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The Occurrence of Tax Amnesties: Theory and Evidence

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Abstract

This paper presents a theoretical model and empirical evidence to explain the occurrence of tax amnesties. We treat amnesties as endogenous, resulting from a strategic game between many taxpayers discounting future payments from punishment and a government that trades off costs and benefits of amnesty programs. From the model we derive hypotheses about the factors that should influence the occurrence of tax amnesties. For our empirical test we rely on amnesty information from US States between 1981 and 2011. In line with the theoretical model, our empirical findings suggest that the likelihood of amnesties is mainly driven by a government's fiscal requirements and the taxpayers' expectations on future amnesties.

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1 Introduction

Many governments around the world, faced with mounting public deficits after the recent financial crisis, frequently initiated tax amnesties to meet their fiscal needs. Such programs give delinquent taxpayers the opportunity to repay all or parts of unpaid taxes without being subject to prosecution and penalties. However, not all of the amnesties raised considerable tax revenues. Short-term revenues depended crucially on whether a significant amount of taxpayers chose to take part in amnesties or not.

Standard tax-evasion theory predicts that a rational taxpayer should only take up amnesties if enforcement, penalty or tax parameters are varied with the amnesty in a way that provides extra incentives to take part (Alm and Beck 1991). In reality, however, we observe that people participate in amnesties even if post-amnesty enforcement and tax rates remain unchanged. Previous research used different approaches to explain this behavior.[1] Andreoni (1991), for instance, points to a consumption shock that hits the taxpayers between the initial declaration and the amnesty, making them unwilling to bear the risk of an audit. Malik and Schwab (1991) assume that taxpayers are initially unsure about their risk preferences and only learn them once an amnesty is offered, and Graetz and Wilde (1993) propose a model where taxpayers are motivated to accept amnesties because detection incurs fines also for non-filing in earlier periods.

This paper provides a novel mechanism to explain the amnesty take-up puzzle, emphasizing that tax cheaters become increasingly scared of detection and fines when the time of potential punishment approaches. Loosely speaking, taxpayers have different objectives at the time they decide on tax evasion and the time they try to avoid punishment. In our model, we assume that the benefits of tax evasion accrue immediately after tax declaration, while (discounted) fines and amnesty payments arise in a later period. Then, a taxpayer finds it worthwhile to delay tax payments by reporting less income initially and some more if an amnesty is announced. An additional novel feature of our model is that we treat amnesties as endogenous. The occurrence of an amnesty results from strategic interaction between many taxpayers and a government that balances benefits (i.e., additional revenues) and costs of amnesties (e.g., loss of reputation or decreasing re-election probability).

Analyzing the equilibrium properties of our model, we are able to figure out which factors are in theory influential to explain the occurrence of tax amnesties and how they shape the probability of amnesties taking place. It turns out that the likelihood of leniency programs is positively

[1] While research on this issue is generally scarce, there exists a broad literature on the fiscal implications of tax amnesties. Evidence from US states on the (short and long run) revenue impact of amnesties is provided by Mikesell (1986), Fisher, Gooderis and Young (1989), Alm and Beck (1991, 1993), Christian, Gupta and Young (2002), Luitel and Sobel (2007) or Mikesell and Ross (2012), among others; Uchitelle (1989), Cassone and Marchese (1995), Alm, Martinez-Vazques and Wallace (2000) or Lopez-Laborda and Rodrigo (2003) investigated amnesties outside the US.

affected by a government's fiscal requirements and the taxpayers' initial expectations on the likelihood of future amnesties. The impact of a country's tax rate is ambiguous. To test these predictions empirically, we use a panel of US state amnesties between 1981 and 2011. In line with our theoretical hypotheses, we find that public expenditure (tax revenues) enter significantly positive (negative) into our regressions. To account for potential short run budgetary shocks we also include the annual change in public debt, which exerts a significantly positive impact. Taken together, these findings indicate that governments tend to initiate amnesties in times of larger fiscal needs.[2] Further, and also in accordance with our model predictions, we observe an insignificant parameter estimate for a state's overall tax burden and a significantly positive impact on taxpayers' expectations on future amnesties (as measured by the number of amnesties that have been enacted in all other states one year ago). Intuitively, initial tax compliance and, hence, tax revenues would be lower if amnesties are anticipated by the taxpayers, which in turn reinforces the necessity of future amnesties. In other words, amnesties are somewhat self-fulfilling, mitigating the potential (long run) revenue success of amnesties. From a tax policy perspective we conclude that governments should be cautious when relying on this instrument only for budgetary reasons.

The remainder is organized as follows. Section 2 presents a game-theoretical model with many taxpayers and a government considering costs and benefits of tax amnesties. In Section 3, we conduct the comparative statics to derive model predictions on how the likelihood of amnesties varies with important model parameters. Section 4 provides some empirical evidence on central model predictions. Finally, Section 5 concludes.

2 The Model

We develop a simple model of taxpayer behavior if amnesties are possible. For the time being, we assume that tax amnesties are exogenous, random events. Later on, we introduce the government, leading to endogenous amnesty decisions.

[2] In this regard, we also contribute to a recent debate on the relationship between tax amnesties and a government's fiscal necessities. In particular, Dubin, Graetz and Wilde (1992), using amnesty data from US states between 1980 and 1988, found that states initiated amnesties mainly for revenue yield rather than fiscal stress motives. Luitel and Tosun (2013) shed doubt on this result showing that fiscal stress contributes to a major explanation for the occurrence of tax amnesties in US states, especially in the period 1989 to 2010 (see also Le Borgne 2006). In contrast to these studies, our primary goal is to explain the occurrence of amnesties theoretically, leading to an empirical specification where fiscal requirements are not only captured by the revenue (as in the aforementioned papers) but also the expenditure side of a government's budget. We come back to this issue in the empirical part of the paper.

2.1 Discounting Future Fines

To explain why a taxpayer participates in an amnesty even if enforcement parameters or tax rates remain unchanged, we require a model that result in a taxpayer delaying tax payments by reporting less income initially in order to declare some in addition if an amnesty takes place. The motive of delaying is closely tied to discounting. In our model future fines are discounted, while the benefit of evaded taxes accrues contemporaneously. In a classical sense, we could think of the taxpayer delaying tax payments anticipating an amnesty in order to realize some capital gains from the initially saved taxes. Then, the incentive to take part in an amnesty vanishes if the government's amnesty requires the taxpayer to repay taxes with interest at the market rate. Due to the small gains possible with typically low real interest rates, amnesty uptake caused by this is likely to be negligible. More interestingly, discounting is thought to capture a larger, psychological effect. Psychological research has shown that humans are, on average, somewhat over-optimistic, which helps motivate them and maintains their mental health (Taylor and Brown 1988). Moreover, in a neuroscience study Sharot et al. (2007) find that their subjects report significantly longer expected times passing before negative events happen than before positive events occur. This difference is the larger the more optimistic subjects are. Moreover, subjects experience future negative events with a weaker intensity of pre-experience than positive events. One can conclude that, as the future is open to interpretation, it is possible to distance oneself from future negative events. We model this psychological regularity by discounting future negative events, i.e., the payment of taxes after an amended tax return and fines from detected evasion.

There is also some evidence in criminology that a higher celerity of punishment reduces re-offending for white-collar crime (Simpson and Koper 1992). This means in our context that (i) the perceived time between crime and punishment matters for the evasion decisions, (ii) humans readily overestimate this time span, and (iii) humans underestimate the severity of future fines. All of these implications can be captured by discounting future fines.

In this light, we might interpret a low discount factor for fines representing a taxpayer who only partly takes into account the negative consequences of his evasion or imagines it to lie further away in the future than it actually does. At the time of the initial tax declaration, the taxpayer is in denial about potential bad consequences of evasion. Then, once an amnesty is announced, the potential fines become more salient and the taxpayer decides to reduce the risk. Our model captures this short-sighted denial by assuming a high discount rate.[3] Note that we assume sophisticated taxpayers who know about their psychological discounting and foresee that they will take part in an amnesty if it comes along.

[3]Similar behavior is quite often attributed to individuals having present-biased preferences. In our model, it is not necessary to introduce time-inconsistent agents. Impatience is sufficient.

