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Abstract

This study investigates the contagious nature of tax avoidance by examining how narratives affect tax avoiding behavior. We adapt the idea of narrative economics indicating that individuals' actions are stimulated by stories that spread within a society. We employ two types of infection models to theoretically investigate how tax avoidance schemes spread over time and vanish eventually consistent with patterns known from epidemiology. We find that general tax avoidance can persist even if its expected outcome is negative, while specific tax avoidance schemes might vanish even though their expected outcome is positive. We find empirical support for the predicted dissemination of narratives related to both general and specific tax avoidance schemes in google n-grams. Finally, we show that dissemination of specific tax avoidance schemes is attenuated by anti-narratives in (social) media. Our findings help to understand how tax avoidance spreads, under what conditions anti-avoidance measures can effectively curb tax avoidance and point towards the crucial role of transparency of enhanced enforcement by visible narratives.

JEL: *H26, C73, K34*
Keywords: *tax avoidance, tax evasion, epidemiology, contagion, SIS-model, SIR-model, n-grams*

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1. Introduction

We study how narratives affect tax avoiding behavior. We adapt the idea of narrative economics (Shiller 2017) to the phenomenon of tax avoidance. We apply two types of infection models to theoretically investigate how tax avoidance schemes spread over time and eventually vanish after being exposed to anti-avoidance regulation or reputational pressure. In line with patterns known from the spreading and extinction of diseases in epidemiology our theoretical models indicate that general tax avoidance might persist even if the expected outcome is negative. Further, we show that *specific* tax avoidance schemes can vanish even though they generate a positive expected tax benefit. We find empirical support for the predicted dissemination of avoidance narratives in google n-grams.[1] Finally, we investigate whether the dissemination of specific tax avoidance schemes is attenuated by anti-narratives distributed, for example, via (social) media. These finding are interesting as developing effective strategies to fight tax avoidance crucially depends on understanding the nature of tax avoidance and how—conditional on this nature—anti-avoidance measures have to be designed.

Tax avoidance and evasion are highly emotional topics and depend on social norms and networks, therefore, rational calculus may take a back seat to feelings and social currents (e. g., Pickhardt/Prinz 2014; Christian/Alm 2014; Coricelli/Rusconi/M. C. Villeval 2014). Prior research concludes that one's own individual behaviour is strongly influenced by the behaviour of the group to which one identifies (for an overview see Alm 2012; Alm 2019). Hence, social interaction theory, network effects and non-monetary drivers such as social pressure have to be taken into account. In this vein, agent-based models have been used to study imitative behavior and the impact of social norms and provide explanations

[1] This approach is related to C. D. Romer/D. H. Romer (2010) who use narratives such as presidential speeches and Congressional reports to identify different motivations for tax policy actions.

for the observed variation in tax compliance over time and regions (e. g., Mittone/Patelli 2000; Davis/Hecht/Perkins 2003; Hokamp/Pickhardt 2010; Diller/Lorenz/Meier 2020). Although these approaches provide theoretical explanations for the role of social interaction and in this respect serve as a foundation for our research, they do not study the dissemination of tax avoidance schemes. Also, empirical evidence on the dissemination of tax avoidance schemes is scarce. A notable exeption is Alstadsæter/Kopczuk/Telle (2019), who show that tax avoidance schemes spread within Norwegian family networks.

Hence, we take a step further and investigate tax avoidance[2] as social narratives. We build on Shiller (2017) and expect that tax avoidance evolves similar as a disease. To examine this pattern we use an approach well-known from epidemiology. We interpret general tax avoidance as a narrative which resembles a desease that does not create (permanent) immunity (susceptible-infectious-susceptible [SIS] model) and, thus, tax avoidance is carried by a time-invariant population share. By contrast, we assume that specific avoidance schemes are not used again if they turn out to be unsucessful and thus resemble a desease that creates (permanent) immunity (susceptible-infected-recovered [SIR] model). We back up our theoretical model by studying the evolution of the frequency of associated n-grams in the google books corpus.

The economics of tax evasion are a prominent topic in theoretical public finance literature (for an overview, see Slemrod/Yitzhaki 2002). Mayshar (1991) provides a generalization of the well-known Allingham/Sandmo (1972)-model by formulating the tax payable as a function of the taxpayers' income, their tax avoidance effort and anti-avoidance regulation chosen by the government. Slemrod (2001) specifies this tax function

[2]For simplicity, we do not distinguish explicitly between tax avoidance and tax evasion but refer uniformly to tax avoidance in the following.

by assuming a linear tariff and linear tax savings as a result of tax avoidance. However, tax avoidance has received lesser attention than explicitly illegal activities (tax evasion).[3]

Diller/Lorenz (2015) build on this literature and study the tax sheltering behavior of taxpayers with uncertain taxable income and the tax authority's response in a game theoretic setting. They capture tax uncertainty as motivated by Kaplow (1998).

Specifying prior literature, we acknowledge that the outcome of tax avoidance is inherently stochastic: Taxpayers have to incur costs, i. e. invest in searching acitivities for finding loopholes. Tax avoidance results are typically uncertain since tax avoidance schemes can be challenged (partially or fully) by the fiscal authorities.[4]

To integrate social interaction effects, we employ epidemic dissemination. Our approach is motivated by literature on social network effects. The respective theoretical literature can be roughly divided into two streams. First, one stream that focuses on social pressure towards conforming behavior using analytical models (e. g. Myles/Naylor 1996; Fortin/Lacroix/M.-C. Villeval 2007), agent-based models (e. g. Mittone/Patelli 2000; Davis/Hecht/Perkins 2003; Diller/Lorenz/Meier 2020) or econophysics models (e. g. Zaklan/Westerhoff/Stauffer 2009; Pickhardt/Seibold 2014). Second, a stream of literature focuses on the effects of social learning (e. g. Hokamp/Pickhardt 2010; Lorenz 2019). Using an agent-based model, Hokamp/Pickhardt (2010) assume imitative taxpayers who check whether tax evasion is successful among their neighbors, and, adapt their behavior accordingly. Their main finding is that under specific conditions the size of the share of inherently honest taxpayers has a considerable impact on overall compliance. Lorenz (2019) uses evolutionary game theory to account for social interaction effects; he studies

[3]For an overview covering both models on tax evasion and tax avoidance and a detailed description of the approaches taken by Mayshar (1991) and Slemrod (2001) see Slemrod/Yitzhaki (2002).

