated with legal challenge to the scheme is borne by the taxpayer. Entering a tax avoidance scheme is therefore a risky choice on the part of the taxpayer.[12] Nonetheless, as taxpayers are not ostensibly violating tax law at the time of entering the scheme, the tax authority cannot levy a fine on the avoided tax.

Given the above, the expected utility of a taxpayer is

$$\mathbf{E}(U) = \phi \log(X - F) + [1 - \phi] \log(X - F + A). \tag{2}$$

As indicated in equation (2), a taxpayer's income is $X - F$ when avoidance is unsuccessful and $X - F + A$ when avoidance is successful. As necessary conditions to observe a demand for avoidance $A \in (0, T]$, we make the boundary assumptions

$$p(0) < 1 - \phi \leq \left\{ 1 + \frac{[1 - p(T)]T}{X} \right\} p(T). \tag{3}$$

The left-hand side inequality in equation (3) ensures that the first unit of avoidance is profitable in expectation; this assumption appears innocuous, at least at the present time.

Taxpayers who engage in avoidance can be partitioned into two sets: one set with $W \in \mathcal{U}$ (*unconstrained*) for whom their first-best choice of avoidance, $A_{\mathcal{U}} \equiv A_{\mathcal{U}}(W) \in [0, T]$, meets the minimum fee at equilibrium price p^* ($p^* A_{\mathcal{U}} \geq \underline{F}$); and a set with $W \in \mathcal{C}$ (*constrained*) for whom their first-best choice is infeasible ($p^* A_{\mathcal{U}} < \underline{F}$). The set of constrained taxpayers with $W \in \mathcal{C}$ can itself be bipartitioned as $\mathcal{C} = \mathcal{F} \cup \mathcal{W}$. Taxpayers with $W \in \mathcal{F}$ are the subset of constrained taxpayers, termed *fee-constrained*, for whom $T \geq \underline{F}/p^*$. Such taxpayers choose – as a second-best outcome – to avoid an amount

$$A_1 = \underline{F}/p^* > A_{\mathcal{U}}, \tag{4}$$

which is just sufficient to meet the minimum fee, in preference to not avoiding tax at all. Taxpayers with $W \in \mathcal{W}$ are the subset of constrained taxpayers, termed *wealth-constrained*, for whom $T < A_1$. When avoiding their full tax liability, such taxpayers still do not meet the minimum fee. With the second-best outcome, A_1, infeasible, to participate in the scheme,

[11] Promoters of failed schemes typically go quickly into voluntary liquidation, thereby preventing the recovery of fees.

[12] By contrast, much early literature treats tax avoidance as riskless (e.g., Alm, 1988; Alm et al., 1990).

such taxpayers opt for the third-best outcome $A = T < A_1$, while still paying the minimum fee $\underline{F}$. As a result, they pay a higher implied per-unit price $\underline{F}/T > p(T)$ for avoidance technology. Combining the analysis of the two types of constrained taxpayer above, it follows that the avoidance of such taxpayers will satisfy

$$A = A_C = \min(A_1, T). \tag{5}$$

The difference between the utility when choosing $A = A_C$ and the utility when choosing $A = 0$ we denote by

$$\Delta(W) = \mathbf{E}(U)|_{A=A_C, F=\underline{F}} - \mathbf{E}(U)|_{A=F=0}.$$

$\Delta(W) > 0$ when avoidance $A = A_C$ is preferred to no avoidance. It follows that taxpayers for whom $\Delta(W) \leq 0$ choose $A = 0$ and are said to be *excluded*.

Summarizing, a taxpayer's optimal demand for avoidance is

$$A^*(W) = \begin{cases} A_{\mathcal{U}}(W) & \text{if } W \in \mathcal{U}; \\ A_C(W) & \text{if } W \in C; \\ 0 & \text{otherwise.} \end{cases} \tag{6}$$

The per-unit price $p(A)$, given $A = A^*(W)$ at the optimum, can be written as a direct function of W:

$$p^* \equiv p^*(W) = \begin{cases} p(A^*(W)) & \text{if } W \in \mathcal{U} \cup \mathcal{F}; \\ \underline{F}/T(W) & \text{if } W \in \mathcal{W}. \end{cases} \tag{7}$$

We now characterize the sets $\{\mathcal{U}, \mathcal{F}, \mathcal{W}\}$ at fixed equilibrium quantities $\{\underline{F}, p^*\}$.

Proposition 1. *Consider the taxpayer avoidance decision for given equilibrium quantities* $\{\underline{F}, p^*\}$.

Let W_2 *be the unique* W *for which* $A_{\mathcal{U}}(W_2) = A_1$ *(i.e.,* $W_2 = A_{\mathcal{U}}^{-1}(A_1)$*).*

Let $W_1 \in (0, W_2]$ *be the unique* W *for which* $T(W_1) = A_1$ *(i.e.,* $W_1 = T^{-1}(A_1)$*).*

Let $W_0 \in (0, W_2)$ *be the unique* W *for which* $\Delta(W_0) = 0$ *(i.e.,* $W_0 = \Delta^{-1}(0)$*). Then:*

(i) *if* $W \geq W_2$*, the taxpayer is unconstrained, choosing the first-best level of avoidance,* $A = A_{\mathcal{U}} \in [0, T]$*, given by*

$$A_{\mathcal{U}} = \frac{1}{p^*}\left[1 - \frac{\phi}{1 - p^*}\right] X;$$

(ii) *for* $\Delta(W_1) > 0$, *if* $W \leq W_0$, *the taxpayer is excluded, if* $W \in (W_0, W_1]$, *the taxpayer is wealth-constrained, and if* $W \in (W_1, W_2)$, *the taxpayer is fee-constrained;*

(iii) *for* $\Delta(W_1) \leq 0$, *if* $W \leq W_0$, *the taxpayer is excluded, and if* $W \in (W_0, W_2)$, *the taxpayer is fee-constrained.*

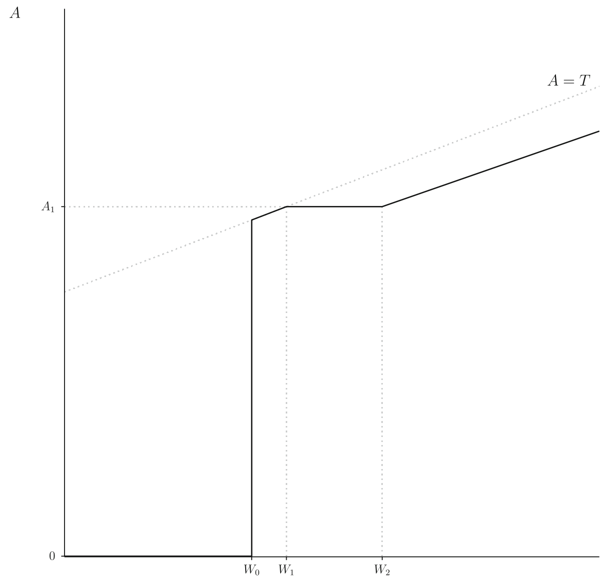
Proposition 1 characterizes the intervals of income for which a taxpayer will be unconstrained, fee-constrained, wealth-constrained, and excluded. Note that its derivation assumes that taxpayers have rational expectations over their equilibrium price, p^*. Thus, for each taxpayer, their expected equilibrium price is p^* and does not change if they deviate by choosing $A \neq A^*(W)$. Also note that, although $W_0 < W_2$ and $W_1 \leq W_2$, there is, in general, no ordering between W_0 and W_1. Rather, it is straightforward to show that the condition $\Delta(W_1) > 0$ in part (ii) of Proposition 1 is equivalent to $W_0 < W_1$, while the condition $\Delta(W_1) \leq 0$ in part (ii) is equivalent to $W_0 \geq W_1$. A further equivalent interpretation of these two cases is that, in part (ii), the marginal constrained taxpayer (at the exclusion margin) is wealth-constrained, whereas in part (iii) the marginal taxpayer is fee-constrained. Accordingly, a taxpayer can never be wealth-constrained in part (iii), implying $\mathcal{W} = \emptyset$. These two cases are depicted in Figure 1: panel (a) illustrates the case in which the marginal taxpayer is wealth-constrained (as in part ii) and panel (b) illustrates the case in which the marginal taxpayer is fee-constrained (as in part iii).