2.2 Timing and Payoffs for a Taxpayer

The timing of our game is as follows

1. Nature determines income y.
2. The taxpayer learns y, declares income $d \in [0, y]$ and pays tax td, where t denotes the tax rate on income.
3. Nature (or later on the government) decides if there is an amnesty.
4. If there is an amnesty, then the taxpayer may declare additional income $a \in [0, y - d]$ and pays additional taxes ta.
5. Nature determines whether the true income is verifiable (with probability p). The taxpayer pays fines $F(y, d, a)$ if that happens.

For simplicity, we assume a linear tax system, which is certainly not very realistic but sufficient for our purpose. A progressive tax system, as applied in most countries around the world, would increase the incentives for evasion, without leading to any qualitatively different results. We assume that the taxpayer discounts the utility from two separate income streams. In the first period (consisting of the timing steps 0 and 1 from above), income is realized and the initial taxes, depending on the declaration, are paid. Fines and amnesty payments are made in period 2 (containing timing steps 2 to 4) if an amnesty takes place. Then, the taxpayers' ex ante expected utility (after the income is revealed) is given by

$$EU\,(d, a) =: U_1(y, d) + \delta EU_2(y, d, a, \phi), \tag{1}$$

where δ is the discount factor and ϕ denotes the (subjectively believed) probability of an amnesty taking place.

In the following, we assume the taxpayer to be risk-neutral and the marginal fine to be increasing in the concealed income, i.e.,[4]

$$F' > 0$$
$$F'' > 0.$$

Risk-neutrality is a simplifying assumption regularly used in the game-theoretical enforcement literature. Assuming an increasing marginal fine seems realistic. In many countries, tax evasion

[4]These assumptions convexify the problem and so interior equilibria become possible. For this purpose, alternative approaches (risk aversion and/or real resource costs of evasion) are also used in the literature.

of small amounts is treated as a minor offence, while the evasion of large sums is treated as a crime, which carries prison sentences and leads to criminal records.[5] Even if the legal fine schedule is not convex in the concealed income, we could interpret increasing marginal fines in our model as the sum of legal fines and psychological cost of fear, mimicking some notion of risk aversion. The main effects from our model can be reproduced with the more standard assumptions of risk-aversion and linear fine schedules. However, our assumptions on fines and risk preferences simplify the algebra considerably.

2.3 Behavior under Tax Amnesties

We start by analyzing a taxpayer's behavior. A taxpayer makes an initial income-tax declaration and later, in the case an amnesty is introduced, decides if and how to amend the tax declaration. After analyzing the taxpayer behavior we turn to the government's amnesty decision. Finally, we combine our findings and derive a Perfect Bayesian Nash Equilibrium for a game of many taxpayers and a government.

We begin with the amnesty stage in order to guarantee subgame perfection. A taxpayer with income y, who has previously declared income d, has the following objective function if an amnesty is announced

$$EU_a\left(a \mid \alpha = 1, y, d\right) \equiv p\left[-F\left(y - d - a\right) - ta\right] + \left(1 - p\right)\left(-ta\right), \tag{2}$$

where $\alpha \in \{0, 1\}$ is an indicator variable taking on the value of one if an amnesty has been announced. The optimal amnesty declaration a (for an interior solution) implicitly solves[6]

$$F'\left(y - d - a^*\right) = \frac{t}{p}, \tag{3}$$

which shows that the taxpayer equalizes the reduction of the expected marginal fine to the marginal amnesty payment. For later use we determine the effect of the initial tax declaration on the additional amount declared in the case of an amnesty by

$$\frac{da^*}{dd} = -\frac{\partial^2 EU_a / \partial d \partial a}{\partial^2 EU_a / \partial d^2} = -1. \tag{4}$$

Note that this property implies that initial declarations and additional declarations in case of an amnesty are perfect substitutes. A policy change before an initial declaration that leaves t, p and $F(\cdot)$ unchanged but increases the initial declaration by one Dollar reduces the additional

[5] In the United States, for example, major tax evasion carries prison sentences of up to five years.

[6] The second-order condition is globally satisfied, i.e., $-pF'' < 0$.

declaration in case of an amnesty by a Dollar. The total declaration in the case of an amnesty $d^* + a^*$ is constant as long as detection probability, tax rate and fine function remain unchanged.

2.4 The Decision to Declare Income

We now turn to the initial declaration decision d of the taxpayer. The taxpayer anticipates her own behavior in case of an amnesty and takes that into account when filing the initial tax return. The objective function is given by

$$EU[d, a^*(d)] \equiv y - td + \delta \left[\phi EU_a \left(d, a(d)\right) + (1-\phi)p(-F\left(y-d\right))\right],$$

where $EU_a \left[d, a^*(d)\right]$ is defined by equation (2) with a replaced by its equilibrium value $a^*(d)$. Taking the first-order condition and using the equilibrium change of the amnesty from (4) leads to the implicit definition of d^*

$$F'\left(y - d^*\right) = \frac{t(1-\delta\phi)}{p\delta(1-\phi)}. \tag{5}$$

Analyzing the effect of a change in the (subjectively believed) amnesty probability on the initial income declaration gives the following result.

Lemma 1 *For $\delta < 1$ at any interior solution*

$$\frac{dd^*}{d\phi} < 0$$

holds.

Proof. The reaction of the initial declaration due to a change of ϕ is given by

$$\begin{aligned}\frac{dd^*}{d\phi} &= -\frac{\partial^2 EU\left(d, a^*(d)\right)/\partial d\partial\phi}{\partial^2 EU\left(d, a^*(d)\right)/\partial d^2} \\ &= \frac{t - pF'\left(y-d\right)}{p(1-\phi)F''\left(y-d\right)}\end{aligned}$$

Using (5) this expression becomes

$$\frac{dd^*}{d\phi} = -\frac{t(1-\delta)}{p\delta(1-\phi)^2 F''\left(y-d\right)} < 0 \text{ for } \delta < 1.$$

■

A high suspected amnesty probability lowers the initially declared income and increases the revenue collected from an amnesty. A taxpayer is willing to engage in a more risky declaration

behavior the more likely it is that he can reduce the risk in an amnesty later. This highlights the importance of the beliefs the taxpayers hold on whether the government will call an amnesty or not. Note that for a high believed amnesty likelihood a taxpayer might not declare any income at all. This corner solution arises whenever

$$F'(y) \leq \frac{t(1-\delta\phi)}{p\delta(1-\phi)}.$$

Also note that a taxpayer who does not discount the future ($\delta = 1$) will not take part in an amnesty. To see this, observe that optimality in such a situation requires $F'(y-d) = F'(y-d-a) = t/p$, which only holds for $a = 0$.

Moreover, the model produces reasonable comparative statics for the initial declaration decision. From our assumption $F'' > 0$ and the first-order condition (5) it follows immediately that declared income decreases with the tax rate ($dd^*/dt < 0$). Similarly, it is easy to see that the declared income goes up with income ($dd^*/dy > 0$) and the detection probability ($dd^*/d\delta > 0$).

There are some other interesting implications that are worth mentioning. The model does not produce time-inconsistent behavior. A taxpayer makes the same declarations d and a in our game as a taxpayer would choose who had to commit to both choices ex ante. A taxpayer is taking up an amnesty if it comes along in order to trade off some lowered detection probability for gains from delaying tax payments and from the outset plans to do this.

Furthermore, it is obvious that the total declaration $a + d$ in case of an amnesty is constant and determined by the equalization of the expected marginal fine to the gain from successful evasion. The gap between the original declaration and the total declaration, which is the additional declaration in an amnesty, grows with the term[7]

$$\omega \equiv \frac{t}{p}\left[\frac{1-\delta}{\delta(1-\phi)}\right].$$

Recall that for a given fine function the total declaration after an amnesty $d^* + a^*$ only depends on t and p. Then, for given t and p we can see that the gap decreases with the patience of the taxpayer δ and increases with the believed probability ϕ that an amnesty takes place.

[7]To see this, note that a^* is determined by the first order condition (5), while $d^* + a^*$ is determined by (3). The assumption of fines increasing in evaded taxes, i.e., $F' > 0$, then allows this comparison, where ω is the difference between the marginal fines at $d^* + a^*$ and at d^*.

2.5 The Government and Many Taxpayers

Next, we endogenize the occurrence of an amnesty. For this, we require a government and many taxpayers. We assume that there is a population of taxpayers with measure one, which are heterogeneous with respect to their gross incomes. Denote the distribution of gross incomes as $q(y)$. The individual taxpayers are atomistic such that they do have a negligible individual impact on the government's revenue.