[4]The general anti-avoidance regulations introduced by Mayshar (1991) in our model are represented by mean and variance of the normal distribution, which can be altered by the government by making changes to the law, e.g., by introducing anti-avoidance regulations, or to the tax framework, e.g., by strenghtening tax enforcement.

the evolution of tax avoidance within a population, where the profit from avoidance (determined by the strength of anti-avoidance regulations) depends on the population share of avoiders. If the government adjusts the strictness of anti-avoidance regulation with a time lag, the share of avoiders oscillates over time.

By contrast, we do not focus on dynamic adaption processes but employ a more detailed setting of tax avoidance. We build on the narrative economics concept introduced by Shiller (2017). Individuals are expected to base their behavior on stories ("narratives"), the spread of which is modeled using epidemiological methodology.[5] While this concept resembles social learning, it emphasizes the fact that individuals do not only adapt behavior that was beneficial for their peers, or is expected to be beneficial for themselves. Rather, theory suggests, that it is the very story that drives individuals to adapt a particular behavior. In the sense of this approach, tax avoiders are considered "infected" individuals. If an "infected" individual meets a "healthy" taxpayer the latter gets infected with a certain probability. If, ex post, it turns out that the tax avoidance investment was not profitable, i. e. the cost of tax avoidance exceeds the resulting tax savings, the taxpayer will refrain from tax avoidance.

Most related to our paper is the approach presented by Davis/Hecht/Perkins (2003). They also use an SIS-like model to describe the aggregate behavior of a population of taxpayers. They consider "honest", "evading" and "susceptible" taxpayers that are prone to two types of social influence: one the one hand, evaders trigger before-honest taxpayers to become susceptible to tax evasion.[6] On the other hand, an increasing share of honest taxpayers boosts a social norm of fidelity that causes evaders to become honest again. The function indicating the strength of this social norm depends in an S-shape

[5]Comparable approaches have been used to describe herd behavior in financial markets (Lux 1995).

[6]Therefore, within the notation of Davis/Hecht/Perkins (2003), somehow oddly, susceptible taxpayers are *not* the ones prone to infection. Taxpayers get "susceptible" *after* having been infected.

on the proportion of honest taxpayers. Therefore, by assumption, with an increasing number of honest taxpayers, at a certain point, there is a rather sudden switch to a strong social pressure towards honesty. Besides that, Davis/Hecht/Perkins (2003) assume an exogenous audit probability that causes an inflow from the share of evaders to the share of honest taxpayers as well as an exogenous probability that a susceptible taxpayer starts evading. It turns out that there exist situations where a decrease in enforcement initially has only a small effect on the behavior of a predominantly honest population until, at a certain point, the population shifts to a high evasion state, while a subsequent small increase in enforcement does not restore the initial "honest" state. This result, however, is largely driven by the authors' assumption of an S-shaped influence of population-wide honesty.[7]

While our model also relies on epidemiological methodology as is the framework proposed by Davis/Hecht/Perkins (2003), our approach differs in four key aspects. First, we omit the interim stage between infection and actual behavioural change. As the transition from the "ready-to-evade" to the "actually-evade" state is determined by an exogenously given parameter in their model, we expect only little qualitatively new insights. As consequence and to maintain the possibly to disentangle the complex forces at work, we decided to keep the model simple in this respect. Second, we replace the audit probability with a probability that tax avoidance was not successful as derived from a simple calculus. This allows us to perform ceteris paribus analyses on the effects of changing mean and variance of avoidance activities. The latter can, e. g., be interpreted as tax code and tax framework complexity (Hoppe et al. 2019) which to some extent can be shaped by the government. Third, we distinguish between temporary and permanent

[7]The authors discuss this property. As a consequence, and also to implement randomness and micro foundation, they supplement their paper with an agent-based simulation. Notice, that sudden shifts in population-wide behavior are also observed in so-called "critical mass models" (i. e., individuals require more than one exposure to become infected), see Dodds/Watts (2005).

immunity (as explained below). Finally, we follow the narrative economics approach by omitting the exogenous pressure towards conformity.

We distinguish three settings: First we assume that taxpayers can contract tax avoidance several times and thus, by assumption, do not get "immune". This setting depicts the situation of general tax avoidance (e. g., by means of using a tax consultant for overall tax avoidance strategies). It can also be thought of as an aggregated, long-term view: If taxpayers had been unsuccessful using a specific avoidance scheme (see below) they might, however, later get convinced by peers that a new scheme is promising. Our model implies that general tax avoidance can persist even if its expected outcome is negative. In this case, the prevalence of tax avoidance increases if the result is less predictable, i.e., if the variance of tax savings increases. Abstracting from other parameter changes, the prevalence of general tax avoidance is expected to be constant over time. To back up this prediction we use the corpus of google books and we show that the frequency of n-grams related to general tax avoidance indeed is relatively constant over time.

Second, we study taxpayers getting immune after experiencing the tax authority challenge their tax avoidance activities and in turn experiencing unsuccessful tax avoidance. This setting depicts specific avoidance schemes: Once a taxpayer discovers that a specific scheme does not pay off (e. g., because it is not accepted by the tax authority or because the tax benefits come at disproportionally high implementation costs), they will refrain from employing this specific scheme again (but, maybe, another scheme, see above). Theoretically, we predict that such specific schemes vanish eventually, even if their expected outcome is positive. Again, investigating the frequency of n-grams related to prominent tax schemes (e.g., "Gift Aid with no real gift", "Stripped bond tax avoidance scheme", "Plan Green—car benefit scheme", etc.) over time, we find support for the predicted pattern.