Writing $A^*(W)$ in equation (6) more completely as $A^*(W; \underline{F}, p^*)$, substitution of $A^*(W; \underline{F}, p^*)$ into expected utility in equation (2) defines the indirect expected utility $V(W, \underline{F}, p^*)$ obtained by a taxpayer of income W from choosing a scheme $\{\underline{F}, p(A)\}$. Therefore, among the sample of schemes searched, taxpayers choose the scheme j that maximizes indirect expected utility $V(W, \underline{F}_j, p_j^*)$. Taxpayers – who observe the distribution of the $\{\underline{F}_j, p_j^*\}$ costlessly (though not the individual $\{\underline{F}_j, p_j^*\}$) – search until the expected increment to $V(W, \underline{F}_j, p_j^*)$ from sampling one more promoter falls below a (small) search cost $c > 0$.

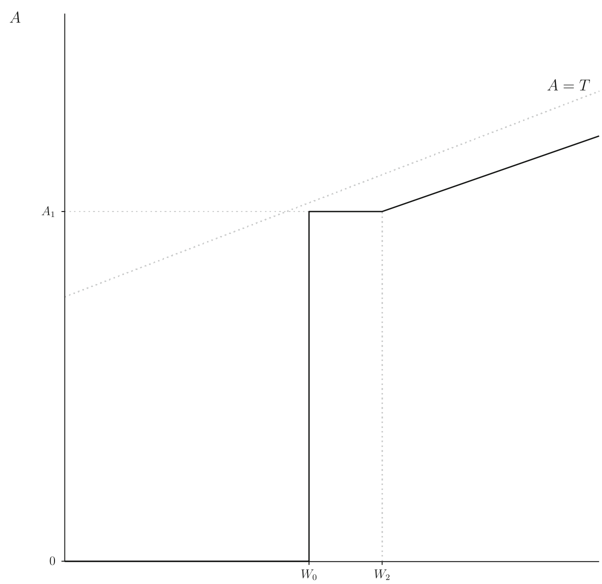
Before continuing, we consider the implications of Proposition 1 for the comparative statics of endogenous parameters. First, we summarize the comparative statics properties of the first-best avoidance $A_{\mathcal{U}}$ in the following remark.

Remark 1. *The avoidance demanded by unconstrained taxpayers,* $A_{\mathcal{U}}$, *is increasing in income,* W, *and decreasing in the probability of the legal challenge being upheld,* ϕ, *and in the equilibrium per-unit price of avoidance,* p^*. $A_{\mathcal{U}}$ *is linear in income under a flat tax, and strictly concave in income under a progressive tax.*

Figure 1. Optimal avoidance demand as a function of income, when the marginal avoider is (a) wealth-constrained and (b) fee-constrained



(a)



(b)

Second, we consider the comparative statics of the threshold incomes $\{W_0, W_1, W_2\}$ in Proposition 1, of which those for W_0 are by far the most significant for the predictions of the model, for it regulates the extensive margin of avoidance.

Lemma 1. *Consider the exclusion threshold income, W_0, such that taxpayers with $W \leq W_0$ do not avoid.*

(i) *W_0 is strictly increasing in the minimum fee, $\underline{F}$, and the probability of successful challenge, ϕ; and weakly increasing in response to an upward shift in the per-unit price schedule $p(A)$.*

(ii) *If $W_0 < W_1$ there exists a critical value of the average tax rate t_0,*

$$t_0 = 1 - \frac{\underline{F}}{[1-\phi]W_0} \in \left(\frac{1}{2}, 1\right),$$

such that W_0 decreases in the average tax rate for $t(W_0) < t_0$, and increases in the average tax rate for $t(W_0) > t_0$. Otherwise $(W_0 \geq W_1)$, W_0 increases in the average tax rate.

The effects of $\{\underline{F}, \phi\}$ on W_0 in part (i) of Lemma 1 are intuitive as both variables make avoidance less attractive to the marginal avoider. The effect of an upward shift in the price schedule $p(A)$, is slightly more complex, however. When $W_0 < W_1$ the marginal avoider (with income just above W_0, i.e., $W \downarrow W_0$) is wealth-constrained, with demand $A = T$. As, per equation (7), wealth-constrained taxpayers do not face the market price schedule $p(A)$, but rather the second-best price $\underline{F}/T$, incremental shifts in $p(A)$ do not alter the avoidance choice of the marginal avoider. In contrast, when $W_0 \geq W_1$, the marginal avoider is fee-constrained with demand $A = A_1$. In this case, an upward shift in $p(A)$, at constant A, induces an equivalent upward shift in p^*, thereby making avoidance less attractive.[13]

Part (ii) of Lemma 1 considers how the extensive margin of avoidance, as regulated by W_0, responds to a proportional increase in taxes (a shift in the average tax function). As in the lemma, we focus here on the case $W_0 < W_1$, which shall hold in equilibrium. In this case, an increase in taxes has competing income and substitution effects on the marginal (wealth-constrained) avoider. The substitution effect, which acts to increase avoidance, arises as an increase in tax decreases the effective per-unit price $\underline{F}/T(W_0)$. However, the taxpayer

[13]The comparative statics of $\{W_1, W_2\}$ are, in respect of sign, those of W_0, with the exceptions that both W_1 and W_2 increase strictly (rather than weakly) with an upward shift in the per-unit price schedule $p(A)$, and both unambiguously increase with a proportional increase in taxes. As these results are derived straightforwardly, we omit a proof.

becomes poorer, which generates an income effect. This income effect acts to decrease avoidance, for log utility implies decreasing absolute risk aversion. The lemma clarifies that, for average tax rates in the (realistic) range below one-half, the substitution effect dominates. Above one-half, however, there exists a threshold point above which it is instead the income effect that dominates.

2.2. Stage 1

Having completed our analysis of the demand side of the market for avoidance, which arises in stage 2 of the model, in this subsection we now turn to supply-side considerations, which arise in stage 1.

There are $N > 1$ would-be promoters. If a would-be promoter does not enter, it receives a payoff of zero. If, alternatively, a would-be promoter chooses to enter the market in stage 1, then they must bear a fixed entry cost $\upsilon > 0$. Also, as motivated in the Introduction, a promoter will, in stage 2, face a (symmetric) one-off set-up (implementation) cost, $\tau > 0$, for each client that they admit to their scheme. As such, when output is increased at the extensive margin (by taking on new clients), the set-up cost acts as a variable cost. But, when output is increased at the intensive margin, the set-up cost acts as a fixed cost. Owing to this set-up cost, any taxpayer only willing to pay a fee $F < \tau$ is loss-making for the promoter. Hence, it is gainful for promoters to utilize a minimum fee provision, as supposed in the model. Once the scheme has been set up for a client, however, the marginal cost to promoters associated with wiring one extra dollar between entities within the scheme is negligible.[14] Accordingly, we set the marginal cost of avoidance at the intensive margin to zero.

Conditional on entry, let the set of taxpayers who, in stage 2, choose to avoid with promoter j be denoted Θ_j. This set can be further partitioned – by constrained and unconstrained taxpayers – as $\Theta_j = \Theta_{\mathcal{U}j} \cup \Theta_{Cj}$. The avoidance purchased from promoter j by an unconstrained taxpayer is denoted $A_{\mathcal{U}j}$. Therefore we can write the payoffs to would-be promoter j as

$$\pi_j = \begin{cases} 0 & \text{if not-enter,} \\ \underline{F}_j|\Theta_{Cj}| + \mathbf{E}_{\Theta_{\mathcal{U}j}}(p_j^* A_{\mathcal{U}j})|\Theta_{\mathcal{U}j}| - \tau|\Theta_j| - \upsilon. & \text{if enter,} \end{cases} \tag{8}$$

[14] As discussed in Humphrey et al. (2003), businesses in financially developed economies typically either pay a per-transaction fee (that is independent of the size of the transaction, implying a zero marginal cost of increasing the amount by one unit) or qualify for free transactions in return for either meeting a bank minimum deposit balance requirement or for obtaining payment services tied to lower (higher) interest rates on deposits (loans).

where $|z|$ denotes the cardinality of z. Promoters observe the distribution of income, but cannot observe directly the income of a particular taxpayer.[15] Despite this, in equilibrium, the price schedule $p^*(A)$ may nonetheless discriminate taxpayers by income. The intuition for this point goes back to equation (7), which relates price schedule $p^*(A)$ to income via the optimal avoidance relation $A = A^*(W)$ in equation (6). Thus, using the chain rule in equation (7), we have

$$\frac{\partial p^*(W)}{\partial W} = \begin{cases} \dfrac{\partial p^*(A^*)}{\partial A^*}\dfrac{\partial A^*(W)}{\partial W} & \text{if } W \in \mathcal{U} \cup \mathcal{F}, \\ -\underline{F}\dfrac{\partial T(W)}{\partial W}/[T(W)]^2 < 0 & \text{if } W \in \mathcal{W}. \end{cases}$$

This implies: (i) that for unconstrained and fee-constrained taxpayers, the per-unit price will move systematically with W whenever $\partial p^*(A^*)/\partial A^* \neq 0$ and $\partial A^*(W)/\partial W \neq 0$; and (ii) that the per-unit price is necessarily decreasing in W for wealth-constrained taxpayers. In DU2010, by contrast, price is not conditioned on A, thereby ruling out a link to W.