We now turn to the government. Suppose that the government has preferences over government spending G relative to some requirement ρ. Think of ρ as a variable that describes the state the economy is in. In a recession, the government might need lots of funds for welfare payments. In a state of credit shortage the government might need lots of funds to service existing debt at high interest rates. Major investments such as infrastructure projects or defence contracts could also lead to a high requirement ρ. In good times ρ might be low. Inflationary pressures could induce governments preferring tight fiscal policy and low budgets. Define $B(G, \rho)$ as the governments valuation of revenue G depending on the revenue requirement ρ. The function B is assumed to be continuous and twice differentiable with respect to G, and ρ additionally satisfies

$$\frac{\partial^2 B\left(G,\rho\right)}{\partial G^2} \leq 0, \tag{6}$$

$$\frac{\partial^2 B\left(G,\rho\right)}{\partial G \partial \rho} > 0. \tag{7}$$

Assumptions (6) and (7) put some structure on the marginal benefits of expenditure. The first assumption reflects decreasing marginal returns to government revenue. The more a government already collects the less desirable raising an additional Dollar becomes. Note that we do not put any restrictions on the sign of the marginal benefit of additional government revenue. We only require the marginal benefit to decrease in revenue. Consequently, our model allows for both governments that inherently try to increase the size of government and also for governments that dislike raising more than necessary. Assumption (7) reflects that a higher finance requirement makes an additional Dollar more valuable (or less harmful).

Denote the aggregate initial declaration of all taxpayers as D and the expected aggregate additional declaration in an amnesty as $\mathsf{E}A$. Then, the expected benefit for a government from announcing an amnesty is given by[8]

$$\mathsf{E}\Delta B \equiv B\left(t\left(D+\mathsf{E}A\right),\rho\right) - B\left(tD,\rho\right),$$

[8]Here, we assume that the government does not take into account fines that will be collected. There are two reasons for this assumption. First, fines will be collected in the future only, while our model is static. Second, this simplifies matters considerably, while most results still hold if fines are taken into account.

which might or might not be positive. Even if it is desirable from a budget point of view to announce an amnesty ($\mathsf{E}\Delta B > 0$), a government might still not want to issue one. Announcing an amnesty might upset some of the citizens, as it is typically seen as unfair by people who do not profit (or profit less than others) from it (e.g., Leonard and Zeckhauser 1987). Furthermore, a government that introduces amnesties might be seen as weak. This perception is the more detrimental to a government the more it relies on being seen as strong, tough on crime, and as the protector of law and order. Introducing an amnesty might reduce the chances of reelection. For this reason, governments potentially dislike amnesties, where the degree of dislike varies across governments. We model the varying dislike as a privately known cost of announcing an amnesty. A government has to bear cost $\theta \in [0, \bar{\theta}]$ if it announces an amnesty, where θ is drawn from a commonly known distribution with cumulative density $H(\theta)$. We assume that the highest possible disutility a government can have, $\bar{\theta}$, is greater than the maximum expected benefit such that there is always the chance that a government does not initiate an amnesty.[9] The actual realization of θ is private knowledge of the government. A government announces an amnesty whenever the benefit is greater than the cost. Using an indicator variable α, which takes on the value of one in case of an amnesty and zero else, we can define the optimal decision of a government after observing declaration D and expenditure requirement ρ as

$$\alpha^*(D, \rho) = \begin{cases} 1 & if \quad \mathsf{E}\Delta B \geq \theta \\ 0 & if \quad \mathsf{E}\Delta B < \theta \end{cases} . \tag{8}$$

2.6 Equilibrium

Having analyzed the behavior of individual taxpayers and the government we can derive an equilibrium. Suppose that the economy is populated by a continuum of taxpayers with measure one. Taxpayers may differ by their gross income. Denote the income distribution by $q(y)$, which is common knowledge. A taxpayer with income y declares $d^*(y, \phi)$ initially and $a^*(y, d^*(\phi))$ in addition to that if an amnesty is announced. The declarations $d^*(y, \phi)$ and $a^*(y, d^*(\phi))$ are determined by the Conditions (5) and (3) derived earlier, where ϕ again denotes the believed probability that an amnesty takes place.

Note the total declaration after an amnesty $d^* + a^*$ only depends on the tax rate, detection probability and the fine schedule. As these parameters and the income declaration are common knowledge, the government is able to anticipate the revenue after an amnesty. Once the government observes the initial declarations it can calculate the benefit when issuing a tax amnesty, which is ΔB. The government initiates an amnesty whenever this net benefit is positive, i.e., $\Delta B > \theta$. Let us establish some properties of the benefit function that will prove useful later on.

[9] This assumption is not crucial but simplifies the analysis.

Lemma 2 *The benefit function has the following properties*

$$\frac{\partial \Delta B}{\partial D} = -t \frac{\partial}{\partial G} B\left(tD, \rho\right) \tag{9}$$

$$\frac{\partial}{\partial G} B\left(tD, \rho\right) \leq 0 \rightarrow \Delta B \leq 0 \tag{10}$$

$$\frac{\partial \Delta B}{\partial \rho} \geq 0. \tag{11}$$

Proof. Recall that

$$\Delta B \equiv B\left(t\left(D + A\right), \rho\right) - B\left(tD, \rho\right),$$

where

$$D + A = \int q(y) \left(d^*(y, \phi) + a^*(y, d^*(\phi))\right) dy.$$

The FOC (5) gives an implicit definition of $d^* + a^*$, which is a function of y but not of ϕ. Consequently, $\partial\left(d^* + a^*\right)/\partial d = 0$, which implies $\partial\left(D + A\right)/\partial d = 0$. We obtain the first condition that claimes

$$\frac{\partial \Delta B}{\partial D} = -t \frac{\partial}{\partial G} B\left(tD, \rho\right).$$

The second condition follows directly from concavity of B in G. Concavity implies that $B'(G) \leq B'(G')$ if $G \leq G'$ and $B''(G) \leq 0$. Then, $\Delta B = B\left(t\left(D + A\right), \rho\right) - B\left(tD, \rho\right) \leq 0$ if $\partial B\left(tD, \rho\right)/\partial G \leq 0$, since $D + A \geq D$.

The derivative with respect to the budget requirement yields

$$\frac{\partial \Delta B}{\partial \rho} = \frac{\partial}{\partial \rho} B\left(t\left(D + A\right), \rho\right) - \frac{\partial}{\partial \rho} B\left(tD, \rho\right).$$

Assumption (7) implies that $\frac{\partial}{\partial \rho} B\left(G, \rho\right) \geq \frac{\partial}{\partial \rho} B\left(G', \rho\right)$ if $G \geq G'$. Then, the observation that $D + A \geq D$ is sufficient for the third property. ■

The first property implies that a reduction in the initial declaration raises the government's benefit from an amnesty in case the government prefers a larger budget than the one implied by the initial declaration. In other words, if the extent of tax evasion increases, an amnesty becomes more valuable for a government that is already short of funds. The second condition basically states that the benefit from an amnesty is always negative when the marginal benefit of an additional Dollar is negative at the initial revenue. The third property indicates that government benefits from an amnesty increase with the budget requirement.

We note that the amnesty decision is mainly driven by the initially declared aggregate income D and by the budget requirement ρ. The initial declaration decisions of the taxpayers are linked to the amnesty decision through the beliefs about the likelihood of an amnesty ϕ. In a Perfect

Bayesian Nash Equilibrium the beliefs have to be consistent with strategies, and players maximize their expected payoff given these beliefs. Two implications follow. First, all taxpayers must have identical beliefs. Second, beliefs have to be consistent with the government's amnesty decision rule as set out in (8). This requires (in a pure-strategy equilibrium) that the ex ante believed probability of an amnesty is identical to the interim belief after the taxpayers' initial declarations. Denote the interim believed probability of an amnesty taking place as μ, which is defined as

$$\mu\left(\Delta B(D)\right) = \begin{cases} H(\Delta B(D)) & if \quad \Delta B > 0 \\ 0 & if \quad \Delta B \leq 0 \end{cases}, \tag{12}$$

where H is the cumulative distribution function of the governments distaste for an amnesty.