Third, we show that individuals may not only refrain from using specific avoidance schemes after having experienced a negative outcome, but—probably even more important—if they catch another story that discourages the usage of the respective model. Such "anti-narratives" can be constituted by media coverage on specific avoidance schemes, which triggers fear of detection or social shame. For example, this applies to media coverage on "LuxLeaks", "Panama Papers", or "Paradise Papers". As another example, starting 2006, German Authorities acquired data containing information on German tax evaders that was leaked by Liechtenstein and Swiss bankers. In the aftermath of an intense medial discourse on this subject, self-disclosures increased dramatically in Germany. We show that such "anti-narratives" reduce the maximum number of taxpayers employing a specific avoidance scheme and accelerate the decrease in tax avoidance over time.

We make two key contributions. First, we contribute to the existing literature by showing how a narrative economics approach applied to tax avoidance combined with a simple model of tax uncertainty helps to explain the spreading of tax avoidance. We provide explanations for differences in general tax avoidance (persists despite of anti-avoidance measures) and specific tax avoidance schemes (vanish without governmental intervention eventually). Second, showing that the frequency of the respective narratives in the google books corpus reflects the theoretically expected results, we provide support for our theoretical model on how media coverage can help to attenuate tax avoidance which opens further avenues for future research in this field. Our findings help to understand tax avoidance as a contagious social phenomenon, the conditions under which anti-avoidance measures are promising tools to attenuate contagion and highlight the crucial role of tax enforcement transparency by visible communication strategies.

In Section 2 we develop an analytical model of tax avoidance. We then extend our model to incorporate social contagion effects in Section 3 for both general and specific tax avoidance schemes and compare our theoretical predictions with anti-avoidance narratives in google book n-grams. In Section 4 we summarize and discuss our results.

2. Probability of Tax Avoidance Failure

We assume that it is possible to reduce one's tax burden by exploiting either tax loopholes or discretion in the interpretation of complex regulations. The search for both tax loopholes and special regulations that provide leeway for tax avoidance is associated with a cost c modeled as a fraction of income before taxes. c can be thought of as the opportunity cost of studying the tax code or of hiring a professional tax consultant.[8] Investing in tax avoidance results in tax savings of $\theta\tau y$, where y is the income before tax, τ is the tax rate, and θ is the fraction of the tax payment that can be saved due to avoidance activities. After taxes, a taxpayer receives the following net return:

$$\Gamma = y(1 - \tau - c + \theta\tau). \tag{1}$$

A comparable (though more general) approach is made by Mayshar (1991), who's tax function—i. e., the tax payable—depends positively on anti-avoidance regulations adopted by the government, and by Weisbach (2002), who discusses anti-avoidance doctrines, the strength of which can be chosen by the government. In our approach, the extent of tax savings, θ, is modeled as a random variable; we assume θ to be normally

[8]Having a linear cost structure is a logical consequence of our assumption that tax avoidance is an all-or-nothing decision, c. f. footnote 9.

distributed with mean μ and variance σ^2. Both mean and variance depend on actions taken by the government. I. e., the government can alter the tax law or tax procedures (tax environment) to increase or decrease tax avoidance possibilities and increase or decrease tax uncertainty. This way of explicitly modelling the impact of changes in the tax environment acknowledges the growing empirical understanding on the different dimensions of tax complexity (e. g. Hoppe et al. 2019).

Modelling tax avoidance as an all-or-nothing decision is a direct consequence of the notion of a narrative suggested by Shiller (2017). Hence, engaging in tax avoidance, is not a mere consequence of rational choice-based decisions but also of societal network effects such as contagion by narratives. Moreover, this approach allows for studying situations in which tax avoidance is not expected to be beneficial (and, therefore, would not be conducted by risk-averse taxpayers in rational choice-based models).[9]

Tax avoidance is (ex post) not beneficial iff $\Gamma \leq y(1-\tau) \iff \theta \leq \frac{c}{\tau}$. Given that θ is normally distributed, this happens with probability $\eta \equiv F\left(\frac{c}{\tau}|\mu, \sigma^2\right)$, where F is the cumulative distribution function of the normal distribution. This probability η c. p. increases with increasing costs c and decreasing tax rate τ.

3. Epidemic Model of Tax Avoidance with Narratives

Consider a total number of N taxpayers, A_t of whom engage in tax avoidance at time t. Whenever an avoiding taxpayer meets a non-avoiding taxpayer there is a certain probability of "infection", meaning that the before non-avoiding taxpayer also starts to avoid. This probability is denoted by κ. We assume that every taxpayer meets exactly

[9] Tax avoidance involves several uncertain numbers (e. g., number of deduction items claimed by the taxpayer). The overall success of tax avoidance is given by the sum of all realizations of these random variables. Applying the central limit theorem, we therefore model θ as a normally distributed random variable. However, in principle, it is possible to assume any continuous probability distribution that allows for a negative mean.

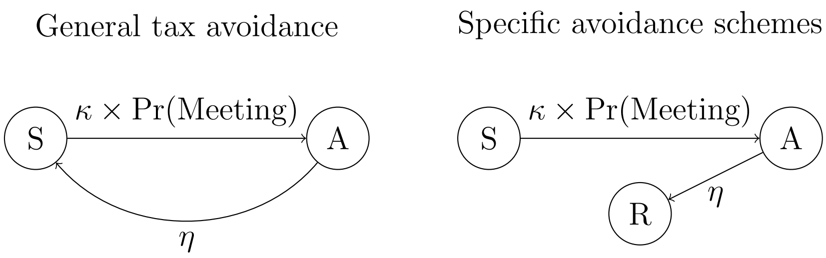

FIGURE 1: *Infection dynamics.*

one other taxpayer per time unit; that is, there are N meetings per time unit. The expected number of "infections" per time unit is thus $N\kappa$. Assume further that taxpayers who experience that tax avoidance did not pay off refrain from avoidance. Existence, prevalence and evolution of tax avoidance then depends on whether unfortunate tax avoiders refrain temporarily or permanently from avoidance. We suggest to distinguish between *tax avoidance in general* (e. g., hiring a tax consultant) or *specific tax avoidance schemes* (e. g., "tax trades" concerning gold or movable goods or cum ex schemes). We expect the duration of "immunity" to depend on the level of specificity of tax avoidance. If general tax avoidance does not pay off, taxpayers might try again later. However, if a specific avoidance scheme does not pay off (probably because it was ultimately rejected by a tax court), taxpayers are likely not to make the same "mistake" again.