2.3. Equilibrium

In stage 1, each would-be promoter j chooses $\{\underline{F}_j, p_j(A)\}$ to maximize profit in (8), taking as given the $\{\underline{F}_j, p_j(A)\}$ of the other promoters. In the absence of taxpayer search costs, a case we rule out, a promoter gains the entire market by undercutting the others. In this case, a would-be promoter would only enter in stage 1 with positive probability if they expected to be a monopolist in stage 2. To allow for multiple entrants we suppose positive search costs, following Diamond (1971).

Proposition 2. *Define the net revenue in stage 2 of the representative promoter as*

$$\mathcal{R}(N) = \frac{1}{N}\left\{\underline{F}[G(W_2) - G(W_0)] + \int_{G(W_2)}^{1} p^*(W)T(W)\mathrm{d}G(W) - \tau[1 - G(W_0)]\right\}.$$

1. *If fixed costs υ are sufficiently small, i.e., $\upsilon \leq \mathcal{R}(N)$, then there is a unique Bertrand–Nash equilibrium in which the following will hold.*

[15]Treating income as private appears the most prudent assumption. A promoter may solicit this information within the client–advisor relationship, but there is no guarantee that clients will disclose truthfully.

(i) *In stage 1, all N would-be promoters choose to enter, and in stage 2, each earns a non-negative profit $\pi_j = \pi \geq 0$.*

(ii) *Taxpayers search for a single $\{\underline{F}_j, p_j(A)\}$. Those with $W > W_0$ avoid maximally, and those with $W \leq W_0$ do not avoid:*

$$A^*(W) = \begin{cases} T(W) & \text{if } W > W_0; \\ 0 & \text{otherwise;} \end{cases}$$

where $W_0 < W_1$.

(iii) *Each promoter sets a symmetric minimum fee $\underline{F} > \tau$, satisfying*

$$\underline{F} = \tau + \frac{G(W_2) - G(W_0)}{(\partial W_0/\partial \underline{F})g(W_0)}.$$

(iv) *Each promoter sets a symmetric per-unit price schedule, $p^*(A)$, given by*

$$p^*(A) = 1 - \frac{A - X(T^{-1}(A)) + \sqrt{[A - X(T^{-1}(A))]^2 + 4\phi A X(T^{-1}(A))}}{2A},$$

such that the implied per-unit price paid by an unconstrained taxpayer with income $W \geq W_2$ is

$$p^*(W) = 1 - \frac{T(W) - X(W) + \sqrt{[T(W) - X(W)]^2 + 4\phi T(W)X(W)}}{2T(W)}$$
$$< 1 - \phi.$$

2. *If $\mathcal{R}(N) < \upsilon \leq \mathcal{R}(1)$, then there exists an $\tilde{N} \in [1, N)$ such that $\upsilon = \mathcal{R}(\tilde{N})$. In the unique equilibrium, would-be promoters in stage 1 enter with probability $\tilde{N}/N$ and do not enter with probability $[N - \tilde{N}]/N$. Entrants make an expected profit of zero in stage 2. Parts (ii)–(iv) of part 1 continue to hold in stage 2.*

3. *If $\upsilon > \mathcal{R}(1)$, no entry occurs in stage 1 and aggregate tax avoidance is zero.*

Proposition 2 characterizes the equilibrium of the model. As first noted by Diamond (1971), it coincides with the joint profit maximizing outcome among the stage 1 entrants (i.e., the outcome that would be chosen by a monopoly promoter). This arises as, when taxpayers only search one price (part ii), promoters neither gain clients from a unilateral price reduction nor lose clients from a unilateral price increase. Given that clients already avoid maximally (part ii), a unilateral price reduction does not induce higher sales. Rather, the same quantity of avoidance is sold at a lower price, causing profit to fall. A unilateral price increase reduces the avoidance sold per client. As avoidance demand is price-elastic (see Claim A1 in the proof of the proposition), this effect on quantity outweighs the effect of the higher price, causing profit to fall.

Part 1 of Proposition 2 considers the case in which fixed costs are sufficiently low (or anti-avoidance efforts sufficiently weak) that, if all N would-be promoters enter, each is profitable in the equilibrium played out in stage 2. As we discuss later, this is arguably the best description of the present situation in most developed economies. Part 1(i) clarifies that, as stage 2 is profitable with N promoters, all would-be promoters will enter.

Part 1(ii) characterizes equilibrium search. The intuition is straightforward. Suppose the equilibrium set of $\{\underline{F}_j, p_j^*(A)\}$ is symmetric across promoters. Given this, taxpayers optimally search for just one price. As, *a priori*, each promoter is searched by a taxpayer with equal probability, the $\{\underline{F}_j, p_j^*(A)\}$ will be symmetric, consistent with the initial supposition.[16] Part 1(ii) also characterizes optimal avoidance behavior. Taxpayers with $W \leq W_0$ are excluded from tax avoidance. Taxpayers with $W > W_0$ avoid maximally, yet still fall into two categories: taxpayers with $W \in (W_0, W_2)$ are wealth-constrained, avoiding all tax at a constrained optimum, whereas taxpayers with $W \geq W_2$ also avoid all tax, but as a first-best choice.[17] The set of fee-constrained taxpayers is empty as W_1 and W_2 are coincident. Maximal avoidance for $W > W_0$ is profit maximizing owing to a combination of monopoly pricing under price-elastic demand, the absence of marginal costs, and perfect price discrimination. This "corner" equilibrium is, thus, distinct from the "interior" market equilibria that characterize outcomes in industries with (higher) marginal costs. In the context of the tax avoidance industry, such a corner equilibrium fits the empirical observation that promoters place lower bounds on the fee, but do not constrain supply by imposing upper bounds. For example, in the context of employee benefit trust schemes, it is standard practice for the full employment income to be paid through the scheme, rather than having part of earnings paid as untaxed loans, and part paid as taxable wages. The principal exception to this point arises only when some intrinsic

[16] Diamond (1971) gives an adjustment process that converges to the Bertrand–Nash equilibrium considered here. Under this process, therefore, the equilibrium is stable with respect to shocks.

[17] The existence of a threshold income below which taxpayers are excluded from the tax avoidance market chimes with prior results in Cowell (1990) and DU2010. In our approach, however, exclusion arises from the cost structure of the promoter, whereas in prior literature it is a consequence of an assumed fixed fee for avoidance.

feature of tax law bounds the amount of tax it is feasible to avoid through a given scheme.

Parts 1(iii) and 1(iv) of Proposition 2 give equilibrium pricing, $\{\underline{F}, p^*(A)\}$. In the Bertrand–Nash equilibrium, these are set at the joint profit maximizing level among the stage 1 entrants. Importantly, however, as avoidance is already maximal at the joint profit maximizing $\{\underline{F}, p^*(A)\}$, it will necessarily remain unchanged at the maximal level at any lower pricing level. As the analyses of the next section shall rely on the comparative statics of price, but not its level, our findings are therefore robust to a range of pricing outcomes. Part 1(iii) gives the symmetric equilibrium minimum fee: it is increasing in the per-client set-up cost, τ, and satisfies $\underline{F} > \tau$. This inequality implies that promoters exclude some profitable clients in order to harvest greater profits from the (constrained) taxpayers they do take. Part 1(iv) characterizes equilibrium pricing, both the price schedule, $p^*(A)$, that implements the profit-maximizing outcome $A = T$, and the resulting relationship between price and income, $p^*(W)$. The latter is derived as the solution to $A_{\mathcal{U}}(p^*, W) = T(W)$. To then see that this outcome is induced by $p^*(A)$, note that $p^*(W)$ and $p^*(A)$ coincide if and only if $A = T$ such that, given $p^*(A)$, the first-best choice is always $A = T$.

Part 2 of Proposition 2 considers the case in which the equilibrium in stage 2 cannot support profitably all N would-be promoters, but can profitably support a monopoly promoter. In this case there is some intermediate number of promoters $\tilde{N}$, $1 \leq \tilde{N} < N$, that can sustain a zero-profit equilibrium in stage 2. A would-be promoter is, therefore, indifferent between choosing not-enter or enter if it expects $\tilde{N}$ promoters to compete in stage 2. This forms the basis of a mixed strategy for entry in which would-be promoters enter with probability $\tilde{N}/N < 1$. Part 3 of Proposition 2 considers the case in which fixed costs are sufficiently high (or enforcement sufficiently strict) that a would-be promoter will not enter even if it expects to be a monopolist in stage 2. Thus, there is no entry.