Lemma 3 *The interim believed probability of an amnesty taking place is a continuous, non-increasing function of the initial aggregate declaration.*

Proof. The interim beliefs are obviously continuous as $\lim_{\Delta B \to 0+} H(\Delta B) = 0$. Observe that $\mu\left(\Delta B(D)\right)$ is non-increasing in D if $\Delta B > 0$, as $H' > 0$ and $\partial \Delta B / \partial D < 0$ for $\partial B\left(tD, \rho\right)/\partial G > 0$, which covers the region where $\Delta B > 0$ (condition two in Lemma 2). For the remaining domain, where D implies $\Delta B \leq 0$, we have $prob\{\alpha^* = 1|D) = 0$. ■

Now consider how the initial beliefs held by the taxpayers translate into an aggregate declaration:

$$D^*(\phi) = \int q(y) d^*(y, \phi) dy,$$

where $d^*(y, \phi)$ follows the first-order condition from equation (5). The aggregate declaration is obviously a non-increasing continuous function of commonly held initial beliefs. In what follows, we prove the existence of an equilibrium. For this, we use the Lemmata from above. We construct a function that in multiple steps maps an initial belief about an amnesty taking place into a probability that an amnesty actually takes place. In equilibrium, these two probabilities have to be equal. If the steps of constructing this mapping are derived using the individually optimal strategies and the mapping has a fixed point, then an equilibrium exists.

Lemma 4 *There exist at least one pair of declaration functions and beliefs $\langle d^*(y, \phi^*), \phi^* \rangle$ for all taxpayers and all admissible prior distributions $H(\theta)$ for the type of the government that satisfy the consistency requirements of a Perfect Bayesian Nash Equilibrium.*

Proof. This follows immediately from a simple fixed point argument. Consider the function

$$\mu = Z(\phi),$$

where

$$Z(\phi) = \mu\left(\Delta B\right) \circ \Delta B(D) \circ D^*(\phi).$$

The function $Z(\phi)$ gives the interim belief of an amnesty taking place if the initial declaration followed the ex ante belief ϕ under an optimal amnesty decision for the given initial declaration. We know from our analysis above that $Z(\phi)$ is a continuous (non-decreasing) mapping from $[0, 1]$ into itself, which has at least one fixed point (Brower's fixed-point theorem). In this fixed point, the ex ante beliefs are equal to the resulting interim beliefs $\mu = \phi$, which determines the equilibrium probability ϕ^* of an amnesty taking place. ■

Figure 1 illustrates such an equilibrium, where we have plotted $Z(\phi)$ and the 45-degree line. The intersection determines the equilibrium probability ϕ^* of an amnesty taking place. In the example, we use specific parameter values for the tax rate ($t = 0.3$), the detection probability ($p = 0.25$), the taxpayers discount factor ($\delta = 0.75$) and the governments revenue requirement ($\rho = 1$).[10] We get a unique equilibrium with a low probability of an amnesty taking place.

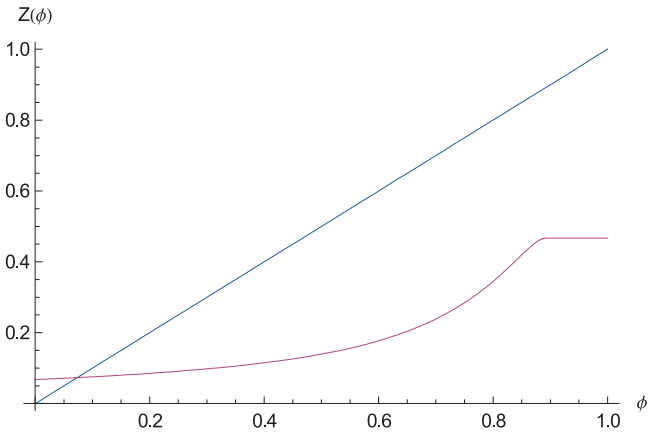

Figure 1: A unique equilibrium with a low probability of an amnesty occuring

Note that ϕ^* also determines the aggregate initial declaration D^* and the aggregate additional declaration A^* in an amnesty. The aggregate initial declaration drops with ϕ^*, while A^* increases by the same amount with ϕ^*.[11]

Although suggested by this example, uniqueness of equilibrium is not a general feature of the model. Multiple equilibria are possible, as shown in our second example. Increasing the government's revenue requirement – now we increase ρ to 1.8 – raises the likelihood of an amnesty in equilibrium and also produces two more equilibria where an amnesty is almost certain, and in

[10] The functional forms and distributions we use here and for all our examples are $F(x) = x^2$; $B(R, \rho) = -(R - \rho)^2$, $y \sim uniform$ on $[1, 2]$, $\theta \sim uniform$ on $[0, \bar{\theta}]$. The parameter $\bar{\theta}$ can be interpreted as a country-specific historical distaste of politicians for amnesties. Here, we use $\bar{\theta} = 1$.

[11] This follows from the analysis of the behavior of an individual taxpayer from above (see in particular equation (4) and Lemma 1).

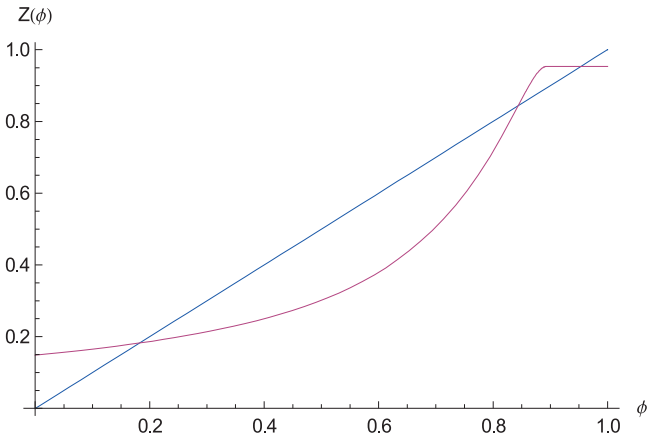

Figure 2: Multiple equilibria with two of them featuring tax revolts

some kind of tax revolt the initial declarations fall to almost zero.

In the following, we analyze how the parameters in the model influence equilibrium outcomes. Thereby, we consider the fact that our model can lead to multiple equilibria as virtue rather than as a defect of our model. With multiple equilibria, our model allows for other factors than the economic environment that influence how likely amnesties are and how much taxpayers evade. Equilibrium selection becomes a coordination problem among taxpayers if there are multiple equilibria. A high tax morale, for example, might lead to taxpayers coordinating on the low-evasion equilibrium where amnesties are rare, while a bad tax morale in an otherwise identical economic environment might act as a self-fulfilling prophecy of widespread evasion and likely amnesties. Instead of imposing further restrictions on payoff functions or the prior distribution of θ in order to ensure uniqueness, we use monotone comparative statics to gain further insights.[12]

3 Comparative Statics

3.1 Changes in the Model Parameters

In what follows, we establish some results on how the equilibrium probability of an amnesty changes with important model parameters. This also allows us to determine how the pre-amnesty revenue is influenced by changes in model parameters. As we have to deal with the possibility of multiple equilibria we use monotone comparative statics. In particular, we rely on a result from Milgrom and Roberts (1994). In their Corollary 1 (p. 446), they prove that the highest and lowest fixed point of a function $g(x,t) : [0,1] \times T \to [0,1]$, where T is a partially

[12]Another way of reducing the number of equilibria would be to add individual noisy signals on the type of the government. This would result in a global game with a unique equilibrium (see Morris and Shin 2002).

ordered set and $g(x,t)$ is continuous for all $t \in T$, increase (strictly) in t if $g(x,t)$ increases (strictly) in t for all $x \in [0,1]$. We can make use of this result as the function $Z(\phi; p, t, \delta, \rho)$ allows to show that at least one fixed point ϕ^* exists which satisfies the conditions necessary for this result. Figure 3 illustrates how the Milgrom-Roberts result is applied in our context. An upward shift of $Z(\phi)$ – here due to an increase in the budget requirement ρ – increases the highest and smallest fixed point. We start our comparative static analysis with the effect of the governments budget requirement.

For this purpose, we denote the amnesty probability in the highest and lowest fixed point as $\phi_h^*(\cdot)$ and $\phi_l^*(\cdot)$, respectively.