3.1. General tax avoidance

As discussed above, we consider general tax avoidance not to convey immunity, meaning that taxpayers are likely to restart to avoid taxes, if they meet an avoiding taxpayer and get "infected" (Figure 1, left-hand side). In epidemiology, deseases that do not create immunity are described using the "susceptible-infected-susceptible" (SIS) model (e. g. Dodds/Watts 2005). Applied to our setting, the number of avoiding taxpayers in period

$t+1$ is then given by

$$A_{t+1} = A_t + N\kappa \frac{A_t}{N} \frac{N - A_t}{N} - \eta A_t. \tag{2}$$

The second term on the right-hand side of equation (2) represents the number of taxpayers who start avoiding in $t+1$, namely, the probability that an avoiding taxpayer meets and infects a non-avoiding taxpayer times the total number of taxpayers. The third term represents the number of unfortunate tax avoiders, who in the next period stop avoiding.

The continuous-time representation of (2) is given by

$$\frac{d}{dt} A(t) = N\kappa \frac{A(t)}{N} \frac{N - A(t)}{N} - \eta A(t). \tag{3}$$

The differential equation (3) has two fixed points $A(t) = 0$ and $A(t) = A^\star$, where

$$A^\star = N\left(1 - \frac{\eta}{\kappa}\right). \tag{4}$$

Intuitively, the fixed points characterize situations where the number of unfortunate avoiders that abstain from tax avoidance is equal to the number of taxpayers who get newly infected. Therefore, inflow to and outflow from the number of avoiders are identical, and, thus, the number of avoiders remains constant over time. To study the stability of the fixed points, consider

$$\frac{d}{dA(t)} \left(\frac{d}{dt} A(t)\right)\Bigg|_{A(t)=0} = -\frac{d}{dA(t)} \left(\frac{d}{dt} A(t)\right)\Bigg|_{A(t)=A^\star} = \kappa - \eta. \tag{5}$$

Regard first the stability of the fixed point $A(t) = 0$. Equation (5) is intuitive. Recall that κ denotes the probability that in an arbitrary meeting between two taxpayers, a before-honest taxpayer gets "infected" to avoid whereas η represents the probability that an individual taxpayer becomes honest again. If the probability κ is greater than the probability η, (5) becomes positive and hence a population state with no one avoiding is not stable and vice versa. In other words, if a single taxpayer is more likely to become honest than to start avoiding, the strategy "avoidance" becomes extinct. Note, that the derivative of the rate of change with respect to $A(t)$ at the interior solution $A^\star$ has the opposite sign. Hence, stability depends on the relation of κ and η. The system is either stable with no one optimizing or stable with $A^\star$ taxpayers avoiding, depending on the relation stated above. The set of stable fixed points, depending on parameters' values can be written as

$$\phi = \begin{cases} 0, & 0 \leq \kappa \leq \eta \\ A^\star, & \eta < \kappa \leq 1. \end{cases} \tag{6}$$

The intersection of the two fixed point curves, where the stability of the system switches from no one avoiding to a positive fraction of the population avoiding is called transcritical bifurcation (Dodds/Watts 2005). Figure 2 illustrates the fixed point curve depending on the tax rate τ. Increasing the tax rate reduces the probability that tax avoidance is unsuccesful (because avoidance gets relatively cheaper), i. e., η decreases. Therefore, it is easily visible from (4) that $A^\star$ in general increases with an increasing tax rate. As to the stability switch, consider first $\tau = 0$. As τ increases, at $\tau = \hat{\tau}$, where $\hat{\tau}$ is such that $F\left(\frac{c}{\hat{\tau}}\right) = \kappa$, the fixed point curve $A(t) = 0$ becomes unstable and the fixed point curve $A(t) = A^\star$ becomes stable. A similar stability switch occurs as the infection rate κ and the cost of tax avoidance c vary. We can conclude that $\eta < \kappa$ from the fact that tax avoidance can be observed empirically (e. g. Lang/Nöhrbaß/Stahl 1997; Cicero 2009).

Given this setting, some insightful statements can be made. The following corollary follows directly from (6):

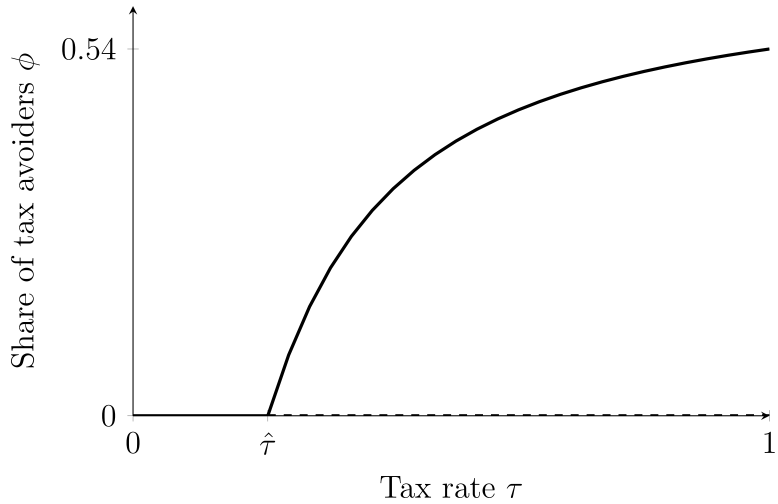

FIGURE 2: *Fixed points depending on tax rate for a population of taxpayers normalized to 1. Parameters are set to $c = 0.25, y = 1, \mu = 0.75, \kappa = 0.67, \sigma^2 = 1$. The solid line represents the stable fixed points, the dashed line indicates the unstable fixed points.*

Corollary 3.1 *The emergence of tax avoidance in a society does not require a positive expected outcome. A necessary condition for tax avoidance to occur despite a negative expected outcome is a probability of infection of at least 1/2. The necessary and sufficient condition is given by $\kappa \geq \frac{1}{2}\text{erfc}\left(\frac{\mu - \frac{c}{\tau}}{\sqrt{2\sigma^2}}\right)$, where $\text{erfc}(\cdot)$ is the complementary error function.*

If tax avoidance gives a negative expected return, the argument of the complementary error function is negative, in which case $\text{erfc}(\cdot)$ is greater than 1. Therefore, κ needs to be equal to or greater than $\frac{1}{2}$ (necessary condition). This result can be explained as follows: Even if the expected result is negative, there are always some taxpayers who are fortunate and gain anyway. These taxpayers then continue to infect others. If the infection rate is high enough, avoidance behavior persists. The strength of this effect is moderated by the variance, as detailed below. Corollary 3.1 also implies that from the fact that we can observe tax avoidance we cannot conclude that tax avoidance is beneficial for taxpayers.