3. Analysis

3.1. Price of avoidance

We first consider the comparative statics properties of the equilibrium per-unit price.

Proposition 3. *The equilibrium per-unit price, $p^*(W)$, has the following properties.*

(i) *For wealth-constrained taxpayers, $p^*(W)$ is independent of the probability of successful legal challenge, ϕ, and a decreasing function of income, W.*

(ii) *For unconstrained taxpayers, $p^*(W)$ is decreasing in the probability of successful legal challenge, ϕ. Under a flat income tax, $p^*(W)$ is independent of W, while, if income taxes are progressive, richer taxpayers pay a lower per-unit price than do poorer taxpayers, i.e.,*

$$\frac{\partial p^*(W)}{\partial W} \leqq 0 \Leftrightarrow \frac{\partial t(W)}{\partial W} \geqq 0.$$

Part (i) of Proposition 3 follows immediately from equation (7), where $p^*(W) = \underline{F}/T(W)$ for wealth-constrained taxpayers. We therefore focus this discussion on part (ii) of the proposition, which considers unconstrained taxpayers. The first result in part (ii) clarifies that the price of avoidance falls when tax authority enforcement increases. We take up the ramifications of this finding in Section 3.2. The second result in Proposition 3 is that the per-unit price is (weakly) decreasing in income, as a function of the structure of income tax. Specifically, under a flat tax, all unconstrained taxpayers face an identical per-unit price. Under progressive taxes, however, the per-unit price faced by unconstrained taxpayers is a decreasing function of income. Our finding under progressive taxation chimes with the sentiments of Cross and Shaw (1981) that tax avoidance is especially attractive to the rich. It also accords with DU2010, in which per-unit prices are decreasing, albeit not as a function of the structure of income taxes.

We illustrate $p^*(W)$ in Figure 2(a) for a parametrized version of the model calibrated to the UK. We approximate the UK marginal tax rate structure, as described in Institute for Fiscal Studies (2021), by

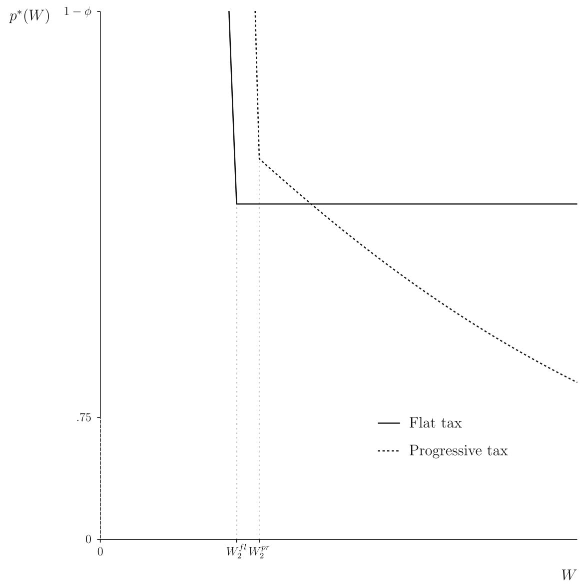
$$\frac{\partial T(W)}{\partial W} = c_0[1 - e^{-\gamma W}], \tag{9}$$

with $c_0 = 0.45$ and $\gamma = 0.00004$.[18] So as to examine the mediating influence of tax structure, we also include in Figure 2 the per-unit price schedule under a flat tax that generates an identical aggregate tax burden to the progressive tax structure implied by equation (9). To do this, we specify $g(W)$ to be lognormal, $\log(W) \sim N(\mu, \sigma^2)$. According to Office for National Statistics (2020), mean (median) income in the UK (2017–2018) is £34,210 (£28,418). Calibrating to these statistics gives $\mu = 10.25$ and $\sigma = 0.61$.[19]

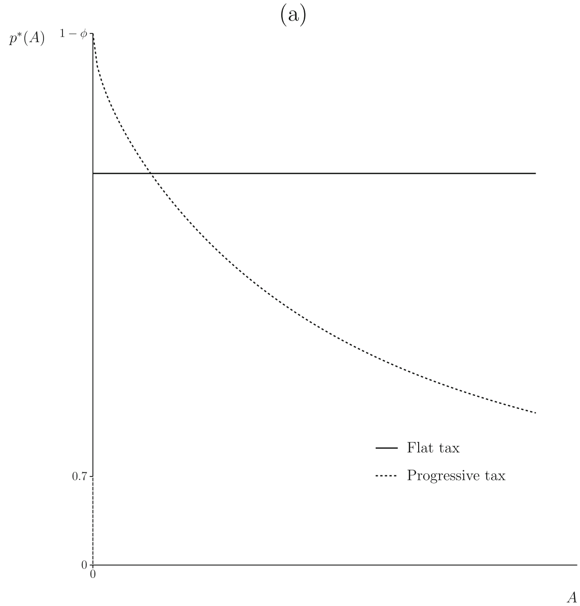
In Figure 2(a), note that, per equation (7), the price function is kinked around $W_2 (= W_1)$, applying to the set of unconstrained taxpayers above the

[18]The tax function corresponding to equation (9) is given by $T(W) = c_0[W - [1 - e^{-\gamma W}]/\gamma]$.
[19]The remaining parameter values are $\phi = 0.15$ and $\tau = 4800$. Except where noted, the qualitative findings of this section are insensitive to variation of these values. The implementation files for all figures in the paper are available at https://github.com/dgdi/marketed_tax_avoidance.

Figure 2. Equilibrium per-unit price of tax avoidance (a) as a function of income, W, and (b) as a function of avoidance, A



(a)



(b)

kink and to the set of wealth-constrained taxpayers below the kink. As W_2 is endogenous to the structure of income tax, it differs slightly between the flat tax (W_2^{fl}) and progressive tax (W_2^{pr}) cases.

In respect of the level of the per-unit price, Figure 2(a) illustrates that a burden-neutral move from a flat tax to a progressive tax can have complex effects, increasing the per-unit price faced by avoiders below a threshold level of income, but decreasing the per-unit price faced by avoiders above this threshold income. This finding is driven by the income effect induced by a change in the level of taxation. A shift to progressive taxation (beginning from a flat tax) lowers the tax burden of some poorer avoiders, who thereby become richer. Richer taxpayers are less risk averse, and so value avoidance more highly, causing the price to rise. For the richest of avoiders, however, the tax burden is increased by a shift to progressive taxation, reversing the previous argument, and therefore resulting in a lower per-unit price.

As a final consideration, Figure 2(b) illustrates the equilibrium $p^*(A)$. Comparing $p^*(A)$ with $p^*(W)$ in Figure 2(a), the schedules are qualitatively similar (at least above the kink). This is to be expected, as the only qualitative source of difference between the schedules arises from non-linearity (if any) in the structure of income tax.

3.2. Effectiveness of anti-avoidance activity

The finding that, in equilibrium, avoidance is maximal at incomes above the exclusion threshold has important implications for enforcement. To discuss this, it is helpful to decompose the effects on avoidance of a shift in one of the exogenous parameters of the model into a direct or "mechanical" effect, which arises when holding fixed the set of excluded taxpayers, and an indirect or "behavioral" effect, which arises from endogenous entry-to and exit-from the avoidance market.

We consider the (three-phase) transition of aggregate avoidance outcomes as enforcement efforts – summarized by the probability, ϕ, that the avoidance schemes are challenged successfully – are increased. First, consider a sufficiently low level of enforcement at which – as in part 1 of Proposition 2 – these efforts are insufficient to restrict entry (for a given level of fixed cost). This case seems to us the closest to present reality. In the UK, for instance, Committee of Public Accounts (2013) speaks of promoters "running rings" around HMRC, the British tax authority, while National Audit Office (2012) concludes that "[. . .] HMRC cannot currently demonstrate that [the present] level of litigation provides an effective deterrent". In this case, as equilibrium avoidance, T, is independent of ϕ, the direct effect of an increase in legal enforcement is exactly zero. This arises as, in response to an increase in ϕ, price adjusts downwards per Proposition 3 such that quantity $A = T$ is unaffected. The result is very different to that in GR2017, where price is assumed fixed, such that an increase in ϕ is reflected entirely in quantity (negatively).

For tax authorities, this finding carries the sobering implication that investments to raise the probability of effective legal challenge, ϕ, will impact aggregate avoidance only through the indirect effect. The indirect effect, however, acts only on avoiders who are marginal with respect to W_0 (which is increasing in ϕ per Lemma 1). The richest taxpayers, those who are supra-marginal with respect to W_0, are therefore untouched by the indirect effect, and yet avoid the most tax.