Proposition 5 *An increase in the budget requirement ρ (a) weakly increases $\phi_h^*(\cdot)$ and $\phi_l^*(\cdot)$ and (b) weakly decreases $D^*(\phi_h^*)$ and $D^*(\phi_l^*)$.*

Proof. Statement (a) requires

$$\frac{\partial Z(\phi, \rho)}{\partial \rho} \geq 0 \ \forall \phi \in [0,1],$$

which directly follows from the third property in Lemma 2, which is

$$\frac{\partial \Delta B}{\partial \rho} \geq 0$$

and the fact that $\mu(\Delta B)$ is non-decreasing in ΔB. Statement (b) requires $D^*(\phi) \leq D^*(\phi')$ if $\phi \geq \phi'$, or on an individual level

$$\frac{dd^*}{d\phi} \leq 0 \ \forall y,$$

which holds due to Lemma 1. ■

The intuition for the result above is quite simple. An increased budget requirement increases the government's benefit from an amnesty, whenever additional revenue increases the government's payoff. In the case where the government is satiated with revenue (even after ρ has increased) the benefit of an amnesty remains unchanged at zero. In the former case, taxpayers anticipate the greater benefit a government receives from an amnesty and therefore, ceteris paribus, the believed probability of an amnesty taking place goes up. This, in turn, makes evasion for the taxpayers more attractive. Taxpayers reduce their declarations, which again weakly increases the benefit of an amnesty for a government. This process converges to a new equilibrium with a higher probability of an amnesty taking place and lower aggregate declarations. The taxpayer's anticipation of an amnesty becoming more likely after an increased revenue requirement is self-reinforcing through the taxpayers reduction of initial income declared. In the latter case, where the government's benefit from an amnesty – even after an increased budget requirement – is still

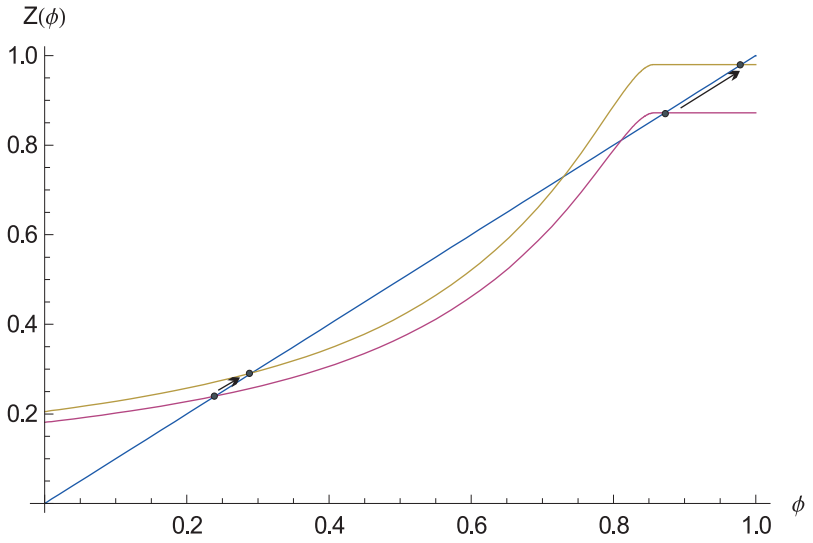

Figure 3: The highest and lowest fix points increase if ρ increases

zero, an increase of ρ has neither an impact on the equilibrium probability of an amnesty nor on the aggregate initial tax declaration.

There is a similar comparative static effect of changes in the prior distribution of the government's distaste for an amnesty. Suppose an exogenous event, like a change in voters attitudes towards amnesties, changes the prior distribution of government's distaste such that the new distribution $\hat{H}(\theta)$ first-order stochastically dominates the new distribution $H(\theta)$. Then, the highest and lowest equilibrium points (with respect to the probability of an amnesty taking place) weakly increase, and, by the same argument as above, the initial aggregate declaration weakly decreases as, ceteris paribus, from the viewpoint of a taxpayer an amnesty becomes more likely (whenever ΔB is greater than zero). This, in turn, induces lower initial declarations, further increasing the likelihood of an amnesty. Denoting the equilibrium probabilities of the highest and lowest equilibrium under $\hat{H}(\theta)$ as $\hat{\phi}_h^*$ and $\hat{\phi}_l^*$, we can state the following proposition.

Proposition 6 *For two cumulative density functions $H(\theta)$ and $\hat{H}(\theta)$, with $H(\theta) \leq \hat{H}(\theta) \forall \theta$, we have*

$$\hat{\phi}_h^*(\cdot) \geq \phi_h^*(\cdot), \;\; \hat{\phi}_l^*(\cdot) \geq \phi_l^*(\cdot) \tag{13}$$

$$D^*(\hat{\phi}_h^*) \leq D^*(\phi_h^*), \;\; D^*(\hat{\phi}_l^*) \leq D^*(\phi_l^*). \tag{14}$$

Proof. For (13) we have to show that $\hat{Z}(\phi) \geq Z(\phi)$, where $\hat{Z}(\phi)$ is the mapping of ϕ into itself under $\hat{H}(\theta)$, while $Z(\phi)$ is the original mapping under $H(\theta)$. This is the case if

$$\hat{\mu}\left(\Delta B\right) \circ \Delta B(D) \circ D^*(\phi) \geq \mu\left(\Delta B\right) \circ \Delta B(D) \circ D^*(\phi),$$

where $\hat{\mu}(\Delta B)$ and $\mu(\Delta B)$ are determined by equation (12) with $\hat{H}(\theta)$ and $H(\theta)$, respectively. From $H(\theta) \leq \hat{H}(\theta)$ it follows immediately that

$$\hat{\mu}(\Delta B) \geq \mu(\Delta B).$$

The earlier observation that $\Delta B(D) \circ D^*(\phi)$ is positive and increasing in ϕ establishes (13). Then, (14) again follows from Lemma 1. ■

The effect of an increase in δ is straightforward. Recall that an increase of δ can be interpreted as an increase of the taxpayers' awareness of a potential future fine when they make their initial declaration. Ceteris paribus, an increasing δ raises first period declarations, without influencing the total declaration after an amnesty, which in equilibrium reduces the probability of an amnesty in the highest and lowest equilibrium.

Proposition 7 *An increase in δ (a) weakly decreases $\phi_h^*(\cdot)$ and $\phi_l^*(\cdot)$ and (b) weakly increases $D^*(\phi_h^*)$ and $D^*(\phi_l^*)$.*

Proof. Statement (a) requires that

$$\frac{\partial Z(\phi, \delta)}{\partial \delta} \leq 0 \ \forall \phi \in [0, 1]. \tag{15}$$

Since

$$\frac{\partial \mu(\Delta B)}{\partial \Delta B} \begin{cases} > 0 & if \quad \Delta B > 0 \\ = 0 & if \quad \Delta B \leq 0 \end{cases}$$

and from Property 1 in Lemma 2

$$\frac{\partial \Delta B}{\partial D} < 0 \text{ for } \Delta B > 0,$$

condition (15) holds whenever

$$\frac{dD^*}{d\delta} \geq 0 \forall \phi \in [0, 1]$$

or at the individual level whenever $dd^*/d\delta \geq 0 \forall \phi \in [0, 1]$. That this condition holds can easily bees seen from the first-order condition (5), where the right hand side decreases with δ, which implies that d^* increases with δ. ■

The impact of a change in the tax rate is more complicated. Ceteris paribus, an increase in tax rates yields reduced first period declarations. However, tax revenues still might increase as the marginal revenue from initial declarations is given by $D^* + t \cdot dD^*/dt$. The same is true for tax receipts after an amnesty. Total tax declarations $D^* + A^*$ decrease, but the marginal post-amnesty revenue still might be positive. Suppose, the government is short of revenue initially

and tax rates are low. Hence, there is a high ex ante probability for an amnesty. Then, ascending tax rates typically increase initial revenues, which hints at a lower probability of an amnesty. However, as shown above, the gap between original and total declarations after an amnesty grows in t, ceteris paribus. Therefore, the additional revenue from an amnesty gets even larger, which works in favor of a higher amnesty probability. Ultimately, in the situation above, the change of the amnesty probability due to varying tax rates depends on the relative size of two effects. One the one hand, increasing tax rates enlarge the gap between revenues with and without an amnesty. This works in favor of a higher likelihood for an amnesty. On the other hand, the value of an amnesty from additional revenues decreases if initial revenues go up (which is a result of the curvature of $B(\cdot)$).