The critical point where tax avoidance leads to an expected net benefit from avoidance of zero, that is, $\mu = \frac{c}{\tau}$, is of importance for the feasible domain on which tax avoidance can occur (i. e., the domain of $A^{\star}$), as well as for the prevalence of tax avoidance behavior (i. e., the level of $A^{\star}$).

Proposition 3.2 *If tax avoidance is not profitable ($\mu < \frac{c}{\tau}$), increasing the variance*

a) increases the set of combinations of avoidance cost c and tax rate τ that allows for tax avoidance to emerge (i. e., the domain of $A^{\star}$ increases);

b) increases the prevalence of tax avoidance (i. e., $A^{\star}$ increases),

and vice versa.

Proof $\hat{\tau}$ is defined such as to solve $\frac{1}{2}\text{erfc}\left(\frac{\mu - \frac{c}{\hat{\tau}}}{\sqrt{2\sigma^2}}\right) = \kappa$. $\hat{\tau}$ is a function of c, μ, and σ^2. The implicit derivative with respect to σ^2 yields $\frac{\partial \hat{\tau}}{\partial \sigma^2} = \frac{\hat{\tau}}{\sigma^2}\left(\frac{\mu\hat{\tau} - c}{c}\right)$, which is negative if tax avoidance is not profitable, and vice versa (Proposition 3.2.a). Regarding Proposition 3.2.b), we observe that the derivative of $A^{\star}$ with respect to σ^2 is positive if $c > \mu\tau$, i. e., if tax avoidance is not profitable (and vice versa):

$$\frac{\partial A^{\star}}{\partial \sigma^2} = \frac{N(c - \mu\tau)e^{-\frac{(\mu - \frac{c}{\tau})^2}{2\sigma^4}}}{\sqrt{2\pi}\kappa\sigma^4\tau}.$$

■

The economic intuition behind this result is as follows. If tax avoidance is *not profitable,* taxpayers will keep avoiding only if they are fortunate, i. e., if the realization of θ is in the upper tail of the distribution. The probability for this to happen increases with increasing variance. These fortunate taxpayers then continue to infect others. On the other hand, if tax avoidance is *profitable,* taxpayers will refrain from avoiding only if they are unfortunate, i. e., if the realization of θ is in the lower tail of the distribution. Again, the probability of this event increases with increasing variance, and, hence, there are fewer avoiders to spread the narrative.

The same reasoning applies to the domain of $W^\star$. If tax avoidance is not profitable, increasing variance lowers the critical ratio $\frac{c}{\tau}$ via increasing the number of taxpayers which avoid taxes successfully despite a negative expected value and which—in turn—infect others. Hence, with a higher variance, there are more combinations of c and τ that foster the emergence of tax avoidance.

This result is also important for empirical investigations on the effects of tax complexity on tax avoidance. If tax complexity is associated with an increase in tax uncertainty, higher complexity should be associated with less tax avoidance *if tax avoidance is profitable.* Hence, empirical studies that find a positive relationship between tax complexity (i. e. tax uncertainty) and tax avoidance (e. g. Borrego/Lopes/Ferreira 2016) could be explained by tax avoidance not being profitable in the underlying settings.

Proposition 3.3 *Increasing the expected tax savings* μ

a) increases the set of combinations of avoidance cost c *and tax rate* τ *that allows for tax avoidance to emerge (i. e., the domain of* $A^\star$ *increases);*

b) increases the prevalence of tax avoidance (i. e., $A^\star$ *increases),*

irrespective of whether initially, tax avoidance was profitable or not profitable.

Proof Implicitly deriving $\hat{\tau}$ with respect to μ provides $\frac{\partial \hat{\tau}}{\partial \mu} = -\frac{\hat{\tau}^2}{c} < 0$ (part a)). Deriving $A^\star$ with respect to μ gives $\frac{\partial A^\star}{\partial \mu} = \frac{N e^{-\frac{(\mu - \frac{c}{\tau})^2}{2\sigma^4}}}{\sqrt{2\pi}\kappa\sigma^2} > 0$ (part b)). ∎

Proposition 3.3 is not surprising. Obviously, increasing the distribution's mean increases the set of parameter constellations that make tax avoidance profitable. Furthermore, as the likelihood of unsuccessful tax avoidance decreases, its prevalence increases.