Continuing with the transition, at higher levels of enforcement, the revenues of the representative promoter fall sufficiently that part 2 of Proposition 2 applies. In this case, the tax authority's enforcement efforts do now deter entry at the margin. Importantly, however – noting that the equilibrium pricing $\{\underline{F}, p^*(A)\}$ in Proposition 2 is independent of N – the reduction in the number of entrants does not in itself exert a downwards force on aggregate avoidance. Instead, those would-be promoters that do enter enjoy a higher market share. The direct effect continues to be zero and the only effect on aggregate avoidance is via the indirect effect.

It is only when ϕ becomes sufficiently high that the marketed tax avoidance industry ceases to be viable commercially – even when comprising of a monopoly promoter – that a discrete fall of aggregate avoidance to zero occurs. This is the case given in part 3 of Proposition 2.[20] If, as we suspect, achieving the no-entry equilibrium in part 3 of Proposition 2 through raising ϕ alone may be infeasible operationally, then anti-avoidance strategy might need to look beyond recourse to legal challenges. In particular, broader regulatory measures that act to increase promoter's fixed costs, υ, such as requiring costly operating and/or entry permits, would help to choke the supply-side. Alternatively, a form of financial transactions tax, especially one that penalized transactions with tax havens (as discussed in, e.g., Kenen, 1996), could also raise the marginal costs to promoters of passing money through entities in tax havens. The widespread imposition of such taxes remains controversial, however, and unlikely in the short term. It is apparent that both these policy responses lie outside the traditional remit and expertise of tax authorities. Accordingly, a wider government approach might be required.

The analysis above conveys the importance of considering anti-avoidance policy in a framework that addresses both sides of the avoidance market. Nonetheless, as a final consideration, we discuss informally how some possible generalizations of the analysis might alter the results of this section.

[20]Note that, owing to positive fixed costs $\upsilon > 0$, at the critical value of ϕ above which part 3 applies, and entry does not occur, sales (avoidance) remain positive. Thus, tax authorities need not choke entirely the demand for avoidance to shut the industry down.

In particular, what perturbations to the model might dislodge the corner solution for avoidance, such that the direct effect would be positive? One such perturbation would be if avoidance demand were not globally price elastic, for then profit maximization may entail offering a price consistent with an interior level of avoidance. We establish that avoidance demand is price elastic under the plausible case of logarithmic utility, but one can find preferences, albeit arguably less plausible, such that this would no longer hold. A second possibility would be if there were not an invertible equilibrium mapping between avoidance and income, for then promoters would be unable to implement the price that induces maximal avoidance as a first-best outcome. Such a case would arise if, for example, taxpayer avoidance demand were a function of multidimensional heterogeneity, unobserved by promoters. In this case, conditional on the unobserved factors, the optimal price schedule $p^*(A)$ would induce some avoiders to avoid maximally as a constrained outcome, while others would avoid at an interior maximum. The avoidance of this latter group would respond to enforcement measures at the margin. A further possibility would be if marginal costs were high enough to offset the preference for low-price and high-quantity induced by price-elastic demand. In this case, profit maximization might again involve setting price to induce demand below the maximal level. As discussed above, however, assuming higher marginal costs would only be descriptive if policymakers can indeed take measures to raise such costs.

3.3. Tax revenue and the structure of income tax

In the analysis of GR2017, in which tax avoidance is supplied perfectly elastically at an exogenously determined price, a proportional increase in taxes always lowers individual avoidance at the intensive margin; this is a finding related closely to the well-known Yitzhaki puzzle (Yitzhaki, 1974). The result is a pure income effect: an increase in tax makes taxpayers poorer and thereby more risk averse (under decreasing absolute risk aversion). Yet, such a finding is at odds with a widespread belief among policymakers of a tax avoidance Laffer curve (e.g., Papp and Takáts, 2008; Vogel, 2012). This belief entails that, as tax rates increase, there exists a level beyond which tax revenue ceases to increase, owing to offsetting increases in avoidance. The income effect discussed above also applies in our model when tax is increased, at least for unconstrained taxpayers. We show here, however, that, because of endogenous variation in the set of excluded taxpayers, a form of tax avoidance Laffer curve may nevertheless emerge from our analysis.

The equilibrium expected tax revenue of the tax authority is given by

$$\mathbf{E}(R) = \int_0^{G(W_0)} T(W)\mathrm{d}G(W) + \phi \int_{G(W_0)}^{1} T(W)\mathrm{d}G(W),$$

where the first term is the (certain) revenue from excluded taxpayers, and the second term is the expected revenue from avoiders. Consider a proportional increase in taxes, that is, a pivot anticlockwise in the tax function $T(W)$ around the origin. The comparative statics effects of such a proportional increase on expected revenue we write – in a mild abuse of notation – as $\partial\mathbf{E}(R)/\partial T$. (This is shorthand for rewriting $T(W)$ as $[1+\varepsilon]T(W)$, differentiating with respect to ε, and then taking the limiting value of the derivative as $\varepsilon \to 0$.) Thus, we obtain

$$\frac{\partial\mathbf{E}(R)}{\partial T} = \underbrace{\mathbf{E}(R)}_{\text{direct effect}} + \underbrace{[1-\phi]\frac{\partial W_0}{\partial T}g(W_0)T(W_0)}_{\text{indirect effect}}. \tag{10}$$

The direct effect in equation (10) is positive, but the indirect effect is the sign of the response of W_0 to a proportional increase in taxes, denoted in equation (10) by $\partial W_0/\partial T$. The implication of Lemma 1, part (ii), is that a proportional increase in taxes decreases W_0 when taxes are sufficiently low (in particular, when the average tax rate at income W_0 is less than one-half), but increases W_0 at higher levels of tax.[21] Accordingly, starting from a sufficiently high level of taxation, a proportional increase in taxes assuredly raises additional revenue. But, when starting from a sufficiently low level of taxation, the sign of $\partial\mathbf{E}(R)/\partial T$ hinges on the relative magnitudes of the opposing direct and indirect effects.

Define a metric of the aggregate level of taxation as

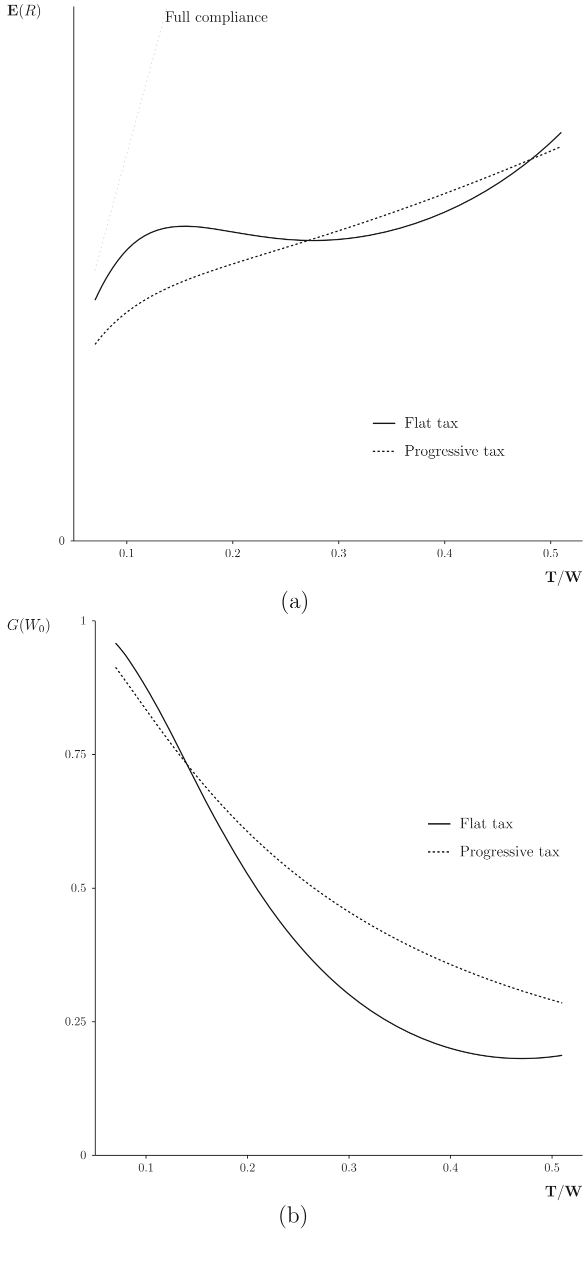
$$\frac{\mathbf{T}}{\mathbf{W}} = \frac{\int T(W)\mathrm{d}G(W)}{\int W\mathrm{d}G(W)},$$

that is, the average tax payment as a proportion of average income. Under a flat tax, this measure coincides with the constant marginal tax rate. In Figure 3(a), we depict expected revenue at different levels of taxation $(\mathbf{T}/\mathbf{W})$, focusing on the empirically plausible range $\mathbf{T}/\mathbf{W} \in (0, 0.5)$. As previously, we draw expected revenue under the progressive schedule for the UK implied by equation (9) and under a flat tax that generates an identical aggregate tax burden.[22] In Figure 3(b), which we include for interpretability, shows the

[21] Strictly speaking, $\partial W_0/\partial T$ in equation (10) includes the effect of equilibrium adjustments in $\underline{F}$, whereas the comparative statics result in Lemma 1(ii) treats $\underline{F}$ as exogenous. As will become apparent in Figure 3(b), however, the equilibrium variation in $\underline{F}$ does not alter qualitatively the message of Lemma 1(ii) on the interval we consider.