3.2 Summary of Theoretical Findings

Let us briefly summarize and evaluate our findings so far. We find that a forward-looking taxpayer, who discounts future taxes and fines, might take up an amnesty even if the enforcement parameters remain unchanged. In previous models, only an increased fine or detection probability made amnesties attractive to tax evaders. Our result is driven by the delay between the original tax payment and the payment of fines and taxes on additionally declared income in an amnesty, allowing the taxpayer to evaluate the consequences of evasion differently when first committed and when an amnesty arises. In this regard, we add a new explanation for the so-called amnesty take up puzzle. Our approach is somewhat related to Personal Equilibrium (Köszegi, 2010) in that our taxpayers have rational expectations in a game with themselves. Our results don't rely on time inconsistency though, which can occur in a Personal Equilibrium.

The main determinant of the initial income declaration is the taxpayers' believed probability of a tax amnesty taking place. The higher the believed probability the lower the initial declaration and the higher the planned additional declaration in a potential amnesty. Once we endogenize the probability of an amnesty by modeling the government, we see that a higher budget requirement increases the likelihood of an amnesty, which in turn reduces initially declared income and therefore reinforces the need of an amnesty.

The effect of a rise in the tax rate on the amnesty probability is ambiguous. On the one hand, a higher tax rate increases the evasion incentive and, therefore, the potential revenue from an amnesty. On the other hand, higher tax rates increase the initial revenue, which mitigates the pressure for a government to earn additional revenue by issuing an amnesty.

The model does not guarantee a unique equilibrium. The same model economy may admit equilibria with different likelihoods of amnesties and different levels of initial income declarations. This allows us to explain why similar economies might have different levels of evasion and

amnesty frequencies. Furthermore, as our example from above shows, the occurrence of a budget crisis might create new equilibria. In addition to a low-evasion equilibrium with a low likelihood of amnesties, high-evasion equilibria with near certain amnesties might arise when the budget requirement increases. Moreover, we have seen that expectations of an amnesty taking place can be self-fulfilling to a certain degree. To see this, recall that everything equal, an increase in the initial amnesty belief of the taxpayers increases evasion reducing initially declared incomes, which in turn makes amnesties more desirable for the government. In the case of multiple equilibria, the initial belief of taxpayers is decisive for the equilibrium actors to coordinate on.

4 Empirical Analysis

4.1 Specification and Estimation

To assess the main predictions of our theoretical model we use data on tax amnesties in US States between 1981 and 2011. The dependent variable is an indicator variable, A_{ij}, with entry one if state i enacts a tax amnesty at year j, and zero otherwise. Accordingly, the (conditional) equilibrium amnesty probability, ϕ_{ij}, is given by

$$\phi_{ij} \equiv P(A_{ij} = 1|\mathbf{x}_{ij}) = \Phi(\mathbf{x}'_{ij}\beta), \tag{16}$$

where $\Phi(\cdot)$ represents the cumulative distribution function (cdf), which is assumed to be standard normal in our case, i.e., we apply a probit model to estimate (16).[13] $\mathbf{x}_{ij}$ represents a vector of covariates, including our variables of interest and additional controls. Regarding the former, our theoretical model firstly suggests to include (i) government expenditures and (ii) a state's total revenues to measure the importance of budgetary requirements (both variables enter in logs). This constitutes a major difference to previous empirical research, only including the revenue side of public households.[14] Further, and in line with the existence of multiple equilibria in our model, one might suspect that fiscal requirements are even higher in times of unexpected

[13] Alternatively, we also applied the logistic cdf and estimate logit models. It turns out that the empirical results are insensitive to this choice, so that we decided to rely on probit estimates throughout. The corresponding results for the logit models are available upon request.

[14] Following Dubin, Graetz and Wilde (1992), most of the existing empirical studies focus on two motives behind the initiation of tax amnesties (see Le Borgne 2006 or Luitel and Tosun 2013). These are significant (short run) revenue gains (the "*yield*" motive), and to overcome periods where governments are short of funds (the "*fiscal stress*" motive). While the yield motive is captured by (income) tax revenues, the fiscal stress motive is accounted for by the state of an economy as measured by per capita income and employment rates. The latter variables enter as controls in our study. Rather, our theory suggests to interpret the fiscal stress hypothesis as the outcome of a subtle interplay between tax revenues and public expenditures, making it necessary to incorporate both of them in the empirical specification. For constant revenues an increase in the public expenditures raises a state's fiscal stress, and vice versa.

budgetary situations (e.g., the recent financial crisis). To capture this idea, we use (iii) a state's annual change in total debt in an alternative specification. From our theory we would expect a higher (lower) probability for an amnesties in states where government expenditures and debt changes (revenues) are relatively large, all else equal.

Second, the impact of the tax rate t on the amnesty probability is captured by a measure of the combined state and local tax burden (below, we provide details on how this burden is calculated). Third, our theory suggests that taxpayers would initially declare a lower income share if they expect an amnesty in the near future, which, in turn, makes it more attractive for a government to skim the accumulated undeclared tax base via an amnesty. We take account for this reasoning including information on amnesty episodes in other states (referred to as *amnesty cycle*) measured by the total number of amnesties in all states in the previous year, which should positively affect taxpayers' expectations on future tax amnesties.[15]

Apart from our variables of interest, we follow Dubin, Graetz and Wilde (1992) and include personal income per capita and the unemployment rate as further controls. For both variables, Dubin, Graetz and Wilde (1992) found a positive relationship with regard to the likelihood of tax amnesties, which has been recently questioned by Luitel (2013).[16] Further, we add information on a state's political and institutional environment, comprising (gubernatorial and presidential) election years and details on possible legal restrictions of policy-making (e.g., re-election limits for a governor in office or majorities needed to pass the budget and/or tax increases). However, most of these variables fail to be significant. Therefore, we rely on a parsimonious version of (16) incorporating only a dummy variable for presidential election years, which appears closest to be (weakly) significant.

Overall, we estimate six versions of (16). First, we distinguish between a specification including government expenditures and state revenues as the only budgetary variables, and one where the change in a state's total debt enters additionally. Second, as our dataset represents a panel (50 states between 1981 and 2011) we apply pooled as well as random effects probit models. For the latter, we follow Chamberlain (1980) who proposed to include all explanatory variables along with their means (see also Wooldridge 2010: pp. 615), except the mean of the time

[15] Alternatively, we also experimented with including information on a state's amnesty history in addition to the amnesty cycle. For this purpose, we define a dummy variable taking entry one if a state implemented no tax amnesty within the last two legislative terms (eight years) and the governor's party was in office for the same period, and zero else. We find that our main estimation results are not affected by this modification. Further, our amnesty history measure enters insignificantly in our regressions, indicating that amnesty expectations are mainly captured by the (contemporaneous) amnesty occurrence in US states. For these reasons and the fact that the amnesty history itself is endogenous, we decided to omit this variable in our preferred specification. The corresponding estimation results are available from the authors upon request.

[16] Among other concerns, Luitel (2013) argued that both variables should enter in logs rather than in levels (as in Dubin, Graetz and Wilde 1992). In our regressions presented below, we do not find any differences under these alternative specifications, so that we decided to report the coefficients of the level-based specifications only.

invariant presidential election dummy and the (only) year-specific amnesty cycle information. This approach allows to more explicitly exploit the time dimension of the data at hand by modelling unobserved state heterogeneity with the respective averages of the covariates. The final distinction relates to the class of pooled probit models. In particular, we treat the explanatory variables as either contemporaneous (*Model A*) or predetermined using first lags (*Model B*).[17]

4.2 Data and Descriptives

Table 1 provides an overview over tax amnesties in US States (including District of Columbia) between 1981 and 2011. The underlying data on amnesty periods, taxes covered and revenue collections are taken from the Federation of Tax Administrators (FTA, 2012) and Mikesell and Ross (2012). Before starting with a description of the data it is interesting to note that American tax administrations, in contrast to their European counterparts, did not make use of tax amnesties until the early 1980's. Since then, and following Illinois as the first state to conduct such a program in 1981, we observe a total of 116 amnesties. The new fiscal tool gained growing attractiveness as early as in the 1980's, as a total number of 30 programs was implemented in 27 states (including District of Columbia; Florida, Illinois and Louisiana already adopted repeated amnesties). This development was somewhat interrupted in the 1990's (including three years without any tax amnesties), but in the new century we can see an unprecedented increase in the amnesty pace. At the state level (reported in Table A1 in the Appendix), only five out of all states had no amnesty within the sample period (Alaska, Montana, Tennessee, Utah and Wyoming). Most of them conducted two or three amnesties, while four states (Arizona, Florida, Louisiana and New York) took extensive use of such programs (five times).