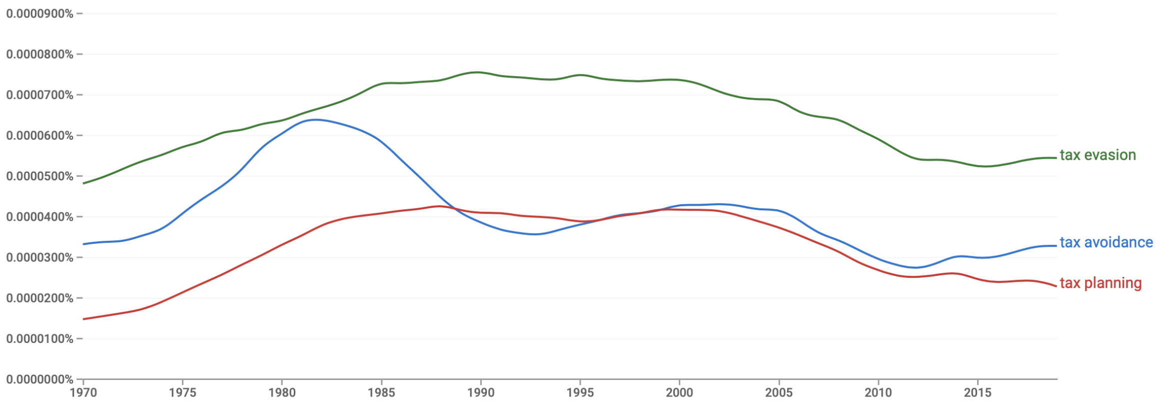

FIGURE 3: *Spread of general tax avoidance over time.*

Our model on general tax avoidance narratives implies that the prevalence of tax avoidance should be constant over time (given that parameters like tax rate, infection rate etc. remain constant). We observe the prevalence of general tax avoidance stories by counting the occurrence of n-grams relating to general tax avoidance in the corpus of google books over the time period 1970–2019. We search for the queries "tax avoidance", "tax planning", and "tax evasion" (Figure 3). It turns out that—while there is some variation (like a peak of "tax avoidance" around the 1980s)—the occurrence of these n-grams over time remains roughly at the same level.

To learn more about the spreading of tax narratives from n-grams we plan to exploit the set of bigrams established by Hassan et al. (2019) and Andreicovici et al. (2020).

3.2. Specific tax avoidance schemes

As above, we assume that taxpayers stop avoiding if avoidance was unsuccessful, which happens with probability η. The number of "recovered" taxpayers at time t is denoted by R_t. In contrast to the above section, we now study the case where the recovery is permanent, because a specific—disadvantageous—avoidance scheme will not be used again (Figure 1, right-hand side). Using continuous-time notation, the prevalence of tax avoidance over time is determined by the system[10]

$$\frac{d}{dt}S(t) = -N\kappa\frac{S(t)}{N}\frac{A(t)}{N} \tag{7}$$

$$\frac{d}{dt}A(t) = N\kappa\frac{S(t)}{N}\frac{A(t)}{N} - \eta A(t) \tag{8}$$

$$\frac{d}{dt}R(t) = \eta A(t). \tag{9}$$

The analysis of the SIR-model is well established in the epidemiology literature (see, e. g., Bailey 1975), however, we provide a short description of basic properties for readers not familiar with this model. The condition for an avoidance-scheme to go viral is

$$\left.\frac{d}{dt}A(t)\right|_{t=0} = \kappa S(0)\frac{A(0)}{N} - \eta A(0) > 0 \tag{10}$$

Starting with an (almost) fully susceptible population, $S(0) = N - 1$ and one creative tax avoider, $A(0) = 1$, the scheme starts to spread if $\kappa\left(1 - \frac{1}{N}\right) > \eta$. For large populations, we have approximately $\kappa > \eta$, which corresponds to the transcritical bifurcation in the SIS-model. I. e., whenever in an SIS-model we observe a positive (time-invariant) number of tax avoiders, in a SIR-model, an avoidance scheme would start spreading.

If a new tax avoidance scheme is invented, the number of recovered (immune) is zero. Therefore, all new tax avoidance schemes will spread iff $\kappa > \eta$.

As more taxpayers engage in the avoidance scheme and observe a negative net income from tax avoidance, the number of susceptibles decreases. Generally, for any given number of susceptibles at time t, the scheme continues to spread iff

$$\frac{\eta}{\kappa} < \frac{S(t)}{N}. \tag{11}$$

[10]This "susceptible-infected-removed model" was introduced by Kermack/McKendrick (1927).

If (almost) the whole population is susceptible, the right-hand side equals one, and we have $\eta < \kappa$ (c. f. above). However, with fewer susceptibles, the probability of failure needs to be smaller in relation to the transmission rate for the story to "keep going". At some point, for positive failure probability η, the number of susceptibles will have reached a value such that (11) is no longer satisfied. This directly leads to the following

Corollary 3.4 *All specific tax avoidance schemes that fail with a positive probability will vanish over time irrespective of whether their expected outcome is positive or negative.*

Given our assumption that the result of tax avoidance is normally distributed, corollary 3.4 can be specified as: *All specific tax avoidance schemes vanish eventually.*

The importance of a specific tax avoidance scheme in terms of government's tax revenue losses depends, among others, on the number of taxpayers employing it. Therefore, it can be helpful to know the maximum number of avoiders for a given scheme. If the initial number of tax avoiders and recovered taxpayers is zero ($S(0) = N, R(0) = 0$), and assuming that condition (11) is fulfilled (i. e., the scheme has the ability to go viral), this number is given by[11]

$$A_{\max} = N\left(1 - \frac{\eta}{\kappa} + \frac{\eta}{\kappa}\log\left(\frac{\eta}{\kappa}\right)\right). \tag{12}$$

E. g., given an infection probability of $\kappa = 0.8$ and a failure probability of $\eta = 0.4$, at its maximum, the scheme will be used by roughly 38 % of the population.

The model outlined above implies that—once a tax avoidance scheme is sufficiently viral, i.e., Condition 11 is fulfilled—the story at first spreads at an exponential rate; growth rate slows down afterwards, the spread of the story reaches a maximum and eventually declines (gray line in Figure 7).

[11] The derivation of the maximum number of infected is well known in the literature (see, e. g., Martcheva 2015, pp. 15 f.). For the interested reader, we provide a short proof in appendix A.

Tax avoidance scheme	Search query
Stripped bond tax avoidance schemes	stripped bond
Plan Green—car benefit scheme	car benefit tax
Gift Aid with no real gift	gift aid

TABLE 1: *Tax avoidance schemes.*

We observe the prevalence of a story by counting the occurrence of related n-grams in the corpus of google books during the time period 1970–2019. In particular, we regard selected tax avoidance schemes highlighted by the UK government (Table 1).[12]

Figures 4, 5, and 6 show the results. The graphs exhibit the characteristic shape expected from our model (Figure 7, gray line).