[22] The two tax functions in the figure are of the form $T(W) = c_0[W - (1 - e^{-\gamma W})/\gamma]$ in the progressive case and $T(W) = c_1 W$ in the flat tax case. Points in the figure correspond to $c_1 \in [0.07, 0.9]$. At each c_1 evaluated, we solve numerically for the c_0 that equates the aggregate tax burden under $g(W)$.

Figure 3. Relationship between the level of taxation and (a) expected revenue and (b) the exclusion threshold income level, W_0 (as measured by $G(W_0)$, its position in the income distribution)



location of the exclusion threshold, W_0, in the distribution of income as a function of the tax level $\mathbf{T}/\mathbf{W}$.

In Figure 3(a), it is seen that the model is consistent with a non-monotone relationship between tax rates and (expected) tax revenue. Under a flat tax, the direct effect initially dominates, causing revenue to increase in $\mathbf{T}/\mathbf{W}$, reaching a Laffer "peak" at around $\mathbf{T}/\mathbf{W} = 0.15$. Above the Laffer peak, however, revenue begins to fall in a region where instead the indirect effect dominates. The direction and magnitude of the indirect effect is driven by the endogenous variation of W_0 in panel (b). It is seen that W_0 is decreasing in $\mathbf{T}/\mathbf{W}$ throughout almost all the figure, indicating that the indirect effect is almost everywhere negative on the interval depicted. Entry into avoidance is at its greatest where $G(W_0)$ falls most steeply, corresponding with the approximate interval $\mathbf{T}/\mathbf{W} \in (0.15, 0.3)$ in which tax revenue is decreasing in panel (a). At $\mathbf{T}/\mathbf{W} = 0.3$, however, we see in panel (b) that the rate of endogenous entry into the avoidance market has already begun to slow. Thus, remarkably, the waning indirect effect is once again outweighed by the direct effect, resulting in a Laffer "valley" (Sturm and Sztutman, 2021) at approximately $\mathbf{T}/\mathbf{W} = 0.3$ in panel (a). The pure (i.e., constant labor supply) effect of avoidance on the relationship between tax rates and tax revenue in the UK calibration is, therefore, to favor low and high levels of taxation over intermediate levels at which revenue falls as taxes rise.

Another feature of Figure 3(a) is that the non-monotone pattern of tax revenues observed under the flat tax is not present under the progressive tax schedule. This finding can be traced to the observation that, in the progressive case, W_0 is less sensitive to changes in the level of taxation (panel (b)). This weaker indirect effect is explained, in turn, by noting that, in the progressive case, the incidence of an increase in taxes is disproportionately on the rich, who are supra-marginal with respect to the exclusion threshold W_0. It is also worth clarifying that, even in the case of a flat tax, a monotone relationship between tax rate and tax revenue emerges if the probability of effective legal challenge, ϕ, is raised sufficiently above the level $\phi = 0.15$ used to draw the figure. Whether the model predicts non-monotone effects, therefore, depends importantly on the level of legal enforcement and on the structure of income taxes.

A further consideration in respect of the effects of tax progressivity is that there is no straightforward relationship between revenue loss due to tax avoidance and the progressivity of income tax. In Figure 3(a), although both tax schedules imply the same aggregate tax burden, the progressive tax generates a higher expected revenue (lower avoidance) at intermediate levels of taxation, but the opposite applies at low and high levels of taxation. This finding is driven by the interplay of two effects with regard to the revenue raised from excluded taxpayers (i.e., the first component of expected revenue in equation (10)). Evidently, it is favorable to aggregate compliance if the (fully compliant) group of excluded taxpayers bear a disproportionately high share of the tax burden. Yet, as the excluded are located in the lower tail of the distribution of income, the opposite holds under progressive taxation. This effect explains the lower revenues under progressive taxation in Figure 3(a) at low levels of taxation. However, there is a second effect that runs counter to this first effect: at higher tax levels, the set of excluded taxpayers is larger under progressive taxation, which acts to raise compliance. This is seen in panel (b), where W_0, having been lower in the progressive case at low levels of taxation, switches to being higher (relative to the case under a flat tax) at higher levels of taxation. The predominance of this second effect accounts for the higher revenues under progressive taxation at intermediate tax levels. To account, finally, for the lower revenues under progressive taxation seen at high levels of taxation, note that the second effect discussed above begins to wane at the far right-hand side of panel (b), such that the first effect once again dominates.

The tax policy literature sometimes intuits that avoidance will necessarily be higher under progressive taxation, as such taxation places a disproportionate burden on the rich (Tanzi and Zee, 2000). Our finding of a complex relationship between tax avoidance and tax progressivity casts doubt on this intuition. Instead it echoes DU2010, who also report a complex relationship. Complexity in the DU analysis arises as progressivity not only makes tax avoidance more attractive to the wealthy at a fixed price but also makes the price of tax avoidance higher. When the former effect dominates, progressivity increases tax avoidance and thereby reduces revenue, whereas the opposite occurs when the latter effect dominates. By contrast, in our analysis, tax avoidance is cheaper for the wealthy (in a per-unit sense) under progressive taxation (Figure 2(a)). The potential for complexity instead arises from the nature of the endogenous adjustments in the exclusion income threshold W_0.

4. Conclusion

Tax avoidance is thought to be responsible for significant losses of tax revenue in developed countries. In recent years, the potential scale of revenue losses due to avoidance has been magnified greatly by the emergence of mass-marketed schemes targeted at the middle (rather than the top) of the income distribution. In this study, we added supply-side considerations – in respect of both entry and pricing – to the demand-side model of marketed avoidance schemes in GR2017. We draw attention to an important consequence of introducing supply-side considerations: the price of avoidance becomes endogenous. In respect of anti-avoidance activity (in the form of challenging the legality of avoidance schemes), we find that the marginal effect of an increase in enforcement is felt entirely in price for all but marginal avoiders. Thus, models that treat the price level as exogenously fixed importantly overstate the ability of tax authority anti-avoidance activity to drive down observed levels of tax avoidance. The policy implication of this finding is that a focus on challenging the legal basis of avoidance schemes might be insufficient to eliminate profit opportunities from promoting marketed schemes (and thereby deter entry). A broader regulatory approach to raising promoter's costs of doing business may be called for, which might require expertise beyond that found currently in tax authorities.

A second feature we have sought to highlight is the potential importance for aggregate outcomes of the (endogenously determined) threshold of income below which taxpayers are excluded from the tax avoidance market. Exclusion arises from a minimum fee arrangement, which, in turn, is driven by the existence of a set-up cost per client entered into a scheme. Endogenous variation in the exclusion threshold as, for example, taxes are raised and lowered, or made more or less progressive, reflects competing income and substitution effects. These effects are not considered fully – or, in some cases, at all – in prior research, yet can drive potential non-monotonicities in the relationship between tax rates and tax revenue, and complicate the implications of tax progressivity. In particular, increased tax progressivity is not an automatic driver of increased tax avoidance. Thus, to the extent that economic policymakers may have been reticent about increasing tax progressivity on the grounds that the hoped-for reductions in inequality might be largely or wholly reversed by endogenous tax avoidance responses, our findings tend to undermine such reticence.

Future research seeking to extend the modeling framework might consider the implications of allowing taxpayers to use multiple differentiated avoidance schemes as a form of diversification against the risk that any one scheme is declared illegal. In equilibrium, one would anticipate a form of "efficient frontier" for avoidance schemes in which riskier schemes offer higher expected returns. In such an environment, it might be interesting also to endogenize the nature of tax authority enforcement, such that the tax authority chooses optimally which schemes to challenge, given a resource constraint. We hope the present contribution will stimulate such research developments.