Table 1: Tax amnesties in US States between 1981 and 2011

	Number of amnesties	**Average duration**	**Revenue collections** (% of total)		
			Mean	Minimum	Maximum
1981 – 1989	33	88.0	0.310	0.001	1.170
1990 – 1999	18	74.9	0.346	0.010	1.394
2000 – 2011	65	76.3	0.317	0.022	1.474
Total	116	85.4	0.346	0.001	1.474

Notes: States without amnesties excluded (Alaska, Montana, Tennessee, Utah and Wyoming). Years without amnesties: 1991, 1993, 1994 and 2000.

[17]The presidential election dummy enters contemporaneously in Model B. For the amnesty cycle, we assume that a state's tax administration considers to conduct a tax amnesty in year j when observing a change in other states' amnesty frequencies at $j-1$. Therefore, we include the lagged values of this variable also in the contemporaneous Model A.

On average, an amnesty lasts for around 85 days and yields revenues of about 0.35 percent of total state revenues (the corresponding minimum and maximum values are 0.001 and around 1.5 percent, respectively).[18] However, and in contrast to the frequency of tax amnesties, we do not find substantial differences in revenue collections over the three decades.

Table 2 reports additional characteristics of our explanatory variables. Most of them are available until 2010. Hence, our final sample used for estimation exhibits 1,500 observations. Concerning a state's amnesty history, it is striking that we do not observe any amnesties within the last two legislative terms in about one quarter of all state-year combinations (in this case, the corresponding dummy variable takes a value of one). On average, there are 3.4 amnesties per year with a maximum value of 12, which belongs to 2009.

Table 2: Descriptive statistics

Variable	**Mean**	**SD**	**Min.**	**Max.**
Public expenditure (ln)	16.008	1.087	13.365	19.168
State revenues (ln)	16.031	1.071	13.441	19.097
Change in public debt	0.075	0.104	−0.391	0.844
Tax burden (%)	9.317	1.274	4.662	12.782
Amnesty cycle[a)]	3.400	3.159	0.000	12.000
Personal income per capita (Tsd. USD)	24.204	9.708	7.842	56.959
Unemployment rate	5.914	2.128	2.300	17.400
Presidential election dummy	0.233	0.423	0.000	1.000
Population (ln)	15.010	1.011	12.944	17.436
Sales tax rate (%)	4.500	1.822	0.000	8.250
Corporate income tax rate (%)	6.112	2.672	0.000	12.650
Personal income tax rate (%)	4.644	4.353	0.000	28.025

Notes: Panel is balanced including 1,500 observations (50 states and 30 years). [a)]Overall number of tax amnesties in all states in the previous year.

Our tax burden measure, defined as the fraction of the total amount of state and local taxes paid by state residents to a state's total income, is provided by the Tax Foundation for each state-year combination in the sample (downloadable at www.taxfoundation.org; see Prante 2008, Malm and Prante 2012, for technical details). It comprises a broad range of taxes such as (general and specific) sales taxes, property, death and gift taxes, personal and corporate income taxes and other charges (such as public utility and amusement licences or insurance premium taxes). Since tax amnesties usually cover more than one type of taxes (see Mikesell and Ross 2012, Luitel and Tosun 2013), we would prefer this comprehensive tax burden measure over specific

[18]Note that 14 amnesties started in one year and ended in the following. In our study, we follow Mikesell and Ross (2012: 533) assigning an amnesty and also its revenue collections to the year of initiation.

statutory tax rates. However, to ensure that our conclusions on the impact of a state's tax rate on the amnesty probability are not driven by the choice of this measure, we alternatively use statutory sales and (personal as well as corporate) income tax rates in our empirical analysis (the corresponding descriptives are reported in Table 2).[19] In qualitative terms, we do not find substantial differences between the various tax burden concepts. For this reason, and to facilitate an easier interpretation of our estimation results, we rely on the comprehensive tax burden measure in the subsequent analysis. On average, this burden is about 9.3 percent, lying within a range of 4.7 to 12.8 percent (see Table 2).

Regarding the other explanatory variables,[20] it is probably worth to mention that, on average, a US state changed its debt position by about 7.5 percent per annum (extreme values in the positive and negative range generally appear in the early 1980's).

4.3 Estimation Results

Table 3 summarizes our empirical results. The left-hand part of the table refers to the specification with only public expenditure and state revenue as budgetary variables, the right-hand one to a model where the change in public debt is included additionally. The explanatory variables enter contemporaneously in *Model A*, and are treated as predetermined in *Model B*.[21] Further, we report average marginal effects (AME) for all six specifications. For this purpose, we compute the average impact of partial or discrete changes over all observations, the corresponding standard errors are obtained using the delta method (for details see Bartus 2005).

First of all, Table 3 shows that our estimation results seem to be robust against various changes in the specification. Regarding the controls, we estimate positive AMEs for personal income per capita and the unemployment rate, but they turn out to be significant only in Models A of the pooled probit models and insignificant in the other specifications. This finding is broadly consistent with Dubin, Graetz and Wilde (1992) as they find that increases in the unemployment

[19] Up to 2001, statutory tax rates are available from Word Tax Database at the University of Michigan (www.bus.umich.edu/otpr/otpr/default.asp). More recent data are downloadable from the website of the FTA (www.taxadmin.org).

[20] Data on state public expenditure, revenues and debt is downloadable from US Bureau of the Census, Government Division (www.census.gov). Information on a state's population, personal income and unemployment rate is taken from the webpage of the Bureau of Economic Analysis (www.census.gov). Data on political variables such as election years and government composition are collected by Klarner (2012a,b).

[21] In the models with contemporaneous explanatory variables (columns 1 and 4), we have a sample size of 1,500 observations (50 states over the years 1981 to 2010). In the models with predetermined variables, we also rely on the year 1980 to avoid a loss of observations. Using lagged values, we obtain an entry for 2011 there, gaining one additional cross-sectional unit. This results in 1,550 observations in columns 2 and 3 of the table (notice that the Chamberlain-type random effects models are based on Models B of the pooled probit models, i.e., all *predetermined* variables enter along with their means except for the presidential election dummy which is available from 1980 to 2011). Further, it should be noted that we loose one cross-sectional unit at the end of the sample period when using the change in debt, explaining the 1,500 observations in columns 5 and 6.

rate and per capita income increase the likelihood of an amnesty taking place (see also Luitel and Tosun 2013, for similar results). Further, the presidential election dummy enters negatively, but is insignificant in all models.[22]

With regard to our variables of interest, we find a positive relationship between public expenditure and the amnesty probability, which is significant throughout. An AME of around 0.25 indicates that a one percent increase in public expenditures raises the probability of an amnesty by 0.25 percent (for illustration, such an expenditure change would increase the ratio of public expenditures to the gross state product by about 1.2 percentage points; the mean of this share amounts to approximately 11.9 percent). In a similar vein, surging state revenues are associated with a decrease in the amnesty probability. Taken together, these findings seem to confirm our theory suggesting that growing revenue requirements (implying higher expenditures and/or lower revenues) should raise the benefits of an amnesty and, therefore, the probability of its implementation. This conclusion still holds when incorporating the change in public debt as additional explanatory variable (last three columns of Table 3). In accordance with Le Borgne (2006), we find significantly positive coefficients on this variable in all models. An AME of around 0.15 suggests that a one percent variation in public debt fosters a change of the amnesty probability by 0.15 percent. The AMEs of public expenditure and state revenue are slightly lower now, but still exert the original signs and also remain statistically significant.