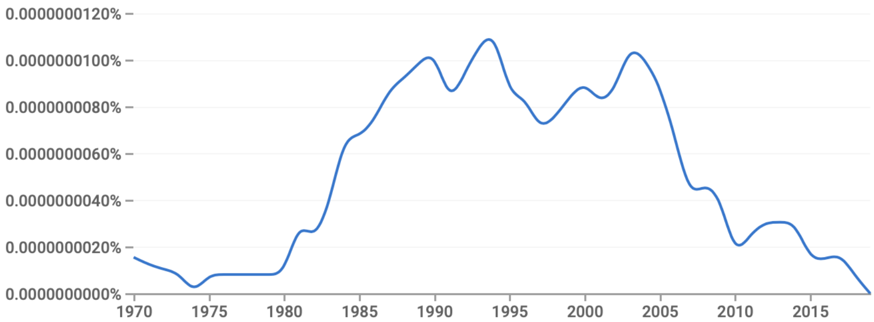

FIGURE 4: *Spread of Plan Green—car benefit scheme.*

3.3. Anti-Avoidance Narratives

While in the section above, we argue that at an individual level avoidance behavior vanishes (only) as a result of a negative outcome from tax avoidance, in reality, a secondary effect can be observed: The avoidance scheme itself creates a response. The manifestation of this response is twofold. First, as tax authorities and / or the government take counteractions by adjusting their set of anti-avoidence measure, i.e. the parameters μ and σ are changed, (possibly) reducing η. Second, probably more important, the

[12] See https://www.gov.uk/government/collections/tax-avoidance-schemes-currently-in-the-spotlight.

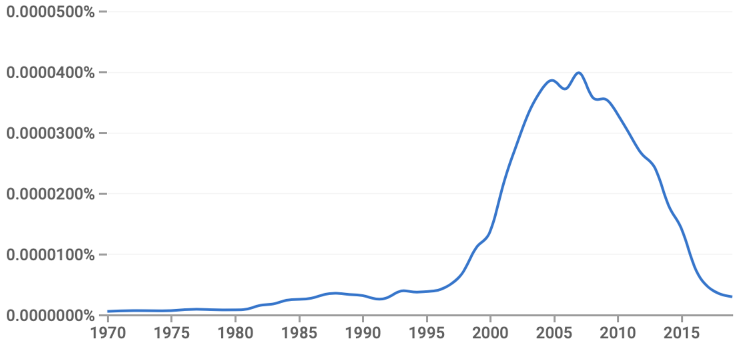

FIGURE 5: *Spread of Gift Aid with no real gift.*

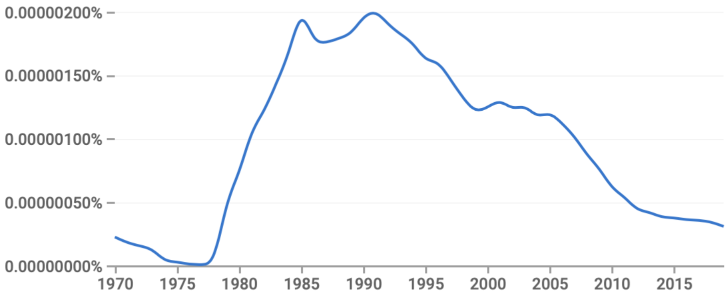

FIGURE 6: *Spread of Stripped bond tax avoidance schemes.*

narrative of said counteractions also spreads, creating fear and thereby instantaneously stopping those avoiders who catch the anti-narrative from using the respective avoidance scheme. E. g., both Switzerland and Liechtenstein are generally considered suitable destination countries for "hiding" money from the tax authorities, especially because of strong secrecy regulations. Starting 2006, German Tax Authorities bought several CDs containing data on German tax avoiders; the data was leaked by Liechtenstein and Swiss bankers. This approach triggered an intense discussion in public media, amongst others, questioning the legality of buying "stolen" data. Although the data obtained by the tax authorities was limited, self-disclosures increased dramatically (in Germany, tax-related self-disclosures are a permanent amnesty, providing exculpation from tax evasion and preventing criminal investigations). As a result, the Swiss- and Liechtenstein-related avoidance scheme was ended for many taxpayers—presumably affecting many more taxpayers than would actually have been threatened by criminal investigations due to leaked data.

In this section we want to account for this interdependence of avoidance-narrative and a respective "anti-avoidance narrative". In particular, we account for the fact that taxpayers stop avoiding if they either were unsuccessful (probability η), or, if they get infected with an anti-narrative (infection probability λ). However, as time passes, people forget again about the anti-narrative; this probability of forgetting is denoted by ρ.

In this setting, the number of tax avoiders changes over time according to

$$\frac{d}{dt}A = \kappa S \frac{A}{N} - \eta A - \lambda A \frac{C}{N} \tag{13}$$

(time dependencies are ignored for the sake of simplicity). As above, the first term characterizes the inflow from susceptibles, and the second term describes the number of unfortunate avoiders. The third term counts the number of tax avoiders that contract the anti-narrative (the number of carriers of the anti-narrative is denoted by C). The number of carriers of the anti-narrative changes according to

$$\frac{d}{dt}C = \lambda A \frac{C}{N} - \rho C. \tag{14}$$

The inflow to the number of carriers of the anti-narrative is characterized by the first term: avoiders get infected if they meet a carrier of the anti-narrative with probability λ. The share ρ forgets about the story, however. The number of susceptibles decreases as they catch either the narrative or the anti-narrative:

$$\frac{d}{dt}S = -\kappa S \frac{A}{N}. \tag{15}$$

Finally, the number of recovered evolves according to

$$\frac{d}{dt}R = \eta A + \rho C. \tag{16}$$

In this model we find that both narrative and anti-narrative initially increase exponentially, reach a maximum, and eventually diminish as low as zero (black lines in Figure 7). The spread of the anti-narrative (black dashed line), however, is time-shifted compared to the spreading of the narrative, as the number of carriers of the anti-narrative is fed from the number of avoiders. The figure illustrates, compared to the setting without an anti-narrative, under this set of assumptions the maximum number of avoiders is lower and the share of avoiders decreases faster. Anti-avoidance narratives therefore have a potential to limit harmful activities even in the absence of a governmental intervention. This result highlights the role of (social) media in the fight against harmful tax practices, but also depicts its limitations. Maximum awareness is expected to occur not until "some of the damage is done".