Appendix

Proof of Proposition 1:

(i) For an unconstrained taxpayer, we have $F = p^*A$ from equation (1), and so expected utility in equation (2) is written as

$$\mathbf{E}(U) = \phi \log(X - p^*A) + [1 - \phi] \log(X + [1 - p^*]A). \qquad \text{(A1)}$$

Under rational expectations, p is fixed at its equilibrium value. Therefore, differentiating expected utility with respect to A, we obtain the first derivative:

$$\frac{\partial \mathbf{E}(U)}{\partial A} = \frac{[1 - p^* - \phi]X - p^*[1 - p^*]A}{[X - p^*A]\{X + [1 - p^*]A\}}. \tag{A2}$$

Setting equation (A2) equal to zero and solving for A yields

$$A_{\mathcal{U}} = \frac{1 - \phi - p^*}{p^*[1 - p^*]}X. \tag{A3}$$

For an unconstrained taxpayer, it must hold that $A_{\mathcal{U}} > A_1$, where A_1 is defined in equation (4). As the left-hand side is increasing at least linearly in W and the right-hand side is constant, there exists a unique $W = W_2$ such that $A_{\mathcal{U}}(W_2) = A_1$. Thus, $W > W_2 \Leftrightarrow A_{\mathcal{U}}(W) > A_1$, where the right inequality holds as $W_2 \geq A_{\mathcal{U}}(W_2) = A_1$. The first-best solution in equation (A3) therefore holds for $W \geq W_2$.

(ii) Let $\underline{W} = T^{-1}(\underline{F}) > 0$. Then $\Delta(\underline{W}) = -\phi[\log(X) - \log(X - \underline{F})] < 0$. As $\Delta(W_1) > 0$, continuity ensures that there exists one or more points $W_0 \in (\underline{W}, W_1)$, which is a subinterval of $(0, W_1)$, such that $\Delta(W_0) = 0$. To see the uniqueness of W_0, note that, for $W \in (0, W_1)$,

$$\frac{\partial \Delta}{\partial W} = \frac{[1 - p^*]A_C[A_C - A_{\mathcal{U}}] + [A_1 - A_C][W - p^*T - \underline{F}]}{X[X - \underline{F}][X + A_C - \underline{F}]} p^* \frac{\partial X}{\partial W} + \frac{1 - \phi}{W - \underline{F}} \frac{\partial A_C}{\partial W} > 0. \tag{A4}$$

The sign of equation (A4) holds for the following reasons.

(a) For Δ to be well defined, the term $\log(X - \underline{F})$ must be well defined, which implies $X - \underline{F} > 0$. Then, also, $X + A_C - \underline{F} > X - \underline{F} > 0$. Further, as $W - p^*T = X + [1 - p^*]T \geq X$, it must hold that $W - p^*T - \underline{F} \geq X - \underline{F} > 0$.

(b) $A_C \geq A_{\mathcal{U}}$, per the respective definitions in equations (5) and (A3).

(c) $A_1 \geq A_C$ as either $A_C = A_1$ $(W > W_1)$ or $A_C = T$ $(W \leq W_1)$, in which case $W \leq W_1$ implies $T \leq A_1$.

(d) $\partial A_C/\partial W \geq 0$.

(e) $\partial A_C/\partial W \geq 0$, $A_C - A_{\mathcal{U}} \geq 0$, and $A_1 - A_C \geq 0$ cannot all be zero simultaneously.

It follows from equation (A4) that W_0 is unique and $\Delta(W) \gtrless 0 \Leftrightarrow W \gtrless W_0$. As $\Delta(W_1) > 0$ and $\partial\Delta/\partial W > 0$ from equation (A4), it holds that

$\Delta(W)|_{W \geq W_1} > 0$. Thus, the constraint for participation in the avoidance market is met on this interval. A taxpayer for whom $W \in (W_1, W_2)$ is therefore fee-constrained. As $\Delta(W_1) > 0$, it must be that $W_0 < W_1$. There is therefore a non-empty interval $W \in (W_0, W_1]$ on which a taxpayer is wealth-constrained. If $\Delta(W) \leq 0$, as occurs for $W \leq W_0$, then the constraint for participation in the avoidance market is not met. Thus, a taxpayer for whom $W \leq W_0$ is excluded.

(iii) We have $\Delta(W_1) \leq 0$. Also, we know $\mathbf{E}(U)|_{A=A_1, W=W_2} > \mathbf{E}(U)|_{A=0, W=W_2}$ because $A = A_1$ is the first-best choice of A at $W = W_2$. Hence $\Delta(W_2) = \mathbf{E}(U)|_{A=A_1, W=W_2} - \mathbf{E}(U)|_{A=0, W=W_2} > 0$. It follows, by continuity, that there exists one or more points $W_0 \in [W_1, W_2)$ such that $\Delta(W_0) = 0$. By equation (A4), W_0 must be unique. Also by equation (A4), $\Delta(W) > 0$ for all $W \in (W_0, W_2)$, so a taxpayer for whom $W \in (W_0, W_2)$ is fee-constrained. A taxpayer for whom $W \leq W_0$ is excluded. This follows on the interval $W \in [W_0, W_1]$ from $\partial\Delta/\partial W > 0$, and on the interval $W \in [0, W_0)$ from $\Delta(W_1) \leq 0$ and $\partial\Delta/\partial W > 0$. □

Proof of Remark 1: Using the definition of $A_{\mathcal{U}}$ in Proposition 1, we have

$$\frac{\partial A_{\mathcal{U}}}{\partial W} = \frac{A_{\mathcal{U}}}{X}\left[1 - \frac{\partial T}{\partial W}\right] > 0;$$

$$\frac{\partial A_{\mathcal{U}}}{\partial p} = -\frac{1}{p^*}\left[A_{\mathcal{U}} + \frac{\phi X}{[1-p^*]^2}\right] < 0;$$

$$\frac{\partial A_{\mathcal{U}}}{\partial \phi} = -\frac{X}{p^*[1-p^*]} < 0.$$

□

Proof of Lemma 1:

(i) If $W_0 < W_1$, then, for an arbitrary exogenous variable z, we have

$$\frac{\partial W_0}{\partial z} = -\left.\frac{\partial\Delta/\partial z}{\partial\Delta/\partial W}\right|_{W=W_0}.$$

As $\partial\Delta/\partial W > 0$ from equation (A4), it follows that the sign of $\partial W_0/\partial z$ is the opposite of the sign of $\partial\Delta/\partial z$. We have

$$\frac{\partial\Delta}{\partial p^*} = \frac{[1-\phi](\partial A_C/\partial p^*)}{X + A_C - \underline{F}} \leq 0; \tag{A5}$$

$$\frac{\partial\Delta}{\partial\phi} = \log(X - \underline{F}) - \log(X + A_C - \underline{F}) < 0; \tag{A6}$$

$$\frac{\partial \Delta}{\partial \underline{F}} = -\frac{p^* A_{\mathcal{U}}[A_1 - A_C] + [A_C - A_{\mathcal{U}}]X}{X[X - \underline{F}][X + A_C - \underline{F}]}[1 - p^*] - \frac{[1-\phi][(1/p^*) - (\partial A_C / \partial \underline{F})]}{W - \underline{F}} < 0. \tag{A7}$$

It follows from equations (A5)–(A7) that $\partial W_0/\partial p \geq 0$, $\partial W_0/\partial \phi > 0$, and $\partial W_0/\partial \underline{F} > 0$.

(ii) If $W_0 < W_1$, the effect of a pivot of the tax function is given by

$$\frac{\partial \Delta}{\partial T} \equiv \lim_{\varepsilon \to 0} \frac{\partial \Delta}{\partial \varepsilon}\bigg|_{T=[1+\varepsilon]T} = \frac{[1-\phi]X - \underline{F}}{X[X - \underline{F}]} T \gtreqless 0 \Leftrightarrow [1-\phi]X - \underline{F} \gtreqless 0.$$

If $t(W_0) = t_0 = 1 - \underline{F}/\{[1-\phi]W_0\}$, then $[1-\phi]X(W_0) - \underline{F} = 0$. As X is decreasing in T, we have $[1-\phi]X(W_0) - \underline{F} \gtreqless 0$ as $t(W_0) \lesseqgtr t_0$ and so $\partial\Delta/\partial T \gtreqless 0 \Leftrightarrow t(W_0) \lesseqgtr t_0$. This in turn implies (from part i) that $\partial W_0/\partial T \gtreqless 0 \Leftrightarrow t(W_0) \gtreqless t_0$. To prove that $t_0 > 1/2$ note, by strict concavity, that

$$\log(X(W_0) - \underline{F} + [1-\phi]T(W_0)) > \phi \log(X(W_0) - \underline{F}) + [1-\phi]\log(W_0 - \underline{F}) = \log(X(W_0)).$$