Next, we find a positive impact of our tax burden measure, which is only weakly significant in Model *A*. Again, this is in line with our theoretical hypothesis, suggesting an ambiguous role of a change in the tax rate on the amnesty probability. To make sure that this finding is not driven by the choice of our tax burden variable, we re-estimate (16) including statutory sales, personal income and corporate income tax rates instead of the tax burden measure from Tax Foundation. We do not estimate any significant effects for one of the three tax rates (the corresponding results are not reported in Table 3, but are available from the authors upon request), indicating that our results concerning the role of the tax rate on amnesty probabilities is insensitive to the choice of the tax burden concept.

Finally, we observe a highly significant and positive impact of the amnesty cycle, as expected. Accordingly, one additional amnesty in other states one year ago raises a state's amnesty probability by 0.007 percent. This let us conclude that expectations on tax amnesties (based on observing the amnesty behavior of other states) are decisive to explain their probability of occurrence. Accordingly, this newly highlighted channel for explaining the amnesty take up puzzle

[22] As indicated above, we also insert a bunch of variables representing a state's institutional environment, but they were rejected at any reasonable significance level. In a similar vein, Luitel and Tosun (2013) use a gubernatorial election dummy and an indicator variable on whether a state is controlled by the Democrats to explain amnesty durations, but they fail do find any significant effects. In our case, only the presidential election dummy comes close to weak significance, so that we only rely on the parsimonious model reported in Table 3.

Table 3: Estimation results (average marginal effects)

	Pooled Probit		**RE Probit**	**Pooled Probit**		**RE Probit**
Variable	Model A	Model B		Model A	Model B	
Public expenditure (ln)	0.239**	0.268**	0.270**	0.210**	0.237**	0.254**
	(0.108)	(0.112)	(0.125)	(0.105)	(0.109)	(0.122)
State revenues (ln)	−0.235**	−0.260**	−0.308**	−0.206*	−0.231**	−0.295**
	(0.109)	(0.113)	(0.133)	(0.106)	(0.110)	(0.131)
Change in public debt				0.153***	0.172***	0.143**
				(0.055)	(0.057)	(0.059)
Tax burden	0.009*	0.007	0.0003	0.009*	0.008	0.004
	(0.005)	(0.005)	(0.016)	(0.005)	(0.005)	(0.016)
Amnesty cycle	0.007***	0.005***	0.006***	0.006***	0.005***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Personal income per capita	0.001	0.001	0.003	0.002**	0.001	0.004
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Unemployment rate	0.009***	0.003	0.002	0.009***	0.003	0.001
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
Presidential election dummy	−0.011	−0.015	−0.015	−0.013	−0.015	−0.015
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Pseudo-R^2	0.064	0.050	0.084	0.072	0.056	0.105
Number of observations	1,500	1,550	1,550	1,500	1,500	1,500

Notes: See also notes to Table 2. Constant not reported. *, ** and *** ... Significant at 10%-, 5%- and 1%-level. Dependent variable is an indicator variable with entry one if a state issued an amnesty in year j, and zero else. **Model A:** All variables except amnesty cycle are measured contemporaneously. **Model B:** All variables except the presidential election dummy are lagged once. **RE model:** Controls of pooled models plus Mundlak-type means (except presidential election dummy) (Chamberlain 1980).

is supported by the data for US state amnesties.

5 Conclusion

This paper is motivated by the observation that rational taxpayers participate in tax amnesties even if they are not coupled with efforts at improving compliance and enforcement. To solve this behavioral puzzle, we present a model with endogenous amnesties where the government interacts strategically with many taxpayers. The latter are assumed to maximize the expected utility of an intertemporal income stream, where future payments of fines and taxes are discounted differently than income gains from evaded taxes in the first period. Governments balance benefits (additional revenues) and costs (e.g., loss of reputation or decreasing re-election probability) when deciding to initiate amnesties. Our model does not guarantee a unique equilibrium, which helps to explain why similar economies might be differently affected by tax evasion and, therefore, exhibit deviating amnesty likelihoods. It might also explain why amnesties are observed to be initiated in waves (e.g., after the recent financial crisis).

Investigating the equilibrium properties of our model, we are able to derive hypotheses about which factors are important to explain the occurrence of tax amnesties. We find that the amnesty probability is clearly influenced by a government's fiscal requirements and also the taxpayers' expectation on future amnesties. Regarding tax rates, our model predicts an ambiguous impact on the likelihood of an amnesty. To test these predictions empirically, we rely on a dataset of US amnesties between 1981 (i.e., the year where an amnesty was enacted for the first time in the US) and 2011. In accordance with our theoretical predictions, our empirical findings indicate that the probability of an amnesty is positively associated with a taxpayer's initial expectations on future amnesties and a state's budgetary requirements. The latter might be interpreted as supportive evidence for the fiscal stress hypothesis. The tax burden of an economy enters insignificantly, which is also in line with our model.

From a policy perspective, we would like to highlight our findings regarding anticipation effects of amnesties. The corresponding theoretical and empirical results indicate that amnesties are self-fulfilling in the sense that initial compliance even get worse if taxpayers believe that amnesties are coming along soon. This reduces initial tax revenues, and in turn reinforces the government's desire to enact future amnesties. Therefore, the long run revenue success of such programs might be modest, which should be a warning for fiscal authorities experiencing with amnesties to obtain quick windfall revenue gains.

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Table A. 1: Tax amnesties in US States between 1981 and 2011

State	**Number of amnesties**	**Average duration**	**Revenue collections** (% of total)		
			Mean	Minimum	Maximum
Alabama	2	87.5	0.049	0.038	0.059
Arizona	5	94.6	0.174	0.063	0.302
Arkansas	3	199.3	0.041	0.030	0.052
California	2	76.5	0.440	0.393	0.487
Colorado	3	44.7	0.141	0.129	0.153
Connecticut	4	81.8	0.477	0.190	0.709
Delaware	1	59.0	0.328	0.328	0.328
District of Columbia[a)]	3	67.3	0.570	0.420	0.721
Florida	5	162.4	0.171	0.050	0.540
Georgia	1	65.0	0.414	0.414	0.414
Hawaii	1	30.0	0.153	0.153	0.153
Idaho	1	102.0	0.028	0.028	0.028
Illinois	4	39.0	0.855	0.001	1.303
Indiana	1	61.0	1.008	1.008	1.008
Iowa	2	58.0	0.497	0.200	0.793
Kansas	3	65.0	0.113	0.020	0.246
Kentucky	2	37.5	0.799	0.633	0.965
Louisiana	5	75.2	0.435	0.004	1.116
Maine	4	82.5	0.483	0.098	1.018
Maryland	3	60.7	0.235	0.088	0.411
Massachusetts	4	67.8	0.404	0.077	1.001
Michigan	3	47.0	0.431	0.201	0.661
Minnesota	1	91.0	0.155	0.155	0.155
Mississippi	2	105.5	0.046	0.028	0.065
Missouri	3	80.3	0.185	0.019	0.410
Nebraska	1	91.0	0.102	0.102	0.102
Nevada	3	130.3	0.230	0.118	0.287
New Hampshire	2	77.0	0.410	0.338	0.483
New Jersey	4	95.8	1.203	0.817	1.474
New Mexico	3	107.3	0.377	0.071	0.628
New York	5	81.8	0.479	0.036	1.072
North Carolina	1	91.0	0.325	0.325	0.325
North Dakota	2	106.0	0.120	0.013	0.227
Ohio	2	68.5	0.089	0.058	0.121
Oklahoma	3	111.7	0.359	0.304	0.459
Oregon	1	49.0	0.186	0.186	0.186
Pennsylvania	2	71.0	0.346	0.284	0.409
Rhode Island	3	187.7	0.126	0.036	0.236
South Carolina	2	69.0	0.107	0.049	0.165
South Dakota	1	44.0	0.023	0.023	0.023
Texas	3	36.3	0.213	0.002	0.530
Vermont	2	41.5	0.046	0.022	0.070
Virginia	3	59.7	0.317	0.277	0.384
Washington	1[b)]	76.0			
West Virginia	2	75.5	0.312	0.123	0.502
Wisconsin	2	64.0	0.248	0.170	0.326
Total	*116*	*84.2*	*0.346*	*0.001*	*1.474*

Notes: States without amnesties not reported (Alaska, Montana, Tennessee, Utah and Wyoming). [a)]District of Columbia is excluded in the subsequent empirical analysis as we do not obtain the entire set of explanatory variable for this jurisdiction. [b)]Amnesty in 2011, no revenue information available.

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