4. Summary

In this paper we model tax avoidance as an investment under uncertainty: Taxpayers have to incur costs (e. g., costs for searching for loopholes in the tax code, costs for tax lawyers, etc.) and receive an uncertain (normally distributed) tax benefit afterwards. In a next step, in a baseline setting, we account for social contagion effects of tax avoidance narratives. Taxpayers start avoiding taxes if they catch a story that encourages them to do so. They stop avoiding taxes, however, if they experience that avoidance was not profitable. We then distinguish two cases:

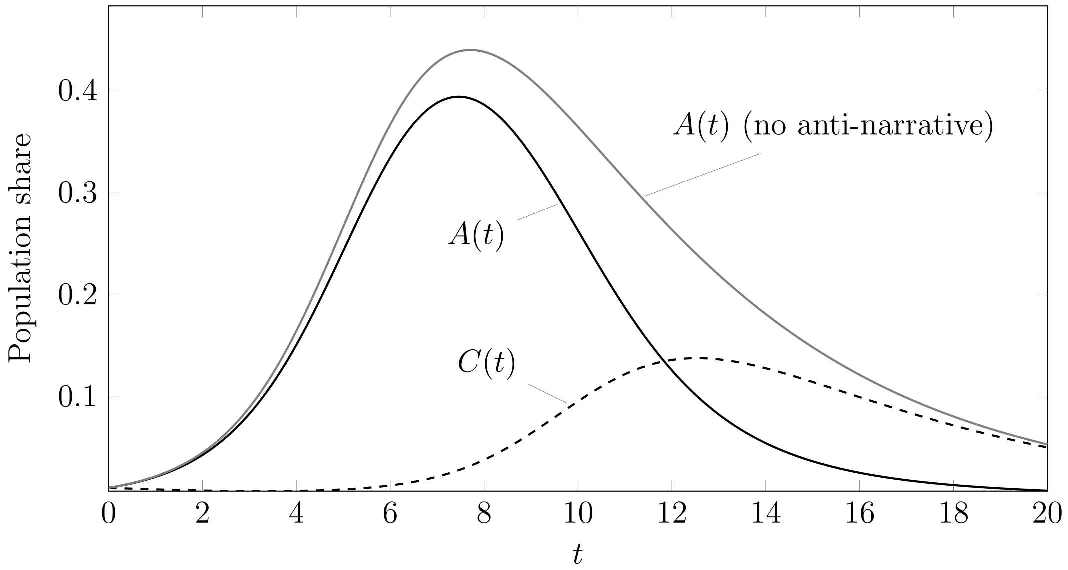

Figure 7: *Evolution of the population share of avoiders and carriers of the anti-narrative.*

First, we consider tax avoidance *in general* (e.g., by means of a tax consultant providing advice on overall tax avoidance strategies). In this case, we assume that taxpayers do not get "immune", that is, they are likely to contract tax avoidance again after an unfavorable outcome. We find that general tax avoidance can persist even if its expected outcome is negative. Furthermore, increasing uncertainty (i.e., making the outcome of tax avoidance less predictable), increases the prevalence of tax avoidance if the latter is *not* profitable (and vice versa). This is because, with increasing variance, positive outcomes of tax avoidance are more likely, giving rise to more overall tax avoidance activities.

Second, we consider specific tax avoidance schemes (e.g., cum ex, artificial leasing, etc.). Here, we stress that taxpayers *permanently* refrain from such a scheme if they experienced a negative outcome before. In contrast to general tax avoidance, we find that all specific tax avoidance schemes vanish eventually, even if they have a positive expected value. Studying the frequency of related n-grams in the corpus of google books over time we show that the spreading of both general tax avoidance and specific tax avoidance schemes over time evolves as predicted by our models.

Finally, we integrate an "anti-narrative" that is expected to additionally work towards persuading taxpayers to stop tax avoidance. We show that the spreading of such an anti-narrative can reduce both the maximum number of tax avoiders and the duration of a specific tax avoidance scheme.

Our contribution is to show how a narrative economics approach on tax avoidance combined with a simple model on tax uncertainty can explain that general tax avoidance persists, while specific avoidance schemes vanish eventually. We provide some evidence for our predictions by showing that the frequency of tax avoidance-related n-grams in the google books corpus over time evolves as predicted. Finally, we highlight the connection between avoidance narratives and respective anti-narratives.

The policy implications of our approach are twofold: First, concerning legal actions, the effect of increasing legal certainty crucially depends on whether the expected outcome of tax avoidance is positive or negative. The attempt to fight tax avoidance by increasing legal certainty can therefore backfire. Second, concerning communication, our results suggest that—while it is hard or impossible to stop the spreading of avoidance narratives—the spread of anti-narratives provides a promising instrument in fighting against undesired tax schemes. Spreading of anti-avoidance narratives should therefore be encouraged, e. g., by committing to whistleblower protection and by making tax authorities' activities more transparent. Visibly communicating narratives of enhanced tax enforcement is important to generate a deterrent effect: When arresting a celebrity tax evader, bring a camera team.

Appendix

A. Maximum number of tax avoiders in the SIR-model

From (7) and (8) one obtains $\frac{dA(t)}{dS(t)} = \frac{\eta N}{\kappa S(t)} - 1$. Applying separation of variables gives $\int dA(t) = \int \left(\frac{\eta N}{\kappa S(t)} - 1\right) dS(t) + C \iff A(t) + S(t) - \frac{\eta}{\kappa} N \log(S(t)) = C$, where C is a constant. $A(t)$ is maximized at $S(t) = \frac{\eta}{\kappa} N$. Given that the initial number of recovered taxpayers is zero, one obtains $C = A(0) - S(0) + \frac{\eta}{\kappa} N \log(S(0))$. Together with $A(0) + S(0) = N$ and $S(0) = N$, one obtains (12).

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