Hence, $X(W_0) - \underline{F} + [1-\phi]T(W_0) > X(W_0)$, which is equivalent to $[1-\phi]T(W_0) - \underline{F} > 0$. As $X \gtreqless T \Leftrightarrow t \lesseqgtr 1/2$, if $t(W_0) \leq 1/2$, then $[1-\phi]X(W_0) - \underline{F} \geq [1-\phi]T(W_0) - \underline{F} > 0$. It must therefore be that $1 - \underline{F}/[1-\phi]W_0 > 1/2$ when $[1-\phi]X(W_0) - \underline{F} = 0$. If $W_0 \geq W_1$, the effect of a pivot of the tax function is given by

$$\frac{\partial \Delta}{\partial T} \equiv \lim_{\varepsilon \to 0} \frac{\partial \Delta}{\partial \varepsilon}\bigg|_{T=[1+\varepsilon]T} = -\frac{\partial \Delta}{\partial W} < 0.$$

□

Proof of Proposition 2:

(1) Assume all would-be promoters enter. Following the insights of Diamond (1971), when search costs are positive, the unique Bertrand equilibrium for N symmetric firms selling a homogeneous product implements the joint profit maximizing price. We now establish the joint profit maximizing price, which will be that arising under a monopoly. Under monopoly, we have

$$|\Theta_{jC}| = G(W_2) - G(W_0); \tag{A8}$$

$$\mathbf{E}_{\Theta_{j\mathcal{U}}}(p_j A_j)\,|\Theta_{j\mathcal{U}}| = \int_{G(W_2)}^{1} p^* A_{\mathcal{U}}(p^*)\,\mathrm{d}G(W). \tag{A9}$$

Using equations (A8) and (A9) in equation (8), the effect of a marginal increase in $\{\underline{F}, p^*\}$ on monopoly profit is therefore given by

$$\frac{\partial \pi}{\partial \underline{F}} = G(W_2) - G(W_0) + [\tau - \underline{F}]\frac{\partial W_0}{\partial \underline{F}} g(W_0); \tag{A10}$$

$$\frac{\partial \pi}{\partial p^*} = -[\underline{F} - \tau]\frac{\partial W_0}{\partial p^*} g(W_0) + \int_{G(W_2)}^{1} [1 - \varepsilon_{A_{\mathcal{U}},p^*}(W)] A_{\mathcal{U}}(W) \mathrm{d}G(W). \tag{A11}$$

Here,

$$\varepsilon_{A_{\mathcal{U}},p^*}(W) \equiv -\frac{p^*}{A_{\mathcal{U}}(W)} \frac{\partial A_{\mathcal{U}}(W)}{\partial p^*} > 0$$

is the price elasticity of demand for avoidance (of unconstrained taxpayers with income W). Setting $\partial \pi / \partial \underline{F} = 0$ in equation (A10) and rearranging for $\underline{F}$, we obtain the expression in part 1(iii) of the proposition. Noting that $\underline{F} > \tau$, the first term in equation (A11) takes the sign of $-\partial W_0 / \partial p^* \leq 0$ (Lemma 1). It follows that, if $\varepsilon_{A_{\mathcal{U}},p^*}(W) > 1$, then $\partial \pi / \partial p^* < 0$. We now prove this.

Claim A1: At each level of income, W, the demand for avoidance of an unconstrained taxpayer is price elastic, $\varepsilon_{A_{\mathcal{U}},p^*}(W) > 1$.

Proof: From the definition of $A_{\mathcal{U}}$ in Proposition 1, we have

$$p^* A_{\mathcal{U}} = X - \frac{\phi}{1 - p^*} X.$$

It follows that $\partial [p^* A_{\mathcal{U}}] / \partial p^* = -\phi X / [1 - p^*]^2 < 0$. But, noting that $\partial [p^* A_{\mathcal{U}}] / \partial p^*$ is also written (by the product rule) as

$$\frac{\partial [p^* A_{\mathcal{U}}]}{\partial p^*} = A_{\mathcal{U}} [1 - \varepsilon_{A_{\mathcal{U}},p^*}],$$

for $\partial [p^* A_{\mathcal{U}}] / \partial p^* < 0$, it must be that $\varepsilon_{A_{\mathcal{U}},p^*} > 1$. □

It follows from Claim A1 that, at price levels consistent with $A_{\mathcal{U}} < T$, a monopoly promoter can always increase profit by lowering the price, i.e., $\partial \pi / \partial p^* < 0$. Once, however, the price is sufficiently low that $A_{\mathcal{U}} = T$, further reductions in price cease to increase avoidance. It follows that a monopoly promoter sets the price to just induce full avoidance: $A_{\mathcal{U}} = T$. Note that $A_{\mathcal{U}} = T$ implies $W_1 = W_2$ and $W_0 < W_1$. Thus, taxpayers with income $W \in (W_0, W_2]$ are wealth-constrained and taxpayers with income $W > W_2$ are unconstrained. Both the wealth-constrained and unconstrained taxpayers avoid all tax, hence part 1(ii) of the proposition. The equilibrium price function $p^*(A)$ must induce the choice $A = T$ in preference to any other choice $A < T$ for all unconstrained taxpayers. Thus, from equation (A2), it must hold that

$$\frac{[1 - p^*(A) - \phi]X - p^*(A)[1 - p^*(A)]A}{[X - p^*(A)A]\,\{X + [1 - p^*(A)]A\}} = 0 \Leftrightarrow A = T. \qquad \text{(A12)}$$

When $p^*(A)$ is of the form in part 1(iv) of the proposition, the left-hand side of equation (A12) is written in the form

$$\frac{[1 - p^*(A) - \phi][X(W) - X(T^{-1}(A))]}{[X - p^*(A)A]\,\{X + [1 - p^*(A)]A\}}.$$

Thus, we have $\partial \boldsymbol{E}(U)/\partial A \gtreqless 0 \Leftrightarrow W \gtreqless T^{-1}(A) \Leftrightarrow T \gtreqless A$. It follows that $A = T$ is the unique optimal choice. Setting $A_{\mathcal{U}} = T$ in equation (A3) and then solving for p^*, we obtain the expression for $p^*(W)$ in part 1(iv) of the proposition (the other quadratic root does not lie in the unit interval). $p^*(W) < 1 - \phi$ as it is straightforward to show that $p^*(W) < 1 - \phi \Leftrightarrow -4\phi[1 - \phi]T^2 < 0$. To be consistent with the initial supposition that all would-be promoters enter, we require the additional restriction that, with N promoters, the representative promoter is profitable ($\pi \geq 0$) when pricing is optimal. This restriction can be written as $\upsilon \leq \mathcal{R}(N)$, as given in the proposition.

(2) If $\upsilon > \mathcal{R}(N)$, then, with N promoters, the stage 2 equilibrium yields profits $\pi < 0$. Thus, a pure strategy for entry cannot be part of equilibrium. If $\upsilon \leq \mathcal{R}(1)$, then there exists an $\tilde{N} > 1$ such that $\mathcal{R}(\tilde{N}) = \upsilon$. Accordingly, if would-be promoters each enter with probability $\tilde{N}/N$, each is indifferent in expectation between choosing not-enter, or choosing enter and then making zero profit.

(3) If $\upsilon > \mathcal{R}(1)$, then not-enter is preferred even when a would-be promoter expects to operate in stage 2 as a monopolist. Accordingly, no would-be promoter will enter. □

Proof of Proposition 3:

(i) Immediate from $p^*(W) = \underline{F}/T(W)$.

(ii) First, we establish the sign of $W - 2Tp^*$. To do this, we rewrite the expression for p^* in Proposition 2 as

$$T + X - 2Tp^* = \sqrt{[T - X]^2 + 4\phi TX}.$$

Noting that $T + X - 2Tp^* = W - 2Tp^*$, this implies that

$$W - 2Tp^* = \sqrt{[T - X]^2 + 4\phi TX} > 0.$$

Then, applying the implicit function theorem to the expression for $p^*(W)$ in Proposition 2, we obtain

$$\frac{\partial p^*}{\partial \phi} = -\frac{X}{W - 2Tp^*} < 0;$$
$$\frac{\partial p^*}{\partial W} = -\frac{W[1 - (p^*)^2 - \phi]\partial t/\partial W}{W - 2Tp^*}. \tag{A13}$$

The expression for $\partial p^*/\partial W$ in equation (A13) takes the sign of $-\partial t/\partial W$, as $1 - (p^*)^2 - \phi > 1 - p^* - \phi > 0$. Hence, $\partial p^*/\partial W \leqq 0 \Leftrightarrow \partial t/\partial W \geqq 0$. □

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